Application Checklist

Instructions:

1. Please check each box below, as appropriate; and
2. The completed checklist *must* be submitted as the first page of the CON application.

☒ Attached is the CON application filing fee in the form of a certified, cashier or business check made out to the "Treasurer State of Connecticut" in the amount of $500.

For OHCA Use Only:

Docket No.: 13-31845-CON Check No.: 1340000325
OHCA Verified by: KR Date: 6/18/13

☒ Attached is evidence demonstrating that public notice has been published in a suitable newspaper that relates to the location of the proposal, 3 days in a row, at least 20 days prior to the submission of the CON application to OHCA. (*OHCA requests that the Applicant fax a courtesy copy to OHCA (860) 418-7053, at the time of the publication)*

☒ Attached is a paginated hard copy of the CON application including a completed affidavit, signed and notarized by the appropriate individuals.

☒ Attached are completed Financial Attachments I and II.

☒ Submission includes one (1) original and four (4) hard copies with each set placed in 3-ring binders.

Note: A CON application may be filed with OHCA electronically through email, if the total number of pages submitted is 50 pages or less. In this case, the CON Application must be emailed to ohca@ct.gov.

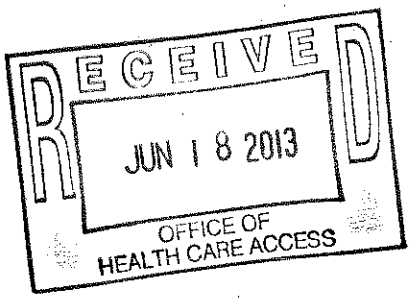
Important: For CON applications(less than 50 pages) filed electronically through email, the singed affidavit and the check in the amount of $500 must be delivered to OHCA in hardcopy.

☒ The following have been submitted on a CD

1. A scanned copy of each submission in its entirety, including all attachments in Adobe (.pdf) format.
2. An electronic copy of the documents in MS Word and MS Excel as appropriate.

YALE NEW HAVEN HEALTH

June 17, 2013



Ms. Kimberly Martone
Director of Operations
Office of Health Care Access
410 Capitol Avenue
MS #13HCA
P.O. Box 340308
Hartford, CT 06106

Re: Yale-New Haven Hospital (YNHH)
Certificate of Need Application
Acquisition of Two SPECT-CT Cameras

Dear Ms. Martone:

As requested, enclosed please find the original, four hard copies in 3-ring binders, and an electronic copy on CD of YNHH's Certificate of Need (CON) application for the acquisition of two (2) SPECT-CT cameras to replace one (1) SPECT camera in the Nuclear Medicine Department and two (2) gammas cameras in the Nuclear Cardiology Department. Also enclosed is a check with the filing fee of $500.00.

Please do not hesitate to contact me with any questions or concerns.

Thank you for your time and support of this project.

Sincerely,

Nancy Rosenthal
Senior Vice President – Health Systems Development

Enclosures

Yale-New Haven Hospital's

Acquisition of Two SPECT/CT Cameras to Replace a SPECT Camera in Nuclear Medicine and Two Gamma Cameras in Nuclear Cardiology

Certificate of Need Application

June 17, 2013

YALE-NEW HAVEN HOSPITAL

ACQUISITION OF TWO SPECT/CT CAMERAS TO REPLACE A SPECT CAMERA IN NUCLEAR MEDICINE AND TWO GAMMA CAMERAS IN NUCLEAR CARDIOLOGY

CERTIFICATE OF NEED APPLICATION

TABLE OF CONTENTS

CON PUBLIC NOTICE

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Angelo.llanezza@gmail.com

LEGALS

PUBLIC NOTICE

Pursuant to section 19a-638 of Connecticut General Statutes, Yale-New Haven Hospital will submit the following Certificate of Need application:

Applicant(s): Yale-New Haven Hospital

Address: 20 York Street

Town: New Haven

Proposal: Acquisition of two SPECT-CT cameras to replace a SPECT camera in Nuclear Medicine and two gamma cameras in Nuclear Cardiology

Estimated Total Project Cost/Expenditure: $1,880,443

STATE OF CONNECTICUT
RETURN DATE: APRIL 9, 2013 : SUPERIOR COURT
PILGRIM'S HARBOR OWNERS ASSOCIATION, INC. : JUDICIAL DISTRICT OF NEW HAVEN
VS. AT NEW HAVEN
THE HEIRS, BENEFICIARIES OR NEXT OF KIN OF JOSEPH V. PISON; DEBRA KACZYNSKI; VICKI PINTO; GAIL MONTANY; THE BANK OF NEW YORK MELLON FKA THE BANK OF NEW YORK AS TRUSTEE FOR THE CERTIFICATEHOLDERS OF THE CWABS, INC., ASSET-BACKED CERTIFICATES, SERIES 2005-2; WEBSTER BANK, N.A.; and STATE OF CONNECTICUT DEPARTMENT OF REVENUE SERVICE, INHERITANCE TAX DIVISION : FEBRUARY 15, 2013

NOTICE TO: THE HEIRS, BENEFICIARIES OR NEXT OF KIN OF JOSEPH V. PISON, FORMERLY OF 25B PILGRIMS HARBOR, OF PILGRIM'S HARBOR CONDOMINIUM, WALLINGFORD, CONNECTICUT, GAIL MONTANY, NOW OR FORMERLY OF ASPEN, COLORADO NOW OF PARTS UNKNOWN, AND ALL UNKNOWN PERSONS, CLAIMING OR WHO MAY CLAIM ANY RIGHTS, TITLE, INTEREST OR ESTATE IN OR LIEN OR ENCUMBRANCE UPON THE REAL PROPERTY DESCRIBED IN THIS COMPLAINT, ADVERSE TO THE PLAINTIFF, WHETHER SUCH CLAIM OR POSSIBLE CLAIM BE VESTED OR CONTINGENT.

The Plaintiff has named the heirs, beneficiaries or next of kin of Joseph V. Pison, as parties defendant in the complaint which it is bringing to the above-named court seeking a foreclosure of its condominium common charge lien upon premises known as 25B Pilgrim's Harbor, Pilgrim's Harbor Condominium, Wallingford, Connecticut. This complaint is returnable to court on April 9, 2013, and will be pending therein after that date.

The Plaintiff has represented to said Court, by means of an affidavit annexed to the said complaint, that Joseph V. Pison died on or about August 8, 2012, and that despite all reasonable efforts to ascertain such information, it has been unable to determine the identities or whereabouts of the Defendant's heirs, beneficiaries or next of kin; and that despite all reasonable efforts to ascertain such information, it has been unable to determine the residence of the said Gail Montany, now or formerly of Aspen Colorado, now of parts unknown, if living, or the identity or residence of her widower, heirs, representatives and creditors, if not living.

Now, therefore, it is hereby ORDERED that notice of the institution of this action be given to each such defendant by some proper officer causing a true and attested copy of this Order to be published in the New Haven Register, once a week for two weeks commencing on or before March 20, 2013, and in the Aspen Times once a week for two (2) weeks commencing on or before March 20, 2013, and that return of service be made to the court.

Michael Maronich
Judge, Superior Court

Dated: February 21, 2013

---

600 EMPLOYMENT & INSTRUCTION

605 INSTRUCTIONS

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645 GENERAL HELP WANTED

Delivery Drivers/Independent Contractors. Need reliable mini van, small cargo van or SUV for same day deliveries. 1-800-818-7958

Licensed Journeyperson Immediate Positions available for R-6 CT License Journeyperson or equal license. Preferred Experience in Installation of Conveyor and Equipment in the Food and Beverage Industry, but not necessary. Project Mid-March through June with 20 to 30 hours of overtime a week available. EOE drug free workplace.
Email resume to:
CTprojects2013@gmail.com

Licensed Process and Mechanical Journeyperson Immediate Positions available for CT PP2, G6 or P2 Licensed Process and Mechanical Journeyperson. Experienced with Stainless Steel Piping in the Food and Beverage Industry preferred but not necessary. Project in the Hartford CT area. All work is inside under Roof and on concrete. Project duration is Mid-March thru June (opportunity on other projects after June) 20 to 30 hours of overtime a week available. EOE drug free workplace.
Email resume to:
CTprojects2013@gmail.com

MASON
BRICK LAYER
5 to 10 yrs Experience
Call
203-498-9198

CALL 203-777-3278 or (TOLL FREE) 1-877-672-3278 TO PLACE YOUR CLASSIFIED AD

---

645 GENERAL HELP WANTED

ROOFER - Commercial, must have 5 yrs exp in Modified and EPDM. Phonable references, must pass drug test, clean driving record required. Top pay/benefits. New England Masonry, 146 Sheridan Dr., Naugatuck. 203-729-2266. AA/EOE

LEGALS

LEGAL NOTICE

As of March 22, 2013, Murphy Moving & Storage Inc., located at 14 Beaver Road, Branford, CT 06405, will no longer represent Atlas Van Lines, Inc.

LIQUOR PERMIT

Notice of Application
This is to give notice that I, KIM DZIUBINSKI
407 WAGNER AVE
MAMARONECK, NY 10543-2939
Have filed an application placarded 03/08/2013 with the Department of Consumer Protection for a RESTAURANT LIQUOR PERMIT for the sale of alcoholic liquor on the premises at 3 LINDEN AVE
BRANFORD, CT 06405-5201
The business will be owned by: SEAGRASS GRILL LLC
Entertainment will consist of: Acoustics (Not Amplified) Disc Jockeys Karaoke Live Bands
Objections must be filed by: 04/19/2013
KIM DZIUBINSKI

NOTICE TO CREDITORS

ESTATE OF:
JOSEPHINE A. MASSELLI

The Hon. John A. Keyes, Judge of the Court of Probate, New Haven Probate District, by decree dated February 27, 2013, ordered that all claims must be presented to the fiduciary at the address below. Failure to promptly present any such claim may result in the loss of rights to recover on such claim.

Edward Cleary, Asst Clerk

The fiduciary is:

Francine Marie Cuomo
c/o Stearns J. Bryant, Jr., Esq., Nugent & Bryant
P.O. Box 217,
North Haven, CT 06473
2536170

---

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MODEL	YEAR	PRICE	PHONE
HD Fatboy 1450cc	2000	asking 12,000	203-793-7983
fully customized, stored 5 yrs, 10K mi, SC bike, history available			

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DOWNSIZING - antique sideboard, wood bedding $250, 2 antique chrs w/cesters $75 ea, small wood table & 2 chrs $75. Cheshire, 203-379-7444.

DOWNSIZING
Blue wing-back chair $200. Barely used
Oak 4-poster bed $50.
Cheshire, 203-379-7444

DOWNSIZING
Custom Southwood Queen Arine white sofa $500. Barely used.
Cheshire, 203-379-7444

Articles For Sale

Hot Tub 6 per. 50 jets with all options, never used. Cost $7,500 Sell $3,600. 203-986-5915.

Portable Generator - 5000 watts, 120/240 volts. Used for 3 days. $900. Call 203-795-3340.

Samsung Frige/icemaker side by side 2004, 25 cub ft. Model: RS2556SH (36x35x70). $800 obo. Middletown. 267-218-0584

TV - Panasonic 56" HDTV Projection. $250. Chest Freezer GE 2003, Model: FCM5SMWW, 5 cubic feet, (25x17x28) $100. Middletown. Call 267-218-0584

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Four ways to place your ad in the Marketplace:
- Call: 203.777.3278 or 1.877.872.3278
- Fax: 203.865.8360
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- Email: classifiedads@nhregister.com

Please be sure to include your name, address and telephone number when submitting your ad.

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LEGALS

LEGAL NOTICE

Pursuant to Conn. Gen. Stat. §16-9, the Public Utilities Regulatory Authority will conduct a reopened public hearing at it offices, Ten Franklin Square, New Britain, Connecticut, on Tuesday, March 26, 2013, at 1:00 p.m., concerning Docket Nos. 03-01-01RE03, DPUC Review of Peaking Generation Projects – Market Rule Changes re: New Audit Rules; 12-07-14RE01, Application of GenConn Energy LLC for Establishment of 2013 Revenue Requirements – Market Rule Changes re: New Audit Rules; and 12-07-17RE01, Application of PSEG New Haven, LLC for Establishment of 2013 Revenue Requirements – Market Rule Changes re: New Audit Rules. The hearing may continue on additional dates. For information and the Notice of Hearing filed with the Secretary of State's Office, contact: PUBLIC UTILITIES REGULATORY AUTHORITY, KIMBERLEY J. SANTOPIETRO, Executive Secretary. The public may call the Authority's offices, at (860) 827-1553, option 4 (using a touch tone phone), commencing each dayfrom 7:30 a.m., to be advised as to whether the reopened hearing has been cancelled or postponed due to inclement weather. The Connecticut Department of Energy and Environmental Protection is an Affirmative Action and Equal Opportunity Employer that is committed to the requirements of the Americans With Disabilities Act. To request an accommodation call 860-424-3194 or e-mail deep.hrmed@ct.gov.

Request For Quotation #06-1219

The State of Connecticut Judicial Branch invites vendors to submit quotations for Perfect binding services.

Sealed quotations must be received by 11:30 A.M. on April 3, 2013. Immediately thereafter all quotations will be publicly opened and prices read aloud.

VENDORS CURRENTLY REGISTERED UNDER THE STATE'S SMALL BUSINESS SET-ASIDE PROGRAM ARE ENCOURAGED TO BID.

Bid package may be picked-up at Judicial Purchasing Services, 90 Washington Street, 4th Floor, Hartford, CT or call 860/706-5200 to request by mail.

PLEASE CHECK THE JUDICIAL WEB SITE AT:

www.jud.ct.gov/external/news/busopp/Default.htm

JUDICIAL BRANCH
PURCHASING SERVICES
90 WASHINGTON STREET
HARTFORD, CT 06106

An Equal Opportunity/Affirmative Action Employer

INVITATION TO BID

Sealed bid proposals will be received at South Central Connecticut Regional Water Authority, 90 Sargent Drive in New Haven, Connecticut until the time and date that is specified below, at which time they will be publicly opened and read aloud.

Copy of the bid proposal, including any specifications, may be obtained at the Purchasing Department of the South Central Connecticut Regional Water Authority at the address given above between the hours of 8:30 a.m. and 4:00 p.m.

A list of current Public Bids is also available on our Website: www.rwater.com

The South Central Connecticut Regional Water Authority reserves the right to reject any and all bid proposals and/or to waive any informalities in bidding if it be in the public interest to do so. South Central Connecticut Regional Water Authority reserves the right to award a contract as it deems in its best interest.

Valve Exercising Trailer April 1, 2013 2:00 p.m.

South Central Connecticut
Regional Water Authority
Peter Bocciarelli
Purchasing Manager
March 19, 2013

NOTICE OF TRANSFER OF APPLICATION FOR A SUBSURFACE SEWAGE DISPOSAL PERMIT

On March 12, 2013, the Department of Energy and Environmental Protection ("DEEP") gave notice of its approval of the transfer of Application Number 200700548 submitted February 25, 2007 by Wayne Paul Corporation ("Application") to Alison Pastorfield Associates, Inc., 89 State Street, Guilford, CT 06437 ("Pastorfield"). Pastorfield is now the applicant seeking the subsurface sewage disposal permit at issue in the Application. On July 31, 2012, the Commissioner issued notice of a tentative determination to issue the permit. A hearing regarding the Application has been requested and will be held, but has not yet been scheduled.

The Application, made pursuant to Conn. Gen. Stat. § 22a-430 and Conn. Agencies Regs § 22a-430-3 & 4, seeks a permit for a subsurface sewage disposal system that would discharge 34,500 gallons per day of domestic sewage to the groundwaters of the state from the operations of a proposed residential development on property owned by Pastorfield at 1940 Boston Post Road, Guilford, Connecticut, 2,000 feet northwest of I-95, Exit 57. The property is within the West River Watershed, contains inland wetlands and watercourses, and is within the coastal area as defined by Conn. Gen. Stat. § 22a-94.

Anyone seeking further information or seeking to inspect the Application should contact Antoanela Daha at (860) 424-3018 or antoanela.daha@ct.gov, Department of Energy and Environmental Protection, Bureau of Materials Management and Compliance Assurance, 79 Elm Street, Hartford, Connecticut, 06106. Interested persons may also obtain copies of the application from Robert Sonnichsen, PE, Waldo & Associates LLC, 89 State Street, Guilford, CT 06437 Telephone: (203) 453-4386.

PUBLIC NOTICE

Pursuant to section 19a-636 of Connecticut General Statutes, Yale-New Haven Hospital will submit the following Certificate of Need application:

Applicant(s): Yale-New Haven Hospital

Address: 20 York Street

Town: New Haven

Proposal: Acquisition of two SPECT-CT cameras to replace a SPECT camera in Nuclear Medicine and two gamma cameras in Nuclear Cardiology

Estimated Total Project Cost/Expenditure: $1,850,443

LEGALS

CITY OF WEST HAVEN
DEPARTMENT OF FINANCE
355 MAIN STREET
WEST HAVEN, CT 06516
(203) 937-3620

INVITATION TO BID

Notice is hereby given that sealed bids on the following will be received at the Department of Finance until 11:00 April 3, 2013 At the following time they will be publicly opened and read

**BID #2013-01
COMPRESSOR AT BENNETT RINK - BD OF ED
MANDATORY PRE-BID MEETING TO BE HELD AT THE PROJECT SITE
1 McDONOUGH PLAZA, WEST HAVEN, CT
10:00 A.M. 3/27/13**

The City of West Haven reserves the right to accept any or all the options, bids or proposals; to waive any technicality in a bid or part thereof submitted, and to accept the bid deemed to be in the best interest of the City of West Haven.

Contract documents may be obtained on the City's website: www.cityofwesthaven.com

SECRETARY

INVITATION TO BID

Proposals are invited by the owners for rehabilitation work on the property specified below:

Project Address:
20 Pepperbush Drive
Clinton CT 06413

Proposals will be received until 11:00 a.m. on Thursday, April 4, 2013 at which time they will be opened. Proposals will be delivered to:

Town of Clinton
First Selectman's Office
54 East Main Street
Clinton, CT 06413

Copies of the Project Specifications and further information may be obtained from Town of Clinton, First Selectman's Office, Mon. – Wed. 9:00 a.m. to 4:00 p.m., Thurs. 9:00 a.m. to 7:00 p.m., Fri. 9:00 a.m. to 12 noon (Project #: 027-32)

Bidders must estimate their proposals by inspection of the above noted structure. A pre-bid conference will be held at the following location and time:

PRE-BID Wednesday, March 27, 2013
9:00 a.m.
20 Pepperbush Drive
Clinton, CT 06413

The above work includes:
Remove electric radiant heat and install new LP Gas fired boiler with indirect water heater.

AN AFFIRMATIVE ACTION / EQUAL OPPORTUNITY EMPLOYER WBE / MBE / SBE AND SECTION 3 DESIGNATED CONTRACTORS ARE ENCOURAGED TO APPLY

NOTICE TO CREDITORS

ESTATE OF:
James R. Coss

The Hon. Michael R. Brandt, Judge of the Court of Probate, East Haven - North Haven Probate District, by decree dated February 14, 2013, ordered that all claims must be presented to the fiduciary at the address below. Failure to promptly present any such claim may result in the loss of rights to recover on such claim.

Mary-Beth Cronk,
Chief Clerk

The fiduciary is:

Mary A. Coss, Executrix, William V. Gambardella, Esq., Nathanson, Cipriano & Gambardella, P.C., 60 Washington Avenue, Hamden, CT 06518
2534190

LEGALS

LEGAL NOTICE

Notice is hereby given that on 3/20/2013 at 3:30 PM at The Storage Depot LLC, 483 Washington Ave., in the City of North Haven, State of CT, the undersigned, The Storage Depot LLC will sell at Public Sale by competitive bidding, the personal property heretofore stored with the undersigned by:

Item Name
Ted Anastasio
31 Locke Dr.
North Haven, CT - 06473
Space # 1653
Description
Household Items

LEGAL NOTICE TOWN OF CLINTON

SEALED BIDS will be received until 11:00 a.m. Wednesday, April 10, 2013 the Office of the First Selectman, Andrews Memorial Town Hall, 54 E. Main Street, Clinton, Conn. 06413 at which time they will be opened and read aloud for ELIOT MIDDLE SCHOOL Window Replacement and Unit Heater Replacement Project. Bids received after the above date and time will be rejected. BID DOCUMENTS may be picked up at the following location:

Town of Clinton, Town Hall, 54 East Main St., Clinton, CT., Office of the First Selectman between the hours of 9:00 am. - 4:00 p.m. Monday thru Wednesday, 9:00 a.m. - 7:00 p.m. Thursday or 9:00 a.m. – 12:00 noon on Friday or by calling 860-669-9333.

A payment of $50.00 in the form of a check or money order made payable to the Town of Clinton is required for each set. The payment is non-refundable.

The First Selectman reserves the right to reject any, or any part of, or all proposals; to waive informalities and technicalities and to accept the Bid which the Town deems to be in the best interest of the Town, whether or not it is the lowest dollar amount.

William W. Fritz, Jr.
First Selectman

**METRO SELF STORAGE
237 Sawmill Rd.
West Haven, CT 06516
203-934-8305**

All contents are to be listed as household goods unless otherwise described.

Tenant	Unit
Charles A. Tyson	D194
Clarissa Edwards	1012
Ali Ahmed	A112
David Sautter	D5
Jerome Prete	B35
Terrecia Dixon	A82
Sybil Thomas	B5
Manuel Catalan	1006

Auction:
March 26, 2013
Time: 3:00 pm

Property contained in the following units will be sold to the highest bidder to satisfy the owner's lien for rent. Auction is With Reserve. Metro Self Storage reserves the right to set minimum bids and to refuse bids.CASH ONLY!!!

NOTICE TO CREDITORS

ESTATE OF:
Julia Mustakos

The Hon. Michael R. Brandt, Judge of the Court of Probate, East Haven - North Haven Probate District, by decree dated March 5, 2013, ordered that all claims must be presented to the fiduciary at the address below. Failure to promptly present any such claim may result in the loss of rights to recover on such claim.

Mary-Beth Cronk,
Chief Clerk

The fiduciary is:

Julie Hurley, Executrix, c/o James O. Walsh, Esq., P.O. Box 1302, New Haven, CT 06505-1302
2535937

LIQUOR PERMIT

Notice of Application
This is to give notice that I,
PATRICIA E WALKER
136 HYDE ST
NEW HAVEN, CT
06512-3612
Have filed an application placarded 03/15/2013 with the Department of Consumer Protection for a RESTAURANT WINE & BEER PERMIT for the sale of alcoholic liquor on the premises at
1012 STATE ST
NEW HAVEN, CT
06511-3944
The business will be owned by: CHESTNUT FINE FOODS AND CONFECTIONS LLC
Entertainment will consist of: None
Objections must be filed by 04/29/2013
PATRICIA E WALKER

ANSONIA

Federal Elderly Wait List for
John J. Stevens
Monsignor Hynes

Housing Authority City of Ansonia

The applicants listed below have submitted an application to the Federal Elderly Wait List at

Names

Luz D. Ortiz Rodriguez-Suzanne Matthies-James Russell-Joseph Brice-David Macknis

David Wright-Dzenita Kadic-Roy Mesah-Natividad Segui-Joann Muniz-Ernest E. Strain III

Odessa Fortes-Jason A. Bolanos-Karl Allen-Virginia Duclos-Patricia Kelly-Irma Muniz

Manuel Ayala-Michael B. Rico-Walter Radzion-Richard Taylor-Jermaine Rogers-Rose L. Papke

Martha Jackson-Hanjra-Cathrine Parrett-Susan Eaton-Karen Gerber-Juanita Smith-Paul Lewis

Eileen C. Garrett-Theresa Kisyk-Pasquale Acelo-Francisco J. Bello-Mary Crockett

Richard Kenny-William K. Vargas-Mary Lea Black-Phyllis J. Coker-Gloria Hersh-Dale Rice

Katrina Cruz-Zaida Vanderbeck-Ruby White-Alice Draper

Please be advised that your name has come up to the top of the waitlist for our Federal Elderly Program. You must come by our office at 36 Main Street Ansonia, CT 06401 by Tuesday, March 26, 2013 no later than 4:00 p.m to complete a full application. Please note that failure to respond to this update will result in your name being placed at the bottom of the wait list.

If you have any questions or require special assistance concerning this notice, you can contact Vicky Clifford, Reasonable Accommodation Coordinator at (203) 735.8688 x300.

The Housing Authority Of The City Of Ansonia Does Not Discriminate In Admission To Their Federally Assisted Housing Programs. Any Eligible Individual With A Disability Will Be Served. Those Who Have Visual Or Hearing Impairment Will Be Provided With The Necessary Information To Understand And Participate In The Program. Efforts Will Be Coordinated To Comply With The Nondiscrimination Requirements Of Section 504.

ORANGE

ORANGE TPZC NOTICE OF PUBLIC HEARINGS

Notice is hereby given that on Tuesday, April 2, 2013, at 8:00 p.m., at the Orange Town Hall, 617 Orange Center Road, the Orange Town Plan and Zoning Commission will conduct a public hearing on the following:

APPLICATION FOR SPECIAL USE, submitted by the University of New Haven for property known as 584 Derby-Milford Road (former Harvey Hubbell). The proposal is to convert the former Hubbell Incorporated headquarters into a Graduate School Campus. A SITE PLAN APPLICATION has also been submitted with this application.

APPLICATION FOR TEMPORARY SPECIAL USE FOR EARTH MATERIALS REMOVAL & FILLING, submitted by the University of New Haven for property known as 584 Derby-Milford Road (former Harvey Hubbell). The proposal is for the construction of parking areas to service the proposed UNH Graduate School. An APPLICATION FOR CERTIFICATION OF SOIL EROSION AND SEDIMENT CONTROL has also been submitted.

APPLICATION FOR TEMPORARY SPECIAL USE FOR EARTH MATERIALS REMOVAL & FILLING, submitted by Strathmore Holdings LLC for property known as 200 Orange Center Road. The proposal is to construct a 5,320 sq.ft. medical/office building with associated site improvements. A SITE PLAN FOR CERTIFICATION OF SOIL EROSION AND SEDIMENT CONTROL has also been submitted.

A copy of this notice has been filed with the Orange Town Clerk. Dated in Orange, CT this 15th day of March, 2013.

Oscar Parente
Secretary
T.P.Z.C.

2536985

LEGAL NOTICE

The Legislative Matters Committee of the West Haven City Council will hold a Public Hearing on Monday, March 25, 2013 at 6:50 P.M. in the City Council Chambers, third floor, City Hall, 355 Main Street, West Haven, on "An Ordinance amending Chapter 115 of the Code of the City of West Haven - Food Establishments" as follows:

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF WEST HAVEN that Chapter 115 of the Code of the City of West Haven, Food Establishments is hereby amended as follows:

115-3 Plans for construction: approval.

A. Whenever a food service establishment is constructed or remodeled and whenever an existing structure is converted to use as a food service establishment, properly prepared plans and specifications for such construction, remodeling or alteration, along with a plan review fee of fifty dollars ($50) shall be submitted to the Director of Health for review and approval twenty (20) calendar days prior to issuing a food service license or a building permit and before construction, remodeling or alteration is begun.

115-9 License Fees

A. Annual license fees shall be charged according to the following schedule:

(1) For food service establishments as classified under the Public Health Code, Sec. 19-13-B42:
 (a) Class 1: One hundred dollars ($100),
 (b) Class 2: Two hundred dollars ($200),
 (c) Class 3: Three hundred dollars ($300),
 (d) Class 4: Four hundred dollars ($400),

(2) For a catering food service establishment: One hundred dollars ($100)

(3) For an itinerant food vending establishment (One hundred dollars ($100) Three hundred seventy five dollars ($375)

(4) For eleemonsynary institutions regardless of classifications: no fee.

115-11. Periodic inspection, suspensions or revocation of license.

The Director shall periodically inspect the premises, equipment and operation of all person holding a valid license issued under this chapter. If he finds that any license is operating in violation of the Public Health Code of the State of Connecticut or other applicable statutes, ordinance or rules and regulations, he shall issue an order to the lincesee forthwith to take such measures as are necessary for full compliance with said code. All licenses issued under the terms of this chapter may be suspended or revoked by the Director for a violation by the licensees of any of the terms of said code or other applicable statutes, ordinances or rules and regulations. Establishments, conveyances or vehicles which fail to pass inspection must have the manager of the establishment or conveyance's or vehicle's owner pay a reinspection fee of one hundred dollars ($100) and attend a one-half (1/2) hour of education and consultation session at the West Haven Health Department prior to reinspection or their license may be revoked by the Director of Health.

A complete copy of the ordinance may be obtained in the City Council office or the City Clerk's office.

Charles A. Marino
Clerk of the Council

NOTICE

On March 20, 2013, U-Haul of Hamden, 1695 Dixwell Ave, Hamden CT 06514 will sell the items that are contained in these storage rooms due to pay the unpaid storage fees.

Harrison Murray	Rm#1022	Marlice Smith	Rm#1917
Lossie Gorham	Rm#1332	Carolyn Jackson	Rm#1919 & 1922
Bruce Cogswell	Rm#1413	Tony Williams	Rm#1926
Christina Landelius	Rm#1428	Trish Smith	Rm#1940
Brianna Dickey	Rm#1501	Renee Gibbs	Rm#1950
Astrid Beltran	Rm#1509	Tremelra Austin	Rm#1956
Mario Biggs	Rm#1510	Marquis Clark	Rm#1960
Yvonne Hammonds	Rm#1513	Linda Camp	Rm#1962
Tamara Gatison	Rm#1552	Richard Nugent	Rm#1964
Brittany Marioni	Rm#1640	Randi Hobson	Rm#2004
Gershom Addlemailu-Bey	Rm#1651	Javier Johnson	Rm#2024 & 2026
Joan Benson	Rm#1705	Amanda Maxwell	Rm#2033
Debra Brantley	Rm#1761	Michael Carter	Rm#2042
Natalia Harris	Rm#1770	Lebheaus James	Rm#2045
Adrienne Johnson	Rm#1903	Brigitte Hall	Rm#2050
Joanne Tart	Rm#1911	Jovan Teague	Rm#2303
Ebony Washington	Rm#1915		

Contents to be sold on the premises of 1695 Dixwell Ave. Hamden CT 06514 on March 20, 2013 at 10:00 am. Purchases to be paid for in cash or credit card at the time of purchase; also a $100.00 cash deposit will be needed on each room purchased. U-HAUL reserves the right to bid or purchase any lot or space. Auction service provided by Storage Auction Solutions. www.StorageAuctionSolutions.com

GENERAL HELP WANTED

645 GENERAL HELP WANTED

Delivery Drivers/Independent Contractors. Need reliable mini van, small cargo van or SUV for same day deliveries. 1-800-618-7958

DRIVERS
CDL Class B Drivers. 2 yrs exp. Must know CT. Heavy lifting. $17/hr. Temp to perm.
AB Temporary Services
Stratford 203-375-5205

DRIVERS - TEMP, CDL A & B, April through June. Delivering plants. Bring current copy of driving record, license and medical card. Pre-employment DOT drug screen & references required. We service the Northeast area. Call John McKone at: Caseiano Greenhouses in Cheshire 203-272-6444.

Hotel
New Haven Hotel and Courtyard by Marriott at Yale
• Cafe Barista Attendant $10.25/hr
• Houseperson $10.75/hr
• Room Attendant $10.75/hr
• Shift Engineer $12.50/hr
• Engineering Supervisor
Must have flex sched. FT/PT.
Apply at:
229 George St., New Haven
30 Whalley Ave, New Haven
or newporthotelgroup.com

MACHINISTS
CNC Lathe Set Up Operator & Swiss Set Up Operator. Full Time, 5 years exp nec. Call Steve at: 203-264-5440.

MASON
BRICKLAYER
5 to 10 yrs Experience
Call
203-499-9199

Part Time
Quinnipiac University
Polling Institute needs Part-Time interviewers. 16-18 hours per week, evenings and weekends. Those who are bilingual in Spanish are also encouraged to apply. Apply online at: http://careers.quinnipiac.edu Please call the polling institute at 203-582-8008 if you have any questions. AA/EOE.

A HOME OF YOUR OWN
The Job of Your Dreams
A Pet for the Children
A Second Car for Commuting
A Tag Sale Buried Treasure
Find these and more in the New Haven Register Classifieds.

645 GENERAL HELP WANTED

Interested In a Career in Real Estate? There's no better place to begin than at

Weichert Realtors

Regional Properties
We will supply you with all the support and training you need, including the widest range of online and in-person courses through our industry-leading training department. We also generate qualified leads for you from our market-leading internet marketing strategies. Your hours are flexible and income potential is unlimited! For more information or to make an appointment contact one of our
Greater New Haven Area Sales Managers:
Orange Regional Center
Rich Mutlick, 203-795-2377
Hamden Office:
Marie Renaldi, 203-287-7643
Downtown New Haven Office:
John Guerra, 475-238-8519
Or Email:
Careers@WeichertRP.com
Equal Opportunity Employer
Independently Owned and Operated

Are you a cigarette smoker 16-19 years old & not looking to quit? You may be eligible to participate in a 2 week research study that involves Chantix® (varenicline) & an fMRI. Earn up to $245. Call (203)974-7614 for more information. All calls are confidential. HIC#1108036525

Retail
Our Growth Creates YOUR Opportunity!
Dollar General is now hiring for our New Store opening in Milford, CT. Apply online at:
www.dollargeneral.com/careers
Serving others is our mission. Make it yours.
DOLLAR GENERAL
EOE M/F/D/V

645 GENERAL HELP WANTED

ROOFER - Commercial, must have 5 yrs exp in Modified and EPDM. Phoneable references, must pass drug test, clean driving record required. Top pay/benefits. New England Masonry, 146 Sheridan Dr., Naugatuck. 203-729-2956. AA/EOE

645P PROFESSIONAL MARKETPLACE

Rehabilitation Teacher
State of CT – Department of Rehabilitation Services - Bureau of Education and Services for the Blind is recruiting for a Rehabilitation Teacher. Closing date is March 22, 2013. Interested candidates may apply by visiting http://das.ct.gov and selecting the "State Employment Jobs, Exams and Special Notices" link. The State of CT is an equal opportunity/affirmative action employer and strongly encourages the applications of women, minorities and persons with disabilities.

650 HEALTH CARE OPPORTUNITIES

CNA's needed 24-32 hrs all shifts including weekends. Apply @ Meadowsea Health & Rehab Center 163 Quinnipiac Ave. North Haven or fax to 203-789-4433 Attn: Annette.

PER DIEM POLYSOMNOGRAPHIC TECHNOLOGISTS/ TECHNICIANS
Gaylord Specialty Healthcare is currently seeking per diem Polysomnographic Technologists or Technicians to staff its Sleep Medicine sites in Trumbull, North Haven and Glastonbury. Sunday-Saturday, 7pm – 7am shifts available. Qualified candidates will be RPSGT or have successfully completed a Polysomnography program, of no less than 1 year in duration, associated with a State licensed and/or national accredited educational facility or have a minimum of 6 months of experience with A-Step education in process for a Polysomnographic Technician. A competitive rate of pay is offered. Please e-mail resumes to Jobs@Gaylord.org or fax to: 203-284-2733 or submit an application on-site at: Gaylord Hospital, P.O. Box 400, Wallingford, CT 06492. We are an Equal Employment Opportunity.

LEGALS

LIQUOR PERMIT
Notice of Application
This is to give notice that I, JOSHUA PAUL HETLAND 155 HUNTINGTON AVE NEW HAVEN, CT 06512-2825
Have filed an application placarded 03/07/2013 with the Department of Consumer Protection for a PACKAGE STORE LIQUOR PERMIT for the sale of alcoholic liquor on the premises at 3540 WHITNEY AVE HAMDEN, CT 06518-1920
The business will be owned by: BOTTOMS UP WINE & SPIRITS LLC
Objections must be filed by: 04/18/2013
JOSHUA PAUL HETLAND

645P PROFESSIONAL MARKETPLACE

LEGALS

LIQUOR PERMIT
Notice of Application
This is to give notice that I, PATRICK F HOGAN 58 HILL CT NORWALK, CT 06850-3029
Have filed an application placarded 03/15/2013 with the Department of Consumer Protection for a CAFE LIQUOR PERMIT for the sale of alcoholic liquor on the premises at 156 CROWN ST NEW HAVEN, CT 06510-2706
The business will be owned by: H2OG LLC
Entertainment will consist of: Karaoke Live Bands Disc Jockeys Comedians Magicians ACOUSTICS
Objections must be filed by: 04/29/2013
PATRICK F HOGAN

NOTICE TO CREDITORS
ESTATE OF
Robert Pritchard, Late of Ansonia, in said district deceased,

The Hon. Clifford D. Hoyle, Judge of the Court of Probate, Derby Probate District, by decree dated December 27, 2012, ordered that all claims must be presented to the fiduciary at the address below. Failure to promptly present any such claim may result in the loss of rights to recover on such claim.

Kay Jeanette, Clerk

The fiduciary is:

Susan Magyar, c/o Timothy P. Dillon, Sheehy & Dillon, 903 Wakelee Avenue, Ansonia, CT 06401
2526657

NOTICE TO CREDITORS
ESTATE OF
Brenda L. Tanski

The Hon. Beverly Streit-Kelaias, Judge of the Court of Probate, Milford - Orange Probate District, by decree dated March 6, 2013, ordered that all claims must be presented to the fiduciary at the address below. Failure to promptly present any such claim may result in the loss of rights to recover on such claim.

Elizabeth Davis, Clerk

The fiduciary is:

Jenny M. Tanski and Kevin M. Tanski, Jr., c/o Steven P. Floman, Esq., Floman DePaola, Attorneys & Counselors at Law, P.O. Drawer 969, 378 Boston Post Road, Orange, CT 06477
2536575

CALL EARLY, CALL LATE!
CLASSIFIED IS OPEN
8:30AM. - 5:30 PM
MON. - FRI.
Or email to:
CLASSIFIEDADS @NHREGISTER.COM

645P PROFESSIONAL MARKETPLACE

LEGALS

NOTICE TO CREDITORS
ESTATE OF:
Kevin M. Tanski, Sr.

The Hon. Beverly Streit-Kelaias, Judge of the Court of Probate, Milford - Orange Probate District, by decree dated March 6, 2013, ordered that all claims must be presented to the fiduciary at the address below. Failure to promptly present any such claim may result in the loss of rights to recover on such claim.

Elizabeth Davis, Clerk

The fiduciary is:

Jenny M. Tanski and Kevin M. Tanski, Jr., c/o Steven P. Floman, Esq., Floman DePaola, Attorneys & Counselors at Law, P.O. Drawer 969, 378 Boston Post Road, Orange, CT 06477
2536575

LEGALS

NOTICE TO CREDITORS
ESTATE OF:
Susan Nolan-Hooksarna

The Hon. Salvatore L. Diglio, Judge of the Court of Probate, Hamden - Bethany Probate District, by decree dated March 6, 2013, ordered that all claims must be presented to the fiduciary at the address below. Failure to promptly present any such claim may result in the loss of rights to recover on such claim.

Valerie A. Dondi, Clerk

The fiduciary is:

Richard G. Nolan-Hooksarna, c/o Kathy K. Priest, Esq., Davis O'Sullivan & Priest, P.C., 129 Church Street, Suites 503 and 505, New Haven, CT 06510
2536161

PUBLIC NOTICE

Pursuant to section 19a-638 of Connecticut General Statutes, Yale-New Haven Hospital will submit the following Certificate of Need application:

Applicant(s): Yale-New Haven Hospital

Address: 20 York Street

Town: New Haven

Proposal: Acquisition of two SPECT-CT cameras to replace a SPECT camera in Nuclear Medicine and two gamma cameras in Nuclear Cardiology

Estimated Total Project Cost/Expenditure: $1,850,443

ANSONIA HOUSING AUTHORITY

Request for Qualifications
Solicitation # AHA-RFQ-2013-04

ARCHITECTURAL AND ENGINEERING SERVICES FOR THE RIVERSIDE MIXED FINANCE DEVELOPMENT

The Ansonia Housing Authority is currently seeking Architecture and Engineering Services for the Riverside Mixed Finance Development. Qualifications will be received until April 15, 2013 at 3:00 PM local time. A pre-bid conference will be held at 36 Main Street, Ansonia, CT 06401 on March 25, 2013 at 11:00 AM local time. The Request for Qualifications can be picked up from AHA at 36 Main Street, Ansonia, CT 06401 beginning on March 20, 2013 @ 3:00 pm local time or contact Carol Mobilio at 203-736-6889x313. Additional questions should be sent to Carol Mobilio at cmobilio@ansoniahousing.com, in the subject line, put the Solicitation number. No questions will be accepted later than April 8, 2013 @ 3:00 PM local time.

Request For Quotation #02-1301

The State of Connecticut Judicial Branch invites qualified vendors to submit quotations for the rental of service uniforms for various Judicial Branch Operating Units.

A Mandatory Pre-Bid Conference will be held Friday, April 12, 2013 at 1:30 p.m. Complete details are available in the bid documents.

Sealed quotations must be received by 11:30 A.M. on April 30, 2013. Immediately thereafter all quotations will be publicly opened and prices read aloud.

VENDORS CURRENTLY REGISTERED UNDER THE STATE'S SMALL BUSINESS SET-ASIDE PROGRAM ARE ENCOURAGED TO BID.

Bid package may be picked-up at Judicial Purchasing Services, 90 Washington Street, 4th Floor, Hartford, CT or call 860-706-5200 to request by mail, or access the web site below.

PLEASE CHECK THE JUDICIAL WEB SITE AT:

www.jud.ct.gov/external/news/bsopp/Default.htm

JUDICIAL BRANCH
PURCHASING SERVICES
90 WASHINGTON STREET
HARTFORD, CT 06106

An Equal Opportunity/Affirmative Action Employer

MILFORD MILFORD

REQUEST FOR QUALIFICATIONS/PROPOSAL
PROPOSAL # 2012/13-17
CONSULTING SERVICES
SCHOOL TRANSPORTATION REVIEW

Notice is hereby given that responses to the above Request for Qualifications/Proposal will be received at the Office of the Chief Operations Officer until Friday, March 29, 2013 at 3:00 p.m.

Specifications may be obtained at the office of the:

JAMES L. RICHETELLI, JR.
CHIEF OPERATIONS OFFICER
MILFORD PUBLIC SCHOOLS
70 WEST RIVER STREET
MILFORD, CT 06460
203-783-3405
jrichetelli@milfordct.org

The Board of Education reserves the right to reject any consultant/firm offering services which, in the committee's opinion does not meet the standard or quality established by this information package, and all proposals, or any part thereof, to waive defects in the same, or to accept any proposal which it deems to be in the best interest of this project, Milford Public Schools and/or the City of Milford.
2557325

ANSONIA ANSONIA

Ansonia Housing Authority
Invitation to Bid
Notice is hereby given that sealed bids for Roof Replacement at John J. Stevens and Monsignor Hynes Apts., Ansonia, CT

will be received until Monday, April 8, 2013 at 3:00 PM. Ansonia Housing Authority ("AHA") is seeking bids for Roof Replacement at Stevens and Hynes Apts. A pre-bid conference will be held on Monday, April 1, 2013 11:00 AM at 70 Woodlawn Ave., Hynes Apts. at the driveway entrance on Woodlawn. Although attendance is not mandatory, it is recommended. AHA reserves the right to award one or more contractors. All's must receive one (1) clearly marked original and three (3) copies of the bid submitted. A complete set of specifications and submittal documents on a CD Rom at no cost may be picked-up starting on Wednesday March 20, at 3:00 PM from AHA, 36 Main Street, Ansonia, CT. Additional questions should be emailed to cmobilio@ansoniahousing.com no later than April 3, 2013.

UNITED STATES POSTAL SERVICE.

NOW HIRING CAREER AND TEMPORARY EMPLOYEES

• Letter Carrier - City and Rural
• Clerks & Sales & Service Associates
(Postal Support Employee)
• Mail Handlers
(Associates)
• Custodians
(Postal Support Employee) (Many Locations)
• Truck Drivers & Tractor Trailer Operators
(Class A or B CDL)
• Postmaster Relief
(Part Time ~ Many Locations)

New job vacancies being added to the website daily
APPLY at www.usps.com/employment
Applicants must have an e-mail address

Hurry before the Post Office job you've always wanted is taken
The USPS is an Equal Opportunity Employer

Warehouse Position

Beverage distributor seeks reliable person to maintain point-of-sale department. Must be organized, self motivated and forklift certified. Receives and distributes POS material. Inventory control and warehouse experience necessary. Proficient in Excel.

If interested, send resume to:
HR Manager
Star Distributors
460 Frontage Road, West Haven, CT 06516
Email to: bmenery@stardistributors.com
or fax resume to HR Manager, 203-479-1608

First Student

Now Hiring
Part-Time School Bus Drivers
TRAINING STARTS NOW!

Apply in person Mon-Fri at
FIRST STUDENT
1551 Dixwell Avenue
Hamden, CT 06514

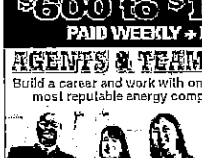
We are proud to offer:
- Competitive hourly wages
- Training leading to a CDL
- Free medical insurance

To qualify, you must be at least 21 years of age, have a valid CT driver's license, three years verifiable driving experience, and be able to pass a background investigation and a drug test.

EOE

$600 to $1300+
PAID WEEKLY + BONUS
AGENTS & TEAM LEADERS

Build a career and work with one of the largest and most reputable energy companies in the US!



- Redundance Benefits
- Paid Weekly
- Full Training Provided
- Fast Advancement

IMMEDIATE PERMANENT OPENINGS

NATIONAL

Call today to schedule an interview 877-389-6674

Education
Wallingford Public Schools
Middle School Principal
(Dag Hammarskjold Middle School)
Anticipated Vacancy -
Start Date: On or about July 1, 2013
Intermediate administrator's certification and experience as a teacher and administrator at the middle school level preferred. Regionally competitive salary and benefits package.

Apply on-line @ www.wallingford.k12.ct.us

Deadline: April 10, 2013
EOE

648 SALES & MARKETING

649 SALES & MARKETING

SALES

RUN YOUR OWN COMPANY!

If you are the best in Sales at present in whatever industry and can prove it,
If you outsell your peers and competitors,
If your customer service sets you apart from all ...and
If you are in hot pursuit of a Big Dream –

WE WILL MAKE IT HAPPEN!

We will get you excited again!
We will make you part of our Success Team!
We will make you an Entrepreneur so you can build your new company into a Power House!

NO investment other than your time. But you have to be the BEST; focus, willing to do what it takes, even sacrifice just so as to end up and stay on TOP OF THE WORLD.

Unique and patented industrial tools, high commissions, punctual payments provide an income potential in excess of $300,000/year.

Send your resume with copies of recent Sales Awards. Then add a note to tell us what makes you the best!

THE TORQUE GUN

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AFFIDAVIT

AFFIDAVIT

Applicant: **Yale-New Haven Hospital**

Project Title: **Acquisition of two SPECT/CT cameras to replace a SPECT camera in Nuclear Medicine and two gamma cameras in Nuclear Cardiology**

I, **James Staten** (Individual's Name), **Chief Financial Officer** (Position Title – CEO or CFO)

of **Yale-New Haven Hospital** (Hospital or Facility Name) being duly sworn, depose and state that

Yale-New Haven Hospital's (Hospital or Facility Name) information submitted in this Certificate of Need Application is accurate and correct to the best of my knowledge.

Signature

6/17/13
Date

Subscribed and sworn to before me on 6/17/13

Notary Public/Commissioner of Superior Court

ROSE ARMINIO
NOTARY PUBLIC
State of Connecticut
My Commission Expires
February 28, 2018

My commission expires:

CON FILING FEE

OFFICE OF HEALTH CARE ACCESS

REQUEST FOR NEW CERTIFICATE OF NEED

FILING FEE FORM

APPLICANT: Yale-New Haven Hospital PROJECT TITLE: Acquisition of Two SPECT/CT Cameras to Replace a SPECT Camera in Nuclear Medicine and Two Gamma Cameras in Nuclear Cardiology DATE: June 18, 2013	FOR OHCA USE ONLY: 1. Check logged (Front desk) DATE _____ INITIAL _____ 2. Check rec'd (Clerical/Cert.) _____ _____ 3. Check correct (Superv.) _____ _____ 4. Check logged (Clerical/Cert).) _____ _____

NEW CERTIFICATE OF NEED APPLICATION	
TOTAL FEE DUE:	$500.00

ATTACH HERE CERTIFIED OR CASHIER'S CHECK ONLY (Payable to: Treasurer, State of Connecticut)

Bank of America

Cashier's Check

No. 1340000325

Void After 90 Days

Date 06/12/13 09:19:32 AM

Notice to Purchaser: In the event that this check is lost, misplaced or stolen, a sworn statement and 90 day waiting period will be required prior to replacement. This check should be negotiated within 90 days.

YALE NEW HAVEN HOSPITAL

0004 0021178 1006

Pay BANK OF AMERICA FIVE ZERO ZERO CTSCTS

$**500.00

To The Order Of TREASURER, STATE OF CONNECTICUT

SPECT CT CON JUNE 2013

Remitter (Purchased By): YALE NEW HAVEN HEALTH SYSTEM

Bank of America, N.A.
SAN ANTONIO, TX

S. Ferguson
AUTHORIZED SIGNATURE

00-53-3364B 11-2010

⑈1340000325⑈ ⑆114000191⑆ 00164100559⑆

THE ORIGINAL DOCUMENT HAS A REFLECTIVE WATERMARK ON THE BACK. HOLD AT AN ANGLE TO VIEW WHEN CHECKING THE ENDORSEMENTS.

CON APPLICATION

State of Connecticut
Office of Health Care Access
Certificate of Need Application

Instructions: Please complete all sections of the Certificate of Need ("CON") application. If any section or question is not relevant to your project, a response of "Not Applicable" may be deemed an acceptable answer. If there is more than one applicant, identify the name and all contact information for each applicant. OHCA will assign a Docket Number to the CON application once the application is received by OHCA.

Docket Number:	
Applicant:	**Yale-New Haven Hospital**
Contact Person:	**Nancy Rosenthal**
Contact Title:	**Sr. Vice President – Health Systems Development**
Contact Address:	**20 York Street, New Haven, CT 06510**
Contact Person's Phone Number:	**(203) 863-3908**
Contact Person's Fax Number:	**(203) 863-4736**
Contact Person's Email Address:	**nancy.rosenthal@greenwichhospital.org**
Project Town:	**New Haven**
Project Name:	**Acquisition of two SPECT/CT cameras to replace a SPECT camera in Nuclear Medicine and two gamma cameras in Nuclear Cardiology**
Statute Reference:	Section 19a-638, C.G.S.
Estimated Total Capital Expenditure:	$1,880,443

Project Description: Acquisition of Equipment

a. Please provide a narrative detailing the proposal.

Response:
Yale-New Haven Hospital (YNHH) is a 1,541 bed (including bassinets) teaching hospital with two integrated campuses located in New Haven and a pediatric campus in Bridgeport. YNHH is affiliated with the Yale University School of Medicine, and includes the Yale-New Haven Children's Hospital, the Yale-New Haven Psychiatric Hospital, and the Smilow Cancer Hospital. YNHH provides primary, secondary, tertiary and many quaternary acute care services.

YNHH acquired two SPECT/CT cameras, one in 2010 and the other in 2011, to replace a SPECT camera in its Nuclear Medicine Department and two gamma cameras in its Nuclear Cardiology Department, with an understanding at the time that, based on the 2010 changes to the Certificate of Need (CON) laws, a CON was not required. Upon further review of CON activity on the Office of Health Care Access (OHCA) website, it became apparent that CON approval may have been required for purchase of the replacement SPECT/CT cameras.

YNHH contacted OHCA for guidance, and per OHCA's instruction, YNHH submitted a CON Determination Form (DN: 12-31807-DTR) and provided detailed responses to OHCA's inquiries. OHCA then requested that YNHH submit a CON application for the acquisition of the SPECT/CT cameras that were purchased in 2010 and 2011. As requested, the purpose of this CON application is to obtain approval from OHCA for the SPECT/CTs. Importantly, the quality of the scans produced by these cameras is significantly superior to the SPECT camera and gamma cameras that were replaced, due in part to the ability of the CT component to provide attenuation correction. Neither camera is used for diagnostic CT scanning. This is described in further detail below. Moreover, the SPECT/CT cameras are critical pieces of equipment in providing full service Nuclear Medicine and Nuclear Cardiology services to meet the demands and expectations of physicians and patients seeking care at YNHH.

Please note that per the instruction of OHCA, this application provides a comprehensive description with respect to both SPECT/CTs. For clarification, the application designates, where appropriate, whether the SPECT/CT is located in Nuclear Medicine or Nuclear Cardiology.

Nuclear Medicine

The first camera, a Siemens Symbia T SPECT/CT, was acquired in January of 2010 to replace an existing SPECT camera, a Phillips Axis purchased in 1996. The Siemens Symbia T is currently installed and in use in the Nuclear Medicine Department on the YNHH York Street Campus. The Nuclear Medicine Department

is a division of the Radiology Department at YNHH, which offers a full range of imaging services including CT, MRI, ultrasound, mammography, and x-ray.

A SPECT/CT can perform several different types of scans, including planar imaging, SPECT, and SPECT/CT. A planar image is a two-dimensional scan and can be performed as a whole body scan or tailored to various parts of the body. A SPECT scan produces a three-dimensional image as the camera rotates around the body. Finally, a SPECT/CT scan produces a three-dimensional image similar to SPECT, but has a CT component that adds clarity to the scan via attenuation correction. The benefits of attenuation correction are discussed in detail below.

Notably, the Siemens Symbia T has a 2-slice CT which can be used for attenuation correction when performing a SPECT scan, for a variety of conditions, including bone scans, brain imaging, I123MIBG (scans performed primarily on pediatric patients for neuroblastomas), whole body scans, octreotide (scans of the liver for carcinoid tumors), parathyroid scans, DaTscans (scans of the brain for Parkinson's) and white blood cell scans. The CT component provides greater image clarity than SPECT scans alone, but cannot be used as a standalone CT scanner for diagnostic CT imaging. The attenuation correction removes shadows and artifacts which frequently can appear in images.

YNHH placed the Siemens Symbia T into operation in March of 2010, and through August of 2012, used only its planar imaging and SPECT functions. YNHH did not use the attenuation correction feature until September of 2012, because the room in which the SPECT/CT was put into operation required remodeling to comply with OSHA regulations to accommodate the low-dose radiation associated with the CT component. YNHH then engaged a construction company to install a lead door, relocate the control panel to a space outside of the room, and insert a lead window through which technicians could monitor patients. When the construction was complete, and the room was made compliant with OSHA requirements, YNHH began performing SPECT scans with the CT component. YNHH began using the CT function for attenuation correction in September 2012, to enhance the clarity and quality of the SPECT imaging.

For clarification, to perform a nuclear medicine scan, a small amount of a radioactive isotope is first injected into a patient. This radioactive tracer is then detected by a nuclear camera to create pictures of internal organs based on the distribution of the isotope. A nuclear medicine scan can be used to assess organ function and internal anatomy for diagnosis and treatment purposes, and can be extremely useful in a broad range of patients, including, but not limited to cardiac, oncology, and neurology patients. As noted above, a SPECT camera can be used to produce planar images or three-dimensional images, depending on the clinical indication and the purpose of the exam. At times, the image produced may be distorted, due in part to the density of tissue within the body. This may result in low quality scans that appear cloudy or obstructed and could produce false positive results. To correct these imperfections, a nuclear medicine scan

that is performed with a SPECT camera may be accompanied by low dose computed tomography (CT), which provides attenuation correction. The SPECT/CT scan has been found to produce significantly higher quality images than SPECT and gamma cameras, because it can eliminate much of the distortion associated with variations in tissue density within the body.

YNHH purchased the Siemens Symbia T as a hybrid modality to continue providing nuclear medicine scans (as were previously provided with the aging Phillips Axis) but with increased clarity, resulting in better and safer patient care. The Phillips Axis camera was near the end of its useful life and needed to be replaced so that YNHH could continue offering the full range of Nuclear Medicine services to patients. The replacement SPECT/CT offered the ability to perform nuclear medicine scans with the added quality of attenuation correction, representing the professionally agreed upon standard of imaging for a large number of patients and clinical indications treated at YNHH.[1] Importantly, DaTscans, which are images of the brain that can be performed in search of Parkinson's Disease, can only be performed with a SPECT/CT. The Siemens Symbia T continues to provide numerous clinical benefits including higher quality exams, less false positives, improved lesion detection, reduced scanning time and a reduction in radiation exposure. Please note that when the Siemens Symbia T was purchased in 2010 to replace the aged Phillips Axis, YNHH removed the old camera and disposed of it thereafter.

Nuclear Cardiology

The second camera, a GE Discovery 570c SPECT/CT, was acquired and installed in September 2011 to replace two existing gamma cameras. The GE Discovery 570c is currently located in the Nuclear Cardiology Department on the YNHH York Street Campus. The Nuclear Cardiology Department is part of the Heart and Vascular Center at YNHH and offers a full spectrum of services, including stress tests, PET/CT, and gated blood pool imaging.

The two gamma cameras that YNHH replaced in 2011 were a GE Varicam with Hawkeye and a GE Dsti Dual Head SPECT camera. The GE Varicam with Hawkeye was purchased in 1999 and was in operation through October of 2011. It was nearing the end of its useful life when it was replaced. This equipment was located on the third floor of the Clinic Building on the York Street Campus at YNHH and was occasionally used by a Yale physician for pre-clinical research that did not involve human subjects. However, it was removed and disposed of on May 16, 2013. The "Hawkeye" component of this camera offered very low dose x-ray that performs attenuation correction (similar to the CT component in the SPECT/CT). However, the Hawkeye could not be utilized for patients over 225 pounds, due in part to the very low dose of the x-ray. With the increasing obesity epidemic in Connecticut and the United States at large, YNHH frequently

[1] Please see Section 3.g. below which references a position statement issued by the American Society of Nuclear Cardiology and the Society of Nuclear Medicine on the quality and efficacy of SPECT/CT.

encounters patients that exceed this weight limit. As described in further detail below, the GE Discovery 570c camera (which replaced the GE Varicam with Hawkeye) offers attenuation correction via its CT component, the images are higher quality than the GE Varicam with Hawkeye, and the scans can be performed on a larger patient population, including those over 225 pounds.

The GE Discovery 570c also replaced a GE Dsti Dual Head SPECT camera that was in operation from 2000 through October of 2011. It was approaching the end of its useful life when it was replaced, and was removed and disposed of on October 25, 2011. This camera did not offer the benefits of attenuation correction. In addition, this camera was in operation for over 10 years and needed replacement due to its age.

The GE Discovery 570c is used in the Nuclear Cardiology Department to perform stress perfusion exams, which are non-invasive tests that can detect heart disease. These tests are widely accepted and commonly used to stratify risk among patients prior to cardiac surgery, and to evaluate the source of chest pain. Importantly, the GE Discovery 570c has a multi-slice CT component, which is used only for attenuation correction. As noted previously, imaging in nuclear medicine and nuclear cardiology is subject to certain inherent limitations due in part to variation in the density of tissues within the body. For example, when conducting a nuclear cardiology scan, overlying breast tissue and/or adipose tissue can create shadows or artifacts, which may appear in a similar manner as true coronary defects. This can make interpretation of a nuclear medicine scan challenging. To resolve these issues, a CT component can be applied immediately after the SPECT scan, offering attenuation correction to remove shadows and artifacts. The result is a high quality nuclear cardiology scan that can be interpreted by a physician with greater confidence, eliminating unnecessary follow-up testing, and decreasing the risk of false positives.

The CT component of the GE Discovery 570c is not used as a standalone CT. Rather, the non-diagnostic CT component provides attenuation correction, and can also evaluate calcium scoring of the coronary arteries, which provides physicians with additional anatomical information when interpreting perfusion scans. This means a more complete picture is available to help plan a patient's cardiac treatment.

Interestingly, the GE Discovery 570c includes Alcyone solid state crystals, which are a new type of crystal technology that improves image quality and the ability to confidently and accurately interpret a nuclear cardiology exam. These crystals are significantly more sensitive than standard Sodium Iodide crystals, allow for a reduction in the amount of isotope injected into a patient when performing a scan, and a reduction in imaging time from 25 minutes to 6 minutes. In contrast, the gamma cameras that were replaced required a greater injection of radioactive isotope, took approximately four times longer to complete the scan, and did not

offer attenuation correction. The SPECT/CT offers significantly safer and higher quality care than the equipment it replaced.

The GE Discovery 570c offers a high quality scan, with accurate images that are not distorted by overlying tissue, and can be performed with low radiation in less time than typical scans via a SPECT or gamma camera. This piece of equipment allows YNHH to combine the physiological results of the SPECT perfusion scan, and enhanced anatomical information from the non-diagnostic CT, which provides attenuation correction with one efficient test. Finally, it improves the quality of care among patients in the community that receive nuclear cardiology services at YNHH.

In summary, YNHH purchased the Siemens Symbia T in 2010 and the GE Discovery 570c in 2011 to replace equipment at the end of its useful life that did not provide the same high-quality scans offered with the CT attenuation correction feature of the replacement cameras. YNHH seeks approval from OHCA to continue providing high quality nuclear medicine services with this equipment, which offers attenuation correction, but is not used as a standalone CT scanner.

b. Provide letters that have been received in support of the proposal.

Response:
Please see Attachment I for a letter in support of the SPECT/CT cameras from Albert J. Sinusas, MD, FACC, FAHA, Professor of Medicine and Diagnostic Radiology, Yale School of Medicine; Section Chief of Nuclear Cardiology; Director of Cardiovascular Imaging, Yale Translational Research Imaging Center.

c. Provide the Manufacturer, Model, Number of slices/tesla strength of the proposed scanner (as appropriate to each piece of equipment).

Response:
Nuclear Medicine
The SPECT/CT within Nuclear Medicine is a Siemens Symbia T, with a 2-slice CT component for attenuation correction.

Nuclear Cardiology
The SPECT/CT within Nuclear Cardiology is a GE Discovery NM/CT 570c, with a 64-slice CT component for attenuation correction.

d. List each of the Applicant's sites and the imaging modalities and other services currently offered by location.

Response:
YNHH currently provides the following SPECT and gamma camera services:

Nuclear Medicine

Camera	Location	Type of Camera
NM2 (Philips Skylight)	Smilow Cancer Hospital YNHH York Street Campus	SPECT Camera
NM3 (Philips Brightview)	Smilow Cancer Hospital YNHH York Street Campus	SPECT Camera
Camera	**Location**	**Type of Camera**
NM4 (Siemens Symbia T)[2]	Smilow Cancer Hospital YNHH York Street Campus	SPECT/CT
NM6 (Philips Skylight)	Smilow Cancer Hospital YNHH York Street Campus	SPECT Camera
SN1 (Siemens Symbia S)	Shoreline Medical Center Guilford, CT	SPECT Camera

Nuclear Cardiology

Camera	Location	Type of Camera
CPCIMG (GE-Myosight)	Emergency Department YNHH York Street Campus	Nuclear Gamma Camera
NMC1 (GE- MPS)	Nuclear Cardiology YNHH York Street Campus	Nuclear Gamma Camera
NMC2 (GE-Infinia)	Nuclear Cardiology YNHH York Street Campus	Nuclear Gamma Camera
NMC3 (GE- 530c)	Nuclear Cardiology YNHH York Street Campus	Nuclear Gamma Camera
NMC4 (GE570 SPECT/CT)[3]	Nuclear Cardiology YNHH York Street Campus	SPECT/CT

YNHH also provides a full range of imaging services on its York Street Campus, including diagnostic x-ray, CT, MRI, ultrasound, mammography, bone density, nuclear medicine, PET, and PET/CT.

YNHH provides additional imaging services at Temple Radiology (in New Haven, East Haven, West Haven, Guilford, and Hamden), North Haven Medical Center (in North Haven), Long Wharf Medical Building (in New Haven), and on its St. Raphael's Campus (in New Haven). The major services provided include diagnostic x-ray, CT, MRI, ultrasound, mammography, and bone density scans.

[2] This is the SPECT/CT purchased in 2010.
[3] This is the SPECT/CT purchased in 2011.

2. Clear Public Need

   a. Explain why there is a clear public need for the proposed equipment. Provide evidence that demonstrates this need.

Response:
Clear public need is based on the following:

- **Nuclear Medicine. The Phillips Axis Dual Head camera that was replaced in 2010 reached the end of its useful life, requiring replacement.**
- **Nuclear Cardiology. The GE Varicam with Hawkeye that was replaced in 2011 reached the end of its useful life, requiring replacement. The GE Dsti Dual Head camera that was replaced in 2011 reached the end of its useful life, requiring replacement.**
- **Quality of Services. Nuclear medicine imaging is a vital service for the diagnosis and treatment of many patients, including, but not limited to oncology, cardiac, and neurologic patients. The replacement SPECT/CT cameras offer superior image quality, less radiation and shorter scan times than the SPECT camera and gamma cameras they replaced. This increases the accessibility and quality of care provided by YNHH. In addition, certain scans, such as brain imaging for Parkinson's Disease, can only be performed effectively on a SPECT/CT to obtain an accurate image.**

Why Were the SPECT and Gamma Cameras Replaced?

Nuclear Medicine. The Phillips Axis Dual Head camera that YNHH replaced in 2010 was purchased in 1996 and at the end of its useful life. In order to continue providing high quality nuclear medicine services, YNHH decided to replace the SPECT camera and upgrade it to a more clinically appropriate SPECT/CT camera, which offered enhanced scanning via the hybrid SPECT/CT capability. Notably, the upgrade did not result in the purchase of equipment that offers full standalone CT services, but simply an add-on feature of CT attenuation correction to enhance the SPECT image. SPECT/CT offers enhanced imaging for nuclear medicine patients, via limitation of artifacts due to attenuation correction, less radiation, shorter scan times, less false positive results, and overall higher-qualify and clinically safe care.

Nuclear Cardiology. The GE Varicam with Hawkeye that YNHH replaced in 2011 was purchased in 1999 and at the end of its useful life. In order to continue providing high quality nuclear cardiology services, YNHH decided to replace the gamma camera, which had been in operation for over 10 years.

The GE Dsti Dual Head camera that YNHH replaced in 2011 was in operation from 2000 to 2011, and at the end of its useful life. In order to continue providing high quality nuclear cardiology services, YNHH decided to replace the gamma camera, which had been in operation for over 10 years.

In light of the need for replacement, YNHH was presented with the opportunity to upgrade the gamma cameras with a more clinically appropriate SPECT/CT, which offered enhanced scanning via the hybrid SPECT/CT capability, and attenuation correction. Notably, the upgrade did not result in the purchase of equipment that is used as a full standalone CT scanner, but simply added the CT as an add-on to the SPECT scan, creating higher quality images with attenuation correction. Thus, the replacement was driven by a need to replace aging equipment, and the need to provide high quality imaging, decreased false positives, shorter scan times, less radiation, and overall clinically superior care.

Clinical Improvement in Care – Attenuation Correction

As described in detail above, a SPECT/CT offers numerous clinical benefits compared to SPECT and gamma cameras. The SPECT/CTs that replaced the old equipment offers low-dose computed tomography (CT) which provides attenuation correction, eliminating artifacts and shadows due to variation in tissue density when performing a traditional nuclear imaging scan. Low-dose CT attenuation correction has been shown to provide significantly more effective scans when combined with the SPECT camera.

Thus, the SPECT/CTs provide a similar service as the equipment they replaced, with enhanced quality due to the low-dose CT function. The improvement in quality offers the ability to detect small lesions in cancer patients that may not have been detected by a SPECT camera. Research suggests that surgeons can minimize the amount of surgical intervention required for breast cancer or melanoma through the use of SPECT/CT. Importantly, certain types of scans can only be performed effectively with a SPECT/CT, including images of the brain to detect Parkinson's Disease. Without a SPECT/CT, this type of exam could not be performed effectively for patients at YNHH. In the field of cardiology, SPECT/CT allows a physician to accurately interpret perfusion tests without the shadows or artifacts created by breast tissue and adipose tissue that overlay the heart. As a result, detection of coronary disease is more accurate, and may avoid unnecessary duplicative testing. In sum, SPECT/CT is a slight variation on the traditional SPECT and gamma camera scans, but offers increased clarity and tremendous value to patients and physicians.

Additional Benefits of SPECT/CT

The SPECT/CTs that replaced the SPECT camera and the gamma cameras utilize a lower dose of radioactive tracers than the outdated equipment. The radioactive isotope is injected prior to the exam, and by reducing a patient's exposure, YNHH is able to improve patient safety at the hospital. In addition, the new technology also offers reduced scan times over the outdated equipment, which provides an additional advantage to patients.

b. Provide the utilization of existing health care facilities and health care services in the Applicant's service area.

Response:
Data regarding utilization of SPECT/CT cameras in the YNHH service area are not publicly available, and so YNHH is unable to provide information responsive to this question. Based on a review of OHCA' website, none of the hospitals in YNHH's service area have pursued the purchase of SPECT/CT cameras.

c. Complete **Table 1** for each piece of equipment of the type proposed currently operated by the Applicant at each of the Applicant's sites.

Response:
Please see Table 1 below.

Nuclear Medicine

Table 1: Existing Equipment Operated by the Applicant

Provider Name Street Address Town, Zip Code	Description of Service *	Hours/Days of Operation **	Utilization [4] [5] FY12 (SPECT and SPECT/CT VOLUME ONLY)
YNHH 20 York Street New Haven, CT 06501	SPECT Camera NM2	Monday – Friday 8am – 4:30pm	29
YNHH 20 York Street New Haven, CT 06501	SPECT Camera NM3	Monday – Friday 8am – 4:30pm	142
YNHH 20 York Street New Haven, CT 06501	[6]SPECT/CT Camera NM4	Monday – Friday 8am – 4:30pm	123
YNHH 20 York Street New Haven, CT 06501	SPECT Camera NM6	Monday – Friday 8am – 4:30pm	260
YNHH 20 York Street New Haven, CT 06501	SPECT Camera SN1	Monday – Friday 8am – 4:30pm	53

[4] **The YNHH fiscal year runs from October 1st to September 30th.**
[5] **Please note that this volume includes only the SPECT and SPECT/CT imaging performed on the equipment listed above, and does not include planar scans which are not considered SPECT volume because these exams create two-dimensional images. Equipment with low SPECT volume is often utilized for planar exams and this volume is not displayed here.**
[6] This SPECT/CT is the Siemen's Symbia T that was purchased in 2010 to replace a SPECT camera (a Philips Axis that was purchased in 1996) at the end of its useful life.

Provider Name Street Address Town, Zip Code	Description of Service *	Hours/Days of Operation **	Utilization ***[4], [5] FY12 (SPECT and SPECT/CT VOLUME ONLY)
YNHH 20 York Street New Haven, CT 06501	SPECT Camera Philips Axis	N/A	Removed in 2010 and replaced with NM4.

* Include equipment strength (e.g. slices, tesla strength), whether the unit is open or closed (for MRI)
** Days of the week unit is operational, and start and end time for each day; and
*** Number of scans/exams performed on each unit for the most recent 12-month period (identify period)

Nuclear Cardiology

Provider Name Street Address Town, Zip Code	Description of Service *	Hours/Days of Operation **	Utilization ***[7], [8] FY12 (SPECT and SPECT/CT VOLUME ONLY)
YNHH (ED) 20 York Street New Haven, CT 06501	Gamma Camera CPCIMG	7 days a week 8am – 8pm	956
YNHH 20 York Street New Haven, CT 06501	Gamma Camera NMC1	Monday – Friday 8am – 5pm	3
YNHH 20 York Street New Haven, CT 06501	Gamma Camera NMC2	Monday – Friday 8am – 5pm	652
YNHH 20 York Street New Haven, CT 06501	Gamma Camera NMC3	Monday – Friday 8am – 5pm	415
YNHH 20 York Street New Haven, CT 06501	SPECT/CT Camera[9] NMC4	Monday – Friday 8am – 5pm	599
YNHH 20 York Street New Haven, CT 06501	Gamma Camera Phillips Prism	N/A	0 (Removed in July 2010 and replaced with NMC3.)

[7] **The YNHH fiscal year runs from October 1st to September 30th.**
[8] **Please note that this volume includes only the SPECT and SPECT/CT imaging performed on the equipment listed above, and does not include gated-blood pool exams which are not considered SPECT volume because these exams create two-dimensional images. Equipment with low SPECT volume is often utilized for gated blood pool exams and this volume is not displayed here.**
[9] This SPECT/CT is the GE Discovery 570c that was purchased in 2011 to replace two gamma cameras (a GE SMV Dsti and a GE Varicam with Hawkeye that were purchased in 2000 and 1999, respectively) at the end of their useful lives.

Provider Name Street Address Town, Zip Code	Description of Service *	Hours/Days of Operation **	Utilization ***[7], [8] FY12 (SPECT and SPECT/CT VOLUME ONLY)
YNHH 20 York Street New Haven, CT 06501	Gamma Camera GE SMV Dsti	N/A	22 (Removed in 2011 and replaced with NMC4.)
YNHH 20 York Street New Haven, CT 06501	Gamma Camera GE Varicam w/ Hawkeye	N/A	41 (Removed in 2011 and replaced with NMC4.)

* Include equipment strength (e.g. slices, tesla strength), whether the unit is open or closed (for MRI)
** Days of the week unit is operational, and start and end time for each day; and
*** Number of scans/exams performed on each unit for the most recent 12-month period (identify period).

d. Provide the following regarding the proposal's location:

i. The rationale for locating the proposed equipment at the proposed site;

Response:
The SPECT/CT equipment is a replacement for existing, technologically outdated nuclear imaging equipment that was located on the York Street Campus at YNHH.

Nuclear Medicine

The Siemens Symbia T was installed in the Nuclear Medicine Department on the YNHH York Street Campus. It is located on the second floor of the Smilow Cancer Hospital. This is where a majority of the nuclear medicine equipment within this Department is located.

Nuclear Cardiology

The GE Discovery 570c was installed in the Nuclear Cardiology Department on the YNHH York Street Campus. This is where a majority of the nuclear cardiology equipment within this Department is located.

ii. The population to be served, including specific evidence such as incidence, prevalence, or other demographic data that demonstrates need;

Response:
The population served includes residents of the YNHH historical core service area, which include Ansonia, Bethany, Branford, Cheshire, Clinton, Deep River, Derby, East Haven, Essex, Guildford, Hamden, Killingworth, Madison, Meriden, Milford, New Haven, North Branford, North Haven, Old Saybrook, Orange, Oxford, Seymour, Wallingford, Westbrook, West Haven and Woodbridge.

The Siemens Symbia T is used for a variety of patient conditions, and the following scans: bone scans, brain imaging, I123MIBG (scans performed

primarily on pediatric patients for neuroblastomas), whole body scans, octreotide (scans of the liver for carcinoid tumors), parathyroid scans, DaTscans (scans of the brain for Parkinson's) and white blood cell scans. This camera serves patients within the Smilow Cancer Hospital, and YNHH, offering services to oncology and neurology patients, among others.

The GE Discovery 570c is used for stress perfusion exams, which are non-invasive exams to detect coronary disease. This camera serves patients within YNHH, and its Heart and Vascular Center.

Importantly, the Connecticut Department of Health's "Burden of Cardiovascular Diseases in Connecticut: 2010 Surveillance Report" notes that cardiovascular disease makes up around 1/3 of deaths among Connecticut residents, with 48% of cardiovascular deaths associated with coronary artery disease, and 15% associated with cerebrovascular stroke. The Connecticut State Health Assessment: Preliminary Findings, published by the Connecticut Department of Public Health on January 31, 2013, reiterates the risks of heart disease in our state, noting that it is the leading cause of death in Connecticut, followed by cancer and stroke. This report also makes it clear that the population of Connecticut is aging, with 7.7% more residents over the age of 65 in 2010 than in 2000, and the leading causes of death among this age group are cardiovascular disease, cancer and stroke. Moreover, according to the Connecticut Cancer Partnership's Comprehensive Cancer Control Plan, "the chances of developing cancer increase as a person gets older, because more mutations are likely to accumulate over time." This suggests that as the population of the state ages, so too will the number of individuals that need cancer screening and treatment. The American Cancer Society's Cancer Facts & Figures notes a similar trend, predicting approximately 21,180 new cancer cases in Connecticut in 2013. Thus, as the incidence of heart disease, cancer and stroke increases in the state, the need for high-quality screening via nuclear medicine will likely increase.

YNHH is currently providing SPECT/CT services to screen and treat a variety of conditions, including heart disease, stroke, and cancer, and respectfully requests to continue providing these services. The Siemens Symbia T and the GE Discovery 570c serve a distinct population in the surrounding community, and the incidence and prevalence of diseases that require SPECT/CT imaging is expected to grow. Thus, with OHCA's approval, the continued operation of this equipment will offer a significant benefit within the community as patients have ongoing access to high-quality nuclear medicine technology.

iii. How and where the proposed patient population is currently being served;

Response:
The patient population is currently being served within the Nuclear Medicine and Nuclear Cardiology Departments on the York Street Campus at YNHH in New Haven, Connecticut. The same population will be served in future years.

iv. All existing providers (name, address) of the proposed service in the towns listed above and in nearby towns;

Response:
YNHH is not aware of any other providers in its historical core service area that provide SPECT/CT nuclear imaging services.

v. The effect of the proposal on existing providers; and

Response:
This CON application is for the replacement of outdated equipment that took place in 2010 and 2011. The SPECT/CTs have served the same patient population that was previously served by the SPECT camera and the gamma cameras, and will continue to serve the same population. Thus, this CON application is not expected to have an effect on existing providers.

vi. If the proposal involves a new site of service, identify the service area towns and the basis for their selection.

Response:
Not applicable.

e. Explain why the proposal will not result in an unnecessary duplication of existing or approved health care services.

Response:
The SPECT/CT cameras are replacements for a SPECT camera and two gamma cameras that were at the end of their useful lives. The SPECT/CT cameras also perform the same type of scans (albeit clinically superior) for the same patient population that was previously served with the outdated equipment. Thus, the SPECT/CT cameras are not expected to duplicate existing services, but will result in higher quality care for patients at YNHH. A total of three cameras (one SPECT and two gamma cameras) were taken out of service, and replaced with two cameras that are more clinically advanced.

3. Actual and Projected Volume

a. Complete the following tables for the past three fiscal years ("FY"), current fiscal year ("CFY"), and first three projected FYs of the proposal, for each of the Applicant's existing and proposed pieces of equipment (of the type proposed, at the proposed location only). In Table 2a, report the units of service by piece of equipment, and in Table 2b, report the units of service by type of exam (e.g. if specializing in orthopedic, neurosurgery, or if there are scans that can be performed on the proposed scanner that the Applicant is unable to perform on its existing scanners).

Response:
Nuclear Medicine. Please see Table 2a and 2b below for the SPECT and SPECT/CT volume in the Nuclear Medicine Department for inpatients and outpatients. Per OHCA instruction, this table includes volume data from the fiscal year the SPECT/CT went into operation, and three years of projected volume from the current fiscal year.

To provide context, it important to note that all of the scanners listed below perform planar imaging and SPECT scans, while the NM4 (the SPECT/CT) is the only scanner in the Nuclear Medicine Department that is capable of performing a SPECT scan with attenuation correction via the CT component. The SPECT/CT can also be used to perform a SPECT scan without the attenuation correction if clinically indicated and instructed by the physician. Certain exams are always performed on the SPECT/CT because the site of the legion or tumor requires attenuation correction to compensate for artifacts and shadows created by surrounding tissue, or the scan requires a highly accurate and clear picture to appropriately plan for treatment. For example, parathyroid scans and octreotide scans are performed with the SPECT/CT. Brain scans for Parkinson's must be performed with the SPECT/CT. The decision as to whether the scan requires a SPECT or SPECT/CT is made by the professional clinical opinion of a physician.

The data listed below includes only the SPECT and SPECT/CT volume, and does not include planar imaging used to create two-dimensional images. Where the SPECT and SPECT/CT volume is low, the equipment is often utilized for planar imaging, which occupies the remaining time on the scanner.

Table 2a: Historical, Current, and Projected SPECT and SPECT/CT Volume, by Equip. Unit[10]

	Actual Volume (Last 3 Completed FYs)			CFY Volume*	Projected Volume (Next 3 Full Operational FYs)**		
	FY10[11]	FY11	FY12	FY13[12]	FY13	FY14	FY15
NM2 (total)	58	41	29	3	9	9	9
IP	10	5	4	2	6	6	6
OP	48	36	25	1	3	3	3
NM3 (total)	195	184	142	23	69	69	69
IP	12	13	7	1	3	3	3
OP	183	171	135	22	66	66	66
NM4 (total)[13] SPECT/CT	19	126	123	80	240	240	240
IP	6	11	13	6	18	18	18
OP	13	115	110	74	222	222	222
NM6 (total)	315	381	260	40	120	120	120
IP	21	35	28	7	21	21	21
OP	294	346	232	33	99	99	99
SN1 (total)	54	31	53	9	27	27	27
IP	1	0	0	0	0	0	0
OP	53	31	53	9	27	27	27

[10] Source: Imagecast (software that provides volume by machine).
[11] The YNHH fiscal year runs from October 1st to September 30th.
[12] Current FY13 includes data from October 1, 2012 through January 31, 2013.
[13] This is the Siemen's Symbia T that was purchased in 2010 to replace a SPECT camera (a Philips Axis that was purchased in 1996) at the end of its useful life.

	Actual Volume (Last 3 Completed FYs)			CFY Volume	Projected Volume (Next 3 Full Operational FYs)		
	FY10	FY11	FY12	FY13	FY13	FY14	FY15
Total IP	50	64	52	16	48	48	48
Total OP	591	699	555	139	417	417	417
Grand Total	641	763	607	155	465	465	465

* For periods greater than 6 months, report annualized volume, identifying the number of actual months covered and the method of annualizing. For periods less than six months, report actual volume and identify the period covered.
** If the first year of the proposal is only a partial year, provide the first partial year and then the first three full FYs. Add columns as necessary.
*** Identify each scanner separately and add lines as necessary. Also break out inpatient/outpatient/ED volumes if applicable.
**** Fill in years. In a footnote, identify the period covered by the Applicant's FY (e.g. July 1-June 30, calendar year, etc.).

Table 2b: Historical, Current and Projected SPECT and SPECT/CT Volume by Type of Scan/Exam[14]

	Actual Volume (Last 3 Completed FYs)			CFY Volume*	Projected Volume (Next 3 Full Operational FYs)**		
	FY10[15]	FY11	FY12	FY13[16]	FY13	FY14	FY15
NM2 (total)	58	41	29	3	9	9	9
Bone Scan	6	3	1	0	0	0	0
Brain Image	3	0	0	0	0	0	0
Liver/Spleen	20	13	5	1	3	3	3
Octreo	13	20	21	1	3	3	3
Parathyroid	13	2	1	0	0	0	0
Para. (Early)	2	1	0	0	0	0	0
General	1	2	0	0	0	0	0
WBC Abscess	0	0	1	1	3	3	3
NM3 (total)	195	184	142	23	69	69	69
Bone Scan	5	4	2	0	0	0	0
Brain Image	3	1	1	0	0	0	0
Liver/Spleen	32	17	8	1	3	3	3
Octreo	25	8	10	0	0	0	0
Parathyroid	55	65	53	5	15	15	15
Para. (Early)	39	68	56	8	24	24	24
Kidney	0	1	11	7	21	21	21
General	36	20	1	1	3	3	3
WBC Abscess	0	0	0	1	3	3	3
NM4 (total)[17]	19	126	123	80	240	240	240
Bone Scan	8	4	1	7	21	21	21
Brain Image	1	1	1	10	30	30	30
Liver/Spleen	0	0	15	11	22	22	22
Octreo	0	15	21	10	30	30	30
Parathyroid	0	40	31	16	48	48	48
Para. (Early)	0	36	32	8	24	24	24
Kidney	0	5	5	2	6	6	6
General	0	11	2	9	27	27	27
WBC Abscess	0	1	1	4	12	12	12
NM6 (total)	315	381	260	40	120	120	120
Bone Scan	8	2	2	0	0	0	0
Brain Image	23	34	31	14	42	42	42
Liver/Spleen	10	10	11	0	0	0	0
Octreo	3	0	0	0	0	0	0
Parathyroid	170	165	108	9	27	27	27

[14] Source: Imagecast (software that provides volume by machine).
[15] The YNHH fiscal year runs from October 1st to September 30th.
[16] Current FY13 includes data from October 1, 2012 through January 31, 2013.
[17] This is the Siemen's Symbia T that was purchased in 2010 to replace a SPECT camera (a Philips Axis that was purchased in 1996) at the end of its useful life.

	Actual Volume (Last 3 Completed FYs)			CFY Volume	Projected Volume (Next 3 Full Operational FYs)		
NM6 (cont'd)	FY10	FY11	FY12	FY13	FY13	FY14	FY15
Para. (Early)	100	165	107	14	42	42	42
Kidney	0	0	1	2	6	6	6
General	1	5	0	0	0	0	0
WBC Abscess	0	0	0	1	3	3	3
SN1 (total)	54	31	53	9	27	27	27
Bone Scan	9	8	9	0	0	0	0
Liver/Spleen	7	9	8	2	6	6	6
Octreo	38	14	14	1	3	3	3
Parathyroid	0	0	11	3	9	9	9
Para. (Early)	0	0	11	3	9	9	9
Total	641	763	607	155	465	465	465

* For periods greater than 6 months, report annualized volume, identifying the number of actual months covered and the method of annualizing. For periods less than six months, report actual volume and identify the period covered.
** If the first year of the proposal is only a partial year, provide the first partial year and then the first three full FYs. Add columns as necessary.
*** Identify each type of scan/exam (e.g. orthopedic, neurosurgery or if there are scans/exams that can be performed on the proposed piece of equipment that the Applicant is unable to perform on its existing equipment) and add lines as necessary.
**** Fill in years. In a footnote, identify the period covered by the Applicant's FY (e.g. July 1-June 30, calendar year, etc.).

Nuclear Cardiology. Please see Table 2a and 2b below for the SPECT and SPECT/CT volume within the Nuclear Cardiology Department for inpatient, outpatient and emergency department patients. Per OHCA instruction, this table includes volume data from the fiscal year the SPECT/CTs went into operation, and three years of projected volume from the current fiscal year.

To provide context, it is important to note that the scans provided in the Nuclear Cardiology Department include gated blood pool exams and myocardial perfusion. A gated blood pool exam uses a radioisotope to produce a planar image captured by a gamma camera that shows heart function at rest. This two dimensional image is used to calculate heart function and can assess if certain areas of the heart are not pumping or contracting normally due to blocked arteries. Like the planar imaging in Nuclear Medicine, this data is not included in the volume listed below because it is a simple two-dimensional scan, not a SPECT scan.

Myocardial perfusion is a non-invasive test that shows how well blood flows through the heart muscle. A radioactive tracer is injected, and a SPECT camera or a SPECT/CT can be used to capture images of the heart immediately after exercise, rest, or both. Depending on the radionuclide injected, this exam can show areas of the heart with blocked arteries or injured heart tissue due to heart attack. This exam produces a three-dimensional image, and the volume listed in the table below includes the myocardial perfusion exams performed on this equipment. Where volume is low, the equipment is often utilized to perform gated blood pool exams, which produce two-dimensional planar images.

Table 2a: Historical, Current, and Projected SPECT and SPECT/CT Volume, by Equipment Unit[18]

	Actual Volume (Last 3 Completed FYs)			CFY Volume*	Projected Volume (Next 3 Full Operational FYs)**		
	FY10[19]	FY11	FY12	FY13[20]	FY13	FY14	FY15
CPIMG (total)	743	713	956	333	999	999	999
IP	189	123	356	187	561	561	561
OP	0	0	0	0	0	0	0
ED	554	590	600	146	438	438	438
NMC1 (total)	17	7	3	1	3	3	3
IP	10	3	0	0	0	0	0
OP	7	4	3	1	3	3	3
ED	0	0	0	0	0	0	0
NMC2 (total)	1185	1136	652	157	471	471	471
IP	580	572	272	69	207	207	207
OP	605	564	374	88	264	264	264
ED	0	0	6	0	0	0	0
NMC3 (total)[21]	50	209	415	102	306	306	306
IP	20	93	162	44	132	132	132
OP	30	116	252	58	174	174	174
ED	0	0	1	0	0	0	0
NMC4 (total)[22] SPECT/CT	N/A	N/A	599	253	759	759	759
IP	N/A	N/A	281	138	414	414	414
OP	N/A	N/A	317	115	345	345	345
ED	N/A	N/A	1	0	0	0	0
SMVDsti (total)[23]	96	56	22	N/A	0	0	0
IP	43	12	9	N/A	0	0	0
OP	53	44	13	N/A	0	0	0
ED	0	0	0	N/A	0	0	0
GE Vari (total)[24]	408	360	41	N/A	0	0	0
IP	101	107	6	N/A	0	0	0
OP	307	253	35	N/A	0	0	0
ED	0	0	0	N/A	0	0	0
Philips (total)[25]	219	N/A	N/A	N/A	0	0	0
IP	99	N/A	N/A	N/A	0	0	0
OP	120	N/A	N/A	N/A	0	0	0
ED	0	N/A	N/A	N/A	0	0	0
Total IP	1042	910	1086	438	1314	1314	1314
Total OP	1122	981	994	262	786	786	786
Total ED	554	590	608	146	438	438	438
Grand Total	2718	2481	2688	846	2538	2538	2538

* For periods greater than 6 months, report annualized volume, identifying the number of actual months covered and the method of annualizing. For periods less than six months, report actual volume and identify the period covered.
** If the first year of the proposal is only a partial year, provide the first partial year and then the first three full FYs. Add columns as necessary.
*** Identify each scanner separately and add lines as necessary. Also break out inpatient/outpatient/ED volumes if applicable.
**** Fill in years. In a footnote, identify the period covered by the Applicant's FY (e.g. July 1-June 30, calendar year, etc.).

[18] **Source: Imagecast (software that provides volume by machine).**
[19] **The YNHH fiscal year runs from October 1st to September 30th.**
[20] **Current FY13 includes data from October 1, 2012 through January 31, 2013.**
[21] **This gamma camera was installed in July 2010 to replace the Phillips gamma camera.**
[22] **This is the GE Discovery 570c that was purchased in 2011 to replace two gamma cameras (a GE SMV Dsti and a GE Varicam with Hawkeye that were purchased in 2000 and 1999, respectively).**
[23] This gamma camera was replaced by the GE Discovery 570c SPECT/CT in 2011.
[24] This gamma camera with hawkeye was replaced by the GE Discovery 570c SPECT/CT in 2011.
[25] This gamma camera was replaced by NMC3 in July 2010.

Table 2b: Historical, Current and Projected SPECT and SPECT/CT Volume by Type of Scan/Exam[26]

	Actual Volume (Last 3 Completed FYs)			CFY Volume*	Projected Volume (Next 3 Full Operational FYs)**		
	FY10[27]	FY11	FY12	FY13[28]	FY13	FY14	FY15
CPIMG (total)	743	713	956	333	999	999	999
Myocardial Perfusion	743	713	956	333	999	999	999
NMC1 (total)	17	7	3	1	3	3	3
Myocardial Perfusion	17	7	3	1	3	3	3
NMC2 (total)	1185	1142	652	157	471	471	471
Myocardial Perfusion	1185	1136	652	157	471	471	471
NMC3 (total)[29]	50	209	415	102	306	306	306
Myocardial Perfusion	50	209	415	102	306	306	306
NMC4[30] (total) SPECT/CT	N/A	N/A	599	253	759	759	759
Myocardial Perfusion	N/A	N/A	599	253	759	759	759
SMVDsti[31] (total)	96	56	22	N/A	0	0	0
Myocardial Perfusion	96	56	22	N/A	0	0	0
GE Vari (total)[32]	408	365	41	N/A	0	0	0
Myocardial Perfusion	408	360	41	N/A	0	0	0
Philips (total)[33]	219	N/A	N/A	N/A	0	0	0
Myocardial Perfusion	219	N/A	N/A	N/A	0	0	0
Total	2718	2481	2688	846	2538	2538	2538

* For periods greater than 6 months, report annualized volume, identifying the number of actual months covered and the method of annualizing. For periods less than six months, report actual volume and identify the period covered.
** If the first year of the proposal is only a partial year, provide the first partial year and then the first three full FYs. Add columns as necessary.
*** Identify each type of scan/exam (e.g. orthopedic, neurosurgery or if there are scans/exams that can be performed on the proposed piece of equipment that the Applicant is unable to perform on its existing equipment) and add lines as necessary.
**** Fill in years. In a footnote, identify the period covered by the Applicant's FY.(e.g. July 1-June 30, calendar year, etc.).

b. Provide a breakdown, by town, of the volumes provided in Table 2a for the most recently completed full FY.

Response:

Please see the following tables, which provide the volumes listed above for each Department, including a breakdown by town.

Nuclear Medicine

The following table shows the SPECT and SPECT/CT volume performed in the Nuclear Medicine Department on the York Street Campus at YNHH.

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[26] Source: Imagecast (software that provides volume by machine).
[27] The YNHH fiscal year runs from October 1st to September 30th.
[28] Current FY13 includes data from October 1, 2012 through January 31, 2013.
[29] This gamma camera was installed in July 2010 to replace the Phillips gamma camera.
[30] This is the GE Discovery 570c that was purchased in 2011 to replace two gamma cameras (a GE SMV Dsti and a GE Varicam with Hawkeye that were purchased in 2000 and 1999, respectively).
[31] This gamma camera was replaced by the GE Discovery 570c SPECT/CT in 2011.
[32] This gamma camera with hawkeye was replaced by the GE Discovery 570c SPECT/CT in 2011.
[33] This gamma camera was replaced by NMC3 in July 2010.

City	FY12	City	FY12	City	FY12
NEW HAVEN	48	DERBY	7	GREENWICH	4
BRANFORD	33	OXFORD	7	MYSTIC	4
WEST HAVEN	28	STRATFORD	7	OAKDALE	4
MADISON	24	WOODBRIDGE	7	OLD SAYBROOK	4
WATERBURY	23	BETHLEHEM	6	SOUTHBURY	4
EAST HAVEN	21	BROOKFIELD	6	WATERFORD	4
HAMDEN	21	HARTFORD	6	WATERTOWN	4
NORTH HAVEN	19	MERIDEN	6	MIDDLEBURY	3
WALLINGFORD	17	OLD LYME	6	MIDDLETOWN	3
GROTON	15	STAMFORD	6	PROSPECT	3
GUILFORD	15	MONROE	5	TORRINGTON	3
CHESHIRE	14	NAUGATUCK	5	WESTON	3
MILFORD	14	NEW CANAAN	5	WESTPORT	3
ORANGE	13	NIANTIC	5	BAYONNE	2
NORWALK	12	N. BRANFORD	5	CHESTER	2
BRIDGEPORT	10	SEYMOUR	5	COLCHESTER	2
ANSONIA	9	WESTBROOK	5	COLUMBIA	2
NORWICH	9	CLINTON	4	CROMWELL	2
DANBURY	8	COVENTRY	4	DURHAM	2
TRUMBULL	8	FAIRFIELD	4	OTHER	77
				TOTAL	607

Nuclear Cardiology

The following table shows the SPECT and SPECT/CT volume performed in the Nuclear Cardiology Department on the York Street Campus at YNHH.

City	FY12	City	FY12	City	FY12
NEW HAVEN	828	DERBY	17	HARTFORD	6
WEST HAVEN	233	STRATFORD	17	MONTVILLE	6
HAMDEN	227	WATERBURY	17	NAUGATUCK	6
EAST HAVEN	158	FAIRFIELD	15	NEW YORK	6
BRANFORD	155	BETHANY	13	BERLIN	5
N. HAVEN	80	MIDDLETOWN	13	DURHAM	5
GUILFORD	78	OLD SAYBROOK	13	EAST LYME	5
N. BRANFORD	73	KILLINGWORTH	12	NEW BRITAIN	5
WALLINGFORD	69	SOUTHINGTON	12	OXFORD	5
MADISON	65	SEYMOUR	11	DARIEN	4
MILFORD	55	NORWALK	10	GROTON	4
CLINTON	38	TRUMBALL	9	MONROE	4
WOODBRIDGE	34	WESTBROOK	9	NEW LONDON	4
CHESHIRE	31	NORWICH	8	STONINGTON	4
ORANGE	31	BRISTOL	7	WATERFORD	4

City	FY12	City	FY12	City	FY12
BRIDGEPORT	29	ESSEX	7	WESTERLY	4
MERIDEN	23	OLD LYME	7	BEACON FALLS	3
ANSONIA	19	STAMFORD	7	CANTERBURY	3
SHELTON	19	GREENWICH	6	OTHER	150
				TOTAL	2688

c. Describe existing referral patterns in the area to be served by the proposal.

Response:
Patients that live and work in the historical core service area of YNHH are referred to the Nuclear Medicine and Nuclear Cardiology Departments at YNHH by community physicians, including internists, cardiologists, oncologists, and neurologists. These referrals are based on medical necessity, and clinical indications that support a nuclear imaging scan.

d. Explain how the existing referral patterns will be affected by the proposal.

Response:
This CON application involves the replacement of an existing piece of equipment, which was completed in 2010 and 2011. The SPECT/CTs have served the same patient base as was served prior to 2010 and 2011, and are expected to continue serving the same patient based in the future. Thus, there are no expected changes in referral patterns.

e. Explain any increases and/or decreases in volume seen in the tables above.

Response:
Several factors have contributed to variation in volumes over the past 3 fiscal years, including those described below.

Nuclear Medicine
Volume within this Department has remained fairly steady over the past 3 fiscal years, with a slight decline from FY11 to FY12. During this time, some of the decrease can be attributed to construction performed in the general area of the Nuclear Medicine Department, which impacted efficiency and the ease of access of patients to this area. Other factors leading to a slight decrease in volume may be attributed to physician practices, including cardiologists, offering nuclear medicine imaging in their offices. Finally, the decrease from FY11 to FY12 may be attributed to operational efficiencies experienced with the new SPECT/CT as this new technology provides a more accurate image which could result in a decrease in the amount of duplicative and follow-up exams due to artifacts and shadows that otherwise exist without the attenuation correction of the CT component of the SPECT. Some of the decrease in volume on the SPECT cameras is due to a shift in preference and volume to positron emission tomography (PET) with CT. In addition, some of the volume previously performed on the SPECT cameras has been shifted to the clinically superior SPECT/CT.

Nuclear Cardiology

Volume within this Department has also remained fairly steady over the past 3 fiscal years, with a slight decline from FY10 to FY11. Some of this decrease in volume can be attributed to advances in PET/CT which can be used to perform a myocardial perfusion exam. Although the SPECT/CT can be used to perform this exam on certain overweight patients, a PET/CT scan is often the preferred exam with severely obese patients with a body mass index (BMI) greater than 30. In addition, some of the drop in volume during FY11 can be attributed to a worldwide shortage in radiopharmaceuticals. Notwithstanding, volume in FY12 increased compared to FY11, and is expected to stay constant.

f. Provide a detailed explanation of all assumptions used in the derivation/ calculation of the projected volume by scanner and scan type.

Response:

The projected volume for each of the scanners in the Nuclear Medicine and Nuclear Cardiology Departments is conservatively held flat for the following 3 fiscal years. YNHH has recently affiliated with a new physician cardiology group which is expected to increase utilization of these services. The physician group includes several cardiologists who care for patients that need nuclear imaging services, and YNHH is well-prepared to offer such services. In addition, within the field of nuclear cardiology, new clinical applications, such as new agents and isotopes, are expected to increase volume over time. For example, the FDA recently approved a new isotope, MIBG, which will be used in the heart failure population to help predict which patients may benefit from defibrillator implantation. As more radiopharmaceuticals are available for an expanded number of clinical applications, volume within nuclear cardiology is expected to increase, at least to the point of conservatively holding constant. In addition, the Centers for Medicare and Medicaid Services (CMS) recently issued a new Current Procedural Terminology (CPT) code for the use of SPECT/CT when performing a scan of the parathyroid. It is expected that more CPT codes will be issued for a variety of scan types as SPECT/CT becomes more common as the preferred scan for several conditions. This will likely increase SPECT/CT volume in Nuclear Medicine. Finally, the growth in and aging of the population will likely contribute to an increase in demand for nuclear medicine imaging, especially as cardiovascular disease and stroke are among the leading health issues and causes of death in our state.

All of these factors are expected to lead to an increase in nuclear medicine imaging volume within the Nuclear Medicine and Nuclear Cardiology Departments over the next few years. To be conservative, YNHH has held the FY13 volume at a constant level for the next three years.

g. Provide a copy of any articles, studies, or reports that support the need to acquire the proposed scanner, along with a brief explanation regarding the relevance of the selected articles.

There are many clinical studies that support the need for, and use of SPECT/CT, as well as the enhanced clarity of the images it produces compared to traditional SPECT and gamma cameras. Please see Attachment III for copies of these articles and studies. The following list describes a few of the major findings from these scientific documents:

American Society of Nuclear Cardiology and Society of Nuclear Medicine Joint Position Statement: Attenuation Correction of Myocardial Perfusion SPECT Scintigraphy. This statement provides the position of the American Society of Nuclear Cardiology and the Society of Nuclear Medicine, which states that "incorporation of attenuation correction in addition to ECG gating with SPECT myocardial perfusion images will improve image quality, interpretive certainty, and diagnostic accuracy. These combined results are anticipated to have a substantial impact on improving the effectiveness of care and lowering health care costs."

SPECT Attenuation Correction: An Essential Tool to Realize Nuclear Cardiology's Manifest Destiny. This article describes the purpose and efficacy of attenuation correction, and notes that "studies have convincingly shown how SPECT with attenuation correction recovers the true regional myocardial activity concentration, while non-attenuation correction SPECT does not."

Clinical Value of Stress-Only Tx-99m SPECT Imaging: Importance of Attenuation Correction. This study examines SPECT imaging with attenuation correction, and notes that "the use of attenuation correction with SPECT has been shown to significantly reduce false positive studies for both rest-stress and stress-only imaging." In addition, "stress-only imaging with attenuation correction in symptomatic patients is an efficient method which appropriately identifies at risk and low-risk patients yielding a low percentage requiring rest imaging" which may result in less exposure to radioactive isotopes.

SPECT/CT. This review highlights technical developments in SPECT/CT, and summarizes current literature on potential clinical uses and future directions for SPECT/CT in cardiac, neurology, and oncology patients. This report notes that "the superiority of SPECT/CT over planar imaging or SPECT has been demonstrated in bone scintigraphy, somatostatin receptor scintigraphy, parathyroid scintigraphy, and adrenal gland scintigraphy. Also, rates of detection of sentinel nodes by biopsy can be increased with SPECT/CT."

SPECT/CT Imaging: Clinical Utility of an Emerging Technology. This article explains the benefits SPECT/CT and notes that "combining the functional imaging available with SPECT and the anatomic imaging of computed

tomography (CT) has gained more acceptance and proved useful in many clinical situations [...] These attributes have proved useful in many cardiac, general nuclear medicine, oncologic, and neurologic applications in which the SPECT results alone were inconclusive."

Clinical Applications of SPECT/CT: New Hybrid Nuclear Medicine Imaging System. **This article provides a comprehensive summary of SPECT/CT technology, including, but not limited to, the general architecture of the device, scan protocols, staff training, advantages of SPECT/CT, and clinical applications such as thyroid cancer, adrenal tumor, neuroendocrine tumors, lymphoma, bone scintigraphy, cerebral masses, and various cardiac images.**

4. Quality Measures

a. Submit a list of all key professional, administrative, clinical, and direct service personnel related to the proposal. Attach a copy of their Curriculum Vitae.

Response:
The following list includes key personnel related to the proposal. The Curriculum Vitae are included as Attachment IV.

- **Marna P. Borgstrom, CEO**
- **Richard D'Aquila, President and COO**
- **James Staten, Senior Vice President, Finance and CFO**
- **David W. Cheng, MD, PhD, Associate Professor of Diagnostic Radiology, Yale School of Medicine; Section Chief of Nuclear Medicine**
- **Albert J. Sinusas, MD, FACC, FAHA, Professor of Medicine and Diagnostic Radiology, Yale School of Medicine; Section Chief of Nuclear Cardiology; Dir. of Cardiovascular Imaging, Yale Translational Research Imaging Center**

b. Explain how the proposal contributes to the quality of health care delivery in the region.

Response:
With this Certificate of Need application, YNHH seeks approval from OHCA to continue operating two SPECT/CT cameras that were purchased to replace a SPECT camera and two gamma cameras. The SPECT/CT cameras contribute to the quality of health care in the region by offering more advanced imaging services than available with the SPECT and gamma cameras. This advanced technology increases image clarity by reducing artifacts via its CT component, increases the ability to detect legions, reduces scan time, and reduces patient exposure to radiation. The reduced radiation dose is a significant quality enhancement. The equipment that the SPECT/CT cameras replaced was approaching the end of its useful life, and did not offer the significant clinical benefits offered by the replacement SPECT/CT cameras. YNHH seeks approval from OCHA for the two SPECT/CT cameras.

Please note that the Yale Cardiovascular Nuclear Imaging Laboratory, which is part of the Nuclear Cardiology Department at YNHH, is accredited by the Intersocietal Commission for the Accreditation of Nuclear Medicine Laboratories (ICANL). This demonstrates the Nuclear Cardiology Department's compliance with ICANL Standards, and commitment to high quality patient care. In addition, the equipment in Nuclear Medicine is accredited by the American College of Radiology, demonstrating YNHH's commitment to compliance with the quality measures of this organization.

5. **Organizational and Financial Information**

a. Identify the Applicant's ownership type(s) (e.g. Corporation, PC, LLC, etc.).

Response:
YNHH is a non-profit corporation.

b. Does the Applicant have non-profit status?
☒ Yes (Provide documentation) ☐ No

Response:
Please see Attachment V for proof of YNHH's non-profit status.

c. Provide a copy of the State of Connecticut, Department of Public Health license(s) currently held by the Applicant and indicate any additional licensure categories being sought in relation to the proposal.

Response:
Please see Attachment VI for a copy of the YNHH license issued by the Connecticut Department of Public Health. This proposal does not involve any changes to licensure.

d. Financial Statements

i. If the Applicant is a Connecticut hospital: Pursuant to Section 19a-644, C.G.S., each hospital licensed by the Department of Public Health is required to file with OHCA copies of the hospital's audited financial statements. If the hospital has filed its most recently completed fiscal year audited financial statements, the hospital may reference that filing for this proposal.

Response:
YNHH's most recently audited financial statements are on file with OHCA.

ii. If the Applicant is not a Connecticut hospital (other health care facilities): Audited financial statements for the most recently completed fiscal year. If audited financial statements do not exist, in lieu of audited financial statements, provide other financial

documentation (e.g. unaudited balance sheet, statement of operations, tax return, or other set of books.)

e. Submit a final version of all capital expenditures/costs as follows:

Response:
Nuclear Medicine

Table 3: Proposed Capital Expenditures/Costs

Medical Equipment Purchase	**$465,000**
Imaging Equipment Purchase	
Non-Medical Equipment Purchase	
Land/Building Purchase *	
Construction/Renovation **	**$61,000**
Other Non-Construction (Specify)	
Total Capital Expenditure (TCE)	**$526,000**
Medical Equipment Lease (Fair Market Value) ***	
Imaging Equipment Lease (Fair Market Value) ***	
Non-Medical Equipment Lease (Fair Market Value) ***	
Fair Market Value of Space ***	
Total Capital Cost (TCC)	
Total Project Cost (TCE + TCC)	**$526,000**
Capitalized Financing Costs (Informational Purpose Only)	
Total Capital Expenditure with Cap. Fin. Costs	**$526,000**

* If the proposal involves a land/building purchase, attach a real estate property appraisal including the amount; the useful life of the building; and a schedule of depreciation.
** If the proposal involves construction/renovations, attach a description of the proposed building work, including the gross square feet; existing and proposed floor plans; commencement date for the construction/ renovation; completion date of the construction/renovation; and commencement of operations date.
*** If the proposal involves a capital or operating equipment lease and/or purchase, attach a vendor quote or invoice; schedule of depreciation; useful life of the equipment; and anticipated residual value at the end of the lease or loan term.

Please see Attachment VII for a copy of the quote from Siemens for the Symbia T SPECT/CT that is located in the Nuclear Medicine Department at YNHH. The installation and full operation of this equipment involved minor construction to install a lead door and insert a lead window in the room in which the equipment is located in order to comply with OSHA regulations. The construction also involved relocating the control panel from the inside of the room to the outside of the room in order to provide a safe environment free from exposure to radiation. Please see Attachment VIII for the quote from Turner Healthcare.

Nuclear Cardiology

Table 3: Proposed Capital Expenditures/Costs

Medical Equipment Purchase	$1,354,443
Imaging Equipment Purchase	
Non-Medical Equipment Purchase	
Land/Building Purchase *	
Construction/Renovation **	
Other Non-Construction (Specify)	
Total Capital Expenditure (TCE)	$1,354,443

Medical Equipment Lease (Fair Market Value) ***	
Imaging Equipment Lease (Fair Market Value) ***	
Non-Medical Equipment Lease (Fair Market Value) ***	
Fair Market Value of Space ***	
Total Capital Cost (TCC)	
Total Project Cost (TCE + TCC)	**$1,354,443**
Capitalized Financing Costs (Informational Purpose Only)	
Total Capital Expenditure with Cap. Fin. Costs	**$1,354,443**

* If the proposal involves a land/building purchase, attach a real estate property appraisal including the amount; the useful life of the building; and a schedule of depreciation.
** If the proposal involves construction/renovations, attach a description of the proposed building work, including the gross square feet; existing and proposed floor plans; commencement date for the construction/ renovation; completion date of the construction/renovation, and commencement of operations date.
*** If the proposal involves a capital or operating equipment lease and/or purchase, attach a vendor quote or invoice, schedule of depreciation; useful life of the equipment; and anticipated residual value at the end of the lease or loan term.

Response:
Please see Attachment IX for a copy of the quote from GE for the GE Discovery 570c that is located in Nuclear Cardiology at YNHH.

f. List all funding or financing sources for the proposal and the dollar amount of each. Provide applicable details such as interest rate; term; monthly payment; pledges and funds received to date; letter of interest or approval from a lending institution.

Response:
The project was funded with YNHH equity.

g. Demonstrate how this proposal will affect the financial strength of the state's health care system.

Response:
This project was completed in 2010 and 2011, and has positively impacted the financial strength of the state's health care system. By replacing two outdated nuclear imaging scanners, YNHH has improved the accuracy and clarity of its nuclear imaging services, decreased scan times, decreased patient exposure to radiation, and reduced the necessity of follow up tests to assess potential false positives or unclear images. In addition, many tests that otherwise could not be performed on a SPECT camera, such as brain scans in search of Parkinson's Disease, can now be performed at YNHH. Overall, the foregoing has resulted in more cost-efficient, safe, and effective care within the state's health care system.

6. **Patient Population Mix: Current and Projected**

a. Provide the current and projected patient population mix (based on the number of patients, not based on revenue) with the CON proposal for the proposed program.

Response:
Current and projected patient population mix is shown in Table 4 below.

Nuclear Medicine

Table 4: Patient Population Mix

	Current* FY 2012	Year 1 FY 2013	Year 2 FY 2014	Year 3 FY 2015	Year 4 FY 2016
Medicare*	34.6%	34.6%	34.6%	34.6%	34.6
Medicaid*	22.0%	22.0%	22.0%	22.0%	22.0
CHAMPUS & TriCare	0.2%	0.2%	0.2%	0.2%	0.2
Total Government	**56.8%**	**56.8%**	**56.8%**	**56.8%**	**56.8**
Commercial Insurers*	41.0%	41.0%	41.0%	41.0%	41.0
Uninsured	2.1%	2.1%	2.1%	2.1%	2.1
Workers Compensation	0.1%	0.1%	0.1%	0.1%	0.1
Total Non-Government	**43.2%**	**43.2%**	**43.2%**	**43.2%**	**43.2**
Total Payer Mix	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0**

* Includes managed care activity.
** New programs may leave the "current" column blank.
*** Fill in years. Ensure the period covered by this table corresponds to the period covered in the projections provided.

Nuclear Cardiology

Table 4: Patient Population Mix

	Current* FY 2012	Year 1 FY 2013	Year 2 FY 2014	Year 3 FY 2015	Year 4 FY 2016
Medicare*	32.9%	32.9%	32.9%	32.9%	32.9%
Medicaid*	11.7%	11.7%	11.7%	11.7%	11.7%
CHAMPUS & TriCare	0.6%	0.6%	0.6%	0.6%	0.6%
Total Government	**45.2%**	**45.2%**	**45.2%**	**45.2%**	**45.2%**
Commercial Insurers*	52.8%	52.8%	52.8%	52.8%	52.8%
Uninsured	1.5%	1.5%	1.5%	1.5%	1.5%
Workers Compensation	0.6%	0.6%	0.6%	0.6%	0.6%
Total Non-Government	**54.8%**	**54.8%**	**54.8%**	**54.8%**	**54.8%**
Total Payer Mix	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

* Includes managed care activity.
** New programs may leave the "current" column blank.
*** Fill in years. Ensure the period covered by this table corresponds to the period covered in the projections provided.

b. Provide the basis for/assumptions used to project the patient population mix.

Response:

Payor mix is based on current payor mix for nuclear medicine and nuclear cardiology patients. The payor mix prior to the replacement of the SPECT camera and gamma cameras has not changed significantly since the installation of the SPECT/CTs. Moreover, the current payor mix is substantially equivalent to the payor mix at the time of the replacement.

7. Financial Attachments I & II

a. Provide a summary of revenue, expense, and volume statistics, without the CON project, incremental to the CON project, and with the CON project. **Complete Financial Attachment I.** (Note that the actual results for the fiscal year reported in the first column

must agree with the Applicant's audited financial statements.) The projections must include the first three full fiscal years of the project.

Response:
Please see Attachment X for Financial Attachments related to the Siemen's Symbia T in Nuclear Medicine.

Please see Attachment X for Financial Attachments related to the GE Discovery 570c in Nuclear Cardiology.

Please note that the source of the volume and revenue data within all of the financial-related attachments is RIMS (software used by the YNHH Finance Department that captures billing and revenue). The data pulled from RIMS is slightly different than the data pulled from Imagecast used to populate the data listed in the tables above and cannot identify volume associated with a particular machine. However, the RIMS data listed in the financial attachments is more applicable with respect to financial matters. Thus, the Imagecast data was used to identify volumes by machine and type of scan, and the RIMS data was used to complete the financial-related attachments.

b. Provide a three year projection of incremental revenue, expense, and volume statistics attributable to the proposal by payer. **Complete Financial Attachment II.** The projections must include the first three full fiscal years of the project.

Response:
Please see Attachment X for a list of assumptions.

c. Provide the assumptions utilized in developing **both Financial Attachments I and II** (e.g., full-time equivalents, volume statistics, other expenses, revenue and expense % increases, project commencement of operation date, etc.).

Response:
Please see Attachment X for a list of assumptions.

d. Provide documentation or the basis to support the proposed rates for each of the FYs as reported in Financial Attachment II. Provide a copy of the rate schedule for the proposed service(s).

Response:
A copy of the rate schedule is on file with OHCA.

e. Provide the minimum number of units required to show an incremental gain from operations for each fiscal year.

Response:
Please see Attachment X for a table of minimum units required to show an incremental gain from operations for each fiscal year.

f. Explain any projected incremental losses from operations contained in the financial projections that result from the implementation and operation of the CON proposal.

Response:
Please see the financial attachments in Attachment X. This is not applicable.

g. Describe how this proposal is cost effective.

Response:
This project was, and continues to be, cost-effective because YNHH replaced outdated nuclear imaging equipment with more efficient and effective SPECT/CT cameras. The new equipment provides an image with more clarity than the old SPECT camera and gamma cameras due in part to the low-dose CT component which provides attenuation correction. Further, with the addition of the two new SPECT/CT cameras, YNHH was able to retire one SPECT camera and two gamma cameras. Prior to replacement, the outdated equipment could not produce the high quality scans offered with the new SPECT/CTs. As a result, nuclear medicine exams were often somewhat difficult to interpret due to artifacts and shadows created by variations in tissue density. For better accuracy, a second exam may be required, exposing patients to an additional injection of the proper radioactive isotope. Now, the replacement SPECT/CTs produce images of substantially greater quality, resulting in less false positives, less secondary testing to confirm otherwise attenuated images, and less exposure to radiation. Moreover, the replacement SPECT/CTs can produce images in much less time than the equipment that was replaced. Thus, the SPECT/CT cameras have provided, and continue to provide, cost effective care.

LETTER OF SUPPORT

Yale SCHOOL OF MEDICINE

ALBERT J. SINUSAS, MD, FACC, FAHA
Professor of Medicine (Cardiology) and Diagnostic Radiology
Director, Cardiovascular Imaging
Director, Yale Translational Research Imaging Center

PO Box 208017 New Haven CT 06520-8017
T 203 785-4915 F 203 737-1026
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courier
330 Cedar Street, 3 FMP New Haven CT 06510

State of Connecticut
Office of Health Care Access
Certificate of Need: Letter of Support

To whom it may concern:

Yale-New Haven Hospital purchased the hybrid SPECT/64-slice CT (Discovery NMCT570c, GE Healthcare) as a replacement for 2 existing gamma cameras that were previously purchased under threshold and were approaching end-of-life. One of these systems, an SMV dual headed gamma camera (installed 2000), did not provided attenuation correction, while the other was a hybrid SPECT/CT (Hawkeye, GE Healthcare, installed 2000) capable of CT-based attenuation correction.

This replacement equipment provides the standard attenuation correction capability that corrects and minimizes shadows caused by tissue and muscle that may mask underlying defects and abnormalities. However, the new system also offers the potential to perform low dose non-diagnostic CT imaging with contrast for definition of the cardiac borders in order to perform additional partial volume correction of SPECT images. This will allow more accurate determination of regional myocardial perfusion, and assessment of the absolute myocardial uptake of newer targeted radiotracers. One of these molecularly targeted agents, ^{123}I-MIBG, was recently approved by the FDA for imaging of sympathetic function of the heart in patients with heart failure. Although this agent was previously approved for non-cardiac imaging, the agent is now available for cardiac imaging. Imaging with ^{123}I-MIBG has been shown to be useful in risk stratifying patients at risk for sudden cardiac death, and potentially for the improved selection of patients for an implantable cardiovertor defibrillator.

Other enhanced functionality and capability are available with the replacement hybrid SPECT-CT cameras that are unavailable with the existing basic gamma cameras, including; state-of-the art technology for simultaneous cardiac and respiratory gating, and improved image alignment capability, and improved detector sensitivity resulting in drastically shorter imaging time and lowered radiation exposure noted below.

The older gamma cameras use a NaI crystal for the detector material, which is the material that has been used for over 50 years. These detectors have inherent limitations and require collimation that makes them less sensitive in terms of light absorption and activity detection. The replacement SPECT-CT system's hybrid gamma camera and 64-slice CT system employs a new and highly innovative detector technology called Alcyone, which **improves energy and spatial resolution and reduces artifacts.** The replacement hybrid SPECT-CT camera employs an array of cadmium-zinc-telluride detectors (Alcyone technology) that provides; 1) vastly improved sensitivity (5-fold increase) for detection of multiple radioisotopes, 2) provides better separation of isotopes with different emission energy, when imaging with multiple isotopes simultaneously, 3) provides better spatial resolution (~5 mm versus 12 mm), and 4) allows dynamic ("PET like") imaging for potential quantification of blood flow and intramyocardial blood volume.

The **increased sensitivity** allows us to image larger patients (BMI > 30) with a lower dose of the radiotracer, and facilitates same day stress and rest imaging, versus the current two day stay (that involves an additional overnight for inpatients). The replacement camera's improved sensitivity also reduces scan times from 20 minutes on a conventional camera to 3-6 minutes or less. Moreover, given the advanced Alcyone technology noted above, as well as the drastically shortened imaging time, imaging protocols can be modified to administer lower doses of radioactive tracer to patients, significantly reducing their radiation exposure. The improved sensitivity also permits dynamic imaging of radiotracer delivery and washout, allowing absolute quantification of radiotracer uptake and clearance.

The **improved energy resolution** allows us to image two isotopes simultaneously, facilitating combined imaging with conventional perfusion agent and new molecular targeted agents like ^{123}I-MIBG.

The **improved spatial resolution** of the Alcyone detectors should allow imaging of the atria along with the ventricles of the heart. The ability to image the atria would permit evaluation and risk stratification of patients at risk for atrial fibrillation, a growing health problem in the US. This type of atrial imaging requires the hybrid system that combines high-resolution CT with high-resolution and high-sensitivity SPECT.

Given the replacement camera's hybrid nature, compared to non-identical images from two separate pieces of equipment, the aligned physiological information from the equipment's gamma component perfusion scan and the anatomical information from the system's CT component will provide physicians with matched images and enhanced ability to detect activity for diagnosis, while also reducing errors resulting from reviewing non-identical images taken from different cameras on different days that must subsequently be manually aligned.

In summary, the replacement hybrid SPECT-CT camera will not only meet our current needs for basic attenuation correction of SPECT, but will also improve SPECT image quality and diagnostic accuracy, enhance imaging capabilities, significantly reduce radiation exposure, and provide the Hospital's patients with safer, more efficient, higher quality care.

Sincerely;

Albert J. Sinusas, MD, FACC
Professor of Medicine and Diagnostic Radiology
Director, Cardiovascular Imaging

PUBLIC HEALTH DOCUMENTS

DPH Keeping Connecticut Healthy

The Burden of Cardiovascular Diseases in Connecticut

2010 Surveillance Report

March 2011

State of Connecticut
Department of Public Health
410 Capitol Avenue
P.O. Box 340308
Hartford, CT 06134-0308

CREDITS AND ACKNOWLEDGMENTS

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We gratefully acknowledge the work of Betty C. Jung who co-authored an earlier edition of this report (*The Burden of Cardiovascular Disease in Connecticut: 2006 Surveillance Report*).

Table of Contents

EXECUTIVE SUMMARY

- Cardiovascular diseases (CVD) are a great public health concern. CVD account for about one-third of all Connecticut resident deaths. Coronary heart disease (CHD), cerebrovascular disease (stroke) and heart failure (HF) are the main types, accounting for 48%, 15%, and 8% respectively of all CVD deaths.

- The CVD, CHD, and stroke age-adjusted mortality rates of Connecticut residents decreased significantly between 1999 and 2008.

- Approximately 55% of all Connecticut resident CVD deaths are among females. However, males have significantly higher age-adjusted CVD mortality rates (2006-2008 data).

- Black Connecticut residents have the highest age-adjusted CVD mortality rate as well as higher age-adjusted CVD, CHD, and stroke premature mortality rates compared with White and Hispanic residents (2006-2008 data).

- Hispanic Connecticut residents have significantly lower age-adjusted CVD and CHD mortality rates than White residents (2006-2008 data).

- About 18% of all hospital discharges in Connecticut are due to CVD. Approximately 26% of CVD hospitalizations are due to CHD, 12% to stroke, and 18% to HF (2008 data).

- Connecticut male residents have higher age-adjusted rates of hospitalizations for CVD, CHD, stroke, and HF than female residents. Black Connecticut residents have higher rates of hospitalizations for CVD, stroke, and HF than White and Hispanic residents (2008 data).

- About $2.2 billion was billed for CVD hospitalizations in Connecticut in 2008. Approximately 34% of CVD charges are for CHD, 12% for stroke, and 12% for HF. CVD also incur enormous indirect costs.

- Risk factors for CVD may be modifiable or non-modifiable. Key modifiable risk factors are high blood pressure, high blood cholesterol, smoking, diabetes, obesity, and physical inactivity. Non-modifiable risk factors include increasing age and family history of heart disease and stroke.

- High blood pressure (HBP) is a major risk factor for heart attack and stroke. About 27% of Connecticut adults have HBP. Connecticut males are more likely than females to have HBP. About 25% of White, 36% of Black, and 22% of Hispanic adults in Connecticut have HBP. Also, Connecticut adults with lower annual household incomes are more likely to have HBP compared to adults with higher annual household incomes (2007-2009 data).

- High blood cholesterol (HBC) is a major risk factor for CHD. About 38% of Connecticut adults have HBC. Connecticut males are more likely than females to have HBC. The prevalence of HBC increases with age. Black and Hispanic Connecticut adults are less likely than White adults to have had their blood cholesterol tested. Connecticut adults with lower annual household incomes are less likely than adults with higher annual household incomes to have had their blood cholesterol tested (2007-2009 data).

- Cigarette smoking increases the risk of heart attack, stroke, and death from CHD. About 16% of Connecticut adults are current smokers. Current adult smokers are more likely to be younger, have lower annual household incomes, and be less educated. Among adults, smoking rates do not vary significantly by gender or race and ethnicity (2007-2009 data). According the 2009 Connecticut School Health Survey, 15.3% of high school students are current smokers. White high school students are more likely than Black and Hispanic students to be current smokers.

- Diabetes has been recognized as a major risk factor for CVD. An estimated 6.9% of Connecticut adults have diagnosed diabetes. Connecticut males are more likely to have diabetes than females. Also, high rates of diabetes are associated with older age, lower socioeconomic position, and racial and ethnic minority status. About 5.6% of White, 14.9% of Black, and 10.5% of Hispanic adults in Connecticut have diabetes (2007-2009 data).

- Obesity is an independent risk factor for CVD. An estimated 10.4% of high school students in Connecticut are obese. High school males are more likely to be obese than females and Hispanic students are more likely to be obese than White and Black students (2009 data). Approximately 21% of Connecticut adults are obese. Older adults are more likely to be obese than younger adults; males are more likely to be obese than females; and those with lower annual household incomes are more likely to be obese than those with higher annual household incomes. Also, Black and Hispanic adults are more likely to be obese than White adults (2007-2009 data).

- Physical inactivity is associated with an increased risk of a number of chronic health conditions including CHD, high blood pressure, and obesity. Approximately 47% of Connecticut adults participate in less than the recommended amount of physical activity. Older adults, females, and adults with lower annual household incomes have higher rates of physical inactivity. About 44.5% of White, 59.7% of Black, and 54.2% of Hispanic Connecticut adults are physically inactive (2007-2009 data).

- The co-prevalence of risk factors places an individual at elevated risk for CHD and stroke. About 42% of Connecticut adults have two or more modifiable risk factors for CVD (2007-2009 data).

- Early recognition of the signs and symptoms of heart attack and stroke increase the likelihood of immediate emergency transport to the hospital and timely medical care. Only 13.6% of Connecticut adults can identify all the proper heart attack signs and only 22.6% can identify all the proper stroke signs. Women tend to be more knowledgeable than men about the signs and symptoms of heart attack and stroke (2007-2009 data).

- Access to health care is crucial to the prevention, treatment, and management of CVD. About 9% of adults in Connecticut do not have health insurance. Approximately 6% of White, 21% of Black, and 30% of Hispanic adults in Connecticut do not have health insurance (2007-2009).

- Targeted public health interventions are warranted for all Connecticut residents with multiple risk factors. Special emphasis should be placed on evidence-based interventions that address risk factor reduction among Black, Hispanic, and lower-income Connecticut adults.

THE BURDEN OF CARDIOVASCULAR DISEASES IN CONNECTICUT

INTRODUCTION

Cardiovascular disease refers to a wide variety of heart and blood vessel diseases. The most common forms of cardiovascular disease are coronary heart disease (CHD) and cerebrovascular disease. Essential hypertension, heart failure (HF), and atherosclerosis are other common cardiovascular diseases (CVD).[1] CVD are of great public health concern because more than one-third of all deaths in Connecticut are due to CVD and because prevention efforts have shown great potential in reducing the morbidity, mortality, and disability of CVD.[2, 3]

MORTALITY

CVD accounted for 9,351 Connecticut resident deaths in 2008, or about 33% of all deaths for the period. In contrast, cancer deaths accounted for 24%; chronic lower respiratory disease, 5%; unintentional injuries, 5%; and diabetes, 2% of all Connecticut resident deaths (Table 1).[3]

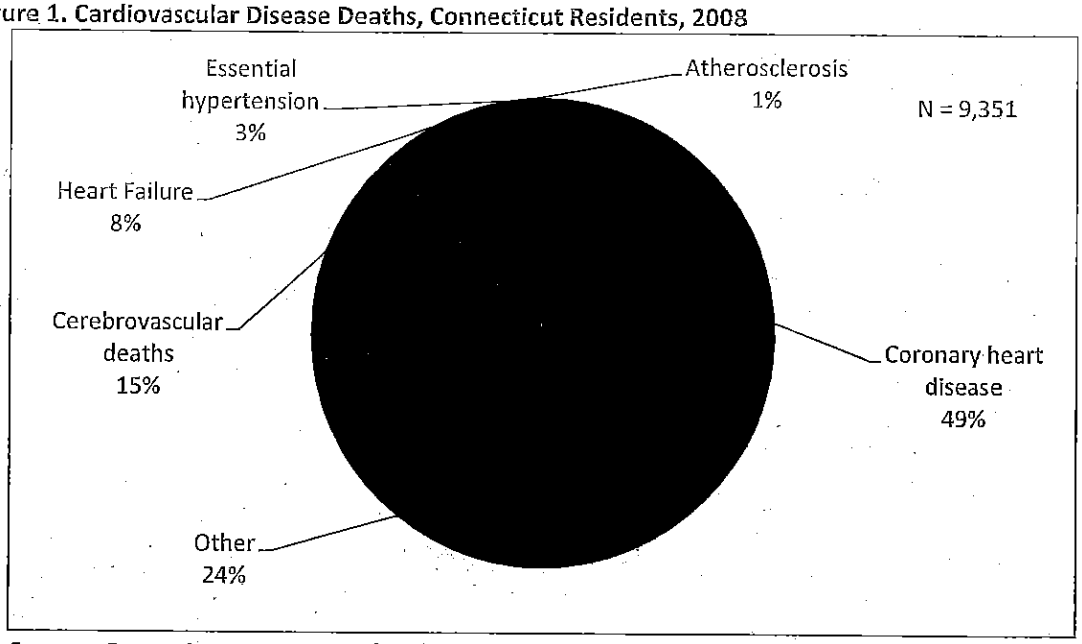
Table 1. Connecticut Resident Deaths, 2008

Cause of Death	Number of Deaths	Percent of Deaths
All Causes	28,749	100%
Cardiovascular Disease	9,351	33%
Cancer	6,765	24%
Chronic Lower Respiratory Disease	1,494	5%
Unintentional Injury	1,362	5%
Alzheimer's Disease	831	3%
Pneumonia and Influenza	688	2%
Diabetes	618	2%

Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

The major CVD are CHD and cerebrovascular disease or "stroke". Stroke is the most severe clinical manifestation of cerebrovascular disease, and the terms are used interchangeably in this report.[4] CHD accounts for 49% of all CVD deaths and includes hypertensive heart disease and ischemic heart disease (2008 data). Stroke is responsible for about 15% of CVD deaths in Connecticut, and includes two major types - ischemic stroke and hemorrhagic stroke. HF accounts for 8% of all CVD deaths, while essential hypertension and atherosclerosis account for 4% of all CVD deaths in Connecticut (Figure 1).[3]

Figure 1. Cardiovascular Disease Deaths, Connecticut Residents, 2008

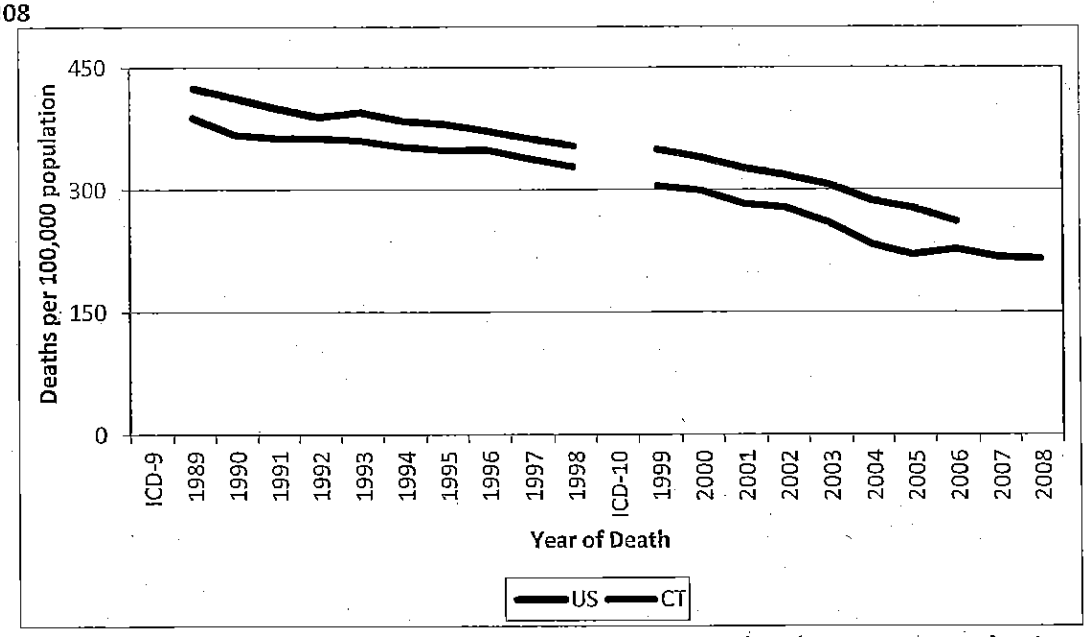


Sources: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Trends in Age-adjusted Mortality

Since the 1990s, CVD and CHD mortality rates* have decreased significantly for all Connecticut residents.[5,6] This continuing decrease in Connecticut CVD and CHD mortality rates mirrors a similar decline in CVD and CHD mortality rates nationwide.[7] CVD and CHD mortality rates for Connecticut residents have been consistently lower than those for the United States population (Figure 2 and Figure 3).[3,7] Since 2001, the Connecticut resident CHD mortality rate has been below the *Healthy People 2010* target of 166 per 100,000 population (Figure 3). There is no *Healthy People 2010* target for CVD.[8]

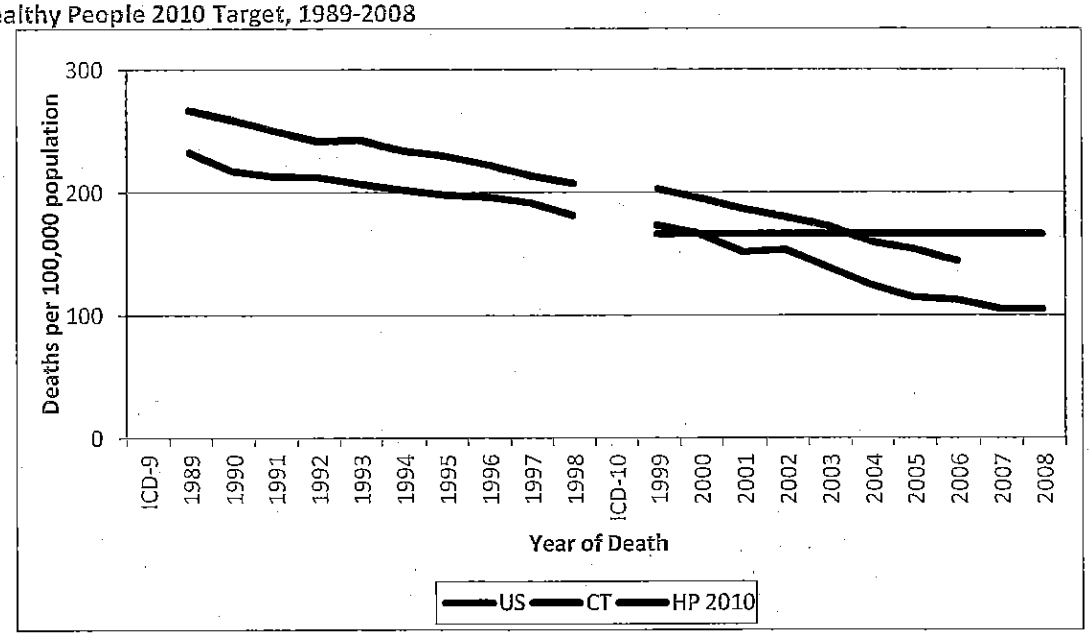
Figure 2. Age-adjusted Mortality Rates for Cardiovascular Disease, Connecticut & United States, 1989-2008



Sources: Connecticut Department of Public Health, Vital Statistics Mortality Files, 2010. Centers for Disease Control and Prevention, 2010. Note: Rates are adjusted to the 2000 US standard population. Classification includes deaths with ICD-9 codes: 390-459.9 (1989 to 1998); ICD-10 codes: I00-I78.9 (1999 to 2008).

* The mortality rates presented in this report are age-adjusted mortality rates (AAMR). The AAMRs were computed by the direct method using the 2000 U.S. standard million population. The AAMRs were calculated using the death records of Connecticut residents.

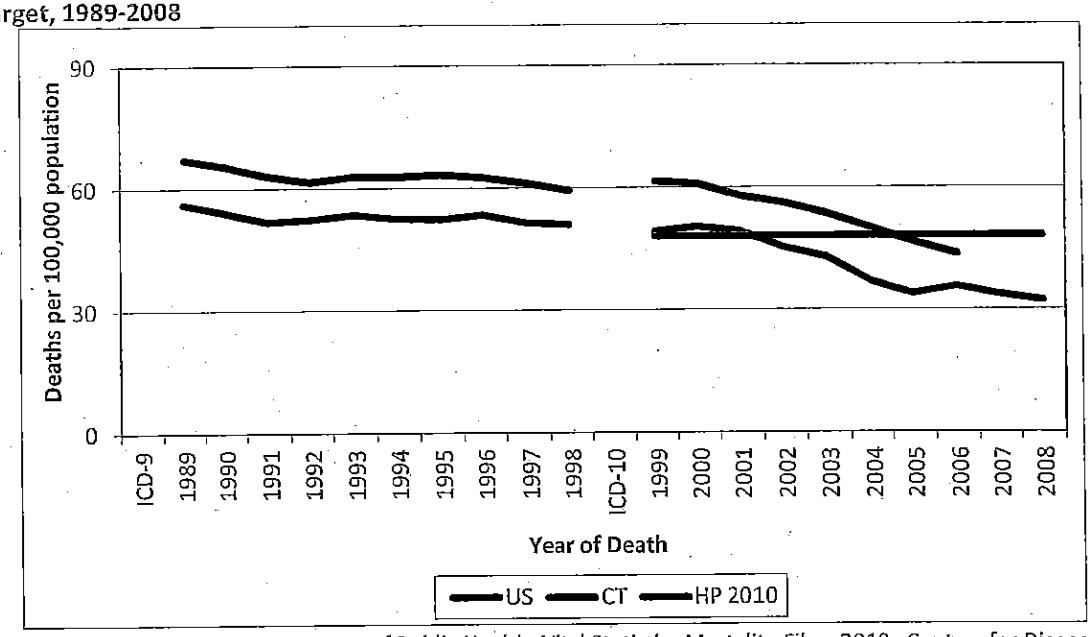
Figure 3. Age-adjusted Mortality rates for Coronary Heart Disease, Connecticut, United States, & Healthy People 2010 Target, 1989-2008



Source: Connecticut Department of Public Health, Vital Statistics Mortality Files, 2010. Centers for Disease Control and Prevention, 2010. Note: Rates are adjusted to the 2000 US standard population. Classification includes deaths with ICD-9 codes: 402,410-414, 429.2 (1989 to 1998); ICD-10 codes: I11, I20-25 (1999 to 2008).

Stroke mortality rates of Connecticut residents did not change significantly in the 1990s.[5] However, decreasing trends have been observed since 1999.[6] Connecticut resident mortality rates from stroke have been consistently lower than those of the U.S.[7] Since 2002, the Connecticut resident stroke mortality rate has been below the *Healthy People 2010* target of 48 per 100,000 population (Figure 4).[3, 8]

Figure 4. Age-adjusted Mortality Rates for Stroke, Connecticut, United States, & Healthy People 2010 Target, 1989-2008

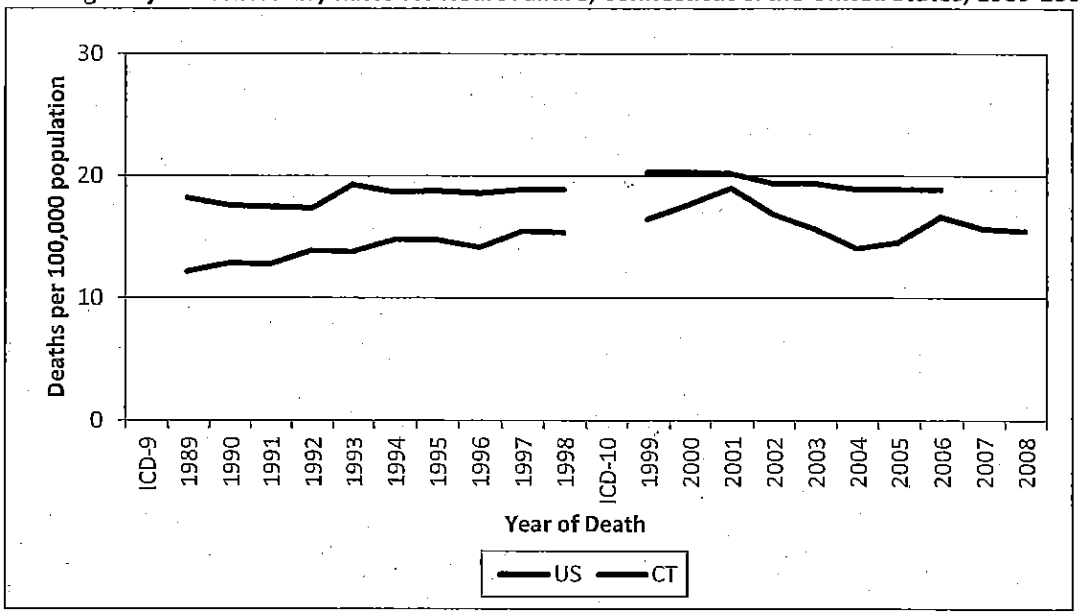


Sources: Connecticut Department of Public Health, Vital Statistics Mortality Files, 2010. Centers for Disease Control and Prevention, 2010. Note: Rates are adjusted to the 2000 US standard population. Classification includes deaths with ICD-9 codes: 430-438 (1989 to 1998); ICD-10 codes: I60-69 (1999 to 2008).

During the 1990s, the Connecticut resident HF mortality rates increased significantly.[5] The increase in the HF mortality rates throughout the 1990s has been attributed to more people surviving heart attacks experienced earlier in life and to the aging population.[1] Approximately 60% of all HF deaths in Connecticut occur in persons aged 85 or older. In contrast, 45% of all CHD deaths and 49% of all cerebrovascular disease deaths occur in persons 85 and older.[7] The 2006-2008 Connecticut resident HF mortality rate was significantly lower than the 1999-2001 rate [data not shown]; however, linear trend analyses of HF mortality rates did not show a statistically significant change ($p \leq 0.05$) for the period 1999-2008.[3,6]

Connecticut HF mortality rates have been consistently lower than those of the U.S.[3,7] There is no *Healthy People 2010* target for HF (Figure 5).[8]

Figure 5. Age-adjusted Mortality Rates for Heart Failure, Connecticut & the United States, 1989-2008



Sources: Connecticut Department of Public Health, Vital Statistics Mortality Files, 2010. Centers for Disease Control and Prevention, 2010. Note: Rates are adjusted to the 2000 US standard population. Classification includes deaths with ICD-9 code: 428.0 (1989 to 1998); ICD-10 code: 150.0 (1999 to 2008).

Mortality by Gender

Approximately 55% of all Connecticut resident CVD deaths are among females (2006-2008 data). While more females than males die from CVD in Connecticut, males have higher CVD mortality rates (Table 2). Connecticut males have a 45% higher mortality rate due to CVD compared with females, a 71% higher mortality rate due to CHD, and a 30% higher mortality rate due to HF ($p<0.001$ for all comparisons). The stroke mortality rates of Connecticut males and females do not differ significantly.[3]

Table 2. Cardiovascular Diseases Deaths and Age-adjusted Mortality Rates (AAMR) per 100,000 Population, Connecticut Residents, 2006-2008

Cause of Death	All		Male		Female	
	Deaths	AAMR	Deaths	AAMR	Deaths	AAMR
All Cardiovascular Diseases	28,369	219.7	12,889	266.8	15,480	184.4
Coronary Heart Disease	13,840	107.4	6,874	141.3	6,966	82.7
Stroke	4,385	33.8	1,646	34.5	2,739	32.6
Heart failure	2,139	16.0	863	18.6	1,276	14.4

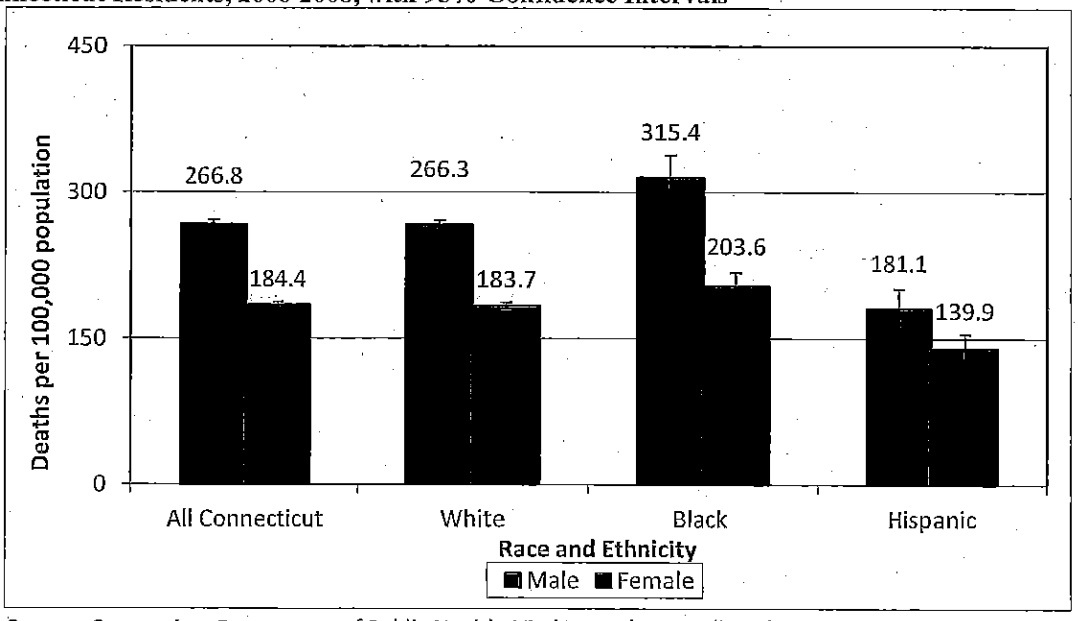
Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Mortality by Gender, Race and Ethnicity

Cardiovascular Disease

The Connecticut resident CVD mortality rates differ by gender, race and ethnicity[†] with Black Connecticut residents having the highest CVD mortality rates (2006-2008 data). The CVD mortality rates of Black males and females are significantly higher than those of White males ($p<0.001$) and females ($p<0.05$), respectively. Black males and females also have significantly higher CVD mortality rates compared with Hispanic males and females ($p<0.001$ for both comparisons).[3] Conversely, Hispanic males and females have significantly lower mortality rates due to CVD than White males and females ($p<0.001$ for both comparisons) [Figure 6].[3] CVD mortality rates declined significantly for all subpopulation groups between 1999-2001 and 2006-2008 ($p<0.001$ for White and Black males and females; $p<0.005$ for Hispanic males; $p<0.01$ for Hispanic females) [data not shown].[3]

Figure 6. Age-adjusted Mortality Rates for Cardiovascular Disease by Gender, Race and Ethnicity, Connecticut Residents, 2006-2008, with 95% Confidence Intervals



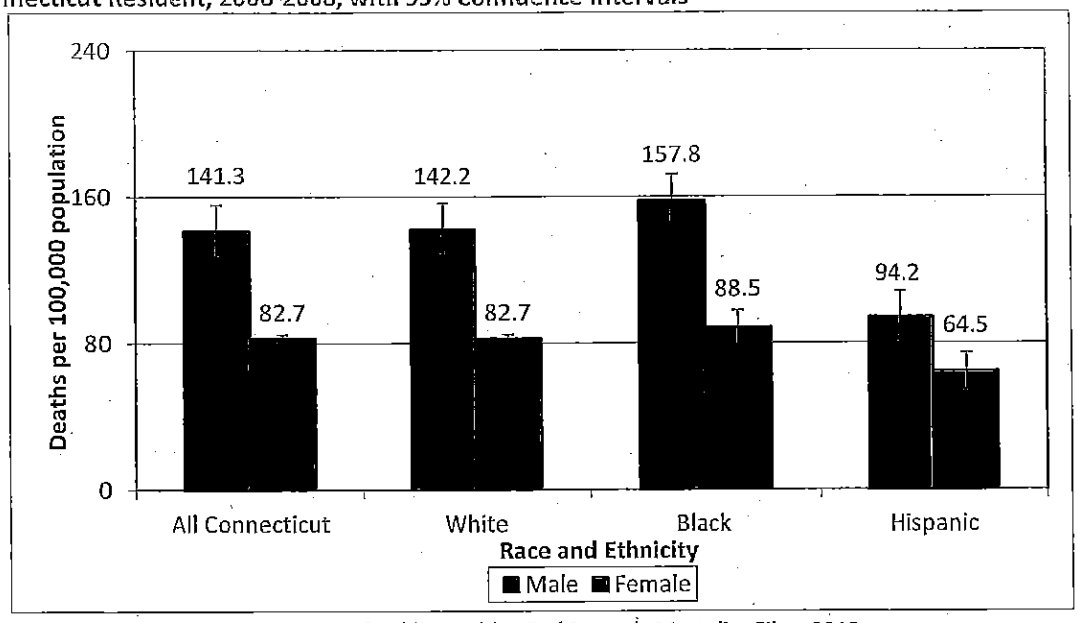
Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

[†] Throughout this report racial groupings (e.g., "Black", "White") exclude persons of Hispanic ethnicity. A Hispanic ethnicity category is included in figures and tables reflecting data separate from race categories. Therefore, the modifier "non-Hispanic" is assumed.

Coronary Heart Disease

The CHD mortality rates differ somewhat by gender, race and ethnicity (2006-2008 data). Hispanic males and females have significantly lower CHD mortality rates than White males and females as well as Black males and females ($p < 0.001$ for males; $p<0.005$ for females) [Figure 7].[3] The CHD mortality rates of White males and females do not differ significantly from the rates of Black males and females (Figure 7).[3] CHD mortality rates declined significantly for all subpopulation groups in Connecticut between 1999-2001 and 2006-2008 ($p<0.01$ for Hispanic females; $p<0.001$ for other comparisons) [data not shown].[3]

Figure 7. Age-adjusted Mortality Rates for Coronary Heart Disease by Gender, Race and Ethnicity, Connecticut Resident, 2006-2008, with 95% Confidence Intervals

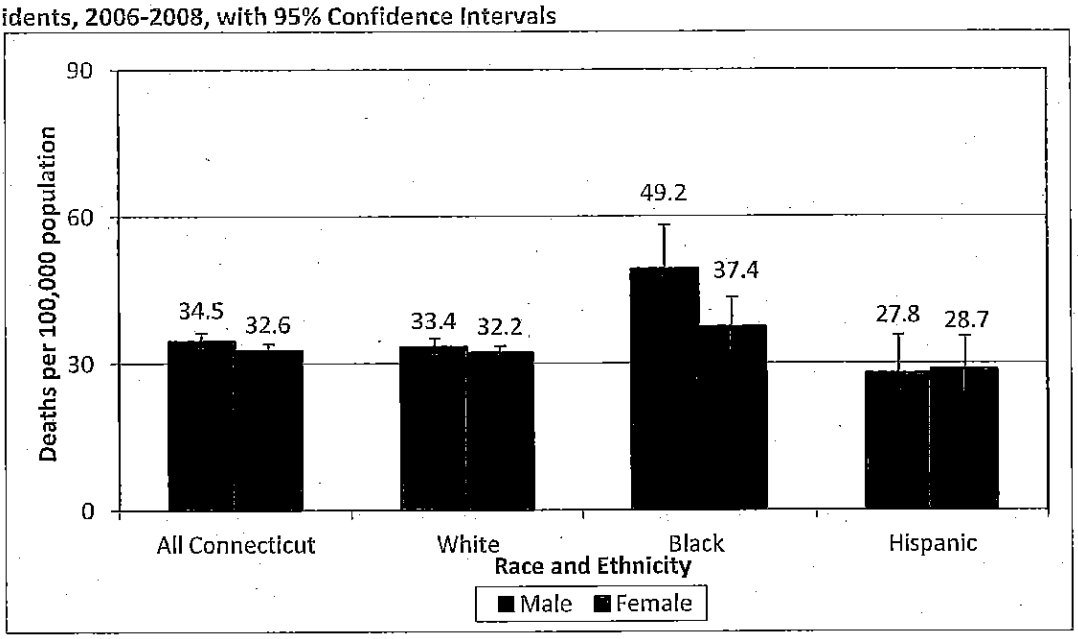


Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Stroke

Stroke mortality rates differ somewhat by gender, race and ethnicity (2006-2008). Black males have a significantly higher stroke mortality rate than White ($p<0.005$) and Hispanic males ($p<0.05$) [Figure 8].[3] However, the stroke mortality rates for Hispanic and White males do not differ significantly.[3] Likewise, the stroke mortality rates for White, Black, and Hispanic females do not differ significantly (Figure 8).[3] Stroke mortality rates declined significantly for White males ($p<0.001$), White females ($p<0.001$) and Black females ($p<0.005$) between 1999-2001 and 2006-2008 [data not shown].[3]

Figure 8. Age-adjusted Mortality Rates for Stroke by Gender, Race and Ethnicity, Connecticut Residents, 2006-2008, with 95% Confidence Intervals

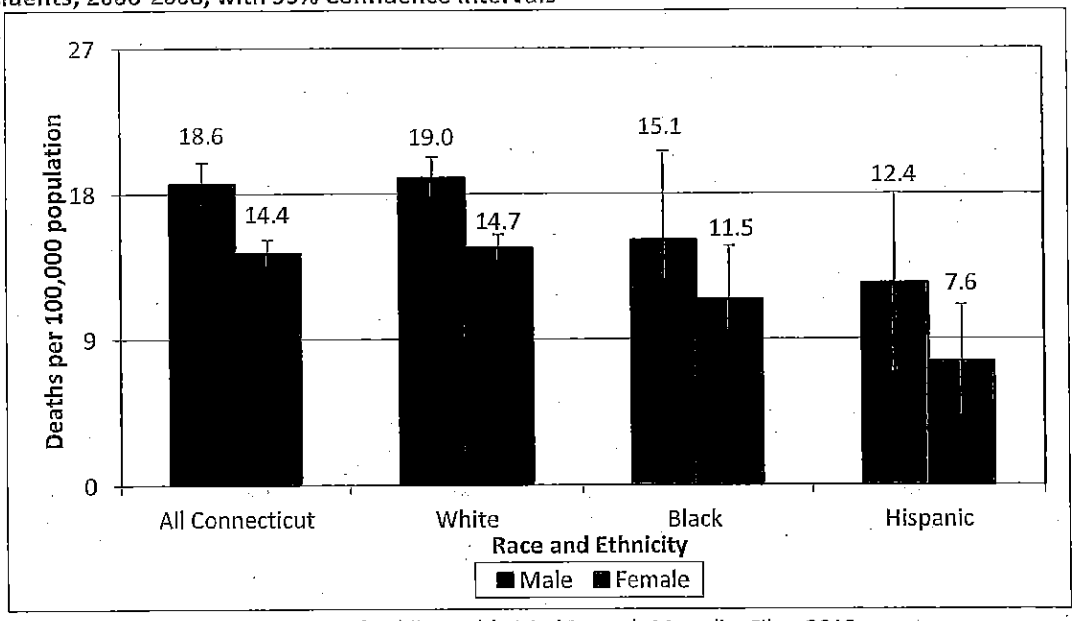


Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Heart failure

HF mortality rates vary little by gender, race and ethnicity (2006-2008 data). While the HF mortality rate of White females is significantly higher than the rate of Hispanic females ($p<0.005$), the HF mortality rate of White and Black females does not differ significantly [Figure 9].[3] The difference in the mortality rates of Black and Hispanic females does not reach statistical significance.[3] Also, the HF mortality rates of White, Black, and Hispanic males do not differ significantly [Figure 9].[3] White females and the overall Black Connecticut population experienced a statistically significant decline in the HF mortality rate between 1999-2001 and 2006-2008 ($p<0.05$ for both comparisons) [data not shown].[3]

Figure 9. Age-adjusted Mortality Rates for Heart Failure by Gender, Race and Ethnicity, Connecticut Residents, 2006-2008, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Premature Mortality by Gender, Race and Ethnicity

Premature mortality[‡], defined as the "years of potential life lost before age 75," focuses on deaths that occur at younger ages. For example, a person who dies at age 45 is considered to have lost 30 years of life, and a person who dies at 70 is considered to have lost 5 years of life.[9] Premature mortality is important because it emphasizes the years of productive life that are lost to society.

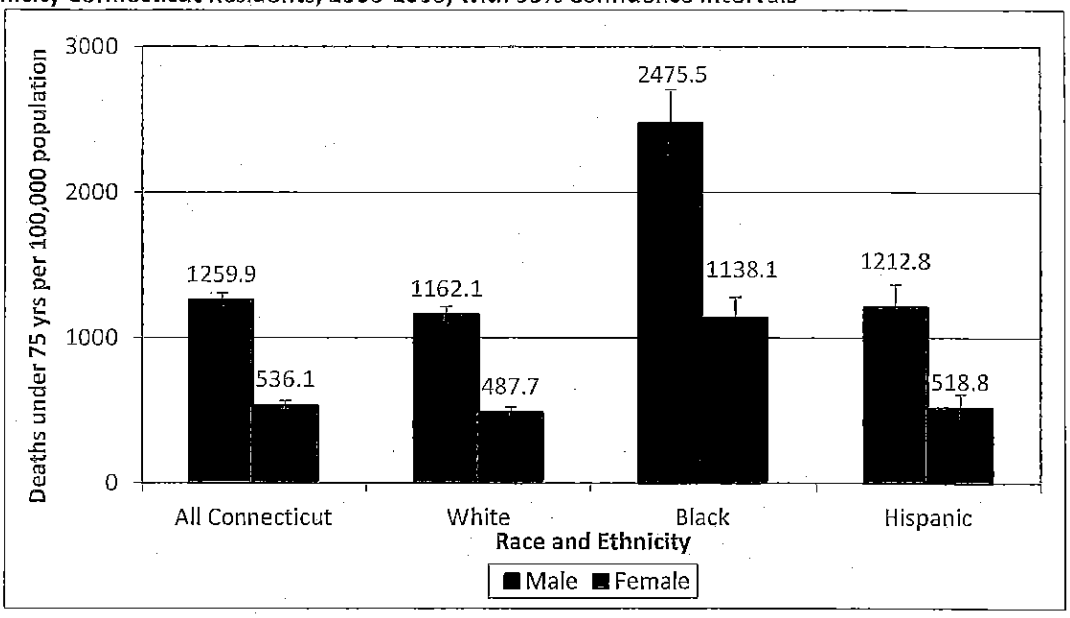
Cardiovascular Disease

CVD premature mortality rates differ by race and ethnicity as well as gender (2006-2008 data). Black males and females have significantly higher CVD premature mortality rates compared with White and Hispanic males and females ($p < 0.001$ for all comparisons) [Figure 10].[3] However, the CVD premature mortality rates of White males and females do not differ significantly from the rates of Hispanic males and females.[3] Also, males have significantly higher CVD premature mortality rates than females ($p<0.001$) (Figure 10).[3]

The CVD premature mortality rate declined significantly for the overall Connecticut population between 1999-2001 and 2006-2008 ($p<0.001$) [data not shown]. Similarly, CVD premature mortality rates declined significantly for White males ($p<0.001$), White females ($p<0.001$), Black females ($p<0.001$), Hispanic males ($p<0.05$), and Hispanic females ($p<0.05$) [data not shown]. CVD premature mortality rates for Black males did not change significantly from 1999-2001 to 2006-2008 [data not shown].[3]

[‡] The premature mortality rates presented in this report are age-adjusted "Years of Potential Life Lost (YPLL) under 75 years". Age-adjusted rates were computed by the direct method using the 2000 U.S. standard million population and Connecticut resident death records.

Figure 10. Age-adjusted Premature Mortality Rates for Cardiovascular Disease by Gender, Race and Ethnicity Connecticut Residents, 2006-2008, with 95% Confidence Intervals



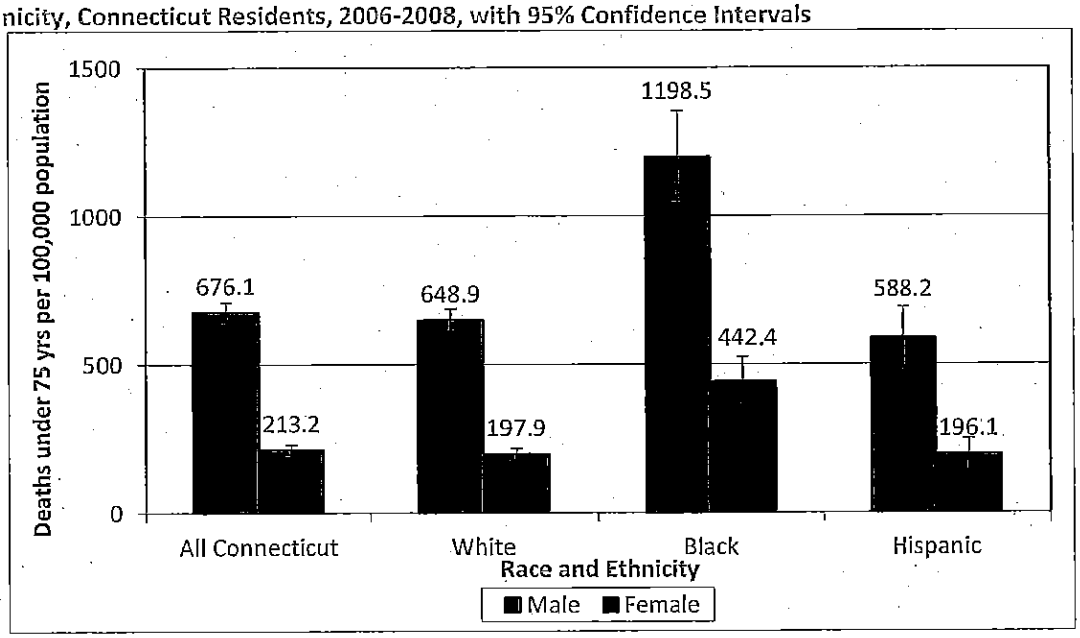
Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Coronary Heart Disease

CHD premature mortality rates differ by race, ethnicity, and gender (2006-2008 data). The CHD premature mortality rates of Black males and females are significantly higher than those of White and Hispanic males and females ($p<0.001$ for all comparisons) [Figure 11].[3] However, the CHD premature mortality rates of White and Hispanic residents do not differ significantly.[3] Also, males have a significantly higher CHD premature mortality rate than females ($p<0.001$) [Figure 11].[3]

The CHD premature mortality rate declined significantly for the overall Connecticut population between 1999-2001 and 2006-2008 ($p<0.001$) [data not shown]. Similarly, CHD premature mortality rates declined significantly for all subpopulation groups (White males, $p<0.001$; White females $p<0.001$; Black males, $p<0.05$; Black females, $p<0.001$; Hispanic males, $p<0.005$; and Hispanic females, $p<0.05$) [data not shown].[3]

Figure 11. Age-adjusted Premature Mortality Rates for Coronary Heart Disease by Gender, Race and Ethnicity, Connecticut Residents, 2006-2008, with 95% Confidence Intervals



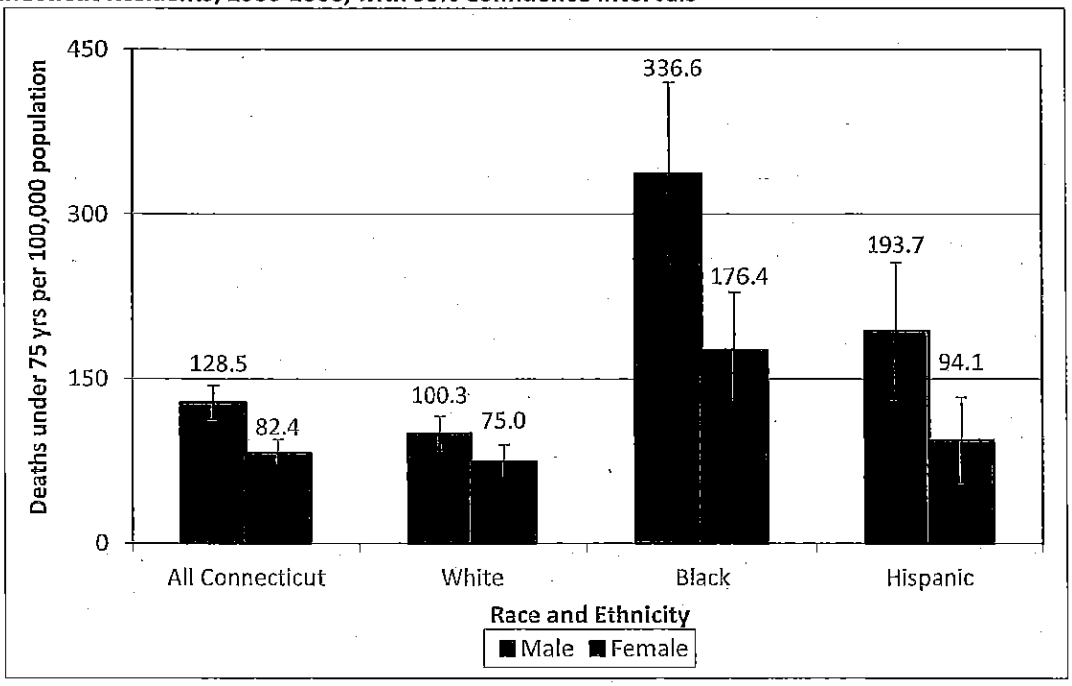
Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Stroke

Stroke premature mortality rates vary by gender, race and ethnicity (2006-2008 data). Overall, males have a significantly higher stroke premature mortality rate than females ($p<0.005$) [Figure 12].[3] The stroke premature mortality rates of Black and Hispanic males are significantly higher than that of White males ($p<0.001$ for Black and White male comparison; $p<0.05$ for Hispanic and White male comparison) [Figure 12].[3] However, the stroke premature mortality rates of Hispanic and Black males do not differ significantly.[3] While Black females have a significantly higher stroke premature mortality rate than White females ($p<0.005$), the stroke premature mortality rates of Hispanic and White females are not statistically different [Figure 12].[3] Also, the stroke premature mortality rates of Black and Hispanic females do not differ significantly.[3]

The stroke premature mortality rate declined significantly for the overall Connecticut population ($p<0.005$), White males ($p<0.05$), and White females ($p<0.05$) between 1999-2001 and 2006-2008 ($p<0.005$) [data not shown]. The decline in the stroke premature mortality rates for Black and Hispanic males and females do not reach statistical significance (data not shown).[3]

Figure 12. Age-adjusted Premature Mortality Rates for Stroke by Gender, Race and Ethnicity, Connecticut Residents, 2006-2008, with 95% Confidence Intervals

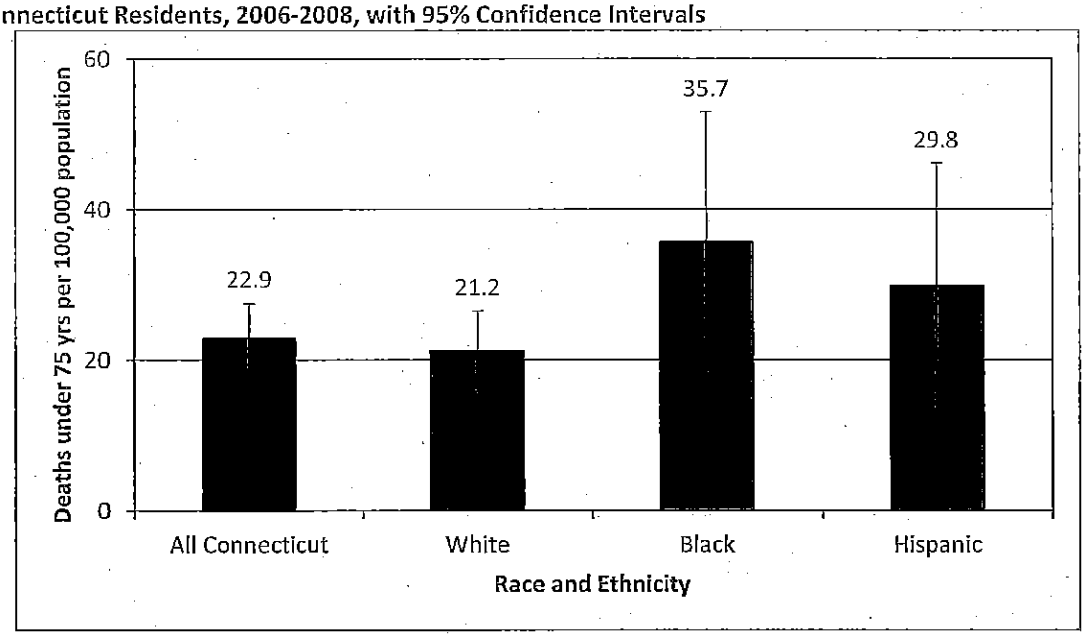


Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Heart failure

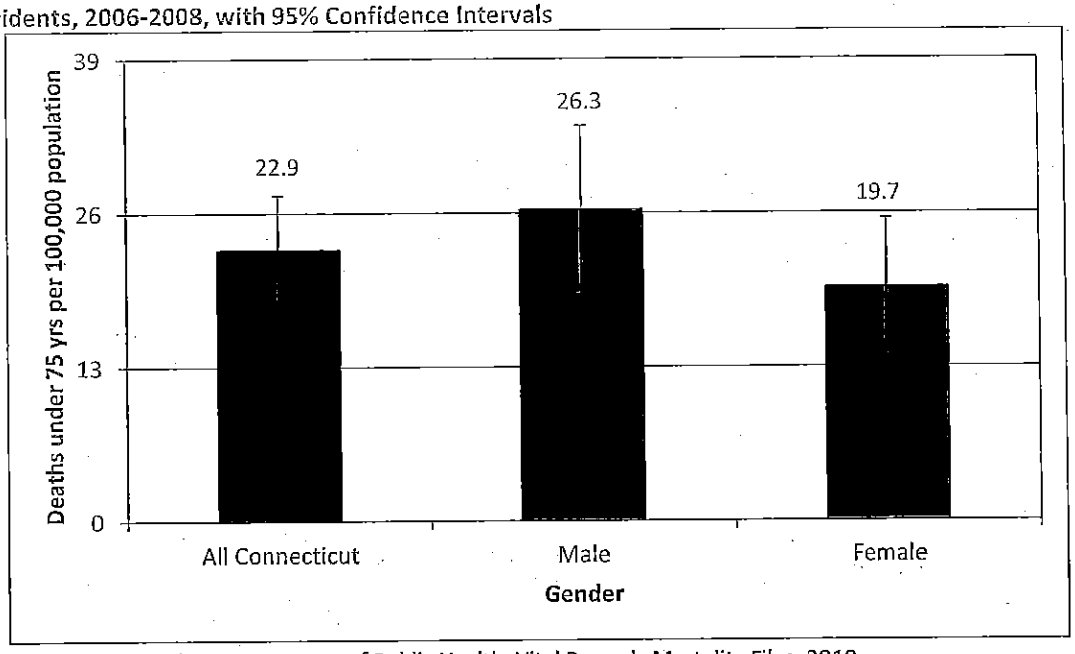
The Connecticut resident HF premature mortality rate does not differ significantly by gender or race and ethnicity (Figure 13 and Figure 14) [2006-2008 data].[3] HF premature mortality rates did not decline significantly between 1999-2001 and 2006-2008 [data not shown].[3]

Figure 13. Age-adjusted Premature Mortality Rates for Heart Failure by Gender, Race and Ethnicity, Connecticut Residents, 2006-2008, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

Figure 14. Age-adjusted Premature Mortality Rates for Heart Failure by Gender, Connecticut Residents, 2006-2008, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, Vital Records Mortality Files, 2010.

MORBIDITY

There were 59,664 Connecticut resident discharges from Connecticut hospitals for all CVD in 2008. This represents 18% of all hospital discharges (excluding pregnancy and childbirth related discharges) and 23% of all hospital billing charges in the state.[10] Approximately 26% of all CVD discharges are due to CHD, 12% are for stroke, and 18% are for HF. The median length of stay for CHD, stroke, and HF is two, three, and four days, respectively. The median length of stay for all hospital discharges in Connecticut is three days.[10]

Hospitalizations by Gender

Hospitalization rates[§] vary by gender (2008 data). Males have significantly higher rates of hospitalizations for all CVD, CHD, stroke, and HF compared with females ($p < 0.001$). More females than males, however, are hospitalized for stroke and HF [Table 3].[10]

Table 3. Hospitalizations and Age-adjusted Hospitalization Rates (AAHR) for Cardiovascular Diseases per 100,000 Population, Connecticut Residents by Gender, 2008

Diagnostic Group	All		Male		Female	
	Discharges	AAHR	Discharges	AAHR	Discharges	AAHR
All Cardiovascular Diseases	59,664	1,483.1	31,748	1,862.9	27,916	1,184.1
Coronary Heart Disease	15,779	392.0	9,877	559.2	5,902	254.2
Stroke	7,413	183.6	3,626	216.1	3,787	158.1
Heart failure	10,725	259.9	5,331	326.8	5,394	213.8

Source: Connecticut Department of Public Health, Connecticut Hospital Discharge Abstract and Billing Data Base, 2010.

[§]Hospitalization rates were calculated using 2008 Connecticut resident hospitalization discharge data and were age-adjusted based on the 2000 U.S. standard million population.

Hospitalization Rates by Race and Ethnicity

Hospitalization rates differ by race and ethnicity (2008 data). Black residents have significantly higher rates of hospitalizations for CVD, stroke, and HF than both White and Hispanic residents ($p<0.001$ for all comparisons). Black residents' rate of hospitalizations for CHD, however, is not significantly different than that of White and Hispanic residents.[10] Hispanic residents have significantly higher hospitalization rates for CVD ($p<0.001$) and CHD ($p<0.01$) than White residents. In contrast, Hispanic residents have a significantly lower rate of hospitalization for HF compared with White residents ($p<0.05$). Furthermore, the rates of hospitalization for stroke of Hispanic and White residents are not significantly different (Table 4).[10]

Table 4. Hospitalizations and Age-adjusted Hospitalization Rates (AAHR) for Cardiovascular Diseases per 100,000 Population, Connecticut Residents by Race and Ethnicity, 2008

Diagnostic Group	All		White, non-Hispanic		Black, non-Hispanic		Hispanic	
	Discharges	AAHR	Discharges	AAHR	Discharges	AAHR	Discharges	AAHR
All Cardiovascular Diseases	59,664	1,483.1	48,395	1,380.4	5,555	2,114.2	3,667	1,713.6
Coronary Heart Disease	15,779	392.0	13,106	378.2	992	375.9	954	427.2
Stroke	7,413	183.6	6,033	170.5	700	270.5	403	195.7
Heart failure	10,725	259.9	8,568	231.0	1,185	463.9	731	390.1

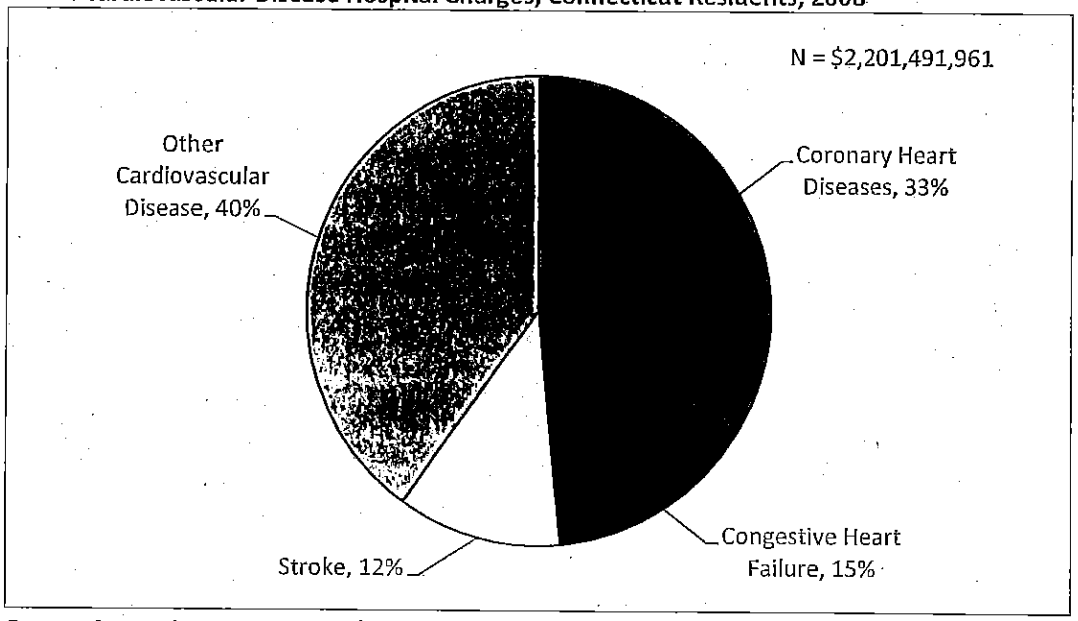
Source: Connecticut Department of Public Health, Connecticut Hospital Discharge Abstract and Billing Data Base, 2010.

Economic Costs

The estimated national annual cost for the medical management of CVD was $503.2 billion in 2010, or about $1600 per person.[2] This estimate includes direct medical costs and indirect costs. The indirect cost of CVD is associated with lost productivity from illness and premature death. Also, CVD are major causes of disability, limiting an individual's ability to live independently and negatively impacting the quality of life for individuals and families. For these reasons, CVD can incur enormous indirect costs. Assuming that disease rates and per person costs are the same in Connecticut as they are nationwide, the estimated economic burden of CVD in the state is about $5.8 billion. A large portion of these costs is attributable to inpatient hospitalizations.

Total Connecticut CVD hospital charges in 2008 were about $2.2 billion, with a median charge of $23,172 (Figure 15). About 33% of total CVD hospitalization charges were for CHD, 12% were for stroke, and 15% were for HF.[10] Median hospital charges were $34,792 for CHD, $19,772 for stroke, and $17,408 for HF. In contrast, the median charge for all hospital discharges in Connecticut was $16,727.[10]

Figure 15. Cardiovascular Disease Hospital Charges, Connecticut Residents, 2008



Source: Connecticut Department of Public Health, Connecticut Hospital Discharge Abstract and Billing Data Base, 2010.

RISK FACTORS

Risk factors for CVD may be non-modifiable (e.g., increasing age or family history) or modifiable (high blood pressure, high cholesterol, smoking, diabetes, obesity, physical inactivity) [Table 5]. Increasing age is a key risk factor for heart disease, stroke, and HF.[1] About 86% of all CVD deaths in Connecticut occur among those aged 65 years and older. About 85% of all CHD deaths, 90% of all stroke deaths, and 96% of all HF deaths in Connecticut occur among persons aged 65 years and older.[7] For men and women, major increases in the CVD mortality rate begin in the 35-to-44-year-old age group.[4] A family history of heart disease and stroke increases one's risk of developing these diseases. A combination of inherited characteristics and behavioral patterns (e.g. similar dietary, smoking, and activity habits) are thought to partially explain increased risk within families.[11]

Lower socioeconomic position (SEP) is an important risk marker for CVD. SEP is commonly measured by personal income, household income, or educational attainment level. Persons of lower SEP have higher CVD morbidity and mortality than do middle- or upper-income persons. Behavioral risk factors such as smoking, hypertension, and obesity are more prevalent in persons of lower SEP and may explain some of the observed disparity; however, other factors, like neighborhood socioeconomic environment, appear to have effects on individuals' risk for CVD.[1] Low-income neighborhood environments may contribute to increased CVD risk and poorer health outcomes because of such factors like poorer air quality, fewer food choices, and lower quality and/or lack of public services. Persons with lower incomes tend to have less access to and/or less effectively use preventive health services that are important to the early detection and treatment of hypertension.[12] While low-socioeconomic position may be considered "modifiable" in the sense that people can move in and out of poverty during a lifetime or over generations, it is not usually within a given individual's control to change his or her social position or neighborhood environment.

Table 5. Risk Factors for Cardiovascular Disease

Modifiable Risk Factors	Non-Modifiable Risk Factors
• High blood pressure • High cholesterol • Smoking • Diabetes • Obesity • Physical inactivity	• Increasing age • Family history

Modifiable Risk Factors

Current Connecticut Behavioral Risk Factor Surveillance System (BRFSS)** data show that about one out of three Connecticut adults report having one modifiable risk factor for CVD.[14] Following are summaries of the six main risk factors (high blood pressure, high blood cholesterol, tobacco use, diabetes, obesity, and physical inactivity) for CVD.

High Blood Pressure

High blood pressure (HBP) is a major risk factor for heart attack and the most important modifiable risk factor for stroke. People with elevated blood pressure (≥140 mmHg systolic / 90 mmHg diastolic) are 2 to 4 times more likely to develop CHD as are people with normal blood pressure (<120 mmHg systolic / 80 mmHg diastolic).[1] Studies have found that individuals with a normal blood pressure have approximately half the lifetime risk of stroke compared to those with high blood pressure.[13]

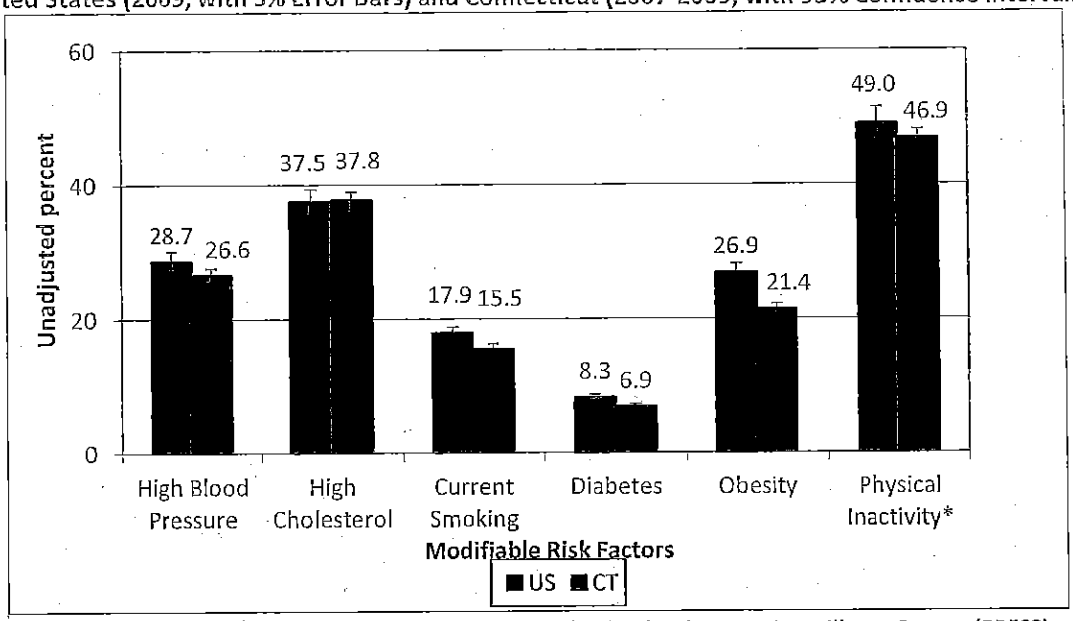
Approximately 27% of Connecticut adults report having HBP (2007-2009 data) compared with about 29% of adults nationwide (2009 data) (Figure 16).[14, 15] The risks for hypertension-related CVD increase markedly with age, as does the prevalence of hypertension, and drug treatment for HBP.[13] For example, 15.4% of Connecticut adults aged 35-44 years report having HBP compared with 57.8% of Connecticut adults aged 65 years and older ($p<0.001$) [data not shown].[14]

The rates of HBP also differ by gender. Approximately 27.4% of Connecticut males have HBP compared with 22.5% of females ($p<0.001$) [data not shown].[14]

The prevalence of HBP varies by race and ethnicity. Black Connecticut adults are more likely to have HBP than White and Hispanic Connecticut adults ($p<0.001$ for both comparisons). The rates of HBP among White and Hispanics adults do not differ significantly. About 25% of White, 36% of Black, and 22% of Hispanic adults report that they were told they had hypertension (Figure 17).[14]

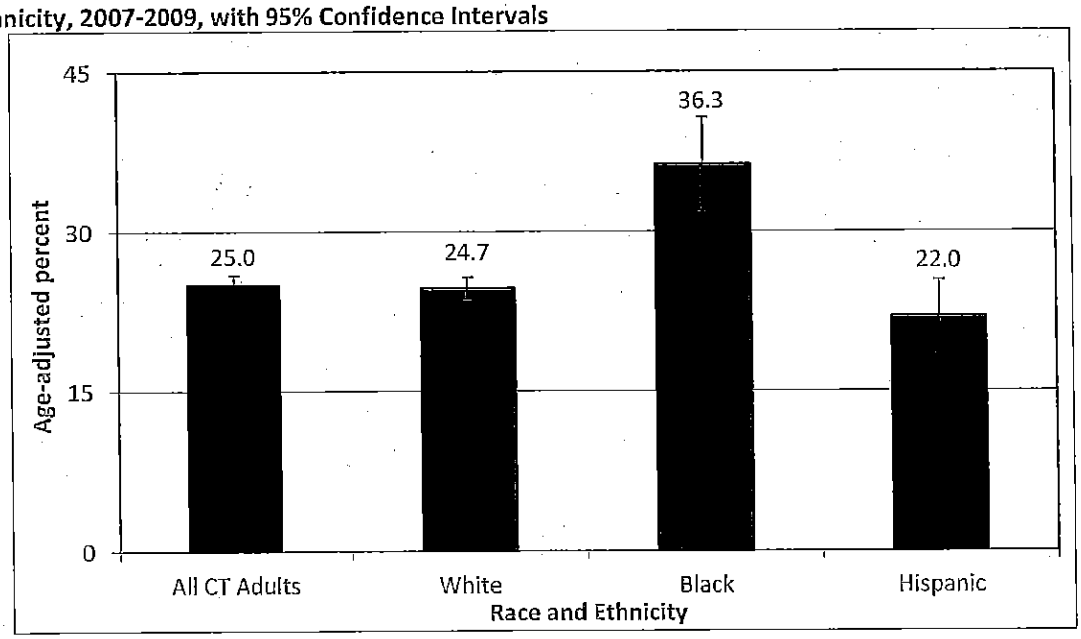
** Unless otherwise stated, the BRFSS data presented in this report are based on 2007-2009 survey responses from non-institutionalized Connecticut adults.

Figure 16. Prevalence of Modifiable Risk Factors for Cardiovascular Diseases among Adults in the United States (2009, with 5% Error Bars) and Connecticut (2007-2009, with 95% Confidence Intervals)



Sources: Centers for Disease Control and Prevention, Behavioral Risk Factor Surveillance System (BRFSS), 2010. Connecticut Department of Public Health, BRFSS, 2010.
*Participated in less than the recommended amount of physical activity.

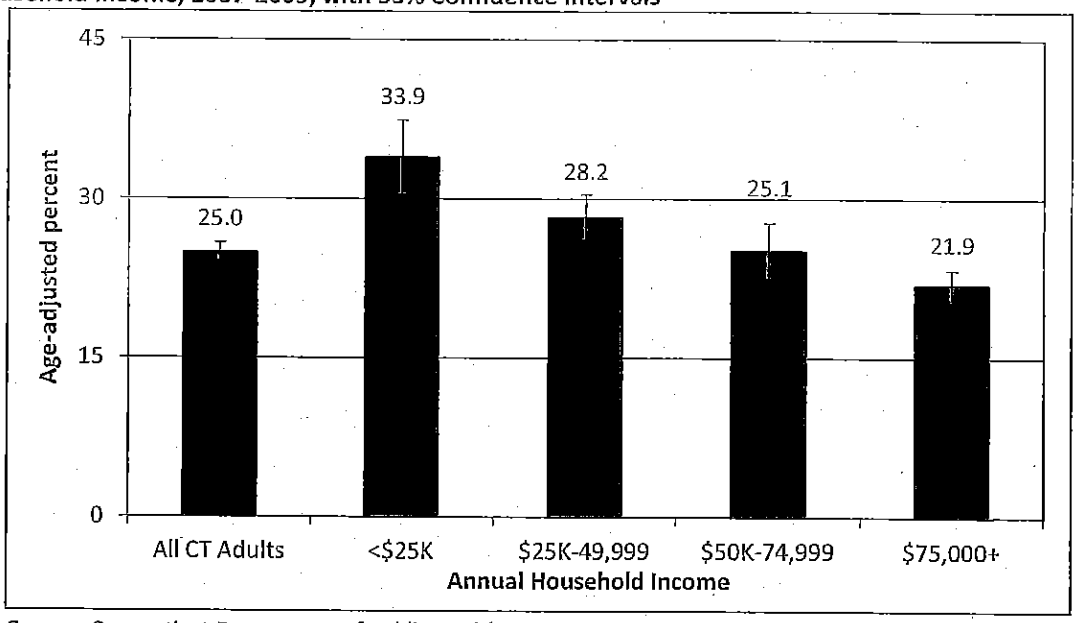
Figure 17. Age-adjusted Prevalence of High Blood Pressure among Connecticut Adults by Race and Ethnicity, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

Connecticut adults with lower annual household incomes tend to have a higher prevalence of HBP compared to Connecticut adults with higher annual household incomes. For example, 33.9% of adults with an annual household income less than $25,000 have diagnosed HBP compared to 21.9% of adults with annual household income of at least $75,000 (p<0.001) [Figure 18].[14]

Figure 18. Age-adjusted Prevalence of High Blood Pressure among Connecticut Adults by Annual Household Income, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

High Blood Cholesterol

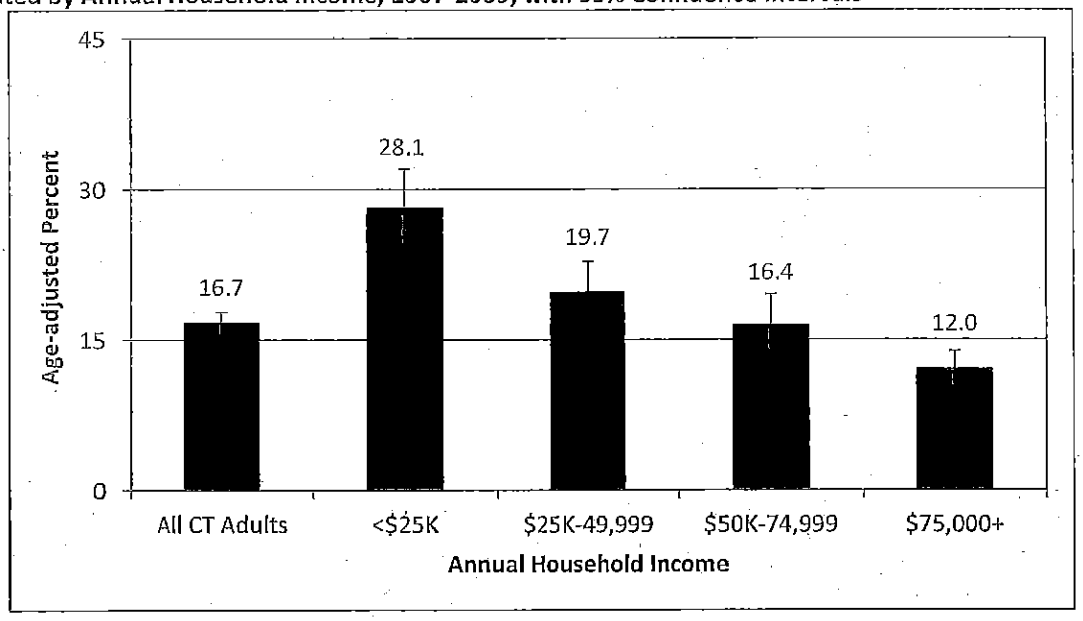
High blood cholesterol (HBC) is considered a major risk factor for CHD.[16, 17] Dyslipidemias, or an abnormal amount of lipids (e.g. high blood cholesterol) in the blood, were not traditionally regarded as a risk factor for stroke; however, a recent meta-analysis of statin therapy found that treatment of dyslipidemia decreases the risk of nonhemorrhagic stroke.[1] Control and reduction of HBC is important. A 10% decrease in total blood cholesterol levels may reduce the incidence of CHD by as much as 30%.[18]

About 38% of adults in Connecticut (2007-2009 data) and nationwide (2009 data) were told they had HBC (Figure 16).[14, 15] The prevalence of HBC increases with age. For example, 38.1% of Connecticut's adults aged 45-54 years report having HBC compared with 53.4% of Connecticut's adults aged 65 years and older ($p<0.001$) [data not shown].[14]

The prevalence of HBC also varies by gender. Approximately, 39.2% of Connecticut males have HBC compared with 29.7% of females ($p<0.001$) [data not shown]. [14]

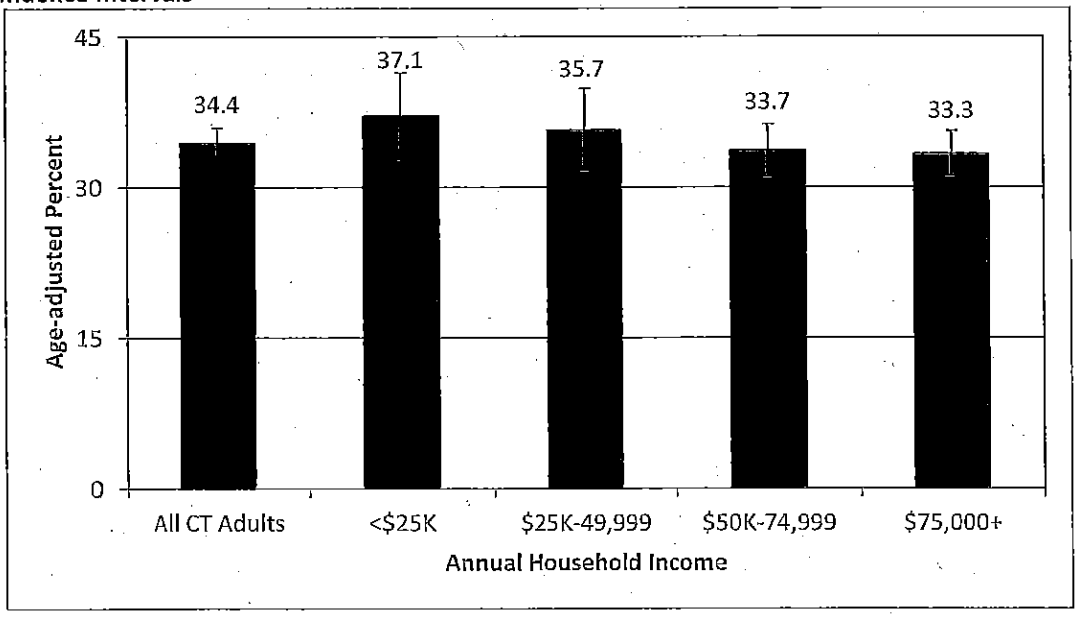
Connecticut adults compare favorably to adults nationwide in terms of cholesterol screening. About 82% of Connecticut adults report having had their blood cholesterol screened within the last five years (2007-2009 data) compared with 77% of adults in the U.S. (2009 data).[14, 15] Connecticut adults with lower incomes are more likely to report that they have never had their blood cholesterol tested compared to adults with higher incomes. For example, adults with annual household incomes less than $25,000 are significantly more likely to report that they have never had their blood cholesterol tested compared to individuals with annual household incomes of $75,000 or more ($p<0.001$) [Figure 19]. In contrast, the prevalence of HBC does not differ significantly by annual household income [Figure 20].[14]

Figure 19. Age-adjusted Percentage of Connecticut Adults Who Have Never Had Their Cholesterol Tested by Annual Household Income, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

Figure 20. Age-adjusted Percentage of Connecticut Adults Who had Their Cholesterol Tested in the Past 5 Years and Were Told It was High by Annual Household Income, 2007-2009, with 95% Confidence Intervals

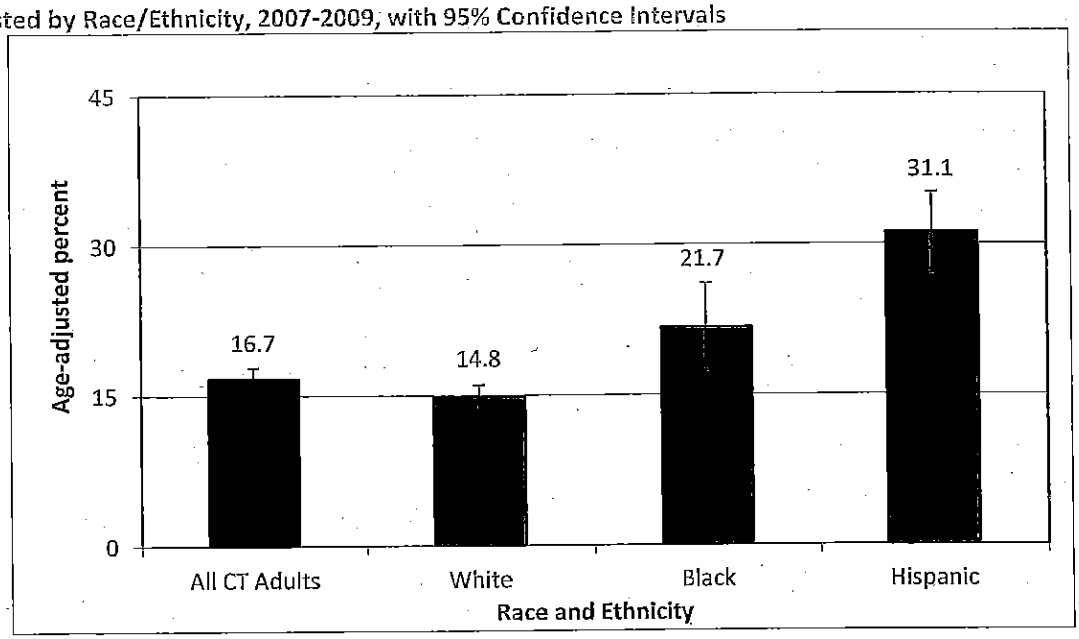


Source: Connecticut Department of Public Health, BRFSS, 2010.

Black and Hispanic adults are significantly more likely than White adults to report never having had their blood cholesterol tested ($p<0.05$ for Black and White comparison; $p<0.001$ for Hispanic and White comparison). Hispanic adults are also more likely than Black adults to report never having had their blood cholesterol tested ($p<0.05$). An estimated 14.8% of White, 21.7% of Black, and 31.1% of Hispanic adults report never having had their blood cholesterol tested [Figure 21]. In contrast, the prevalence of HBC does not differ significantly by race and ethnicity [data not shown].[14]

The rates of never having had blood cholesterol tested do not differ significantly by gender. Approximately, 16.9% of males and 16.4% of females in Connecticut have never had their blood cholesterol tested [data not shown].[14]

Figure 21. Age-adjusted Percentage of Connecticut Adults Who Have Never Had Their Cholesterol Tested by Race/Ethnicity, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

Smoking

Cigarette smoking is a major modifiable risk factor for CVD. Smoking causes reduced blood vessel elasticity by increasing arterial wall stiffness. Smoking increases the risk of heart attack two-fold. Smokers have higher CHD mortality rates than non-smokers and the risk of death increases with greater number of cigarettes smoked. Current smokers have more than twice the risk of stroke compared with those who have never smoked. People who stop smoking decrease their stroke risk and their risk of CHD mortality.[1]

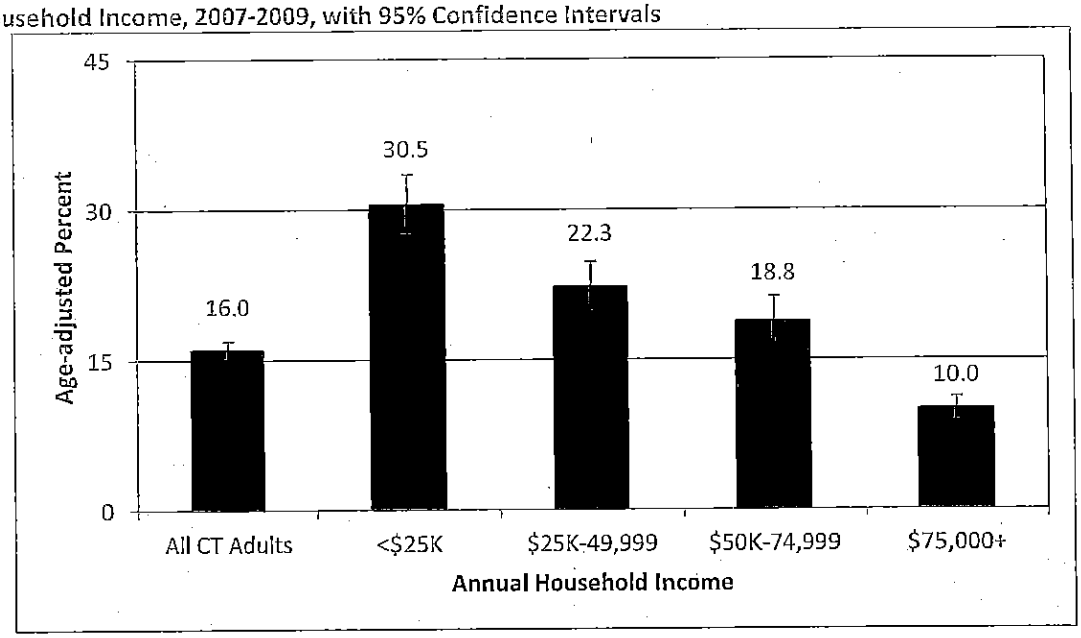
About 16% of Connecticut adults report being current smokers (2007-2009 data) compared with about 18% of adults nationwide (2009 data) [Figure 16].[14, 15] According to the 2009 Connecticut School Health Survey (CSHS), 17.8% of high school students report being current smokers.[19]

Among adults, current smokers are more likely to be younger. For example, an estimated 22% of Connecticut adults aged 18 to 24 years old are current smokers compared with 14% of those aged 55 to 64 ($p<0.01$), and 6% of those aged 65 and older ($p<0.001$) [data not shown].[14] Smokers are also more likely to be individuals who have lower incomes and are less educated. For instance, about 31% of Connecticut's adults with annual household incomes under $25,000 are current smokers, compared to 10% of adults with annual household incomes of $75,000 or more ($p<0.001$) [Figure 22].[14] Similarly, about 31% of adults with less than a high school education report being current smokers compared to about 9% of adults who graduated from college ($p<0.001$) [data not shown].[14]

The rates of smoking do not differ significantly by gender. An estimated 16.8% of adult males and 15.2% of adult females are current smokers while an estimated 19.0% of high school males and 16.5% of high school females are current smokers (data not shown).[14, 19]

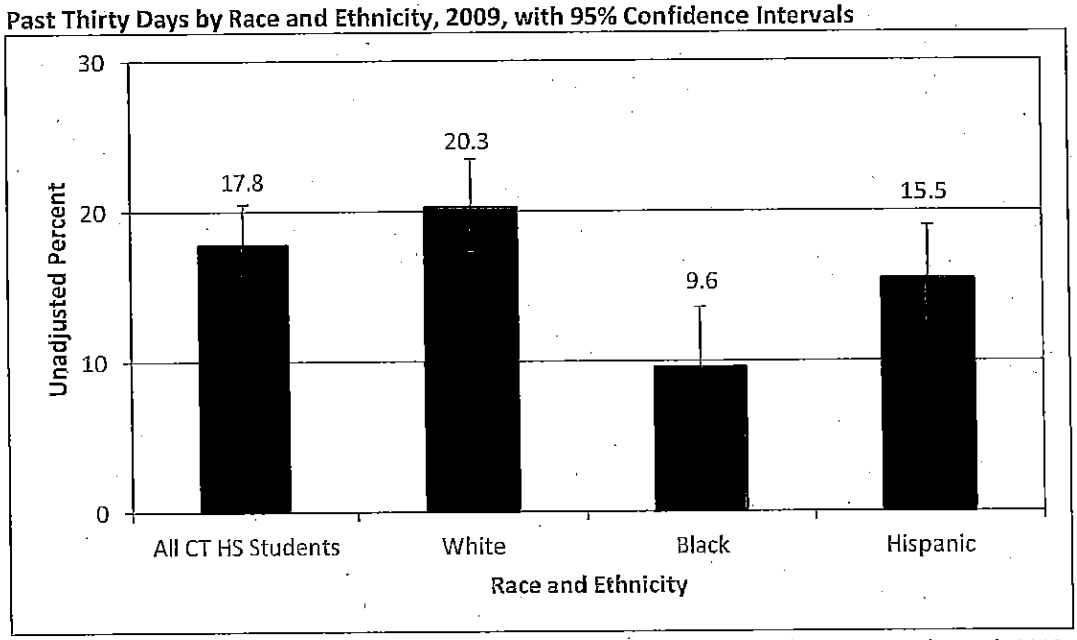
Among Connecticut adults, smoking rates do not differ significantly by race and ethnicity. An estimated 15.8% of White, 19.1% of Black, and 15.6% Hispanic adults report being current smokers [data not shown].[14] However, the rates of smoking among high school students do vary by race and ethnicity. White Connecticut high school students are more likely to be current smokers than Black ($p<0.001$) and Hispanic ($p<0.05$) students. Also, Hispanic students are more likely than Black students to be current smokers ($p<0.05$) [Figure 23].[19]

Figure 22. Age-adjusted Percentage of Connecticut Adults Who Are Current Smokers by Annual Household Income, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

Figure 23. Percentage of Connecticut High School Students Who Smoked Cigarettes on One or More of the Past Thirty Days by Race and Ethnicity, 2009, with 95% Confidence Intervals



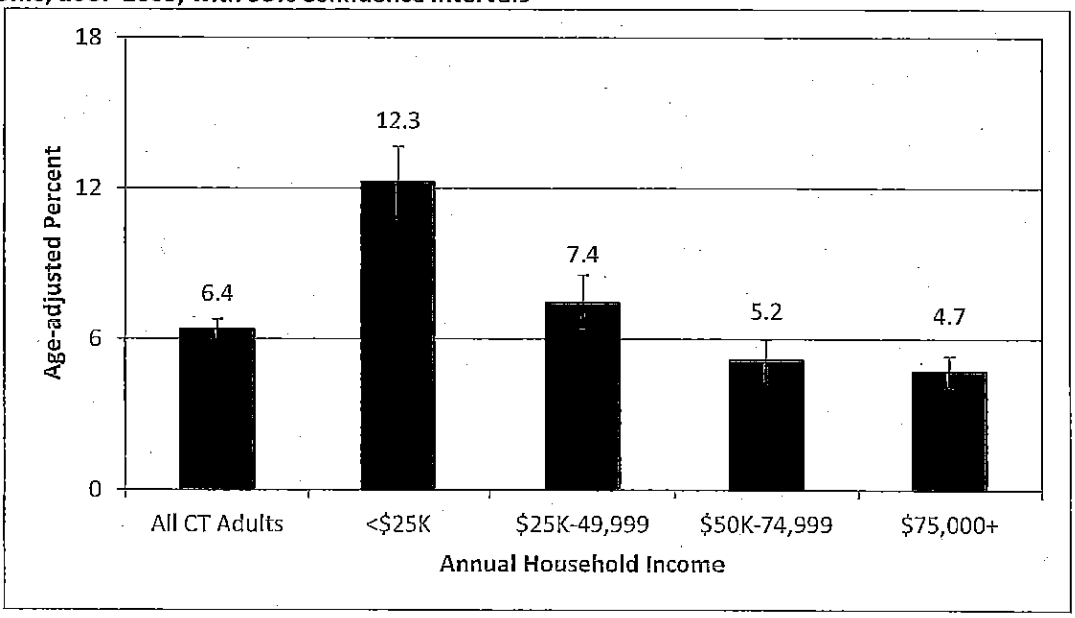
Source: Connecticut Department of Public Health, Youth Risk Behavior Surveillance System (YRBSS), 2010.

Diabetes

Diabetes has been recognized as a major risk factor for CVD. CVD is the primary cause of death for persons with diabetes, accounting for about 65% of the mortality. Individuals with diabetes are 2 to 4 times more likely to develop CHD and 2 to 5 times more likely to have a stroke than the rest of the population. People with diabetes often have HBP, HBC, and are overweight, further increasing their risk for CVD.[1]

An estimated 6.9% of Connecticut adults have diagnosed diabetes (2007-2009 data) compared with about 8% of adults nationwide (2009 data) [Figure 16].[14,15] The prevalence of diabetes varies by gender, age, race and ethnicity, and SEP.[14,20] Males are more likely to have diabetes than females. An estimated 7.3% of Connecticut males have diabetes compared with 5.7% of females ($p<0.005$) [data not shown].[14] Also, the prevalence of diabetes increases with age. Approximately 3% of adults aged 35-44 years report having diabetes compared to approximately 16.5% of adults aged 65 years and older ($p<0.001$) [data not shown].[14] Black and Hispanic adults have a significantly higher prevalence of diabetes compared with White adults ($p<0.001$ for both comparisons). The prevalence of diabetes among Black and Hispanic adults does not differ significantly. An estimated 5.6% of White, 14.9% of Black, and 10.5% of Hispanic adults report having diabetes [data not shown].[14] Adults with lower annual household incomes have a higher prevalence of diabetes compared to adults with higher annual household incomes. For example, approximately 12% of adults with annual household incomes under $25,000 report having diabetes, compared with about 5% of adults with household incomes over $75,000 ($p<0.001$) [Figure 24].[14]

Figure 24. Age-adjusted Prevalence of Diabetes among Connecticut Adults by Annual Household Income, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

Diabetes self-management education is essential because improperly controlled diabetes can result in CVD, kidney disease, blindness and loss of limb. It is, therefore, a particular concern that about 52% of Connecticut adults with diabetes report that they have never taken a course to manage the disease.[14]

Obesity

Body mass index (BMI), or weight adjusted for height, is a widely used screening method for obesity. For children and adolescents, BMI is compared to age- and gender-specific percentiles on the Centers for Disease Control and Prevention (CDC) growth charts. Children and adolescents with a BMI greater than or equal to the 85 percentile but less than the 95 percentile are considered overweight. Children and adolescents with a BMI greater than or equal to the 95 percentile are considered obese.[21] Medical guidelines for adults identify normal/desirable weight as a BMI under 25, overweight as a BMI of 25 to 29.9, and obese as a BMI of 30 or more. The prevalence of obesity has more than doubled over the past three decades in the United States.[21] The development of obesity involves social, behavioral, cultural, physiological, metabolic, and genetic factors. High calorie diets, along with less physical activity, have contributed to the obesity epidemic in our society.[21, 22]

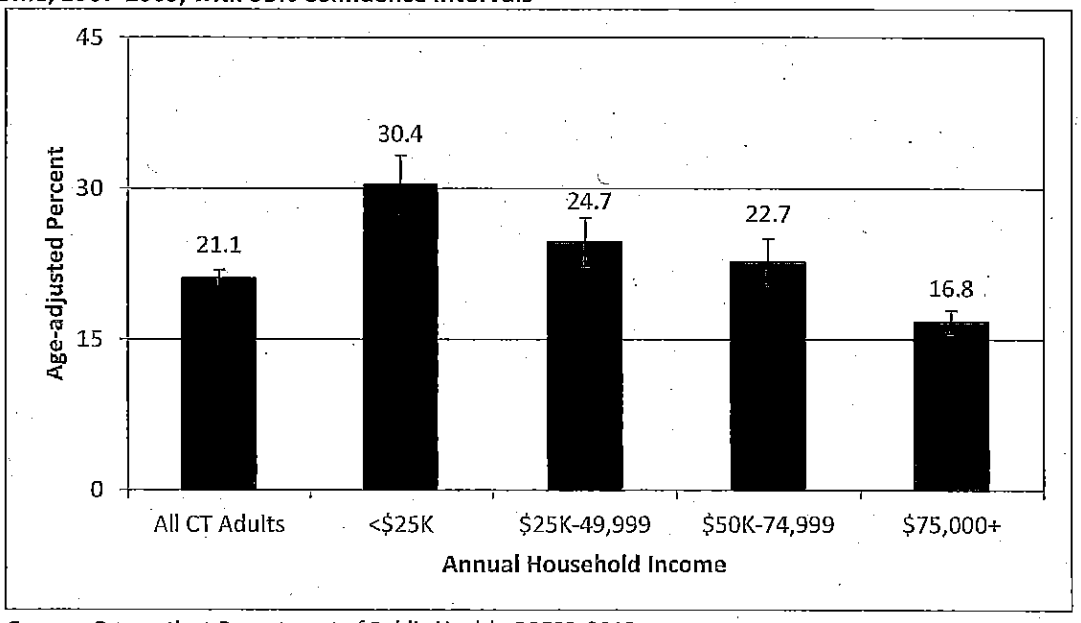
Obesity increases the risk of morbidity from hypertension, dyslipidemia, CHD, and stroke. All-cause mortality increases with increasing body weight.[22] Obesity is also an independent risk factor for CVD. The risk of ischemic stroke increases with increasing BMI. Studies have also suggested that body fat distribution may affect CHD risk. Upper body or abdominal fat seems to increase CHD risk regardless of BMI. Weight reduction can affect several of the modifiable risk factors for stroke thereby reducing the incidence of stroke.[1]

According to responses to the 2009 CSHS, an estimated 14.5% of Connecticut high school students were overweight and 10.4% were obese.[19] Obesity rates among high school students in Connecticut vary by gender and race and ethnicity. Male Connecticut high school students are significantly more likely to be obese than female high school students ($p<0.05$). An estimated 13.8% of male and 6.7% of female high school students in Connecticut are obese [data not shown].[19] Also, Hispanic Connecticut high school students have higher rates of obesity than both White ($p<0.001$) and Black ($p<0.05$) high school students. The difference in the rate of obesity among White and Black high school students does not reach statistical significance. An estimated 8.7% of White, 12.5% of Black, and 17% of Hispanic Connecticut high school students are obese [data not shown].[19]

An estimated 21% of Connecticut adults are obese (2007-2009 data) compared with about 27% of adults nationwide (2009 data) [Figure 16].[14, 15] Approximately 38% of Connecticut adults are overweight and 41% are neither overweight nor obese [data not shown].[14] Rates of obesity differ by SEP. For example, approximately 30% of adults with annual household incomes less than $25,000 are obese compared with 17% of those with annual household incomes over $75,000 (p<0.001) [Figure 25].[14] Rates of obesity also differ by race and ethnicity. Black and Hispanic adults are more likely to be obese than White adults (p<0.001 for both comparisons) [data not shown]. Black adults are also more likely to be obese than Hispanic adults (p<0.05). About 20% of White, 36% of Black, and 27% of Hispanic adults are obese [data not shown].[14] Furthermore, males are more likely to be obese than females. An estimated 27.9% of males are obese compared with 19.2% of females (p<0.005) [data not shown].[14] Additionally, older adults are more likely to be obese than younger adults. Approximately 11% of adults age 18-24 years are obese compared with 25% of adults aged 55-64 years (p<0.001) [data not shown].[14]

Obese adults are significantly more likely to report that they are in poorer health compared with non-obese adults. About 19% of adults who are obese report that they are in fair or poor health compared with about 9% of Connecticut adults who are not obese (p<0.001) [data not shown].[14]

Figure 25. Age-adjusted Prevalence of Obesity among Connecticut Adults by Annual Household Income, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

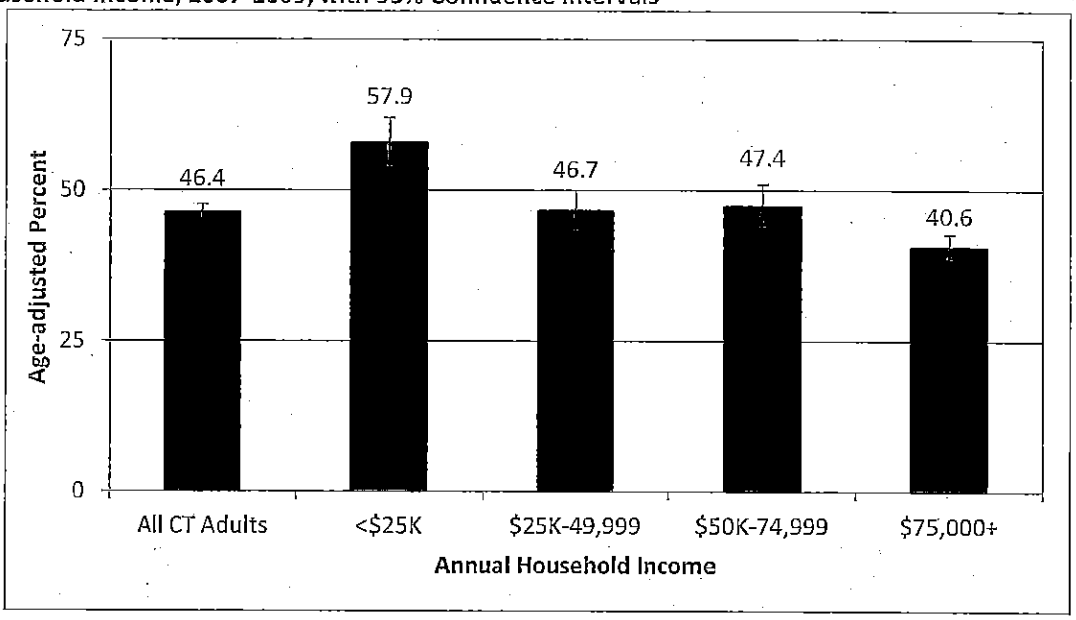
Physical Inactivity

Physical inactivity is associated with an increased risk of a number of chronic health conditions including CHD, diabetes, some cancers, HBP, obesity, and osteoporosis. Studies have shown that physical activity has protective effects on strokes.[1, 23]

The American College of Sports Medicine (ACSM), the American Heart Association (AHA), and the CDC recommend that healthy adults aged 18-65 years participate in moderate-intensity aerobic physical activity for a minimum of 30 minutes on five days per week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes on three days per week.[24, 25] The guidelines are the same for adults aged 65 years and older; however, if older adults are unable to meet these guidelines because of chronic conditions, it is recommended that they participate in as much physical activity as possible.[25]

"Physical inactivity" is defined here as not meeting the recommendations of the ACSM, AHA, and CDC as described above. Approximately 47% of Connecticut adults report participating in less than the recommended amount of physical activity (2007-2009 data) compared with 49% nationwide (2009 data) (Figure 16).[14, 15] Rates of physical inactivity are higher among older adults, women, racial or ethnic minorities, and people with low incomes.[23] Physical inactivity increases with age. About 56% of adults 65 years old and older are physically inactive compared with about 48% of adults aged 45 to 64 years , and 43% of adults aged 18 to 44 years ($p<0.001$ for both comparisons) [data not shown]. Similarly, the physical inactivity rate among adults aged 45 to 64 years is significantly higher than that of adults aged 18 to 44 years ($p<0.005$) [data not shown].[14] Likewise, females are more likely to be physically inactive than males. An estimated 48.5% of adult females are physically inactive compared with 44% of adult males ($p<0.05$) [data not shown].[14] Additionally, Black and Hispanic adults are significantly more likely to report higher rates of physical inactivity than White adults ($p<0.001$ for Black and White comparison; $p<0.005$ for Hispanic and White comparison). The rates of physical inactivity among Black and Hispanic adults do not differ significantly. Approximately 44.5% of White, 59.7% of Black, and 54.2% of Hispanic adults report that they are physically inactive (data not shown).[14] Furthermore, adults with lower incomes are more likely to be physically inactive compared to adults with higher incomes. For example, about 58% of adults with annual household incomes of less than $25,000 are physically inactive compared to 41% of adults with annual household incomes of $75,000 or more ($p<0.001$) [Figure 26].[14]

Figure 26. Age-adjusted Prevalence of Physical Inactivity among Connecticut Adults by Annual Household Income, 2007-2009, with 95% Confidence Intervals



Source: Connecticut Department of Public Health, BRFSS, 2010.

Co-Prevalence of Cardiovascular Risk Factors

The co-prevalence of risk factors places an individual at elevated risk of CHD and stroke.[26] Approximately 42% of Connecticut adults report having two or more and 19% report having three or more modifiable risk factors for CVD.[14] The co-prevalence of risk factors contributes to the complexity of disease management.

RECOGNIZING THE SIGNS AND SYMPTOMS OF HEART ATTACK AND STROKE

The *Healthy People 2010* national objectives for both heart disease and stroke include increasing the proportion of persons who are aware of the early warning signs and symptoms of heart attack and stroke and the necessity of calling 911 when persons are suffering from either of these conditions (Table 6).[8] Early recognition of heart attack and stroke and calling 911 increase the likelihood of immediate emergency transport to the hospital and timely medical care that can reduce disability and death.

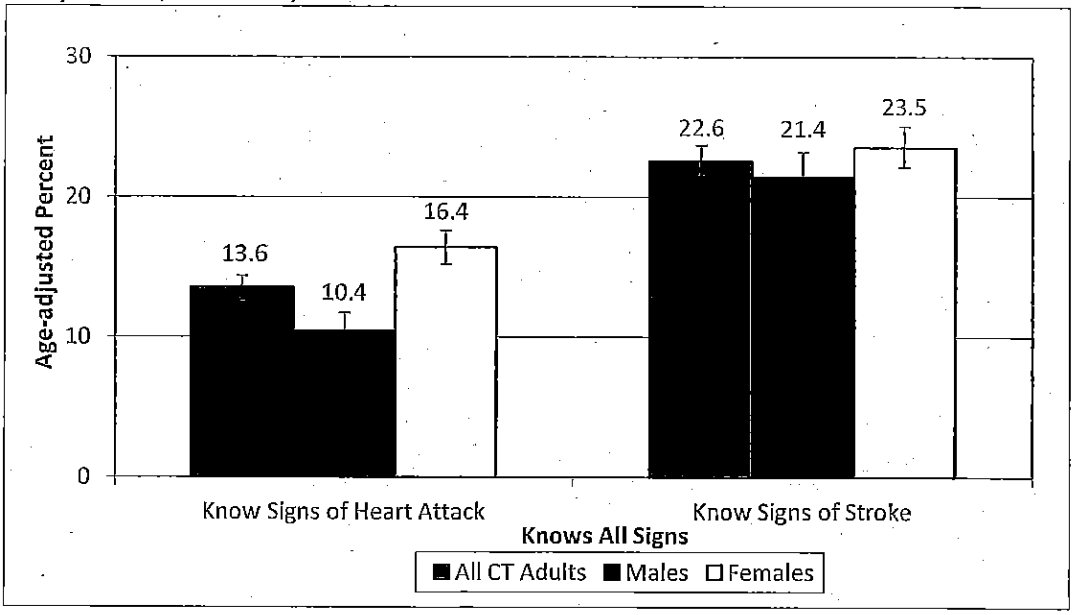
Table 6. Warning Signs for Heart Attack and Stroke

Heart Attack	Stroke
• Jaw, neck, back pain	• Severe headache with no known cause
• Lightheaded, faint	• Trouble seeing in one or both eyes
• Shortness of breath	• Confusion, trouble speaking
• Arm or shoulder discomfort	• Trouble walking, dizziness, or loss of balance
• Chest pain or discomfort	• Sudden numbness/weakness of face, arm, or leg

Source: American Heart Association, 2010.

The percentage of Connecticut adults who know all the warning signs and symptoms for heart attack and stroke tends to be very low. Only 13.6% of adults can identify all the proper heart attack signs and only 22.6% can identify all the proper stroke signs (2007-2009 data).[14] Women tend to be more knowledgeable than men about the signs and symptoms of heart attack and stroke. An estimated 16.4% of females know all heart attack signs compared with about 10.4% of males ($p<0.001$).[14] Also, approximately 23.5% of females know all signs of stroke compared with about 21.4% of males; however, this difference is not statistically significant [Figure 27].[14] Most adults, 91.4%, know that they should call 911 if they thought that someone was having a heart attack or stroke [data not shown].[14]

Figure 27. Age-adjusted Percentage of Connecticut Adults Who Know All the Signs of Heart Attack and Stroke by Gender, 2007-2009, with 95% Confidence Intervals

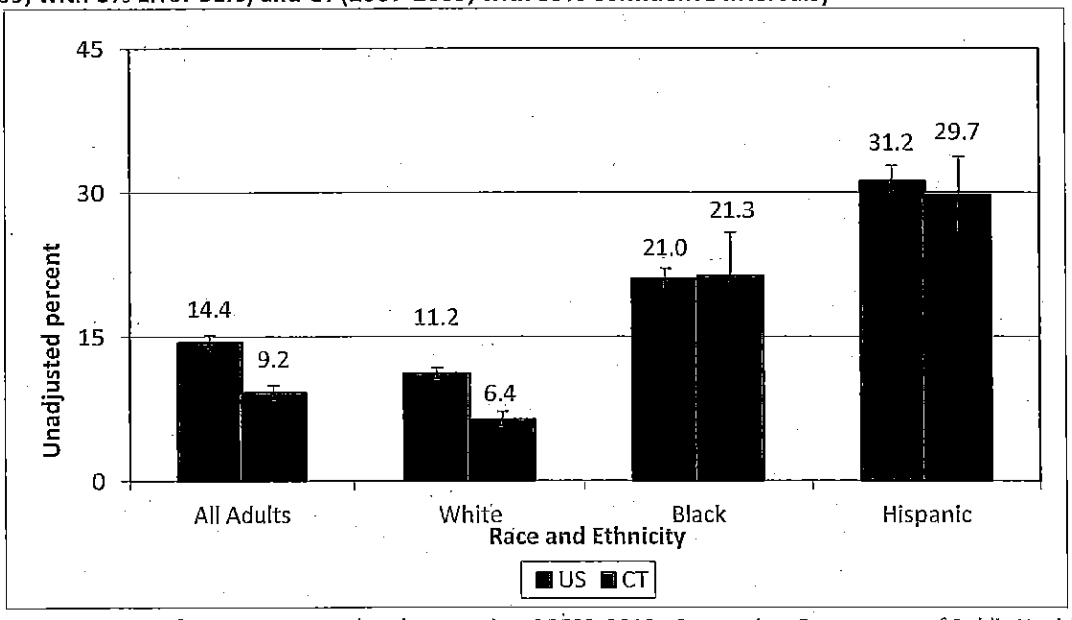


Source: Centers for Disease Control and Prevention, BRFSS, 2010.

ACCESS TO HEALTH CARE

Access to health care is crucial to the prevention, treatment, and management of heart disease and stroke. People without health insurance are less likely than those with health insurance to have a usual source of care, to receive preventive health care services, and to receive appropriate medical management of chronic conditions such as HBP, HBC, and diabetes.[27] About 9% of adults aged 18 and over do not have health insurance (2007-2009 data) compared with approximately 14% of adults nationwide (2009 data).[14, 15] Black and Hispanic Connecticut adults are significantly less likely to have health insurance than White Connecticut adults ($p<0.001$ for both comparisons). Approximately 6% of White, 21% of Black, and 30% of Hispanic adults do not have health insurance.[14] Comparable national figures show that about 11% of White, 21% of Black, and 31% of Hispanic adults report having no health insurance (Figure 28).[15]

Figure 28. Percentage of Adults Who Do Not Have Health Care Coverage by Race and Ethnicity, US (2009, with 5% Error Bars) and CT (2007-2009, with 95% Confidence Intervals)



Source: Centers for Disease Control and Prevention, BRFSS, 2010. Connecticut Department of Public Health, BRFSS, 2010.

TARGETING HIGH-RISK POPULATIONS

The high co-prevalence of modifiable risk factors for CVD indicates the need for public health interventions that focus on the prevention, early detection, and control of modifiable risk factors. The CDC recommends focusing efforts on increasing low dose aspirin therapy according to recognized guidelines; preventing and controlling HBC; reducing sodium intake; preventing and controlling HBC; and increasing the number of smokers counseled to quit and referred to quit lines as well as increasing the availability of no or low-cost cessations products.[28] The CDC also recommends addressing the priority areas through policies, systems, and environmental changes with the potential for broad reach and impact on the general population and high-risk populations.[28]

High-risk populations in Connecticut include Black, Hispanic, and lower-income residents. Black Connecticut residents have higher CVD and stroke mortality rates as well as higher CVD, CHD, and stroke premature mortality rates compared with White Connecticut residents. Black and Hispanic Connecticut residents have significantly higher rates of some important modifiable risk factors for CVD, such as HBC, diabetes, obesity, and physical inactivity compared with White Connecticut residents. Lower-income residents are also more likely to have higher rates of HBC, never having had cholesterol tested, diabetes, current smoking, obesity, and physical inactivity compared with higher-income residents.

Targeted, evidence-based public health interventions are warranted for all Connecticut residents with multiple risk factors. Special emphasis should be placed on interventions that address risk factor reduction among Black, Hispanic, and lower-income Connecticut residents. Evidence-based guidelines for disease prevention in the areas of diabetes, nutrition, physical activity, tobacco, and obesity are provided in the CDC's *Guide to Community Preventive Services*.[29] The 2011 Connecticut Chronic Disease planning process has focused its statewide health promotion and disease prevention efforts on policy, systems, and environmental changes at the state and local levels. Such policy, systems, and environmental changes have the potential to influence health-related behaviors in the general and high-risk populations.

APPENDICES AND REFERENCES

Appendix 1. Data Sources

Connecticut Vital Records Mortality Files

The Connecticut Vital Records Mortality Files are part of the state's vital statistics data base that contains records pertaining to deaths that occur within the state as well as deaths of Connecticut residents occurring in other states, or in Canada. Mortality statistics are compiled in accordance with the World Health Organization (WHO) regulations, which specify that deaths be classified by the current Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. Deaths for the 1989-1998 period included in this report are classified by the Ninth Revision of the International Classification of Diseases [ICD-9].[30] Deaths for the 1999-2008 period are classified by the Tenth Revision of the International Classification of Diseases [ICD-10].[31]

The race-ethnicity designation is typically based on report by next of kin, a funeral director, coroner, or other official, often based on observations. As such, the race-ethnicity designation based on observation may be reported incorrectly. Another potential source of error is the fact that death rates are calculated using two different sources of data – the death certificate for the numerator and the U.S. Census Bureau population estimates for the denominator. Errors in under- or over-counting populations by race and/or ethnicity will affect the death rates reported for these groups. Mortality data are reported using racial categories that exclude persons of Hispanic origin (White, non-Hispanic and Black, non-Hispanic) and by Hispanic ethnicity (Hispanics of any race). Death Registry data follow the National Center for Health Statistics guidelines for coding race and Hispanic ethnicity.[5]

Connecticut Hospital Discharge Abstract and Billing Data Base

The Connecticut Hospital Discharge Abstract and Billing Data Base is the source of inpatient hospitalization data. It is maintained by the Connecticut Office of Health Care Access, and it contains patient-level demographic, clinical, and billing data for all non-federal acute care hospitals in the state. In addition to age, gender, and town of residence, the demographic data elements include race and ethnicity. Race and ethnicity may be based upon observation of the patient or self-reporting by the patient. Race is designated as White, non-Hispanic and Black, non-Hispanic; Hispanic ethnicity includes persons of any race.

It should be noted that counts reflect hospitalizations not persons. For example, a patient admitted to a hospital on two separate occasions in 2008 would be counted twice in these data. Another limitation of the data is the fact that it is an administrative data set. It contains diagnoses and procedures based on the International Classification of Diseases, Clinical Modification (ICD-9-CM) codes. The literature contains many reports on the reliability and validity of hospital discharge data with clinical conditions emphasizing discrepancies between ICD-9-CM codes and clinical data.[32]

Behavioral Risk Factor Surveillance System

The Behavioral Risk Factor Surveillance System (BRFSS) survey is a state-based system of health surveys that generate information about health risk behaviors, clinical preventive practices, and health care access and use. The BRFSS, sponsored by the Centers for Disease Control and Prevention, is the world's largest telephone survey, and is conducted in all 50 states. It is an on-going random sample telephone survey of non-institutionalized adults, 18 years and older. Information from the survey is used to improve the health of people nationwide and in Connecticut. Racial and ethnic classifications are based on self-report and include White, non-Hispanic, Black, non-Hispanic, and Hispanic (including persons of any race). Other national and state-specific risk factor data and information regarding BRFSS methodology can be accessed on the CDC's BRFSS Web site at: http://www.cdc.gov/brfss/.

Connecticut School Health Survey

The Connecticut School Health Survey (CSHS) is a comprehensive survey that consists of two components: Youth Tobacco Component (YTC) and the Youth Behavior Component (YBC). The CSHS is conducted by the Connecticut Department of Public Health in cooperation with the CDC, the Connecticut State Department of Education, and partners from local school health districts and local health departments. The YTC is a comprehensive survey of tobacco use, access, cessation, knowledge and attitudes, and exposure among Connecticut students in grades 6-12. The YBC collects data that is used to monitor priority health-risk behaviors and the prevalence of obesity and asthma among high school students in Connecticut. The YBC is administered to a representative sample of all regular public high school students in Connecticut. Racial and ethnic classifications are based on self-report and include White, non-Hispanic; Black, non-Hispanic; and Hispanic (including persons of any race). Further information about the CSHS can be found on the Connecticut Department of Public Health's web site: http://www.ct.gov/dph/cshs. Other national and state-specific youth risk factor data and information can be accessed on the CDC's web site: http://www.cdc.gov/HealthyYouth/YRBS/.

Appendix 2A. ICD-10 Coding for Selected Causes of Death, 1999-2008

Cause of Death	ICD-10 Code
All Causes	A00.0 – Y89.9
All Cancers	C00 – C97
Diabetes Mellitus	E10 – E14
Alzheimer's Disease	G30
Cardiovascular Disease	I00-I78
Diseases of the Heart	I00 – I09, I11, I13, I20 – I51
Coronary Heart Disease	I11, I20-I25
Congestive Heart Failure	I50.0
Essential Hypertension & Hypertensive Renal Disease	I10, I12
Cerebrovascular Disease	I60 – I69
Atherosclerosis	I71
Pneumonia and Influenza	J10 – J18
Chronic Lower Respiratory Diseases	J40 – J47
Unintentional Injuries	V01 – X59, Y85 – Y86

Source: World Health Organization. 1992. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, based on the recommendations of the Tenth Revision Conference, 1992 (ICD-10). World Health Organization, Geneva.

Appendix 2B. ICD-9 Coding for Selected Causes of Death, 1989-1998

Cause of Death	ICD-9 Code
All Causes	1-E999
Cardiovascular Disease Deaths	390-459
Diseases of the Heart	390-398,402,404-429
Coronary Heart Disease	402, 410-414, 429.2
Congestive Heart Failure	428.0
Hypertension without Renal Disease	401, 403
Cerebrovascular Disease	430-438
Atherosclerosis	440

Source: World Health Organization. 1977. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, based on the recommendations of the Ninth Revision Conference, 1975 (ICD-9). World Health Organization, Geneva.

Appendix 2C. ICD-9-CM Coding for Selected Causes of Hospitalizations

Cause of Hospitalization	ICD-9-CM Code
Circulatory	390-459
Coronary Heart Disease	402, 410-414, 429.2
Congestive Heart Failure	428
Cerebrovascular Disease	430-438

Source: Practice Management Information Corporation (PMIC). 2004. The International Classification of Diseases, Ninth Revision, Clinical Modification. 6th ed. PMIC, Los Angeles, CA.

Appendix 3A. Glossary of Statistical Terms

Age-adjustment. "Age adjustment, using the direct method, is the application of observed age-specific rates to a standard age distribution to eliminate differences in crude rates in populations of interest that result from differences in the populations' age distributions. This adjustment is usually done when comparing two or more populations at one point in time or one population at two or more points in time. Age adjustment is particularly relevant when populations being compared have different age structures, for example, the U.S. white and Hispanic populations...."[33]

Age-adjusted BRFSS rates. Some of the Behavioral Risk Factor Surveillance System (BRFSS) rate estimates presented in this report were age-adjusted, using the direct method, in order to eliminate differences in crude rates in populations of interest that result from differences in the populations' age distributions, such as those of Hispanics and Whites. The following age distributions and age-adjustment weights, based on the 2000 projected U.S. population, were used[34]:

Age Distributions and Age-adjustment Weights, 2000 Projected U.S. Population

Age	Population in thousands	Adjustment weight
18 years and over	203,851	1.000000
18 – 24 years	26,258	0.128810
25 – 44 years	81,892	0.401725
45 – 64 years	60,991	0.299194
65 years and over	34,710	0.170271

Age-adjusted Mortality Rates (AAMR) and Age-adjusted Hospitalization Rates (AAHR) are used to compare relative mortality and hospitalization risk, respectively, across groups and over time. They are not actual measures of risk but rather an index of risk. They are weighted statistical averages of the age-specific rates, in which the weights represent the fixed population proportions by age.[35] The AAMR and AAHR were computed by the direct method. The 1940 and 2000 U.S. standard million population distributions are shown below:

Age group	1940	2000
0-4	80,057	69,136
5-9	81,151	72,533
10-14	89,209	73,032
15-19	93,665	72,169
20-24	88,002	66,477
25-29	84,280	64,529
30-34	77,787	71,044
35-39	72,501	80,762
40-44	66,744	81,851
45-49	62,696	72,118
50-54	55,116	62,716
55-59	44,559	48,454
60-64	36,129	38,793
65-69	28,519	34,264
70-74	19,519	31,773
75-79	11,423	26,999
80-84	5,878	17,842
85+	2,765	15,508
Total	1,000,000	1,000,000

Cause-of-death classification. Mortality statistics for this report were compiled in accordance with the World Health Organization (WHO) regulations, which specify that member nations classify causes of death by the current Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. Deaths for the 1989-1998 period were classified by the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, Ninth Revision of the International Classification of Diseases (ICD-9).[30] Deaths for the 1999-2008 period were classified according to the Tenth Revision of the International Classification of Diseases (ICD-10).[31]

Healthy People 2010 is part of a national strategy addressing the prevention of major chronic illnesses, injuries, and infectious diseases. It is the product of an effort, involving expert working groups, a consortium of national organizations, all state health departments, and the Institute of Medicine of the National Academy of Sciences to set health objectives for the nation. After extensive national and regional hearings were conducted with a period of public review and comment, the health objectives were published in 1990 as *Healthy People 2000—National Health Promotion and Disease Prevention Objectives.* It established national objectives and served as the basis for the development of state and community plans. *Healthy People 2010* provides a comprehensive view of the nation's health in 2000, and establishes national goals and targets to be achieved by 2010, and monitors progress over time.[36]

Hispanic origin refers to people whose origins are from Spain, the Spanish-speaking countries of Central America, South America, and the Caribbean, or persons of Hispanic origin identifying themselves as Spanish, Spanish-American, Hispanic, Hispano, or Latino. Since 1988, the Connecticut death certificate has had a separate line item for Hispanic ethnicity. Individuals identified as "Hispanic" can be of any race, and are also counted in the race breakdown as either "white," "black," "Asian or Pacific Islander," "American Indian," or other.[5]

International Classification of Diseases 9th and 10th Revisions(ICD-9, ICD-10) have been the internationally accepted coding system for determining cause of death since the early 1900s. It is periodically revised. The Ninth Revision (ICD-9) was in use from 1975 through 1998. Beginning with 1999 deaths, the Tenth Revision (ICD-10) is being used.

Preliminary estimates of the comparability of ICD-9 to ICD-10 have been published and indicate that the discontinuity in trends from 1998 to 1999 for some leading causes of death (septicemia, influenza and pneumonia, Alzheimer's disease, nephritis, nephrotic syndrome, and nephrosis) is substantial.[37]

International Classification of Diseases, Clinical Modification (ICD-9-CM) is a coding system recommended for use in all clinical settings to describe medical procedures and diagnoses. It is required for reporting diagnoses and diseases to all U.S. Public Health Service and Department of Health and Human Services programs, including Medicare and Medicaid. The foundation of the ICD-9-CM is the *International Classification of Diseases, 9th Revision* published by the World Health Organization.[30]

Population bases for computing rates are taken from the U.S. Census Bureau's *Estimates of the population of states by age, sex, race, and Hispanic origin*. These data are estimates of the population of Connecticut by 5-year age groups (age 0 to 4, 5 to 9,...85 and over), sex (male, female), modified race (white; black; Native American including Alaska Natives; Asian and Pacific Islander) and Hispanic origin (Hispanic, non-Hispanic) for each year, July 1, 1999 through July 1, 2009.[5]

Premature mortality. See Years of Potential Life Lost.

Race refers to a population of individuals identified from a common history, nationality, or geographical place. Race is widely considered a valid scientific category, but not a valid biological or genetic category.[38, 39] Available scientific evidence indicates that racial and ethnic classifications do not capture biological distinctiveness, and that there is more genetic variation within racial groups than there is between racial groups.[40, 41] Contemporary race divisions result from historical events and circumstances and reflect current social realities. Thus, racial categories may be viewed more accurately as proxies for social and economic conditions that put individuals at higher risk for certain disease conditions.[32]

Data in this report include two racial groups in Connecticut: white, non-Hispanic and black, non-Hispanic. Individuals identified as "Hispanic" can be of any race.

Socioeconomic position refers to a person's social and economic place in a society, and is operationalized or measured by characteristics such as per capita or household income, educational attainment, or occupation. Historically, lower socioeconomic position has been strongly correlated with less favorable health outcomes such as premature mortality and higher death rates from all causes; conversely, persons of higher socioeconomic position do better on most measures of health status.[12]

Years of potential life lost (YPLL) represents the number of years of potential life lost by each death before a predetermined end point (e.g., 65 or 75 years of age). Whereas the crude and adjusted death rates are heavily influenced by the large number of deaths among the elderly, the YPLL measure provides a picture of premature mortality by weighting deaths that occur at younger ages more heavily than those occurring at older ages, thereby emphasizing different causes of death. Age-adjusted YPLLs are calculated using the methodology of Romeder and McWhinnie.[42] This method consists of a summation of the number of deaths occurring at each age (betweem 1 and 75) multiplied by the remaining years of life had the deceased lived up to age 75.

Appendix 3B. Glossary of Medical Terms

Atherosclerosis: A disease that affects the arteries, particularly those supplying the heart, the brain, the aorta, and the lower extremities. Atherosclerosis underlies the occurrence of heart attacks, many strokes, peripheral arterial disease, and ruptures of the aorta.[43]

Cardiovascular Diseases (CVD): Diseases of the circulatory system, which include acute myocardial infarction, ischemic heart disease, valvular heart disease, peripheral vascular disease, arrhythmias, high blood pressure and stroke.[44]

Coronary Heart Disease (CHD): A form of heart disease resulting from impaired circulation in one or more coronary arteries. Common clinical manifestations of CHD include chest pain (angina pectoris) or "heart attack".[44]

Cerebrovascular Disease: A disease of one or more blood vessels in the brain, which often results in the sudden development of a focal neurologic deficit, or stroke. Stroke, or a "brain attack" is the most severe clinical manifestation of cerebrovascular disease.[1, 45]

Congestive Heart Failure: The inability of the heart to maintain adequate pumping function, which can be caused by a number of factors, such as untreated hypertension, heart attacks, or infections. Heart failure increases the risk for other cardiovascular disease events and often results in physical disability. Congestive Heart Failure is commonly referred to as "heart failure".[43-45]

Diabetes (or diabetes mellitus): A metabolic disorder that results from the body's insufficient production or utilization of insulin. The most common types of diabetes includes "Type 1 diabetes," formerly known as "juvenile diabetes," and "Type 2 diabetes," formerly known as "adult-onset diabetes." Long-term effects of diabetes include cardiovascular complications.[43]

Dyslipidemia: A disorder of lipoprotein metabolism, such as an overproduction or deficiency of lipoprotein. Dyslipidemia is often manifested by elevated levels of total cholesterol, the "bad" or low-density lipoprotein (LDL) cholesterol, and the triglyceride concentrations, as well as decreased levels of the "good" or high-density lipoprotein (HDL) cholesterol concentration in the blood.[46]

Essential Hypertension: high blood pressure without a secondary cause such as renal failure. Approximately 95% of all cases of hypertension are classified as essential hypertension.[47]

Heart Failure: See Congestive Heart Failure.

Hemorrhagic Stroke: Hemorrhagic stroke occurs when a weakened blood vessels ruptures causing bleeding within the brain. The resulting accumulation of blood compresses nearby brain tissue. Hemorrhagic stroke is often associated with high blood pressure. About 13% of all strokes are hemorrhagic.[48]

High Blood Cholesterol: Cholesterol is a substance found in all cells of the body; it is carried in lipoproteins, made of fat (lipid) on the inside and proteins on the outside. Low-density lipoprotein (LDL) cholesterol is sometimes called "bad cholesterol" because it leads to a buildup of cholesterol in arteries. The chance of heart disease increases with increasing LDL levels in the blood. The buildup of cholesterol in the arteries is called plaque, which over time causes the narrowing of the arteries, or "atherosclerosis." Some plaques can burst, releasing fat and cholesterol into the bloodstream, which may cause the blood to clot and block the flow of blood. This blockage can cause angina or a heart attack. Lowering one's cholesterol level decreases the chance of having a plaque burst and a subsequent heart attack. Lowering cholesterol may also slow down, reduce, or even stop plaque from building up.[49]

High Blood Pressure: A condition in which the pressure in the arterial circulation system is greater than clinically recommended, that is a systolic pressure greater than or equal to 140 mm Hg or a diastolic pressure greater than or equal to 90 mm Hg. High blood pressure is associated with increased risk for heart disease, stroke, and chronic kidney disease.[43]

Hypertensive Heart Disease: An abnormality in the structure and function of the heart caused by long-standing high blood pressure. A common, clinical manifestation of hypertensive heart disease is heart failure.[43]

Ischemic Heart Disease: A condition in which heart muscle is damaged or works inefficiently because of an absence or deficiency of its blood supply. Ischemic heart disease is most often caused by atherosclerosis, and includes angina pectoris, acute myocardial infarction, chronic ischemic heart disease, and sudden death.[44]

Ischemic Stroke: The most common type of stroke that results from an obstruction within a blood vessel supplying blood to the brain. Atherosclerosis is the cause of the obstruction. About 87% of strokes are ischemic strokes.[50]

Obesity: Defined in terms of body mass index (BMI), and calculated as body weight in kilograms (1 kg = 2.2 lbs.) divided by height in meters (1 m = 39.37 in) squared. Adults with a BMI of greater than or equal to 30.0 kg/m2 are considered "obese," and those with a BMI of 25–29.9 kg/m2 are considered "overweight".[43]

Classification of Overweight and Obesity in Adults According to BMI.[44]
Obesity is classified as BMI ≥ 30 kg/m^2.

Classification	BMI (kg/m^2)	Risk of Health Problems
Underweight	< 18.5	Low (but risk of other clinical problems increased)
Normal range	18.5-24.9	Average
Overweight	25.0-29.9	Mildly increased
Obese	**> 30.0**	
Class I	30.0-34.9	Moderate
Class II	35.0-39.9	Severe
Class III	> 40.0	Very severe
Note that these values are age-independent and correspond to the same degree of fatness across different populations.		

Serum (Blood) Lipids: Cholesterol and triglycerides are types of lipids circulating in the blood. Over time, elevated cholesterol and triglycerides in the blood can become plaque in artery walls leading to atherosclerosis. Elevated cholesterol and triglyceride levels are often found in individuals with other major risk factors for heart disease (obesity, diabetes, and/or high blood pressure).[51]

Stroke: The most common clinical manifestation of cerebrovascular disease. Stroke describes an interruption of the blood supply in the brain that results in damaged brain tissue. It can be caused by clots or by bleeding in the brain from a ruptured blood vessel or a significant injury.[1, 52]

REFERENCES

1. Newschaffer, C.J., L. Liu, and A. Sim. 2010. Cardiovascular Disease. *In* P.L. Remington, R.C. Brownson, and M.V. Wegner (eds.), *Chronic Disease Epidemiology and Control.* 3rd ed. p. 383-428. American Public Health Association, Washington, D.C.

2. American Heart Association (AHA). 2010. *Heart Disease and Stroke Statistics- 2010 Update At-A-Glance*. AHA, Dallas, TX. Available at http://www.americanheart.org/downloadable/heart/1265665152970DS-3241%20HeartStrokeUpdate_2010.pdf.

3. Connecticut Department of Public Health. 2010. *Vital Records Mortality Files*. Connecticut Department of Public Health, Hartford, CT. Available at http://www.ct.gov/deathdata.

4. World Health Organization (WHO). 2006. *ICD-10: International Statistical Classification of Diseases and Related Health Problems, 10th revision*. 2nd ed. WHO, Geneva. Available at http://apps.who.int/classifications/apps/icd/icd10online/.

5. Hynes, M.M., L.M. Mueller, H. Li, and F. Amadeo. 2005. *Mortality and Its Risk Factors in Connecticut, 1989-1998*. Connecticut Department of Public Health, Hartford, CT. Available at www.ct.gov/dph/DeathData.

6. Mueller, L.M. 2011. *Linear Trend Analysis of Connecticut Residents Age-adjusted Mortality Rates, 1999-2008* (unpublished tables). Connecticut Department of Public Health, Hartford, CT.

7. Centers for Disease Control and Prevention (CDC), National Center for Health Statistics. 2009. *CDC WONDER Mortality Data, 2005-2007*. CDC, Atlanta, GA. Available at http://wonder.cdc.gov/cmf-icd10.html.

8. United States Department of Health and Human Services. 2000. Chapter 12- Heart Disease and Stroke. *In Healthy People 2010*, vol. 1. 2nd ed. U.S. Government Printing Office, Washington, D.C. Available at http://www.healthypeople.gov/2010/Document/pdf/Volume1/12Heart.pdf.

9. National Center for Health Statistics. 2010. *Health, United States, 2009: With Special Feature on Medical Technology*. U.S. Government Printing Office, Hyattsville, MD. Available at http://www.cdc.gov/nchs/data/hus/hus09.pdf.

10. Connecticut Department of Public Health. 2010. *Connecticut Hospital Discharge Abstract and Billing Data Base*. Connecticut Department of Public Health, Hartford, CT. Available at http://www.ct.gov/dph/heartstrokedata.

11. Arnett, D.K., A.E. Baird, R.A. Barkley, et al. 2007. Relevance of Genetics and Genomics for Prevention and Treatment of Cardiovascular Disease: A Scientific Statement from the American Heart Association Council on Epidemiology and Prevention, the Stroke Council, and the Functional Genomics and Translation Biology Interdisciplinary Working Group. *Circulation 115*: 2878-2901. Available at http://circ.ahajournals.org/cgi/content/full/115/22/2878.

12. Adler, N.E. and K. Newman. 2002. Socioeconomic Disparities in Health: Pathways and Policies. *Health Affairs 21* (2):60-76.

13. Bautista, L.E. 2010. High Blood Pressure. *In* P.L. Remington, R.C. Brownson, and M.V. Wegner (eds.), *Chronic Disease Epidemiology and Control.* 3rd ed. p. 335-362. American Public Health Association, Washington, D.C.

14. Connecticut Department of Public Health, Behavioral Risk Factor Surveillance System (BRFSS) Program. 2010. *Connecticut 2007-2009 BRFSS Calculated Variables Reports* (unpublished tables). Connecticut Department of Public Health, Hartford, CT.

15. Centers for Disease Control and Prevention (CDC), Behavioral Risk Factor Surveillance System (BRFSS) Program. 2010. *United States 2009 BRFSS Data.* CDC, Atlanta, GA. Available at http://apps.nccd.cdc.gov/BRFSS/.

16. Johnson, H.M. and P.E. McBride. 2010. High Blood Cholesterol. *In* P.L. Remington, R.C. Brownson, and M.V. Wegner (eds.), *Chronic Disease Epidemiology and Control.* 3rd ed. p. 363-382. American Public Health Association, Washington, D.C.

17. National Institutes of Health (NIH). 2002. *Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III): Final Report.* NCEP, National Heart, Lung, and Blood Institute, and NIH, Bethesda, MD. Available at http://www.nhlbi.nih.gov/guidelines/cholesterol/atp3full.pdf.

18. Centers for Disease Control and Prevention (CDC). 2000. State-Specific Cholesterol Screening Trends- United States, 1991-1999. *MMWR 49*(33): 750-755.

19. Centers for Disease Control and Prevention (CDC), Youth Risk Behavior Surveillance System (YRBSS). 2009. *Connecticut 2009 YRBSS Results.* CDC, Atlanta, GA. Available at http://apps.nccd.cdc.gov/youthonline/App/Results.aspx?LID=CT.

20. Bishop, D.B., P.J. O'Connor, and J. Desai. 2010. Diabetes. *In* P.L. Remington, R.C. Brownson, and M.V. Wegner (eds.), *Chronic Disease Epidemiology and Control.* 3rd ed. p. 291-334. American Public Health Association, Washington, D.C.

21. Galuska, D.A and W.H. Dietz. 2010. Obesity and Overweight. *In* P.L. Remington, R.C. Brownson, and M.V. Wegner (eds.), *Chronic Disease Epidemiology and Control.* 3rd ed. p. 269-290. American Public Health Association, Washington, D.C.

22. National Institutes of Health (NIH). 1998. *Clinical Guidelines on the Identifications, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.* NIH, U.S. Department of Health and Human Services, Bethesda, MD. Available at http://www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf.

23. Ainsworth, B.E. and C.A. Macera. 2010. Physical Activity. *In* P.L. Remington, R.C. Brownson, and M.V. Wegner (eds.), *Chronic Disease Epidemiology and Control.* 3rd ed. p. 199-225. American Public Health Association, Washington, D.C.

24. Haskell, W.L., I-Min Lee, R.R. Pate, et al. 2007. Physical Activity and Public Health: Updated Recommendations for Adults from the American College of Sports Medicine and the American Heart Association. *Circulation 116*: 1081-1093. Available at http://circ.ahajournals.org/cgi/reprint/CIRCULATIONAHA.107.185649.

25. United States Department of Health and Human Services. 2008. *2008 Physical Activity Guidelines for Americans*. U.S. Department of Health and Human Services, Washington, D.D. Available at www.health.gov/paguidelines.

26. American Heart Association (AHA). 2010. *Metabolic Syndrome*. AHA, Dallas TX. Available at http://www.americanheart.org/presenter.jhtml?identifier=4756.

27. Institute of Medicine Committee on the Consequences of Uninsurance. 2002. *Care without Coverage: Too Little, Too Late.* National Academy Press, Washington, D.C. Available at http://iom.edu/Reports/2002/Care-Without-Coverage-Too-Little-Too-Late.aspx.

28. Centers for Disease Control and Prevention (CDC). 2010. *National Heart Disease and Stroke Prevention Program: Strategies to Address the "ABCS", Program Guidance*. CDC, Atlanta, GA.

29. Task Force on Community Preventive Services. 2005. *The Guide to Community Preventive Services*. Oxford University Press, New York. Available at http://www.thecommunityguide.org/library/book/index.html.

30. World Health Organization (WHO). 1977. *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, Based on the Recommendations of the Ninth Revision Conference, 1975*. WHO, Geneva.

31. World Health Organization (WHO). 1992. *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, Based on the Recommendations of the Tenth Revision Conference, 1992*. WHO, Geneva.

32. Stratton, A., M.M. Hynes, and A.N. Nepaul. 2009. *The 2009 Connecticut Health Disparities Report*. Connecticut Department of Public Health, Hartford, CT. Available at http://www.ct.gov/dph/cwp/view.asp?a=3132&q=388116%20%20%20.

33. Klein, R.J. and C.A. Schoenborn. 2001. Age Adjustment Using the 2000 Projected U.S. Population. *Healthy People Statistical Notes, no. 20*. DHHS Publication No. (PHS) 2001-1237. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention/ National Center for Health Statistics, Hyattsville, MD.

34. Centers for Disease Control and Prevention (CDC). 2011. *Division for Heart Disease and Stroke Prevention's Data Trends & Maps Online Tool*. CDC, Atlanta, GA. Available at http://apps.nccd.cdc.gov/ncvdss_dtm/.

35. Murphy, S.L. 2000. Deaths: Final Data for 1998. DHHS Publication No. (PHS) 2000-1120. *National Vital Statistics Reports 48*(11).

36. United States Department of Health and Human Services. 2000. Introduction. *In Healthy People 2010*, vol. 1. 2nd ed. U.S. Government Printing Office, Washington, D.C.

37. Anderson, R.N., A.M. Minino, D.L. Hoyert, and H.M. Rosenberg. 2001. Comparability of Cause of Death between ICD-9 and ICD-10: Preliminary Estimates. *National Vital Statistics Reports 49*(2): 1-32.

38. Lewontin, R. 1995. *Human Diversity*. Scientific American Books, New York.

39. Gould, S.J. 1981. *The Mismeasure of Man*. W.W. Norton and Company, New York.

40. Williams, D.R., R. Lavizzo-Mourey, and R.C. Warren. 1994. *The Concept of Race and Health Status in America*. Public Health Reports *109*: 26-41.

41. American Anthropological Association (AAA). 1998. *American Anthropological Association Statement on "Race"*. AAA, Arlington, VA. Available at http://www.aaanet.org/stmts/racepp.htm.

42. Romeder, J.M. and J.R. McWhinnie. 1977. Potential Years of Life Lost between Ages 1 and 70: An indicator of Premature Mortality for Health Planning. *International Journal of Epidemiology 6*: 143-151.

43. National Forum for Heart Disease and Stroke Prevention. 2008. *A Public Health Action Plan to Prevent Heart Disease and Stroke, Appendix A*. Centers for Disease Control and Prevention, Atlanta, GA. Available at http://www.cdc.gov/dhdsp/action_plan/index.htm.

44. Heart and Stroke Foundation of Canada. 2003. *The Growing Burden of Heart Disease and Stroke in Canada 2003*. Heart and Stroke Foundation of Canada, Ottawa, Canada. Available at http://www.cvdinfobase.ca/cvdbook/En/Glossary.htm.

45. The Cleveland Clinic Information Center. 2004. *Hypertension Glossary*. Cleveland Clinic, Cleveland, OH. Available at http://www.clevelandclinic.org/health/health-info/docs/3800/3846.asp?index=12273.

46. MedicineNet.com. *Definition of Dyslipidemia*. MedicineNet, Inc., San Clemente, CA. Available at http://www.medterms.com/script/main/art.asp?articlekey=33979.

47. Carretero, O.A. and S. Oparil. 2000. Essential Hypertension, Part I: Definition and Etiology. *Circulation*. 101: 329-335. Available at http://circ.ahajournals.org/cgi/content/full/101/3/329#R8.

48. American Heart Association (AHA). 2010. *Types of Stroke: Hemorrhagic (Bleeds)*. AHA, Dallas, TX. Available at http://www.strokeassociation.org/STROKEORG/AboutStroke/TypesofStroke/HemorrhagicBleeds/Hemorrhagic-Bleeds_UCM_310940_Article.jsp.

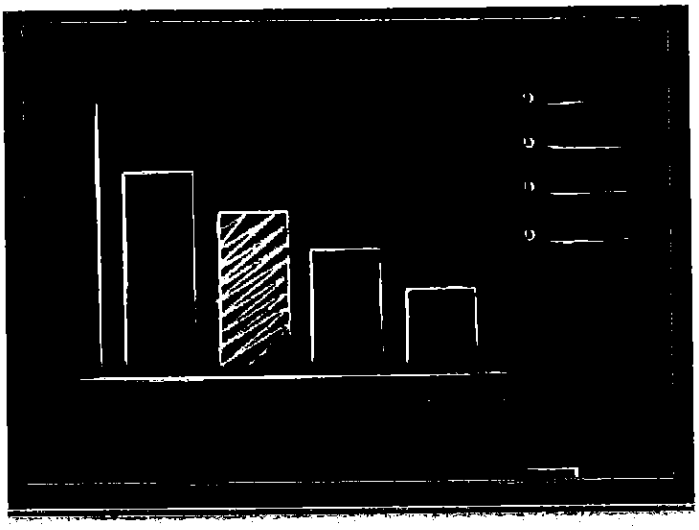
49. National Heart, Lung and Blood Institute (NHLBO). 2008. *What is Cholesterol?* NHLBI, Bethesda, MD. Available at http://www.nhlbi.nih.gov/health/dci/Diseases/Hbc/HBC_WhatIs.html.

50. American Heart Association (AHA). 2011. *Stroke*. AHA, Dallas, TX. Available at http://www.americanheart.org/presenter.jhtml?identifier=4755.

51. National Heart, Lung and Blood Institute (NHLBI). 2005. *Your Guide to Lowering Your Cholesterol with TLC*. NHLBI, Bethesda, MD. Available at http://www.nhlbi.nih.gov/health/public/heart/chol/chol_tlc.pdf.

52. The Cleveland Clinic Information Center. 2009. *Understanding Stroke*. Cleveland Clinic, Cleveland, OH. Available at http://my.clevelandclinic.org/disorders/Stroke/hic_Understanding_Stroke.aspx.

CONNECTICUT
State Health Assessment



Preliminary Findings

January 31, 2013

Connecticut Department of Public Health

DPH

Connecticut State Health Assessment: Preliminary Findings

Prepared for the Kick-off Meeting of the
Connecticut Health Improvement Planning Coalition

January 31, 2013

(Rev. 2/4/13)

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Disclaimer:

The content of this document does not necessarily represent the official position of or endorsement by the Centers for Disease Control and Prevention.

CONTENTS

Connecticut State Health Assessment: *Preliminary Findings*

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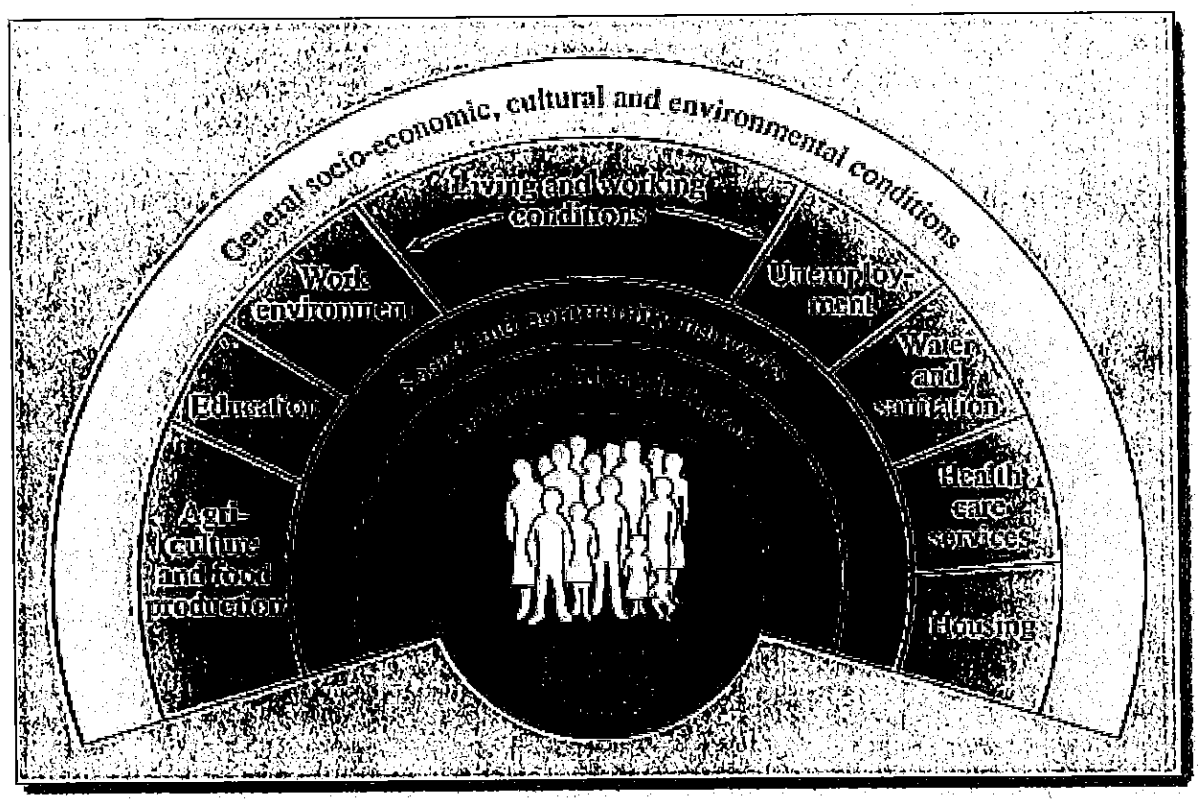
Health Resources in Action, Inc.

CONNECTICUT HEALTH IMPROVEMENT PLANNING COALITION

KICK-OFF MEETING

January 31, 2013

Social Determinants of Health



Source: World Health Organization, Commission on the Social Determinants of Health, Towards a Conceptual Framework for Analysis and Action on the Social Determinants of Health: Discussion paper for the Commission on Social Determinants of Health, 2005.

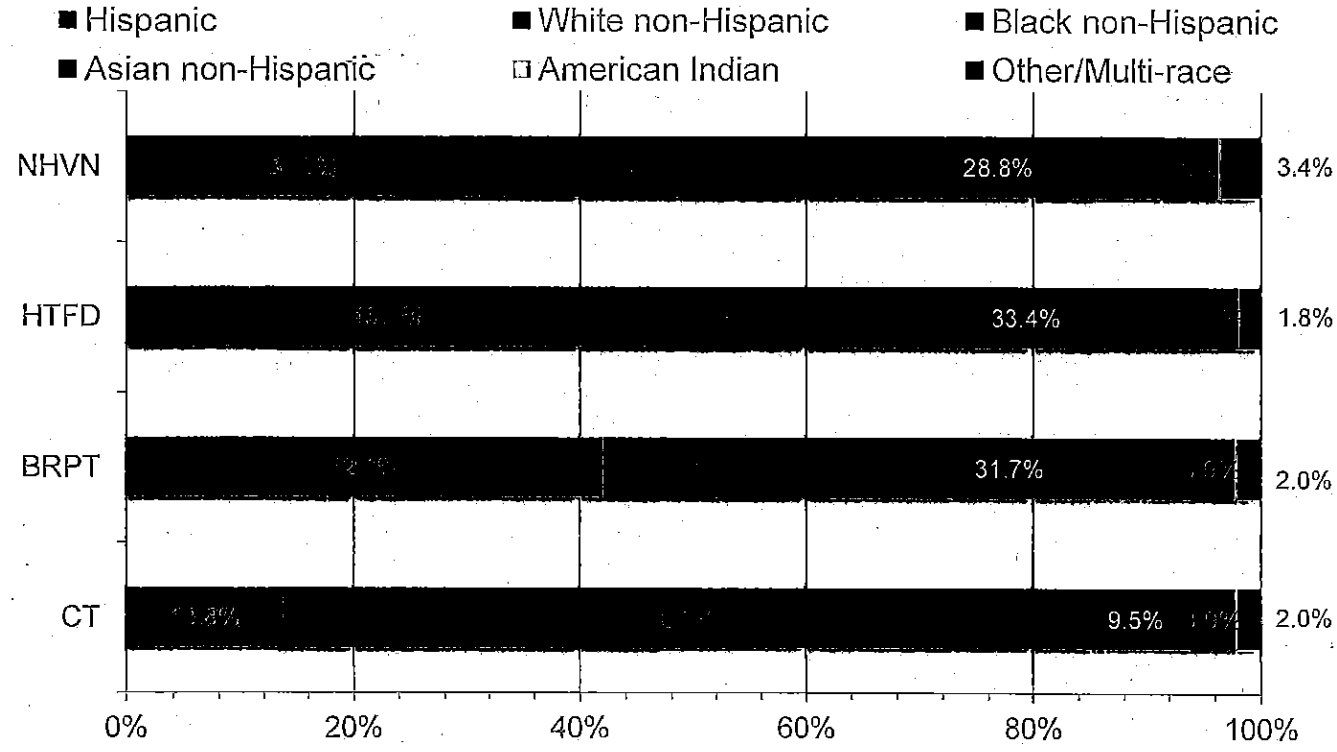
DEMOGRAPHIC CHARACTERISTICS

Changes in Population Characteristics, Connecticut, 2000 and 2010

	Connecticut		Change 2000-2010
	2000	2010	
Population	3,405,565	3,574,097	+4.9%
Median age	37.4 yrs	40.0 yrs	+2.6 yrs
65+ yrs of age	13.8%	14.2%	+36,376 (+7.7%)
Race/ethnicity			
White only	81.6%	77.6%	-7,945 (-0.3%)
Black/Afr. Am. only	9.1%	10.1%	+52,653 (+17%)
Asian only	2.4%	3.8%	+53,252 (+65%)
American Indian only	0.3%	0.3%	+9,637 (+17%)
Other/2+ races	6.6%	8.20	+69,155 (+31%)
Hispanic any race	9.4%	13.4%	+158,764 (+50%)

U.S. Census Bureau, 2000 and 2010 Census

Percent of Population by Race/Ethnicity, Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, DP05 File.

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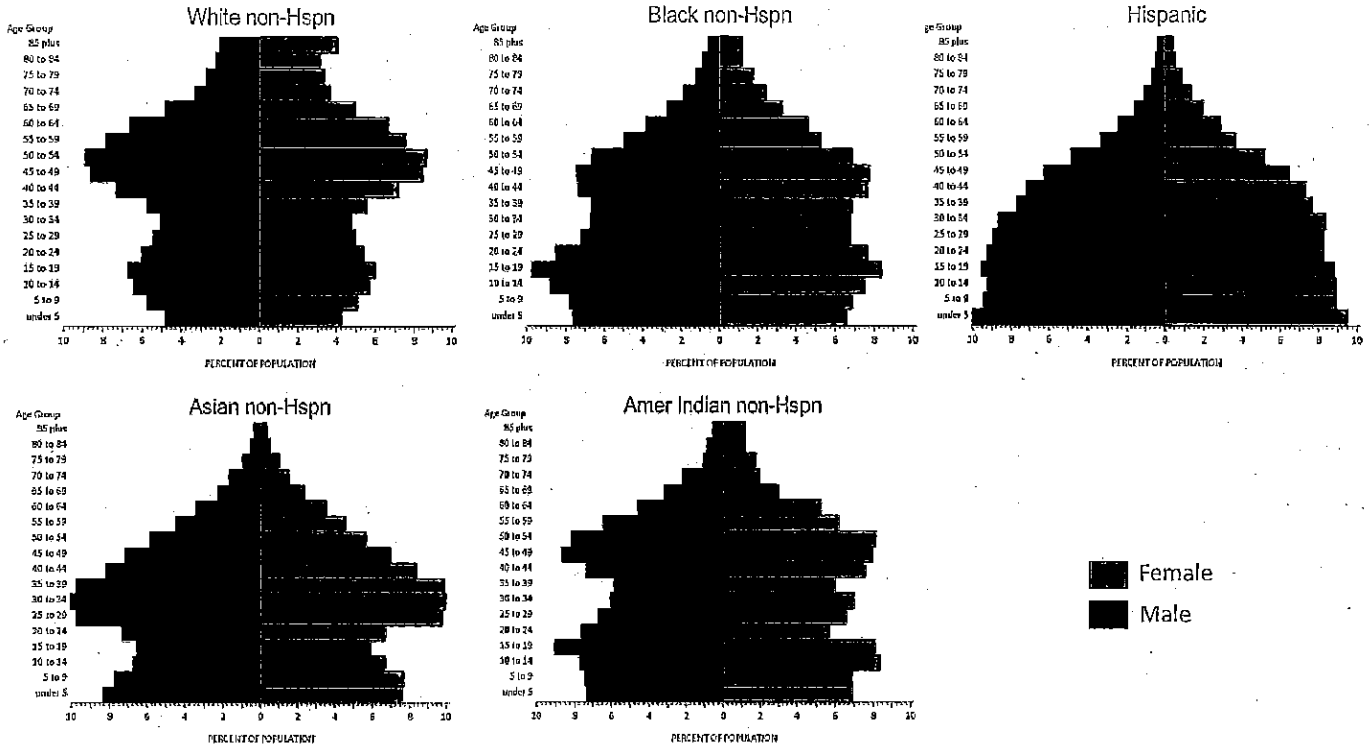
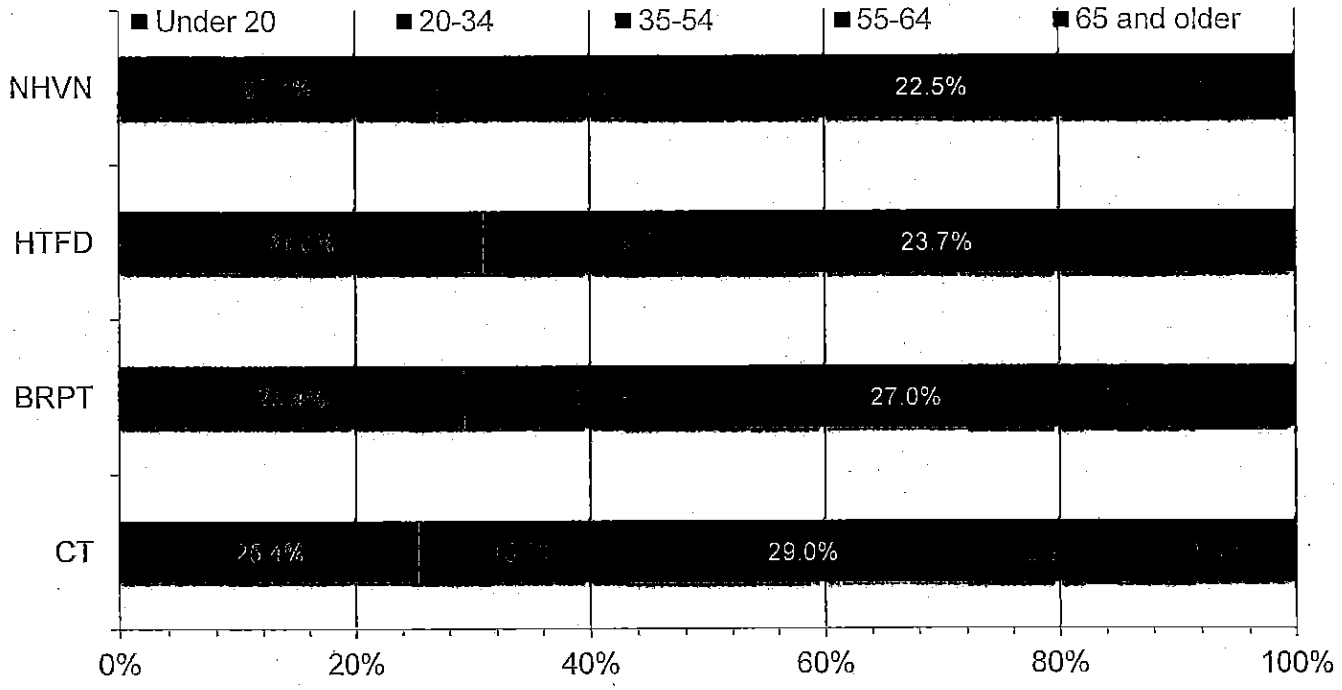
Population Distribution by Age, Sex, Race, and Ethnicity Connecticut, 2010



Source: Connecticut Department of Public Health, Public Health Systems Improvement, 2013. Data from U.S. Census Bureau Postcensal Estimates, 7/1/2010 to 7/1/2011.

Percent of Population by Age
Connecticut and its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, DP05 File.

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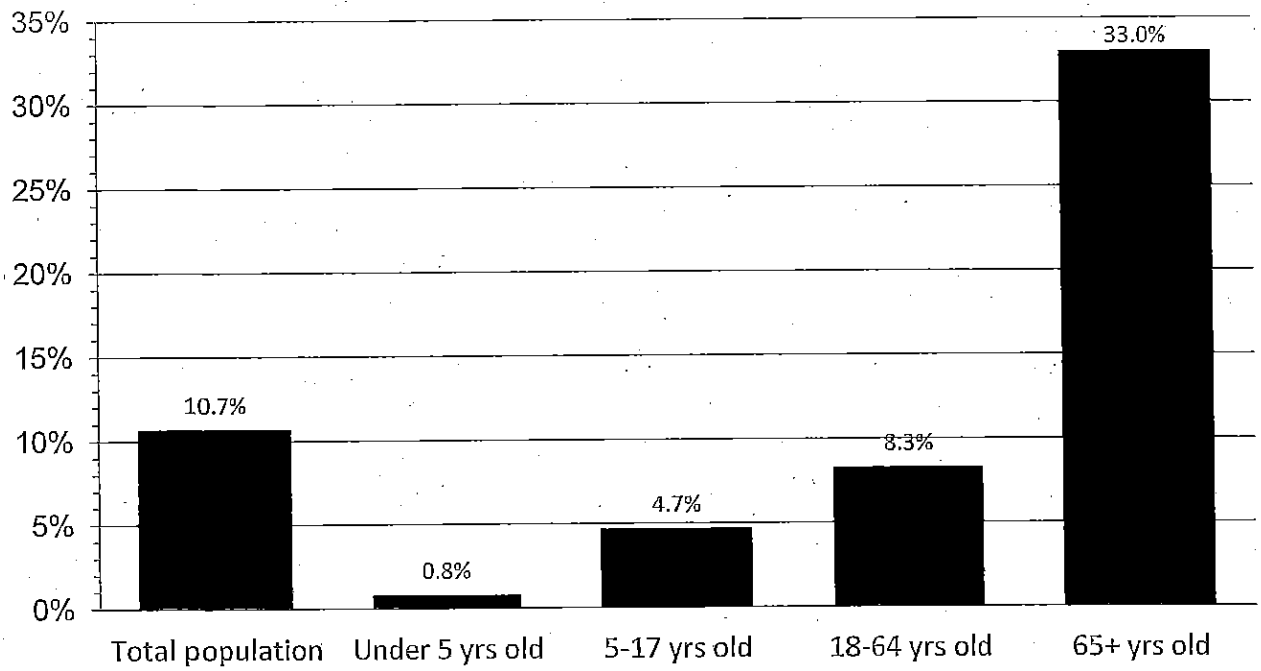
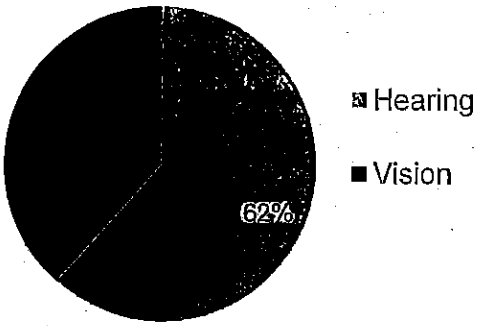
Percent of Residents with Disability by Age Group Connecticut, 2011



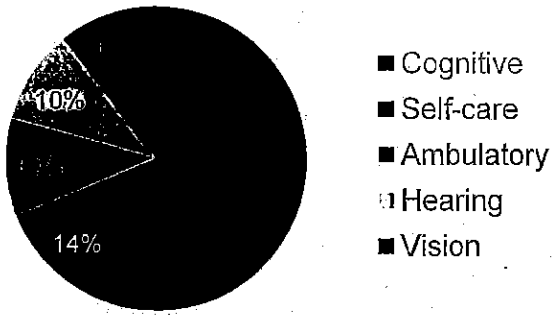
Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, Table S1810.

Disability Difficulty, by Age Group Connecticut, 2011

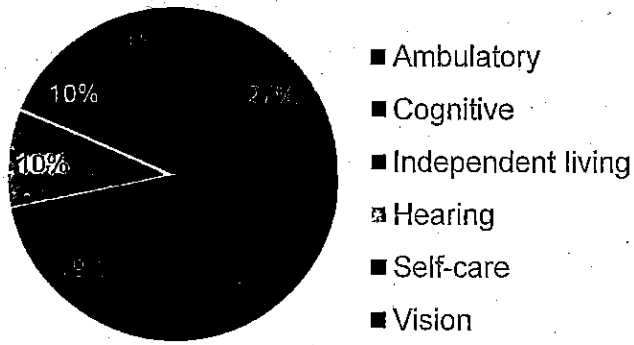
Under 5 yrs old, n=1,630



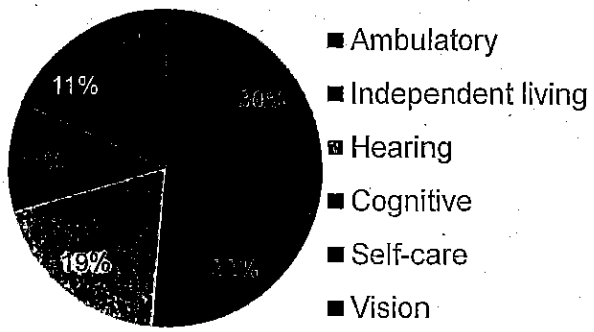
5-17 yrs old, n=28,234



18-64 yrs old, n=185,373



65+ yrs old, n=162,610



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, Table S1810.

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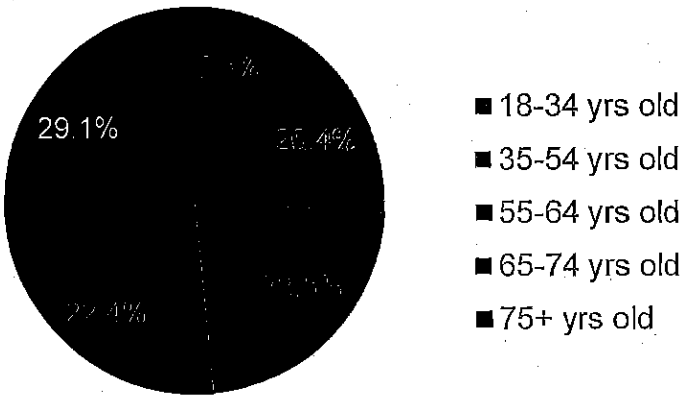
Veterans
Connecticut, 2011

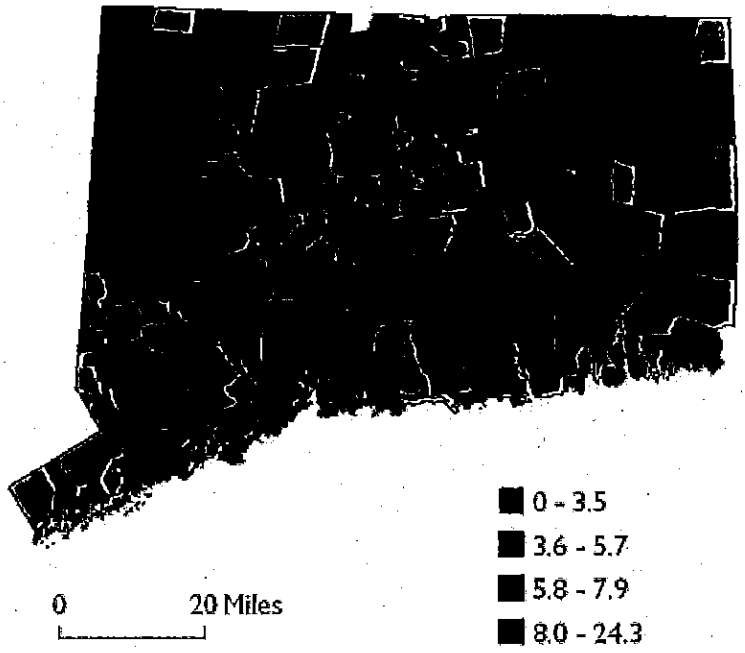
- 8.2% of CT residents (225,987 individuals) are veterans

Connecticut Veterans by Age, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, Table S201.

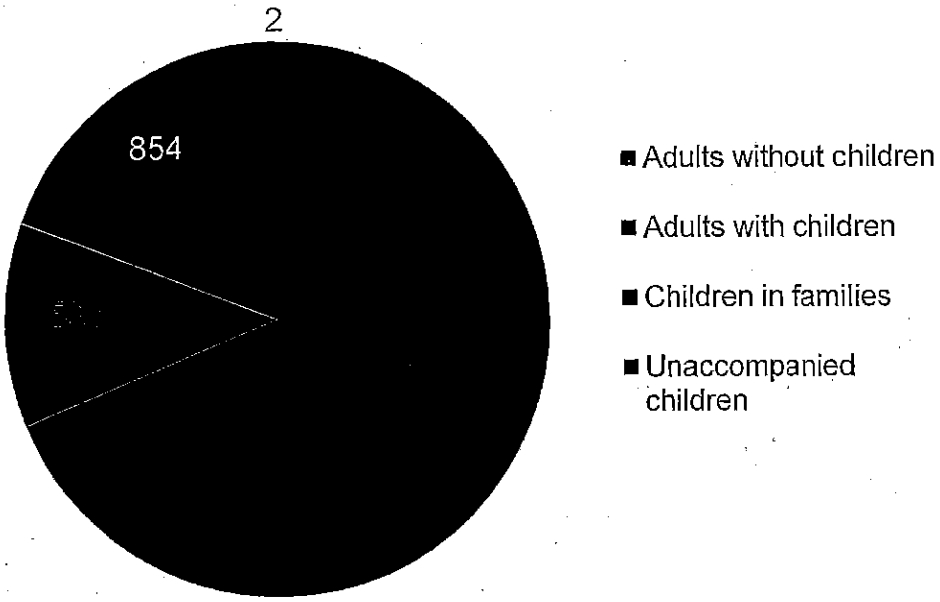
Same-sex Couples per 1,000 Households by Census Tract Connecticut, 2010



- There were 7,852 same-sex couples in Connecticut in 2010.

Source: Map developed by Gates, G. & Cooke, A.. The Williams Institute, UCLA, Connecticut: Census Snapshot: 2010.

Estimated Number of Homeless Persons Connecticut, 2011

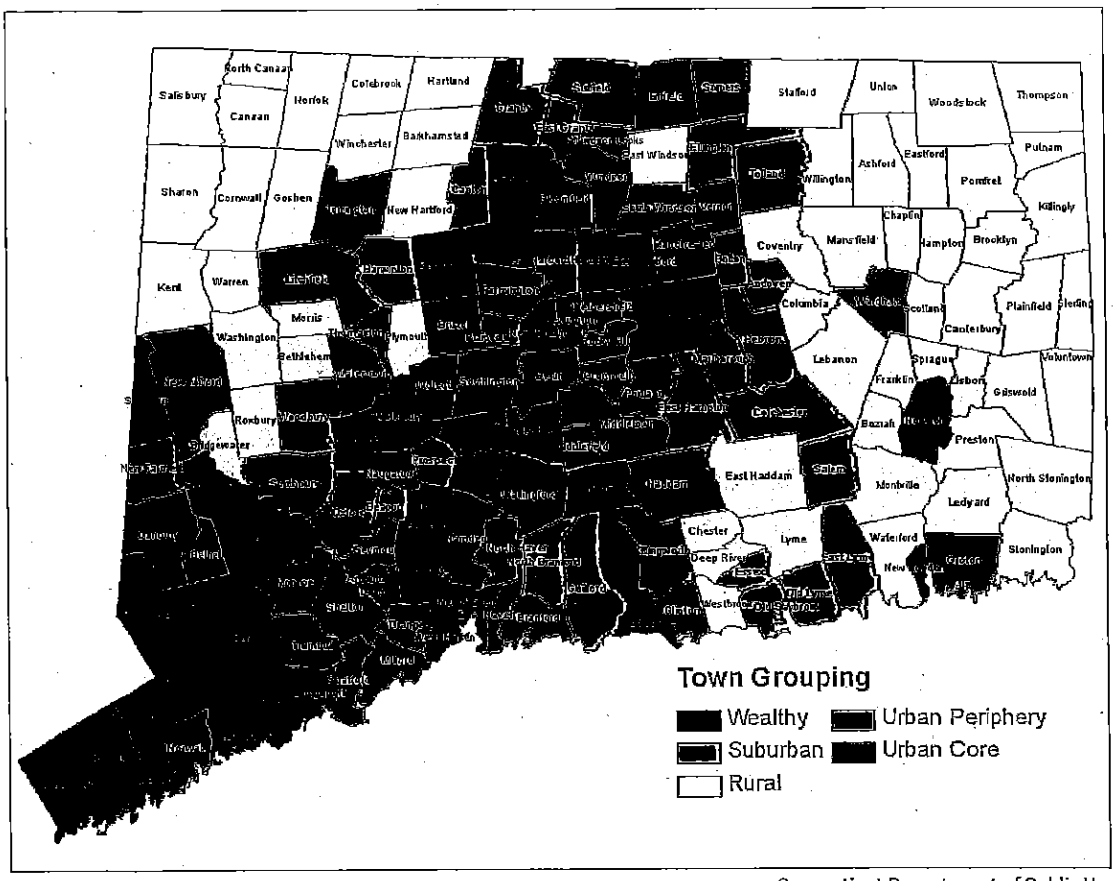


- There were at estimated 4,451 homeless persons in Connecticut in 2011.

Source: CT Coalition to End Homelessness, CT Point in Time Count Brief, 2011

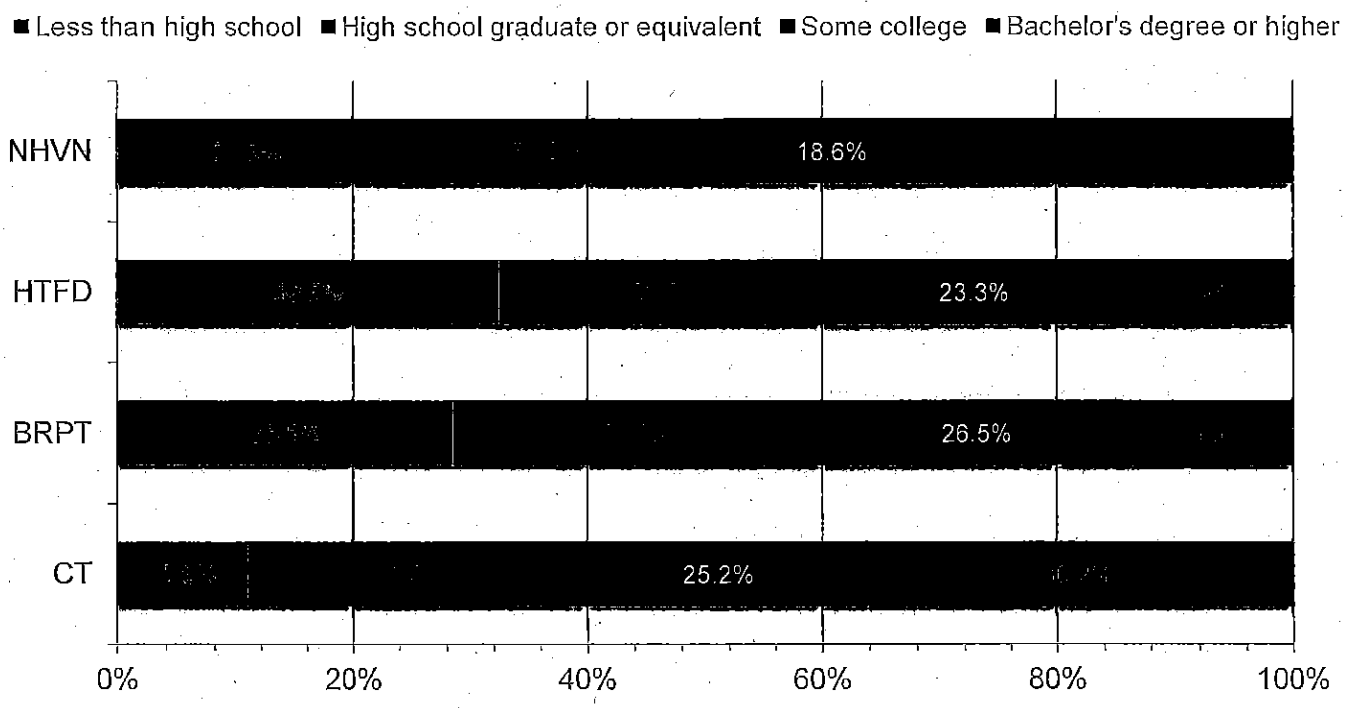
DETERMINANTS OF HEALTH

Five Connecticut Regions, by Socioeconomic Groupings, 2009



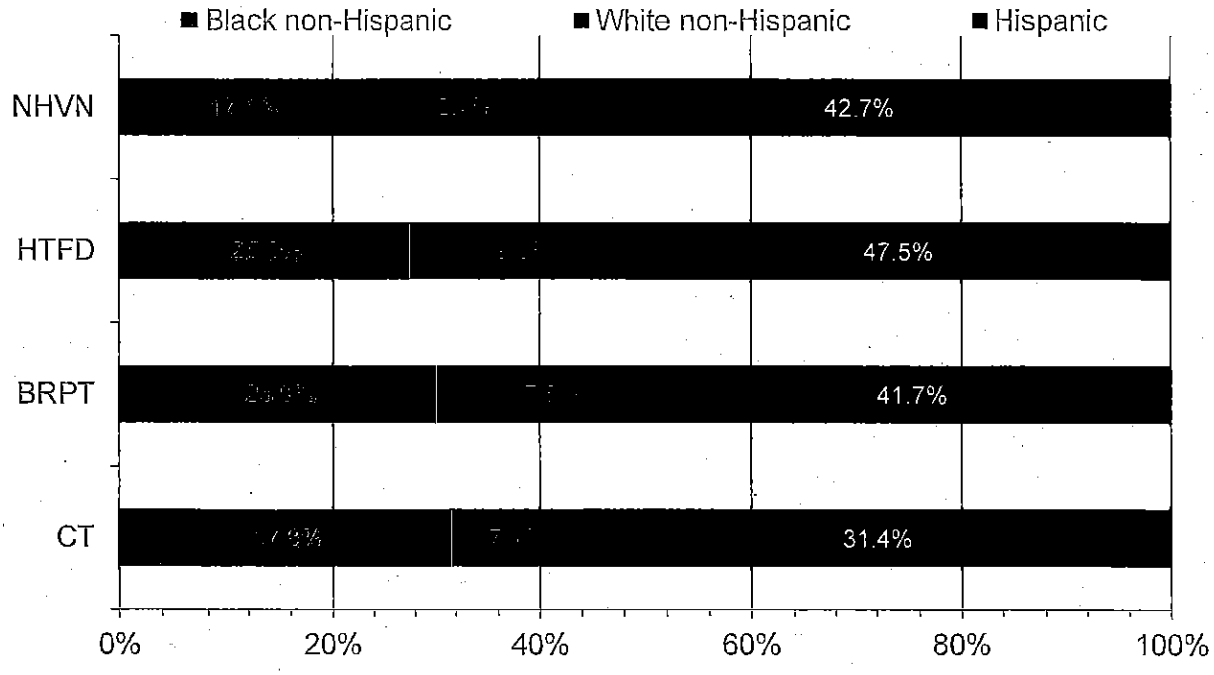
Source: CT State Data Center, The Changing Demographics of Connecticutt: The Five Connecticutts, recreated graph from updated 2009 data provided through personal communication.

Educational Attainment (25 Years of Age and Older), Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, B15002B, B15002D, B15002F, B15002H, B15002I Files.

Less than High School Education by Race/Ethnicity Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, B15002B, B15002D, B15002F, B15002H, B15002I Files.

Connecticut Department of Public Health
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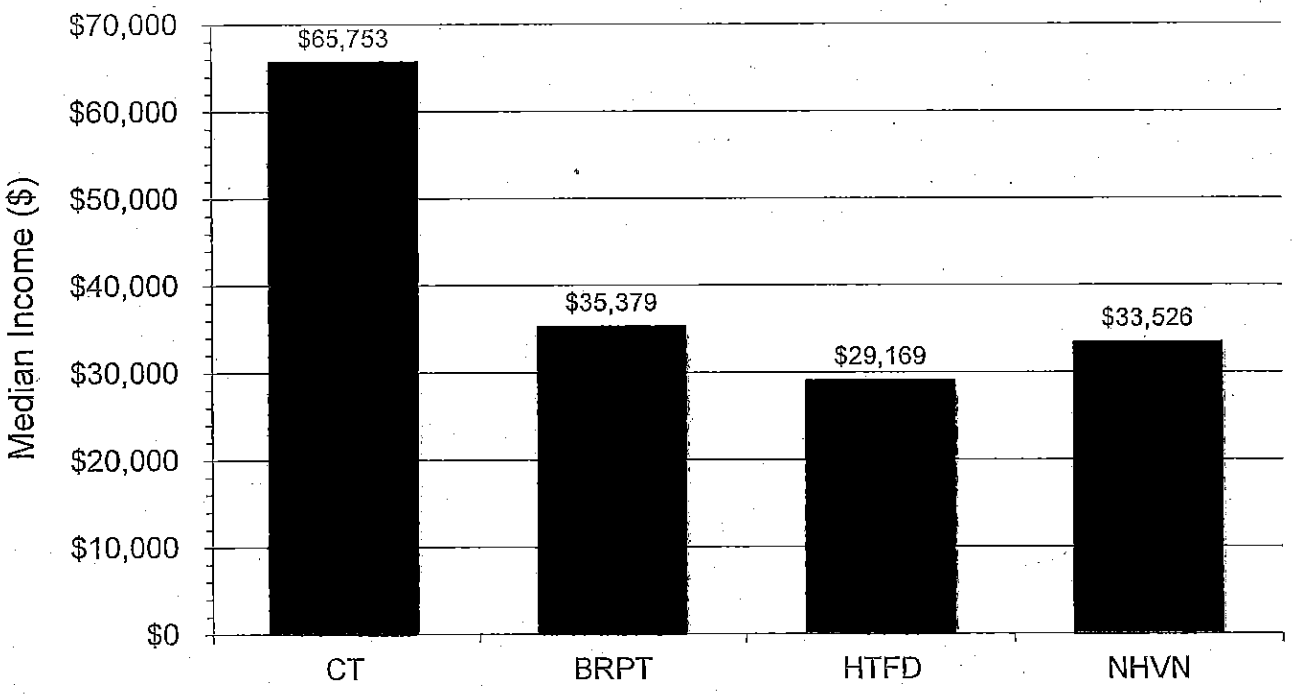
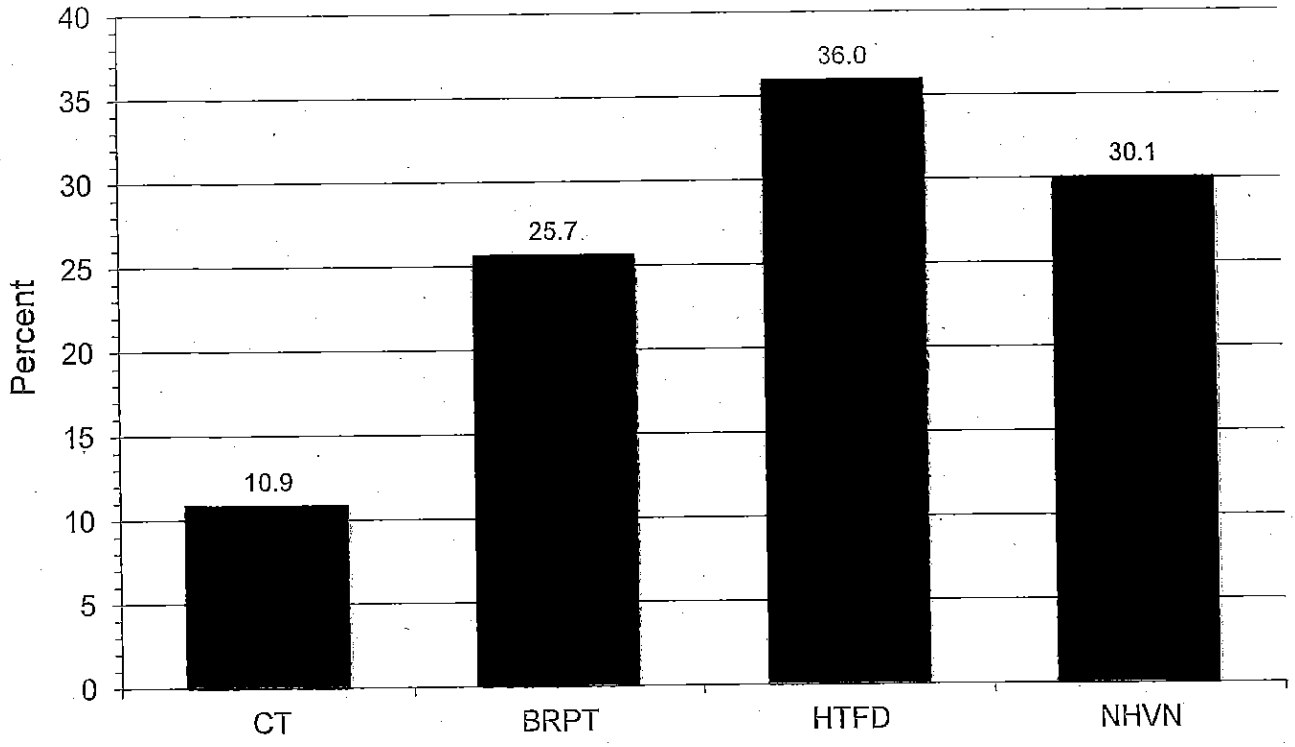
Median Household Income, Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, DP-03 File.

Percent of Individuals below Poverty Level Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, DP-03 File.

Connecticut Department of Public Health
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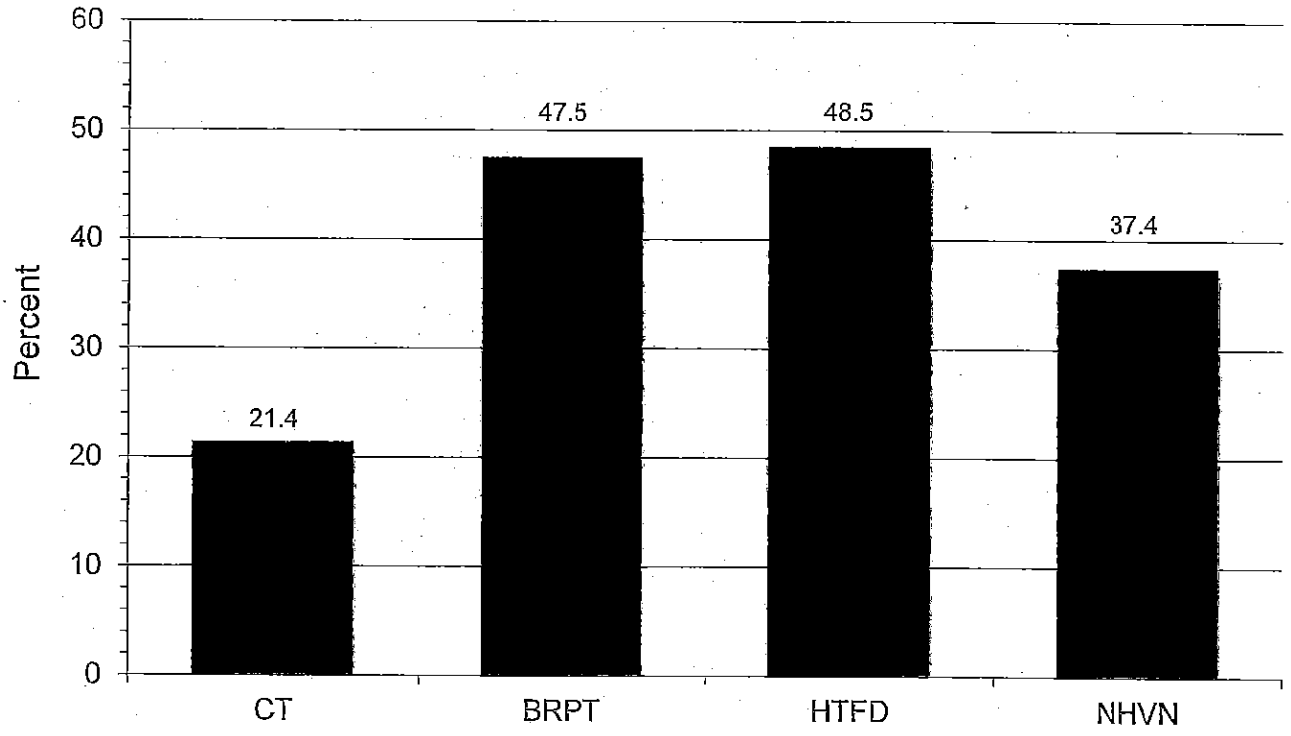
Percent of Population Who Speak Language Other Than English at Home Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, DP-02 File.

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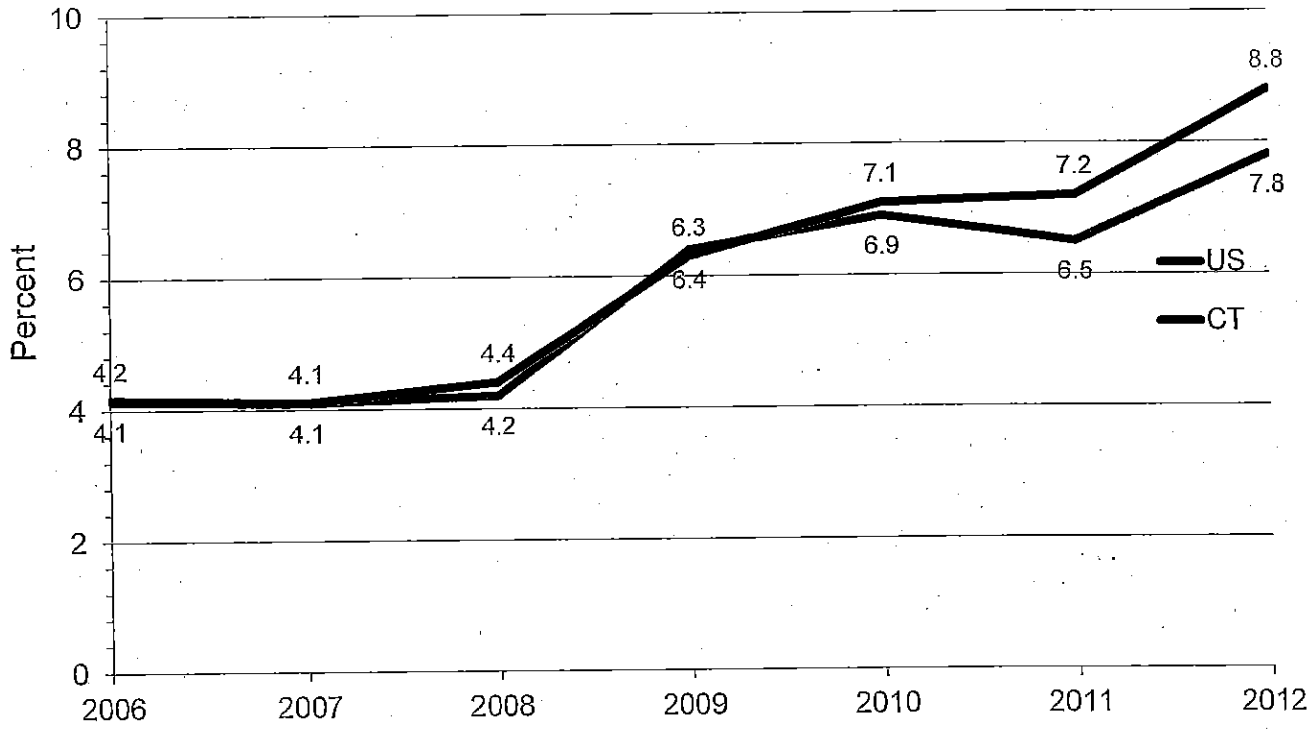
Unemployment Rate
U.S. vs. Connecticut, 2006-2012



Source: US Bureau of Labor Statistics, 2012; US Census Bureau, American Community Survey, 1-Year Estimates, 2006-2011, DP03 File.

Connecticut Department of Public Health
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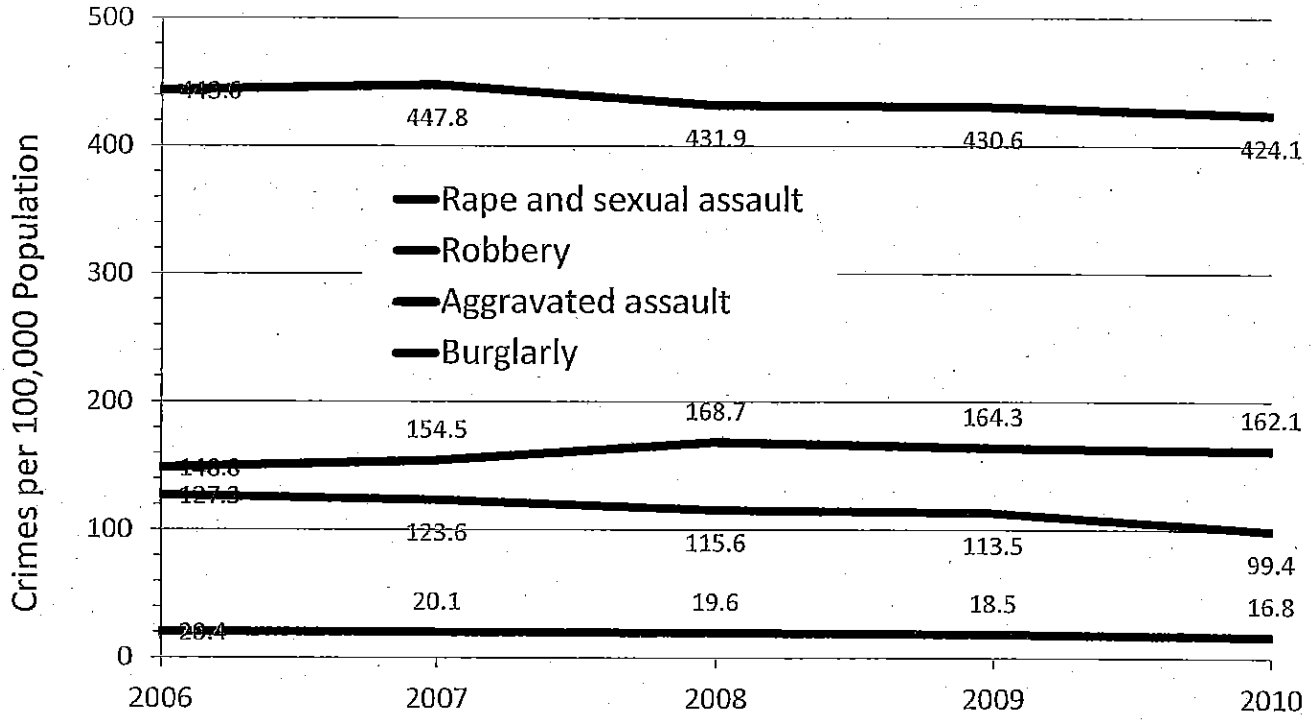
Violent Crimes by Type of Crime Connecticut, 2006-2010



Source: Connecticut Department of Public Safety
Uniform Crime Reports: Publications and Queriable Statistics, 2006-2010.

Connecticut Department of Public Health
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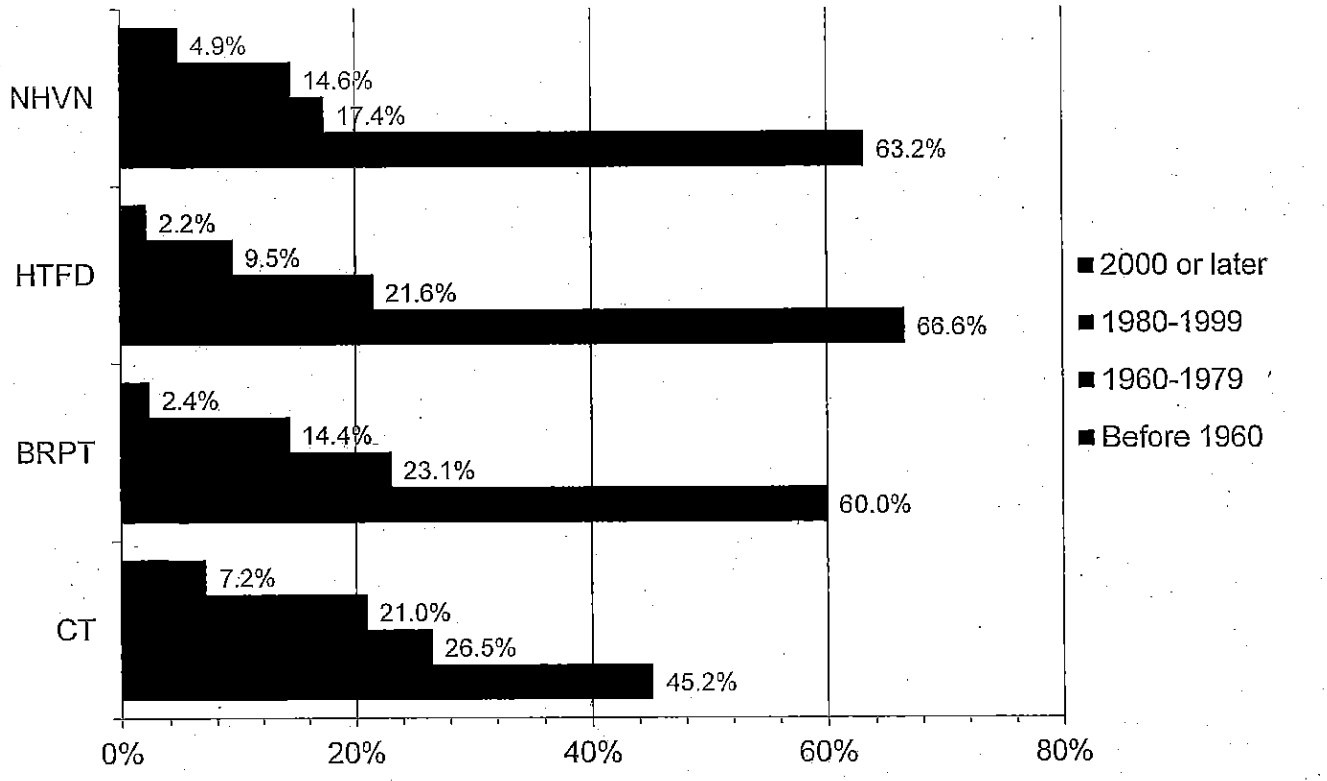
ENVIRONMENTAL DETERMINANTS OF HEALTH

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Percent of Housing Stock Constructed, by Year, Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011

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www.ct.gov/dph/SHIPcoalition

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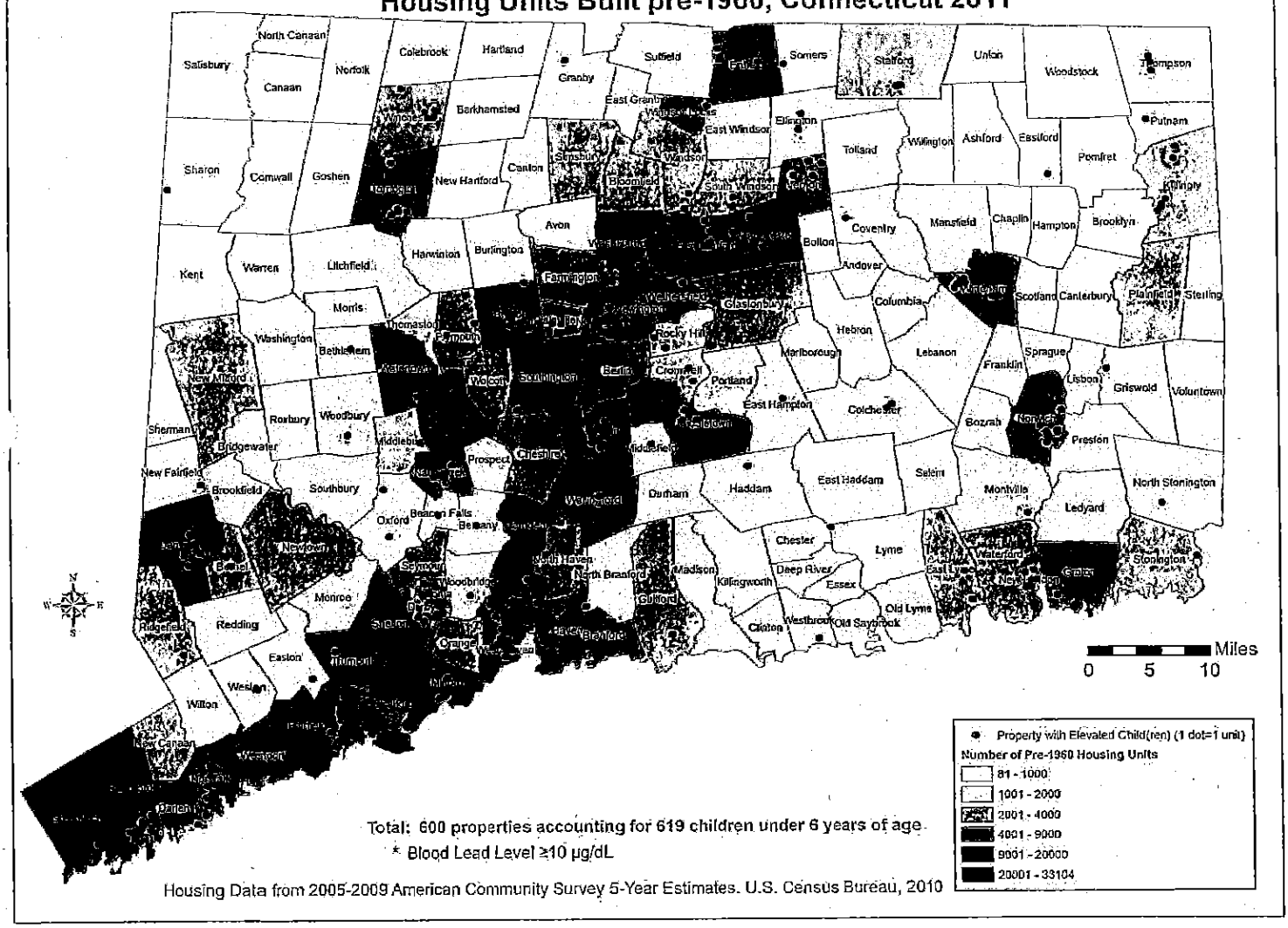
Properties Associated with Lead Poisoned Children* & Housing Units Built pre-1960, Connecticut 2011

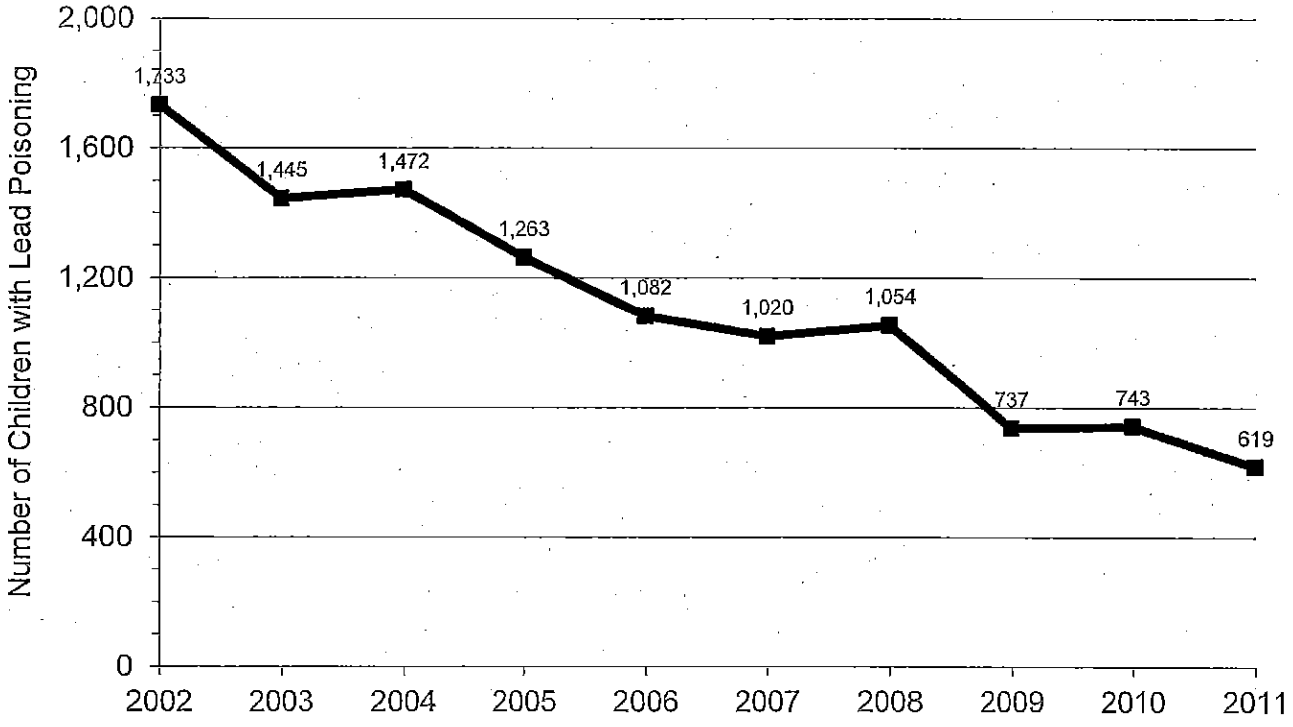


Total: 600 properties accounting for 619 children under 6 years of age

* Blood Lead Level ≥10 µg/dL

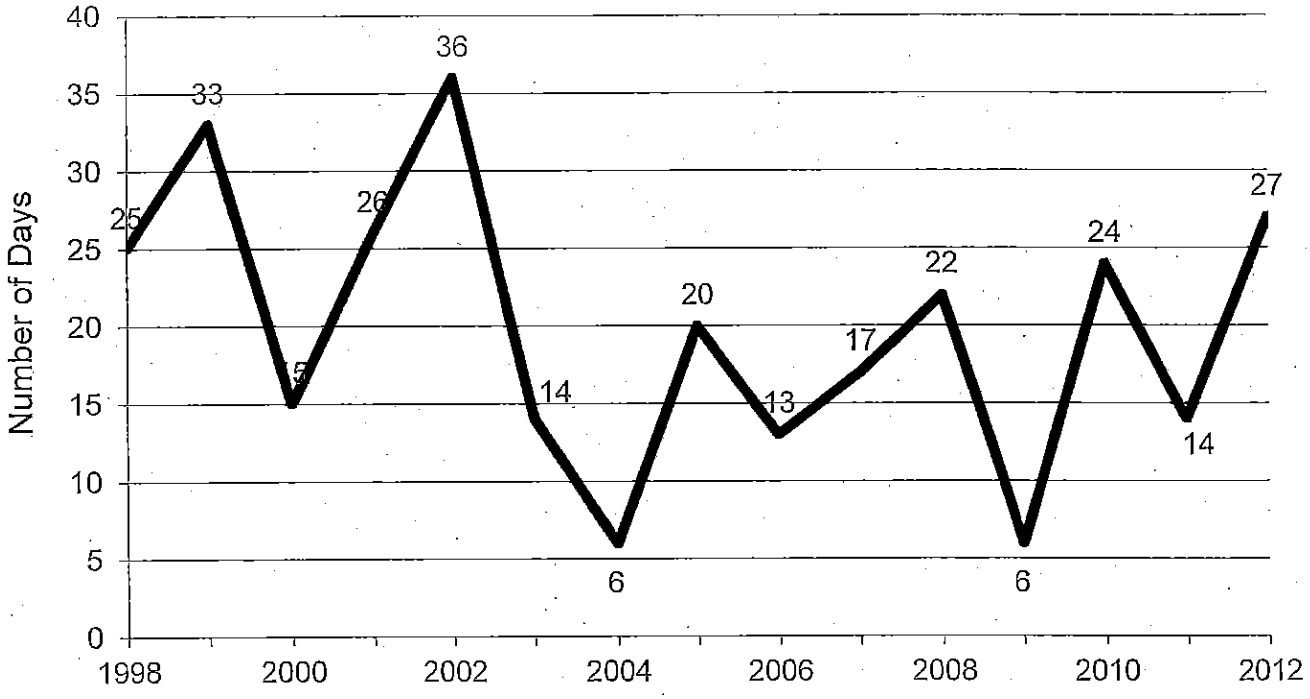
Housing Data from 2005-2009 American Community Survey 5-Year Estimates. U.S. Census Bureau, 2010

Number of Children <6 Years of Age with Lead Poisoning (>=10ug/dL) Connecticut, 2002-2011



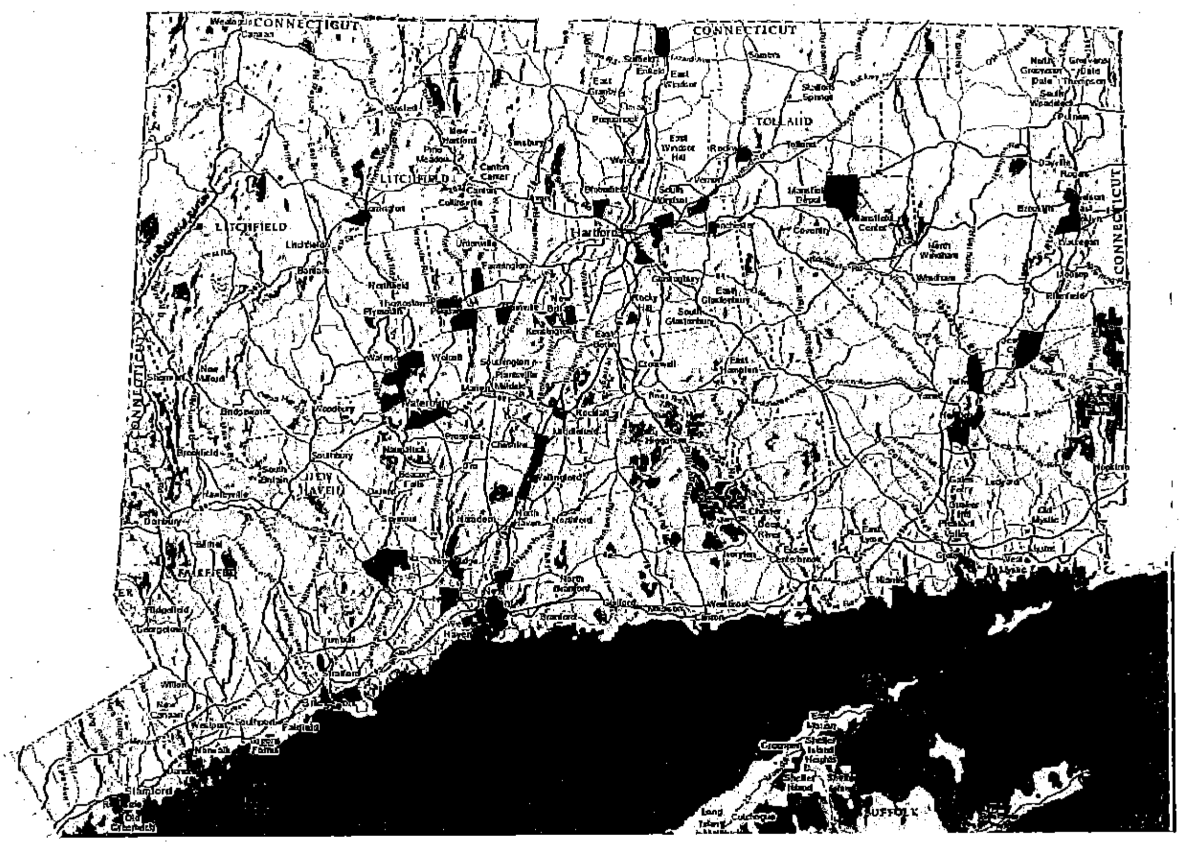
Source: Connecticut Department of Public Health
Lead and Healthy Homes Program,
Childhood Lead Poisoning in Connecticut 2011 Surveillance Report,
Figure 8.

Number of 8-hour Ozone Exceedance Days, Connecticut, 1998-2012



Source: Connecticut Department of Environmental Protection, Bureau of Air Quality Management. *Annual Summary Information for Ozone*, 1999-2009

Low Income Census Tracts Considered "Food Deserts" Connecticut, 2009

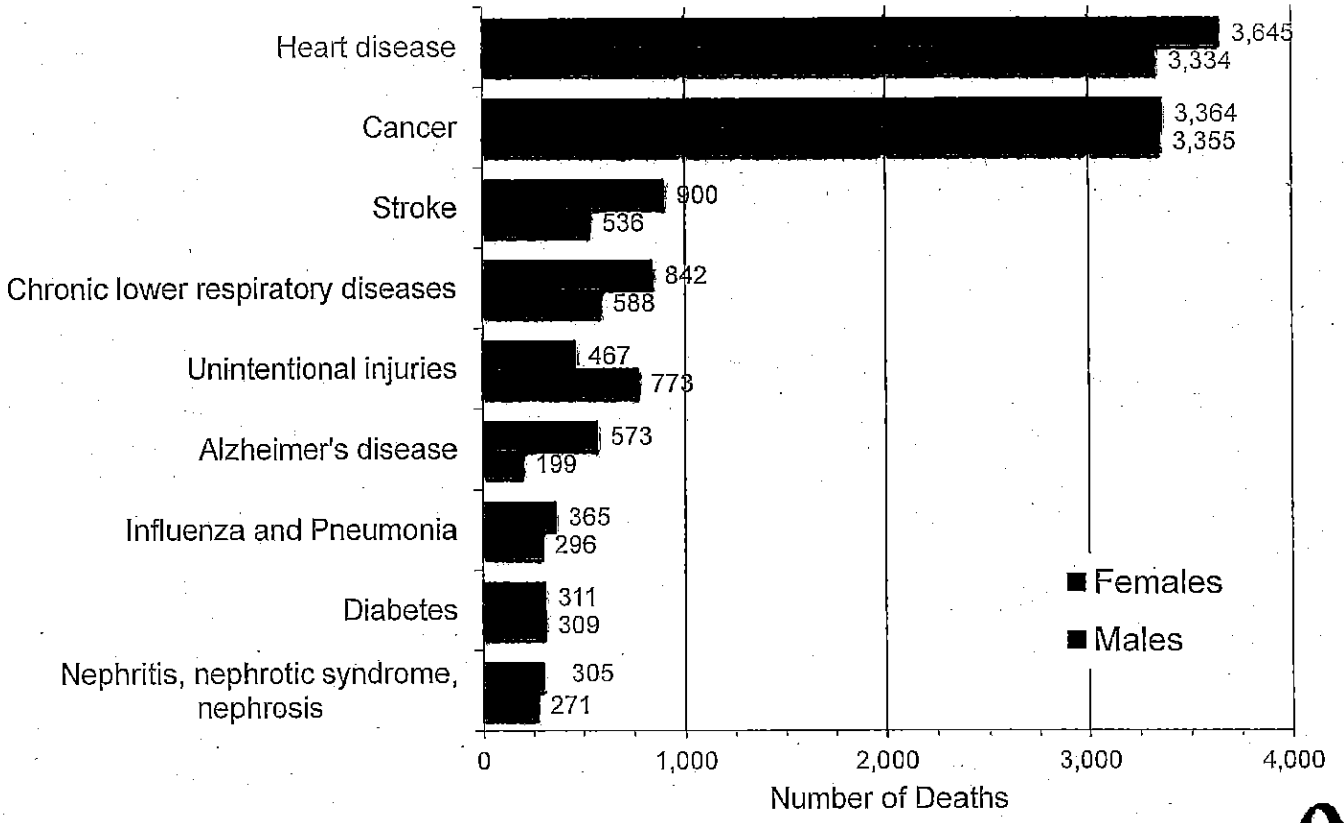


Source: United States Department of Agriculture,
Economic Research Service, Food Desert Locator, 2009.
Map provided by personal communication.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

MORTALITY AND HOSPITALIZATION

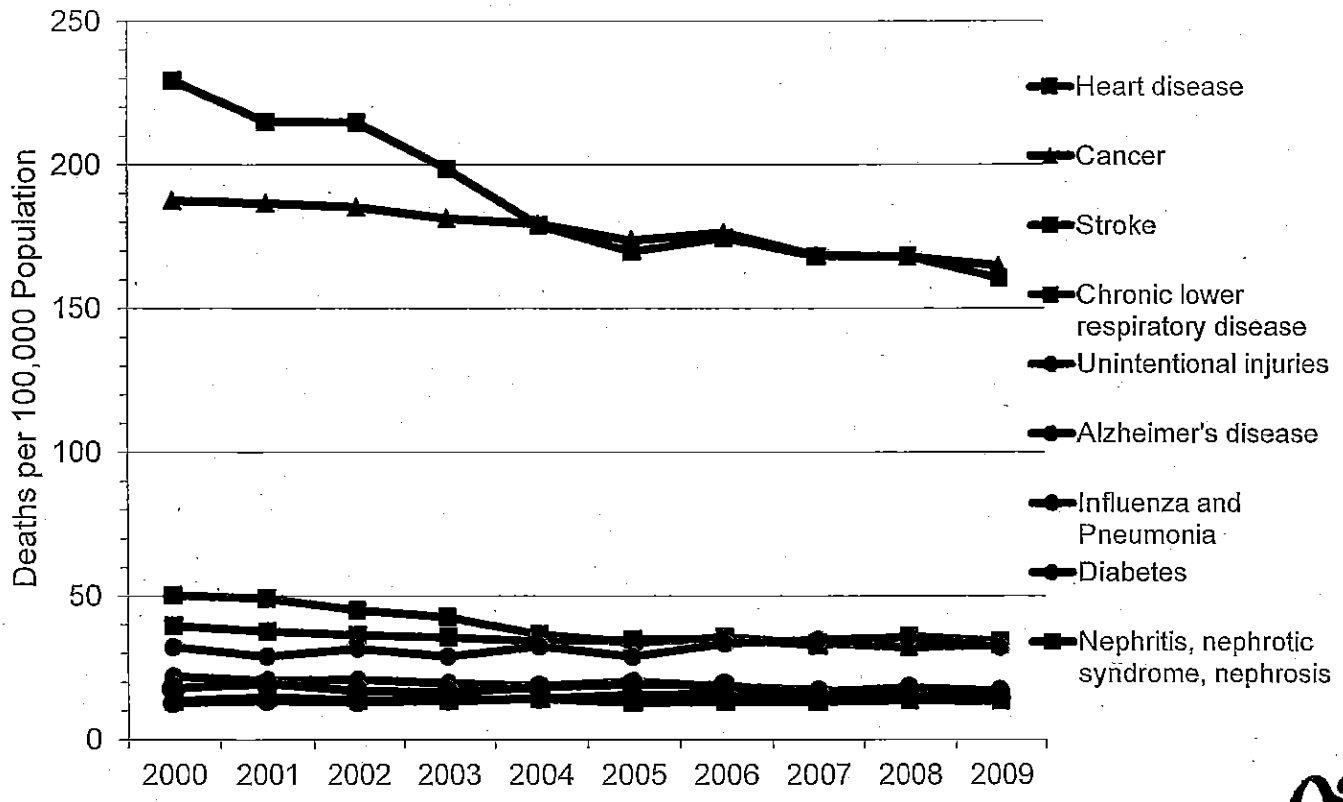
Leading Causes of Death, by Sex
Connecticut, 2009



Source: Connecticut Department of Public Health, Mortality Tables, 2009, Tables 9 and 10.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Age-adjusted Death Rates for Leading Causes of Death Connecticut, 2000-2009



Source: Connecticut Department of Public Health, Mortality Tables, Age-Adjusted Mortality Rate, 2000-2009.

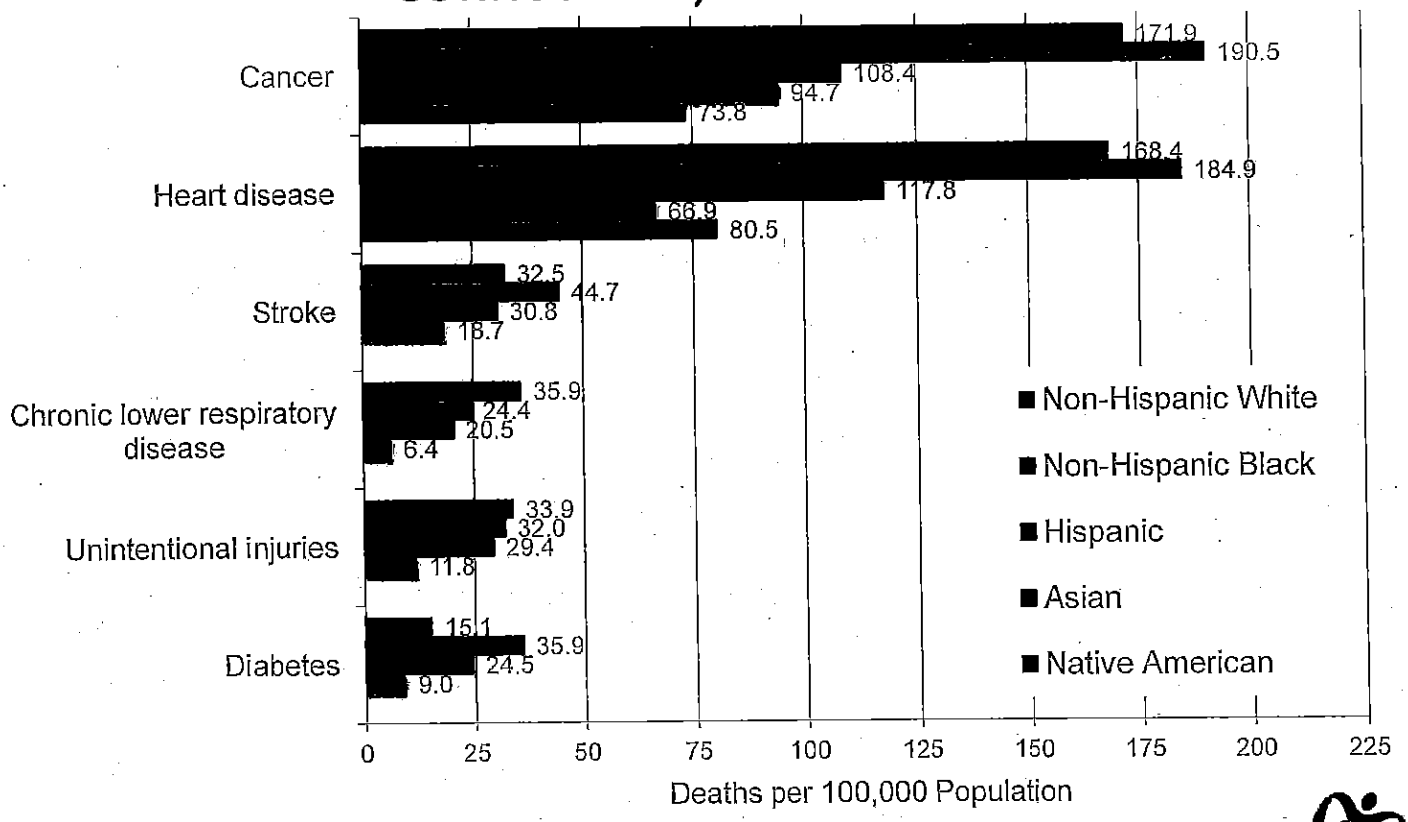
Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Leading Causes of Death by Age Group Connecticut, 2009

Rank	Age Group			
	Children (0-14 yrs)	Young Adults (15-34 yrs)	Adults (35-64 yrs)	Elderly (65+ yrs)
1	Congenital anomalies	Unintentional injuries	Cancer	Heart disease
2	Unintentional Injuries	Suicide	Heart disease	Cancer
3	Cancer	Homicide	Unintentional injuries	Stroke
4	Septicemia	Heart disease	Chronic liver disease and cirrhosis	Chronic lower respiratory disease
5	Chronic lower respiratory disease, Homicide, Heart disease	Cancer	Suicide	Alzheimer's disease

Source: Connecticut Department of Public Health, Mortality Tables, Leading Causes of Death, 2009, Table 10.

Age-adjusted Death Rates for Leading Causes of Death, by Race and Ethnicity Connecticut, 2005-2009



Source: Connecticut Department of Public Health, Mortality Tables, Age-Adjusted Mortality Rate 2005-2009.

Connecticut Department of Public Health
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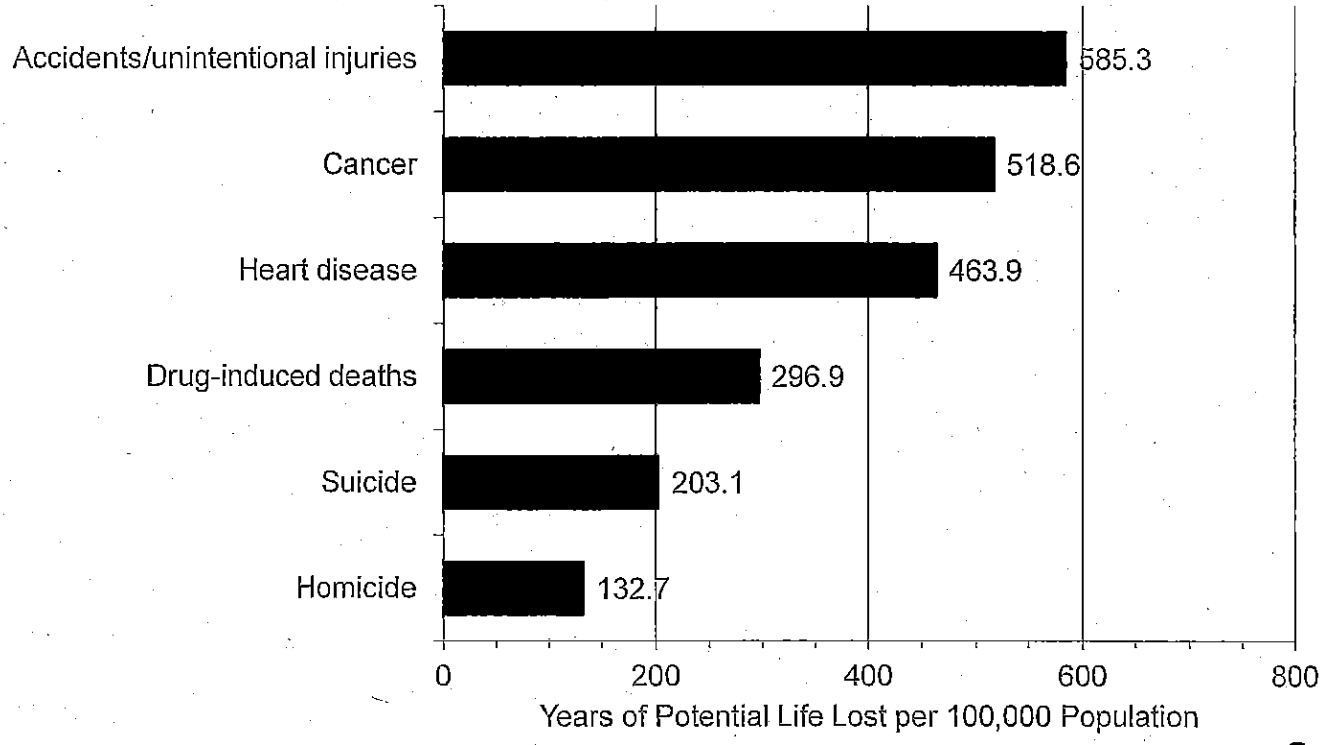
Leading Causes of Premature Death

[Years of Potential Life Lost (YPLL) before 65 Yrs of Age]

Connecticut, 2009



Source: Connecticut Department of Public Health, YPLL Tables, Age-Adjusted YPLL Rate <65, 2009.

Connecticut Department of Public Health
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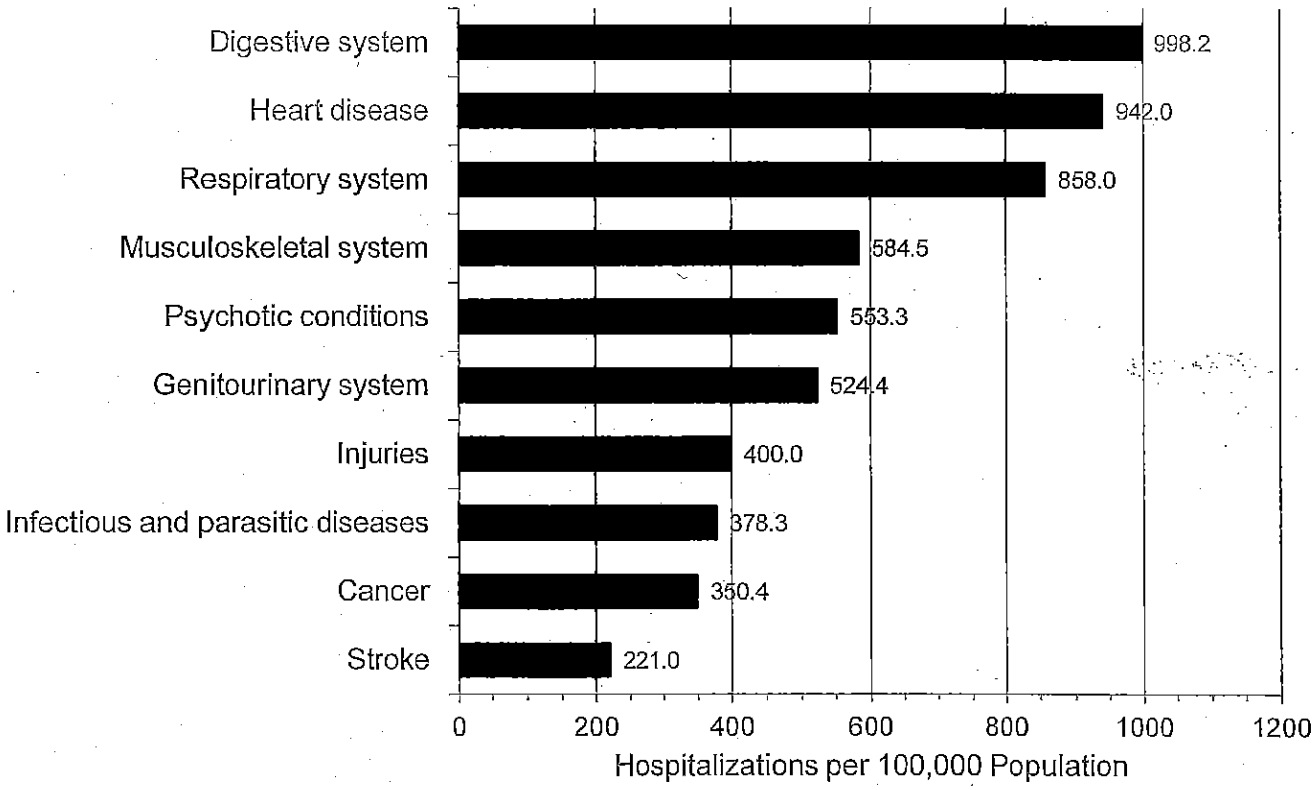
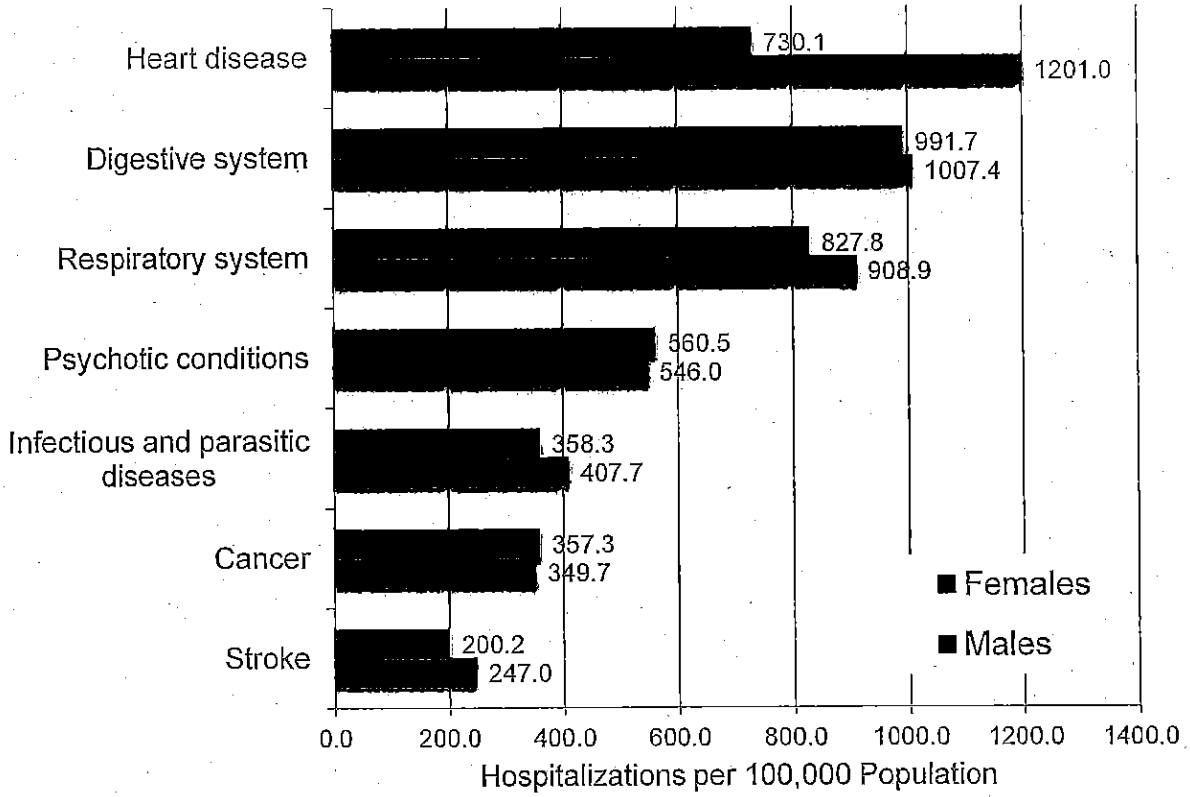
Hospitalization Rates for Leading Causes Connecticut, 2010



Source: Connecticut Department of Public Health, Hospitalization Tables, 2010, Table H-1.

Hospitalization Rates for Leading Causes, by Sex Connecticut, 2010



Source: Connecticut Department of Public Health, Hospitalization Tables, 2010, Table H-1.

Leading Causes of Hospitalization, by Age Group Connecticut, 2010

Rank	Age Group			
	Children (0-14 yrs)	Young Adults (15-24 yrs)	Adults (25-64 yrs)	Elderly (65+yrs)
1	Respiratory system	Mental disorders	Mental disorders	Circulatory system
2	Injury & poisoning	Digestive system	Digestive system	Respiratory system
3	Nervous system & sense organs	Injury and poisoning	Injury & Poisoning	Digestive system
4	Mental disorders	Respiratory system	Circulatory system	Genitourinary system
5	Digestive system	Endocrine, nutritional, metabolic, and immunological disorders	Genitourinary & Musculoskeletal systems	Musculoskeletal system

Source: Connecticut Department of Public Health, Hospitalization Tables, 2010, Table H-1.

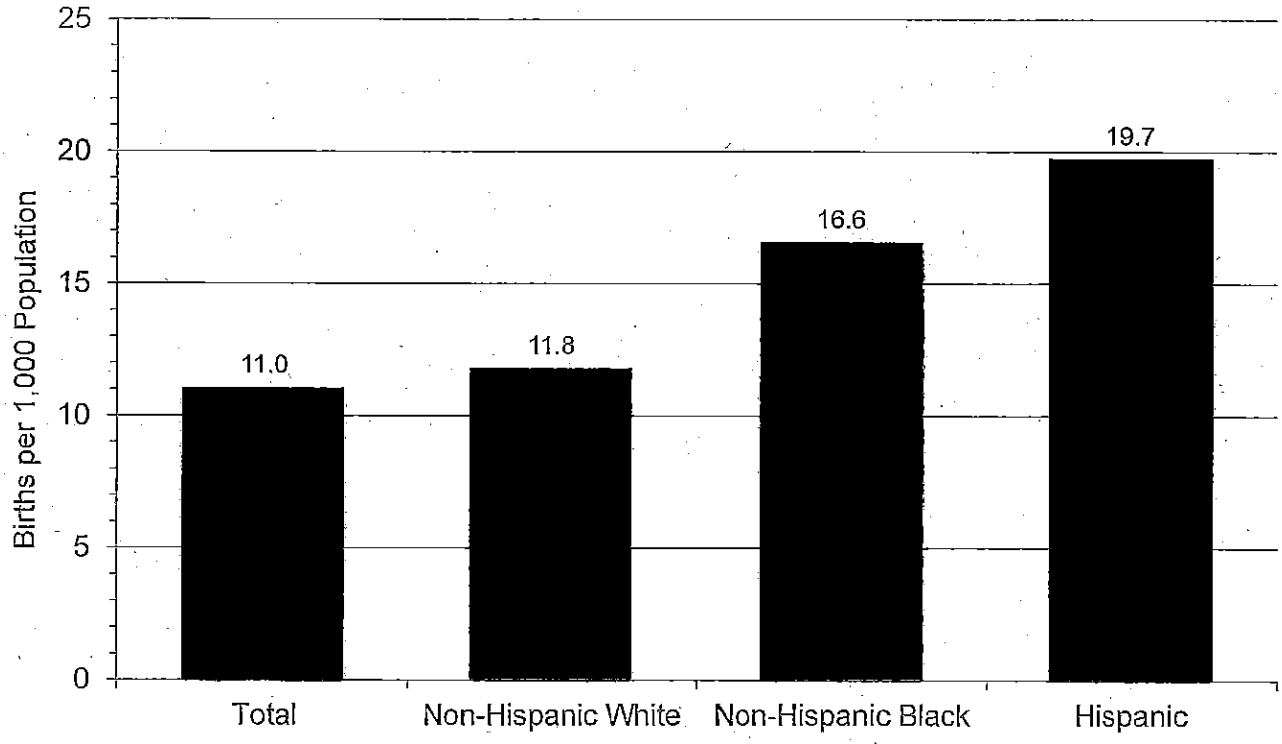
Leading Causes of Hospitalization, by Race/Ethnicity, Connecticut, 2010

Rank	Race and Ethnicity		
	White	Black	Hispanic
1	Circulatory system	Circulatory system	Circulatory system
2	Digestive system	Respiratory system	Digestive system
3	Mental disorders	Digestive system	Respiratory system
4	Respiratory system	Mental disorders	Mental disorders
5	Injury & Poisoning	Injury & Poisoning	Injury & Poisoning

Source: Connecticut Department of Public Health, Hospitalization Tables, 2010, Table H-2.

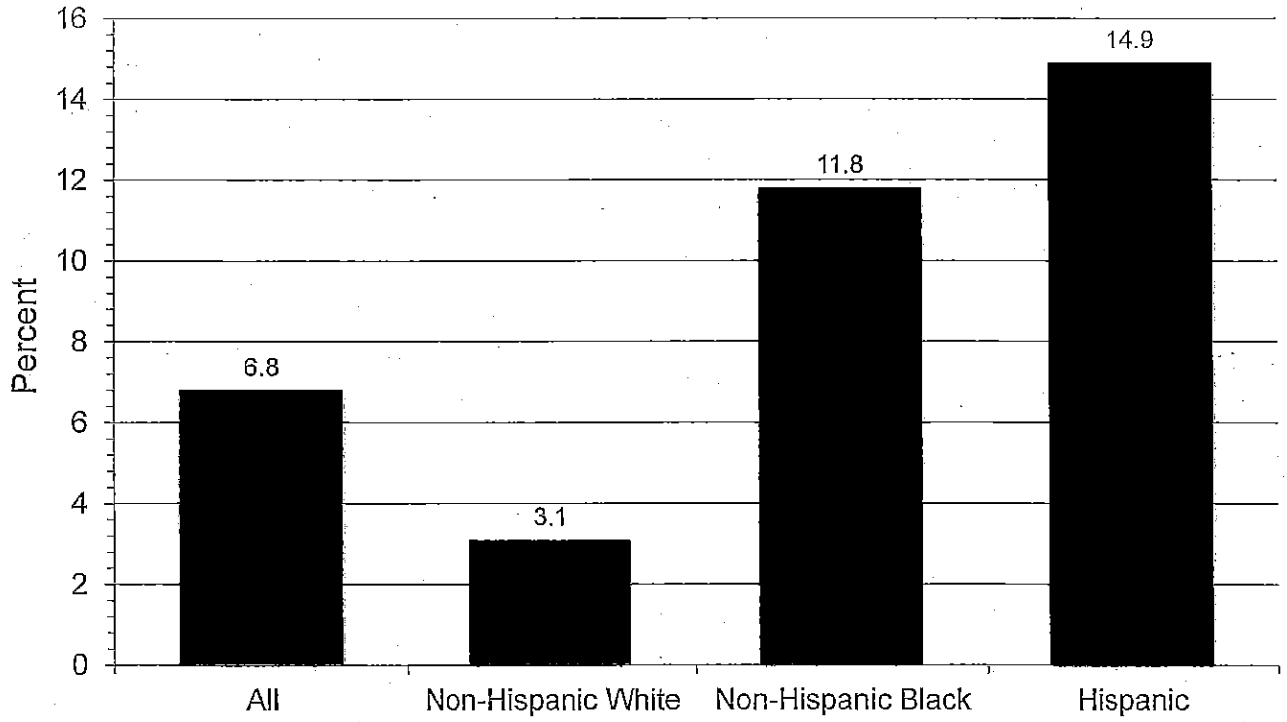
MATERNAL, INFANT, AND CHILD HEALTH

Birth Rate by Race and Ethnicity Connecticut, 2009



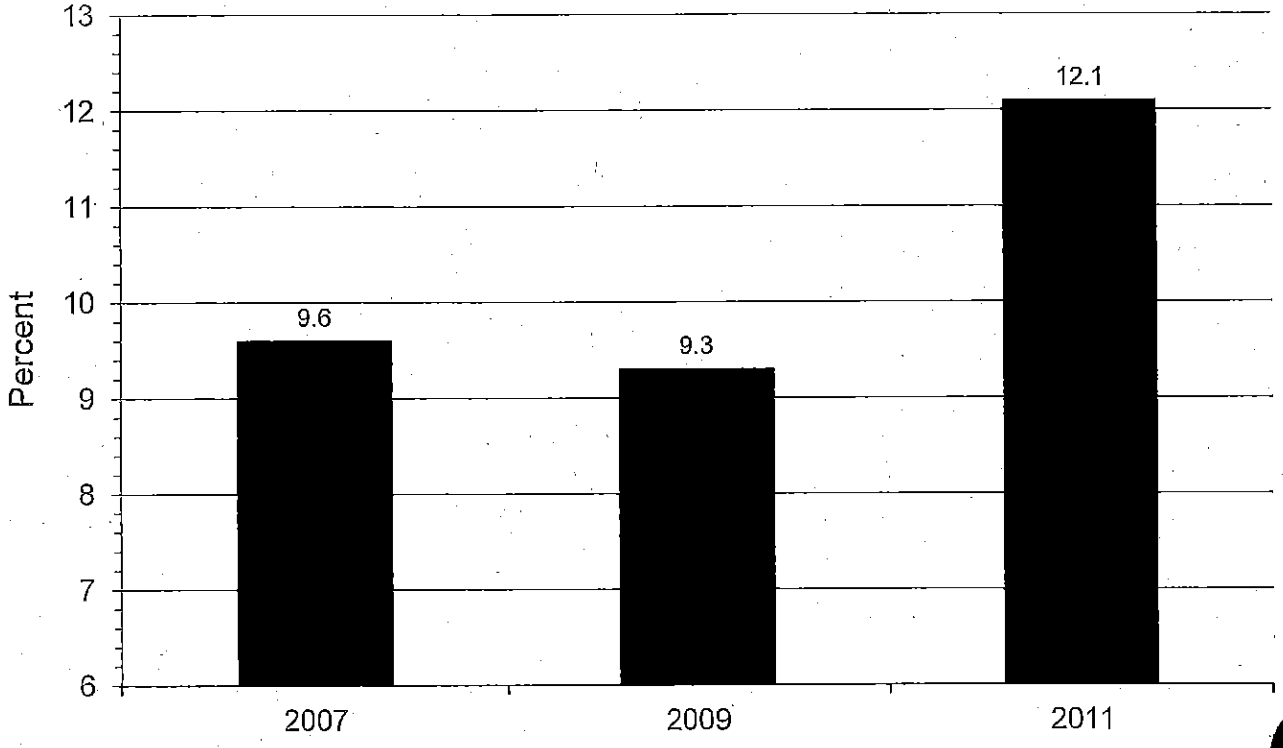
Source: Connecticut Department of Public Health, Vital Statistics (Registration Report), 2009, Table 2B.

Percent of Births to Mothers <20 Years of Age by Race and Ethnicity Connecticut, 2009



Source: Connecticut Department of Public Health, Vital Statistics (Registration Report), 2009, Table 12.

No Pregnancy Prevention Method Used during Last Sexual Intercourse Students, Grades 9-12 Connecticut, 2007-2011



Source: Connecticut Youth Risk Behavior Survey, 2007-2011

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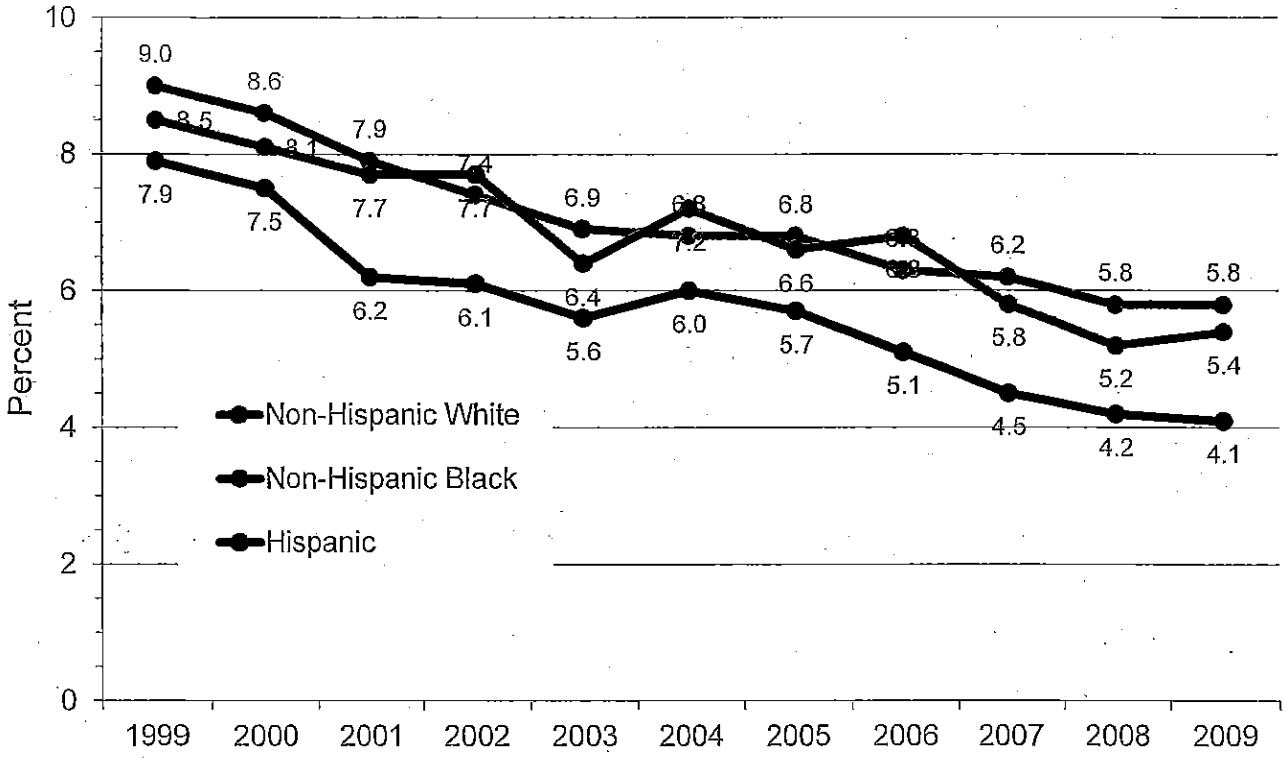
Percent of Women Who Smoked during Pregnancy by Race and Ethnicity Connecticut, 1999-2009



Source: Connecticut Department of Public Health, Vital Statistics (Registration Reports), 1999-2009, Table 12.

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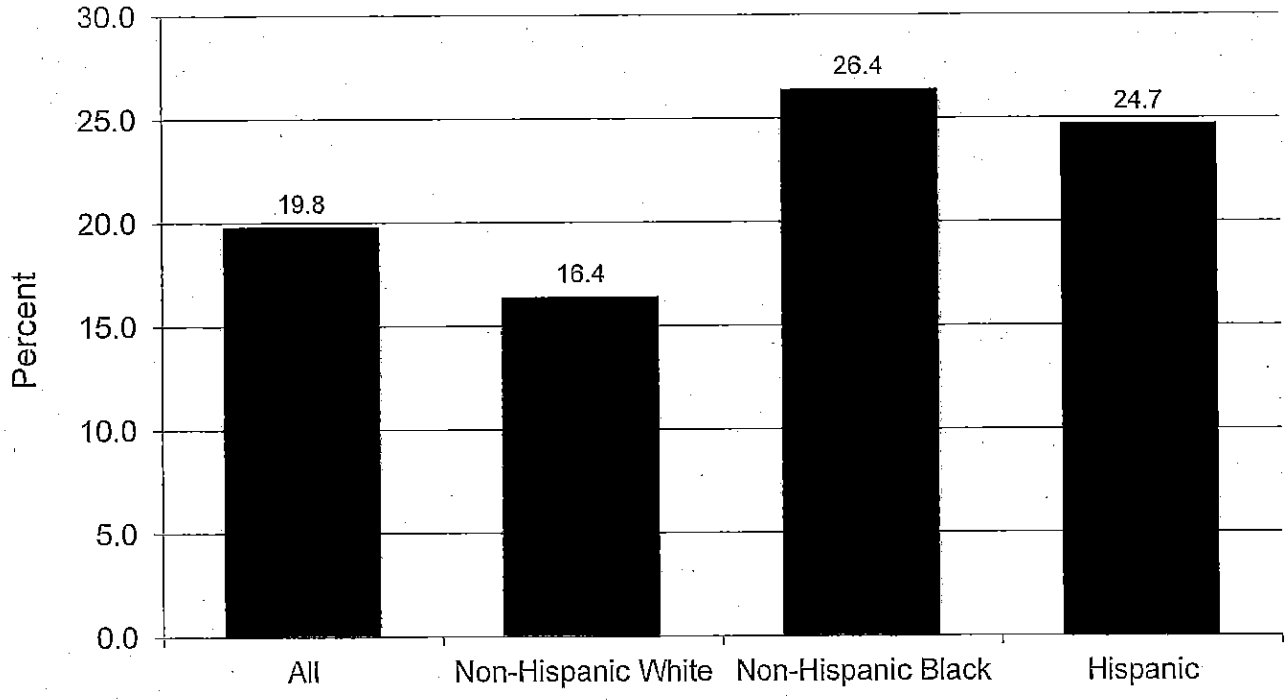
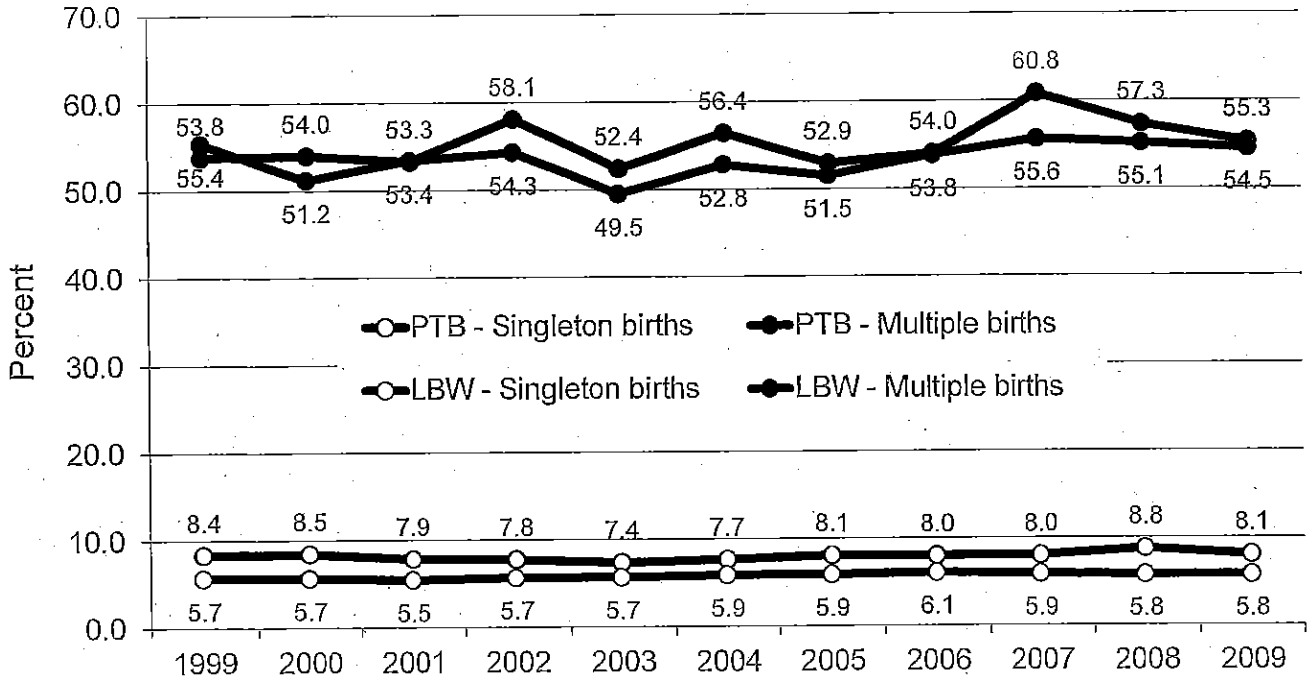
Percent of Women Who Received Nonadequate Prenatal Care by Race and Ethnicity Connecticut, 2009



Source: Connecticut Department of Public Health, Vital Statistics (Registration Reports), 2009 ,Table 12

Percent of Preterm and Low Birthweight Births by Plurality Connecticut, 1999-2009



Source: Connecticut Department of Public Health,
Vital Statistics (Registration Reports), 1999-2009, Table 3.
NOTE: Preterm birth (PTB) defined as birth at <37 weeks gestation,
Low birth weight (LBW) defined as <2500 grams

Connecticut Department of Public Health
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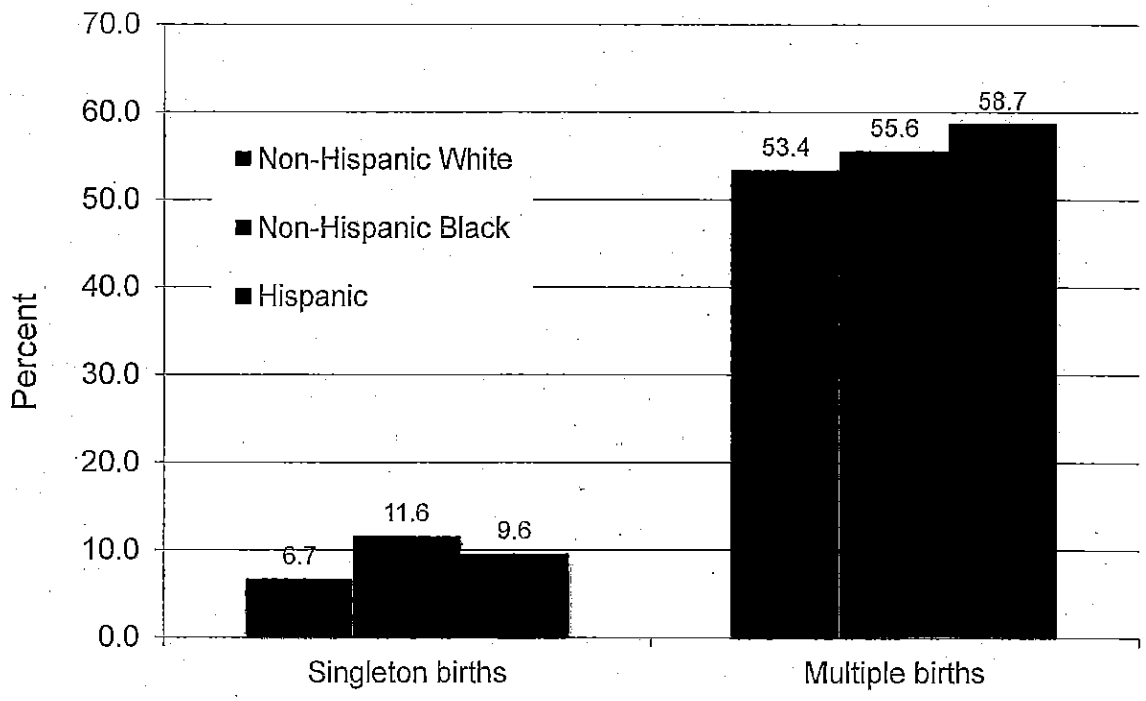
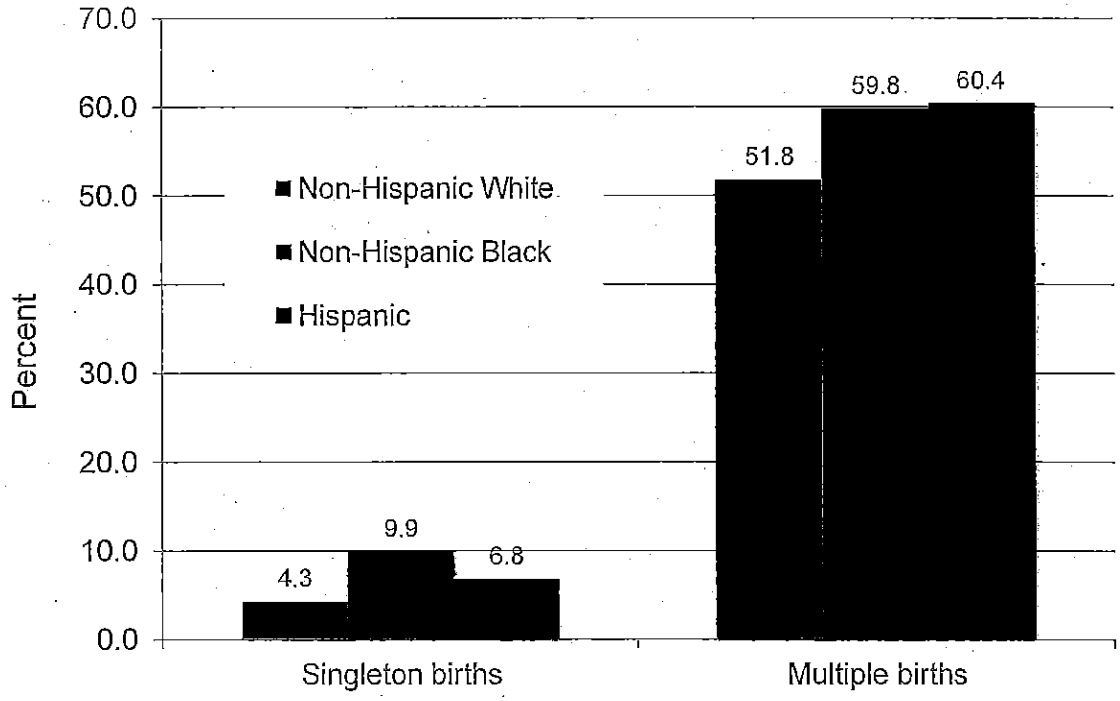
Percent of Preterm Births by Race, Ethnicity, and Plurality Connecticut, 2009



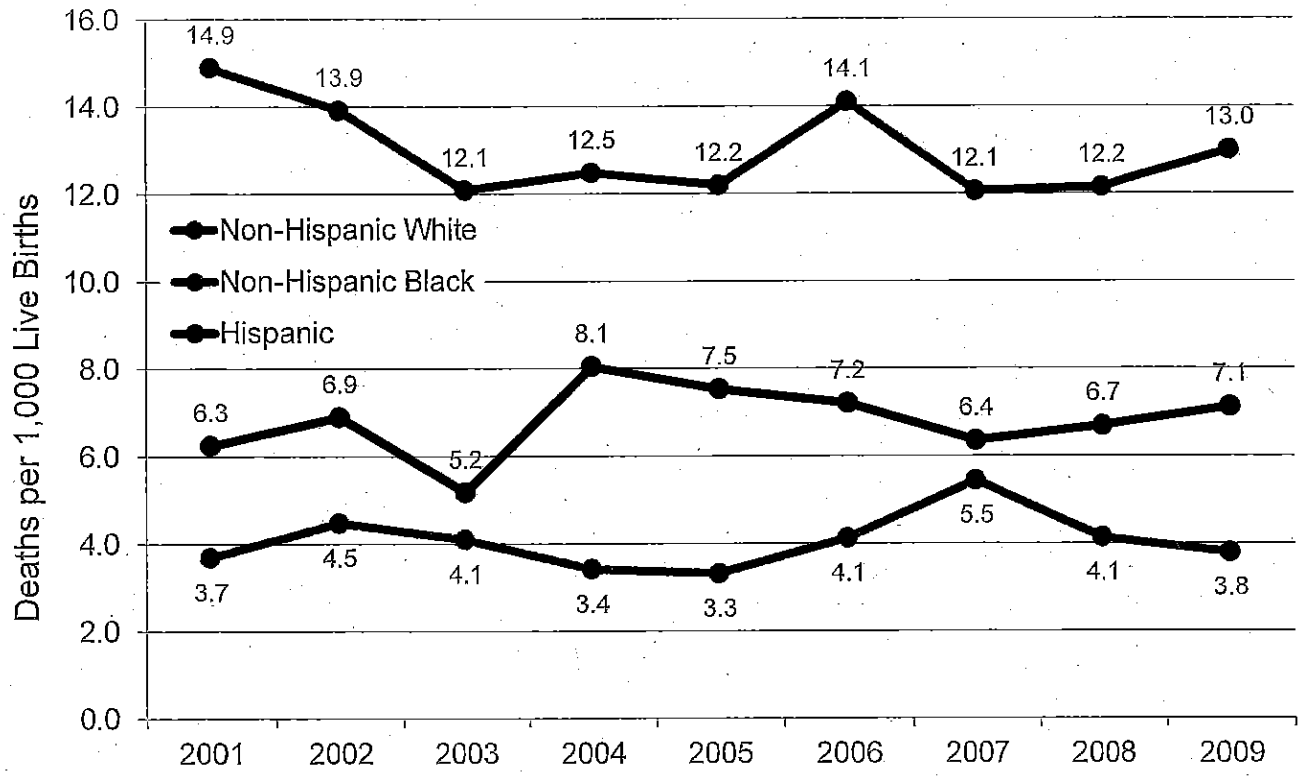
Source: Connecticut Department of Public Health,
Vital Statistics (Registration Reports), 2009, Table 3.
NOTE: Preterm birth defined as birth at <37 weeks gestation

Percent of Low Birthweight Births by Race, Ethnicity and Plurality Connecticut, 2009



Source: Connecticut Department of Public Health, Vital Statistics (Registration Reports), 2009, Table 3.
NOTE: Low birth weight defined as <2500 grams

Infant Mortality Rate
Connecticut, 2001-2009



Source: Connecticut Department of Public Health,
Vital Statistics (Registration Reports), 2001-2009, Table 12.
Note: Infant mortality defined as death within 1 year of birth

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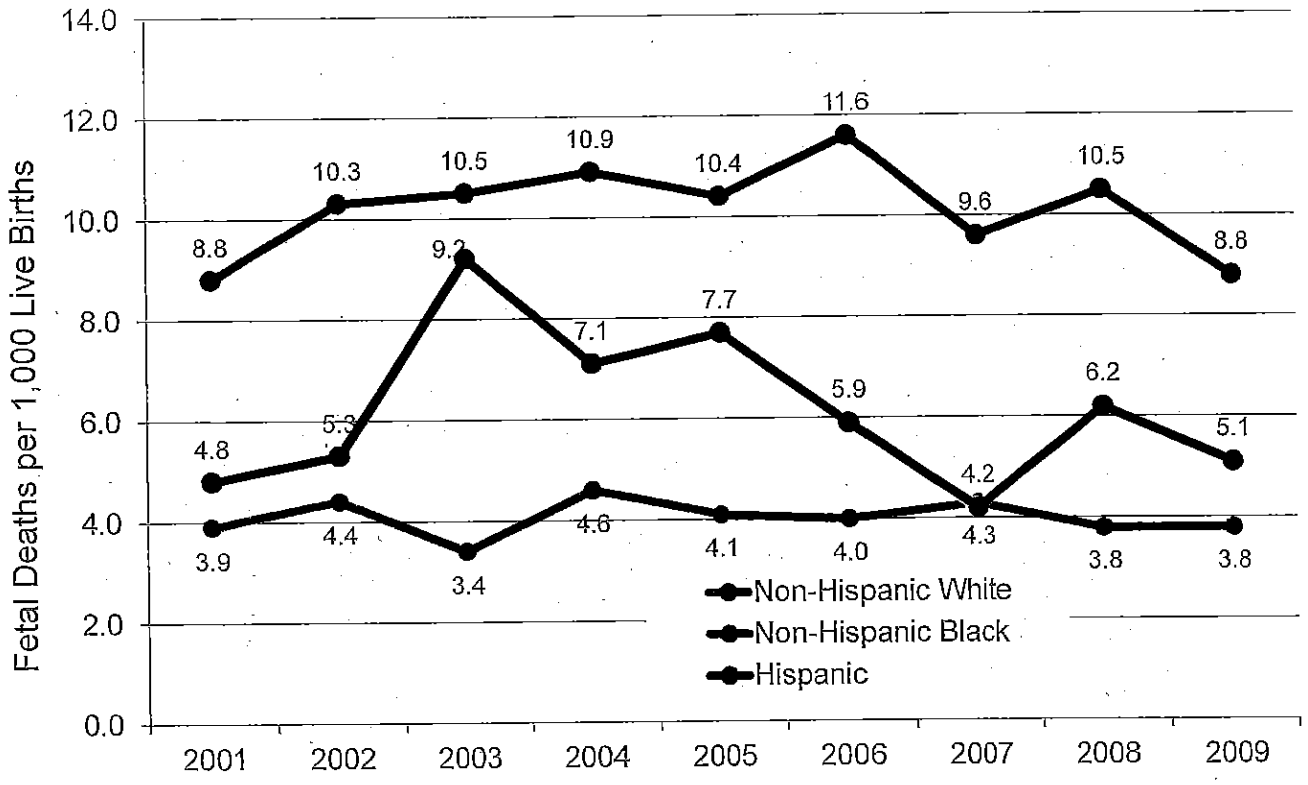
Fetal Mortality
Connecticut, 2001-2009



Source: Connecticut Department of Public Health,
Vital Statistics (Registration Reports), 2001-2009, Table 12.

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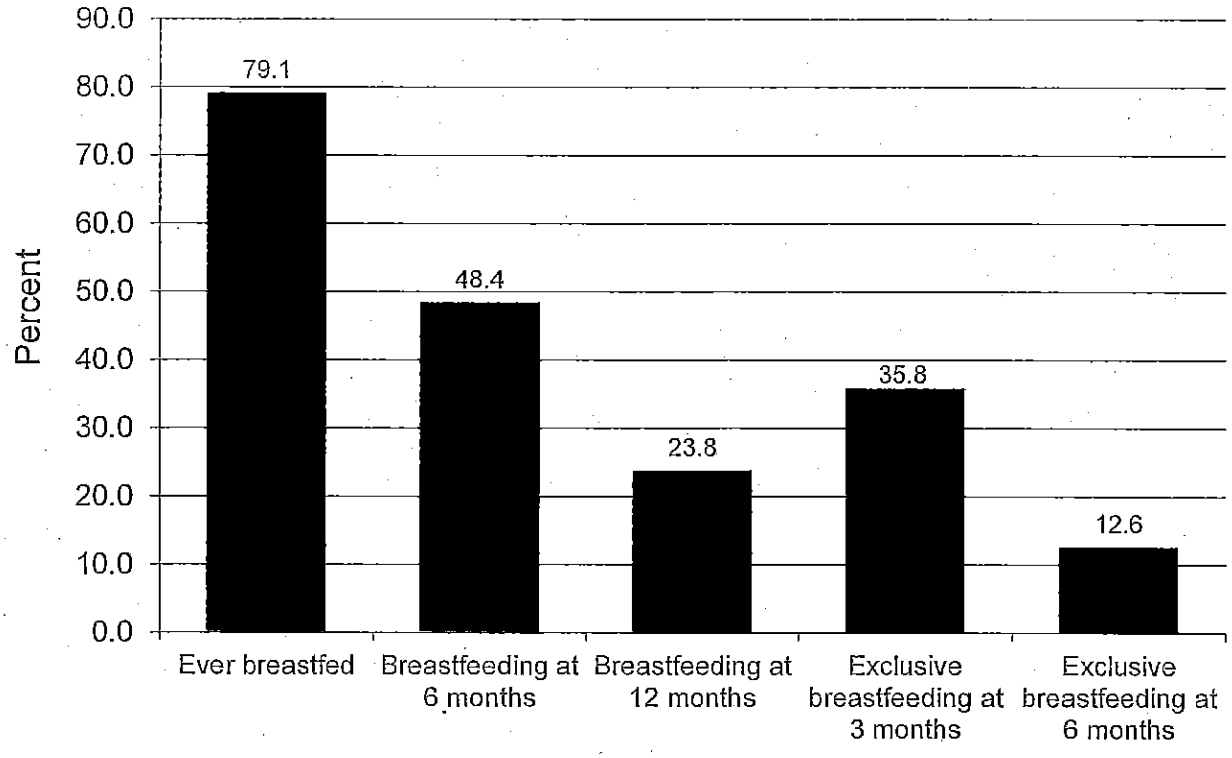
Percent of Mothers Who Breastfed Connecticut, 2009



Source: Centers for Disease Control and Prevention, Breastfeeding Report Card, 2012, data from 2009 National Immunization Survey

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CHRONIC DISEASE PREVENTION AND CONTROL

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

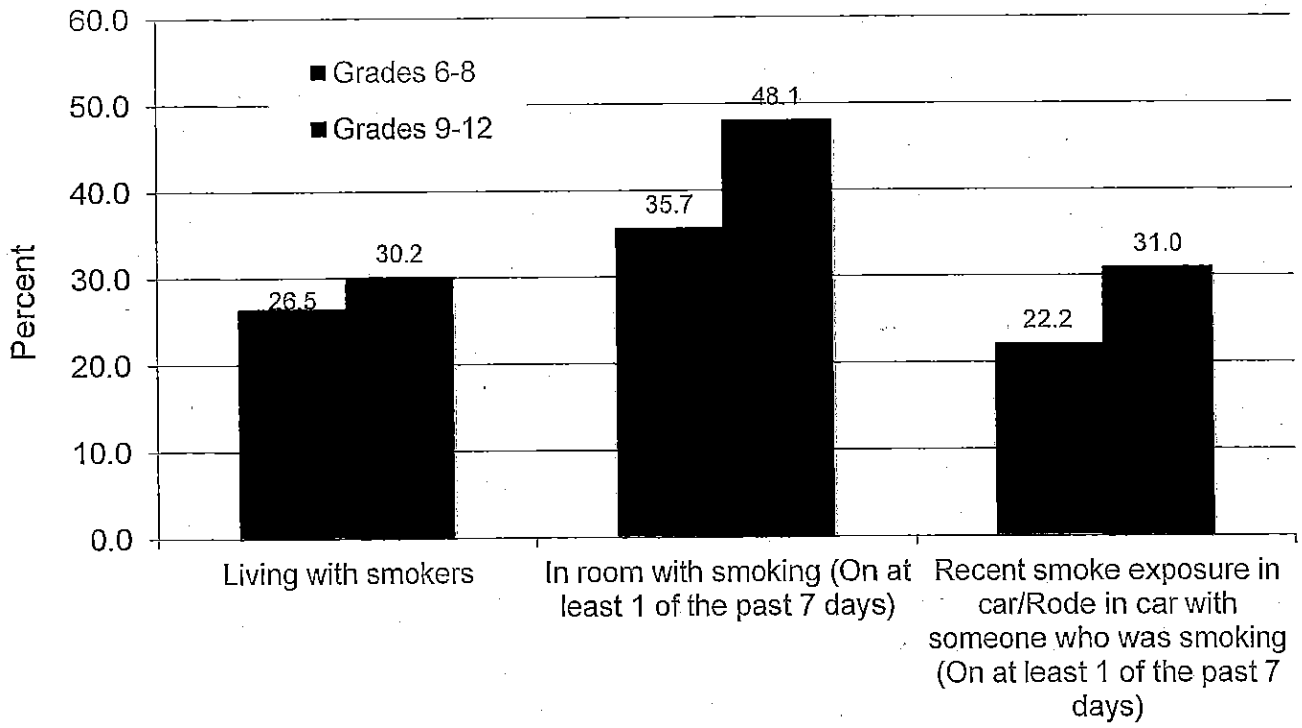
Known Modifiable Risk Factors for Most Common Chronic Diseases

	Asthma	Cancer	CVD	Diabetes
Lack of physical activity	√	√	√	√
Poor nutrition	√	√	√	√
Tobacco use	√	√	√	√
Excessive alcohol use		√	√	√
Obesity*	√	√	√	√
Hypertension/high blood pressure*			√	√
High cholesterol*			√	√
Exposure to second-hand smoke*	√	√	√	
Poor oral health*			√	√

Bolded indicators are identified by CDC. Asterisks (*) mark indicators identified by Chronic Disease Executive Committee via research.
Source: Table recreated from Connecticut Chronic Disease Prevention Plan, Working draft, 2010.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

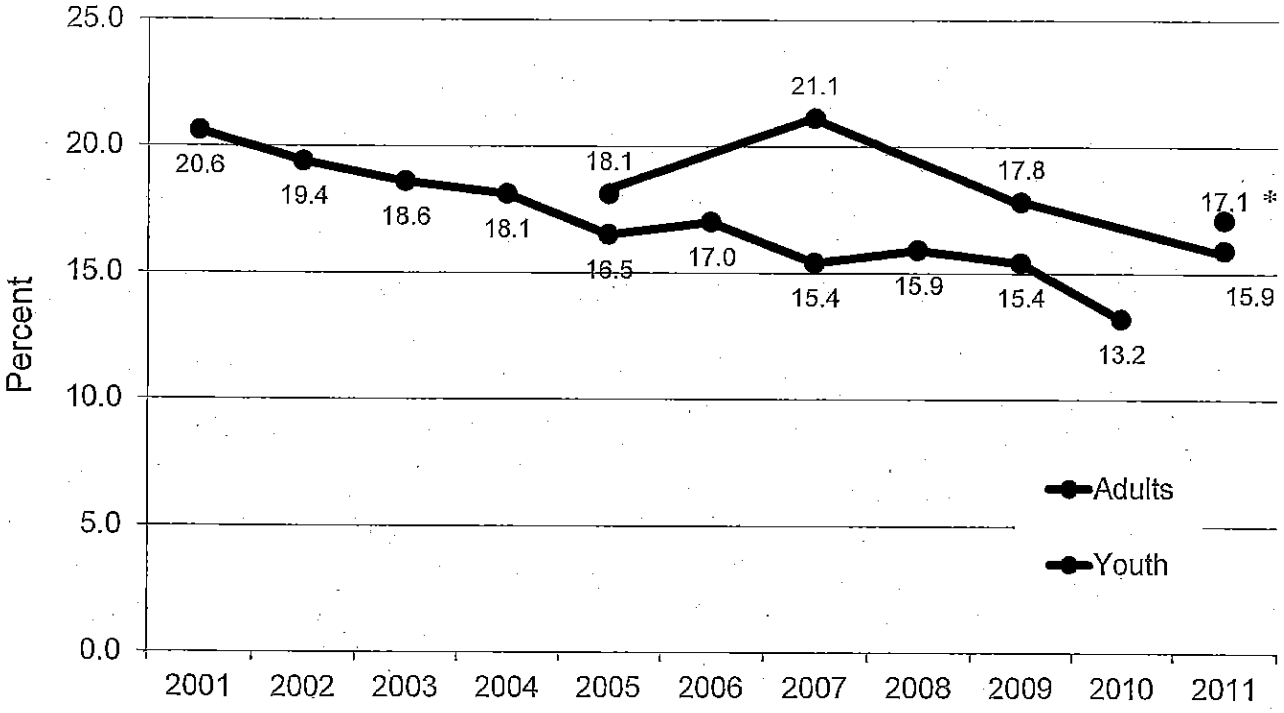
Percent of Non-smoking Students with Tobacco Exposure, Connecticut, 2011



Source: Connecticut Youth Risk Behavior Survey, 2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Percent of Current Smokers Connecticut 2001-2011



* Break in trend for adults due to new weighting in 2011

Source: Connecticut Behavioral Risk Factor Surveillance System, 2001-2011; Connecticut Youth Risk Behavior Survey, 2005-2011.

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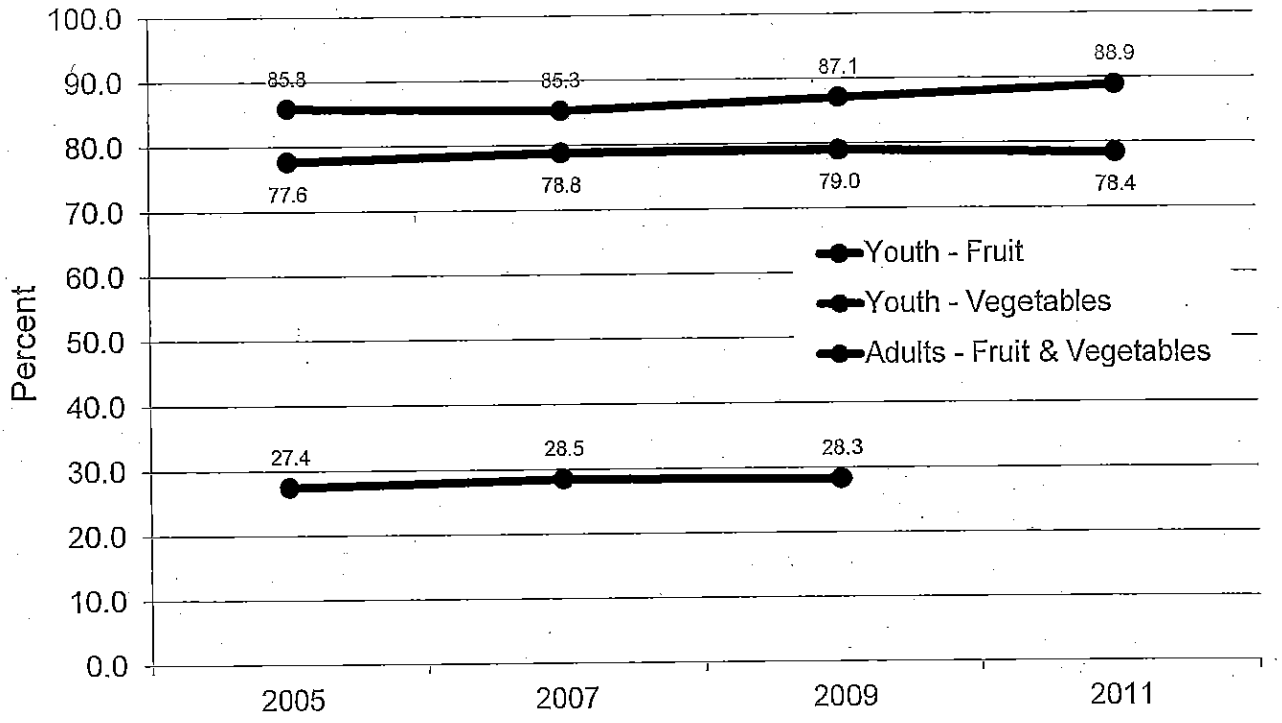
www.ct.gov/dph/SHIPcoalition

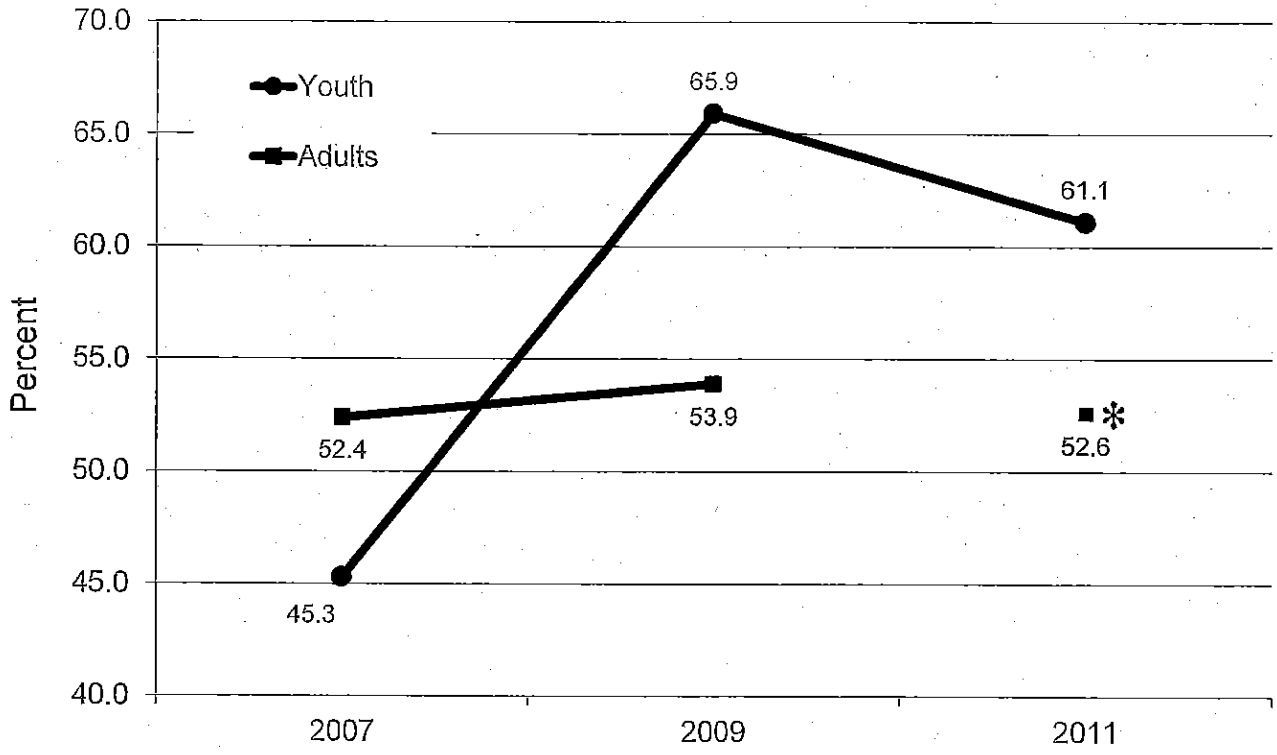
Percent with Recommended Fruit and Vegetable Consumption Connecticut, 2005-2011



Source: Connecticut Behavioral Risk Factor Surveillance System and Youth Risk Behavioral Survey, 2005-2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Percent Who Met Physical Activity Guidelines Connecticut, 2007-2011



* Break in trend due to new weighting in 2011

Source: Connecticut Youth Risk Behavior Survey, 2007-2011;
Connecticut Behavioral Risk Factor Surveillance System, 2007-2011.

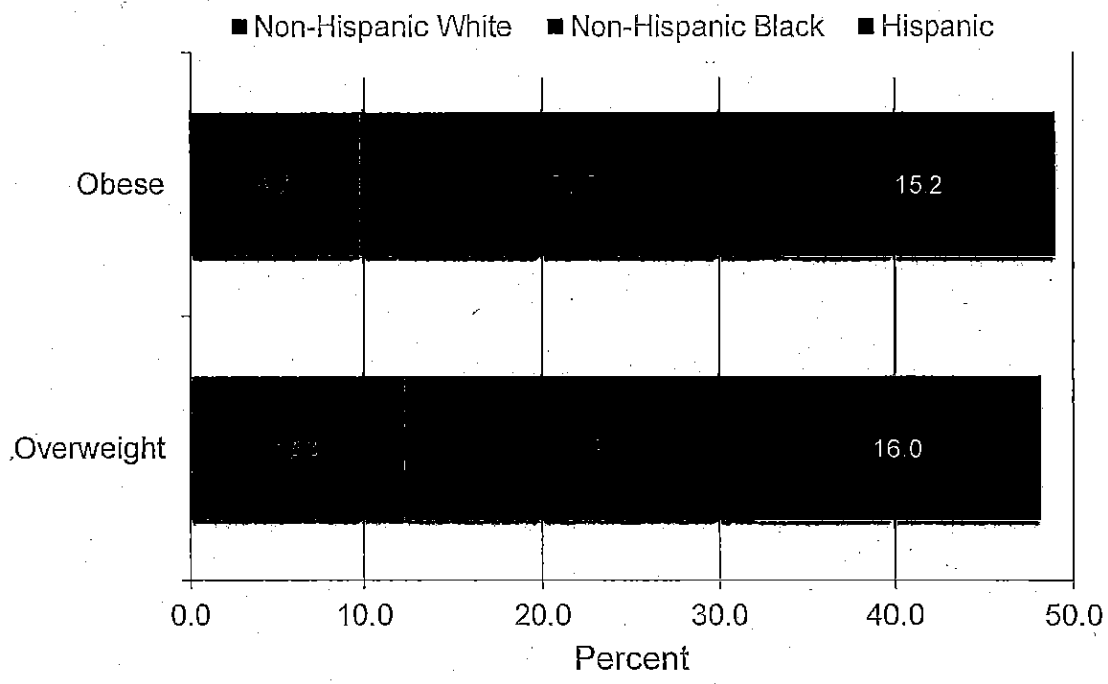
Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Percent Overweight & Obesity Students in Grades 9-12 by Sex Connecticut, 2005-2011

Source: Connecticut Youth Risk Behavior Survey, 2005-2011.

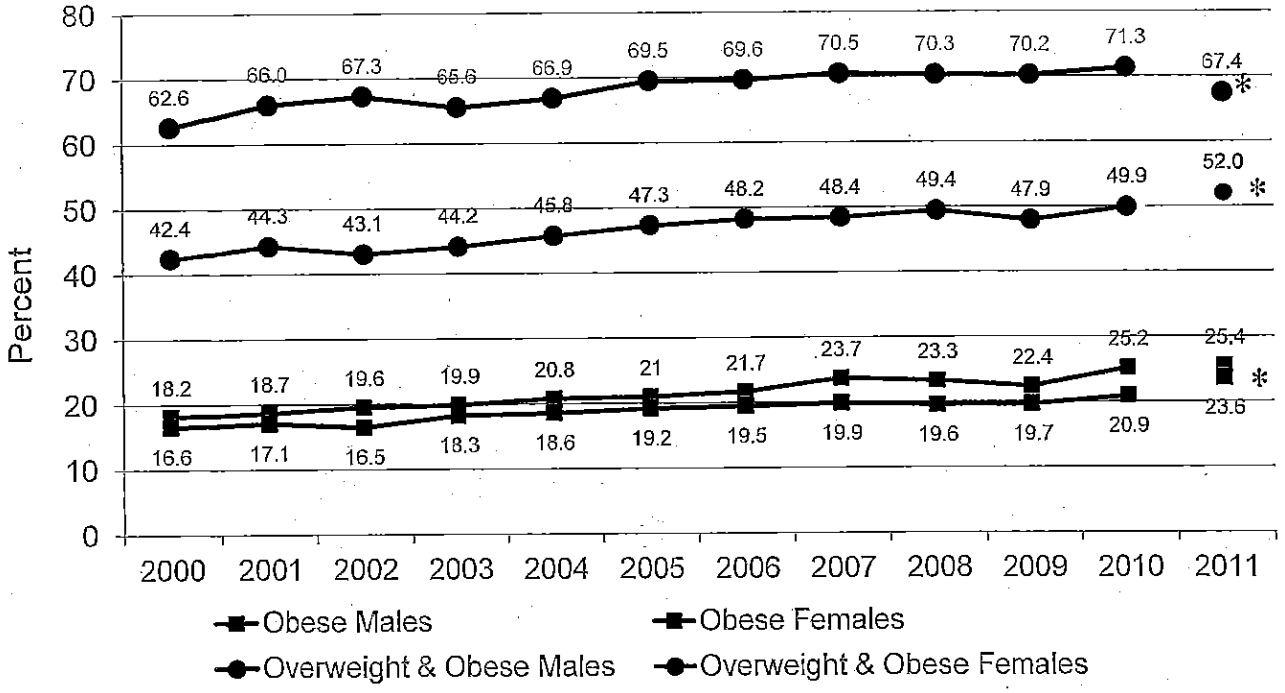
Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Percent Overweight & Obesity Students in Grades 9-12 by Race/Ethnicity Connecticut, 2011



Source: Connecticut Youth Risk Behavior Survey, 2011.

Percent Overweight and Obesity Adults 18+ Years of Age Connecticut, 2001-2011



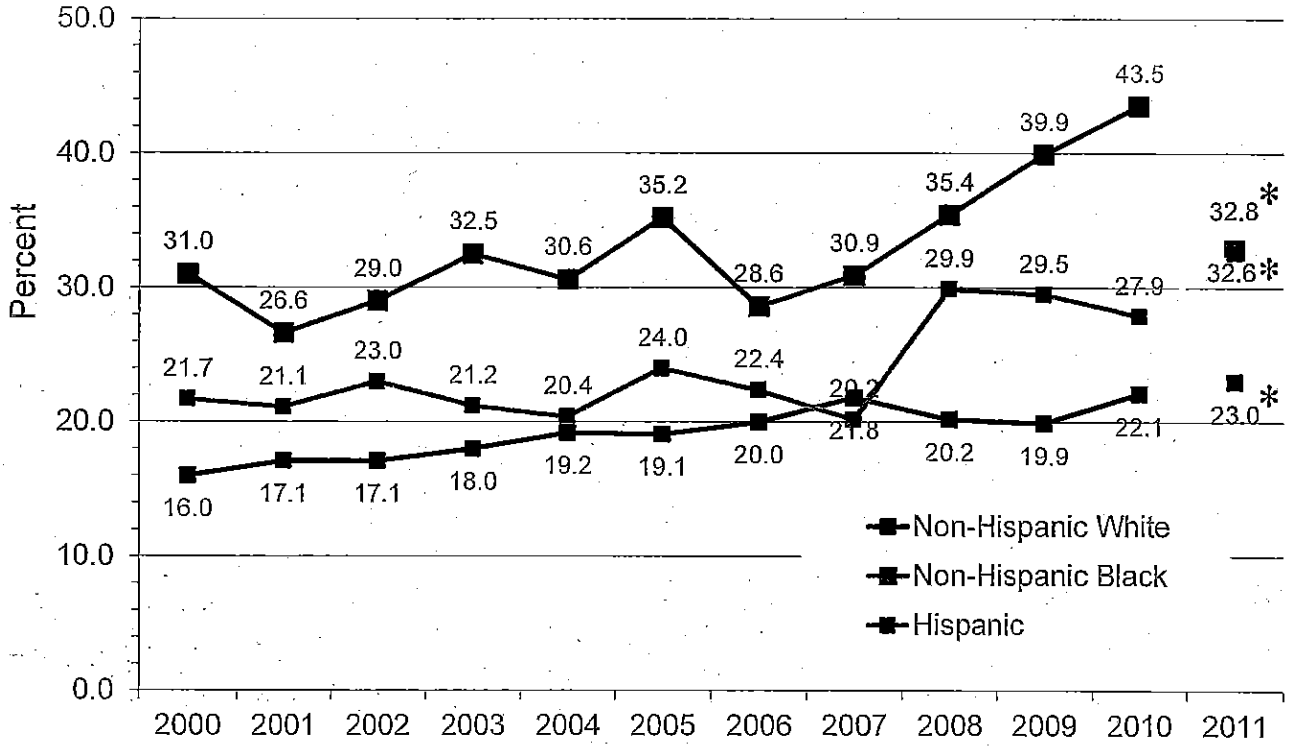
* Break in trend due to new weighting in 2011

Source: Connecticut Behavioral Risk Factor Surveillance System, 2001-2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

59

Percent of Obese Adults, by Race/Ethnicity Connecticut, 2000-2011



* Break in trend due to new weighting in 2011

Source: Connecticut Behavioral Risk Factor Surveillance System, 2000-2011.

Connecticut Department of Public Health
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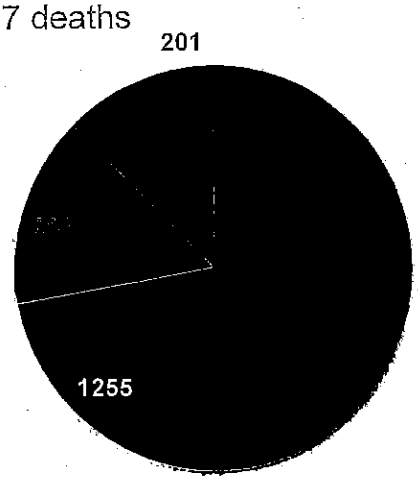
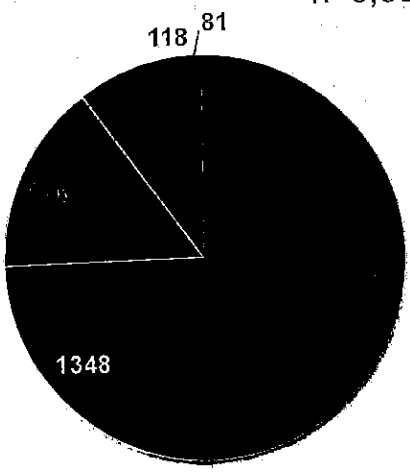
Number of New Cancer Cases by Cancer Site and Sex Connecticut, 2009

Males
n=5,857 deaths



- Prostate
- Colon & Rectum
- Liver & Bile Duct
- Lung & Bronchus
- Melanoma

Females
n=5,856 deaths

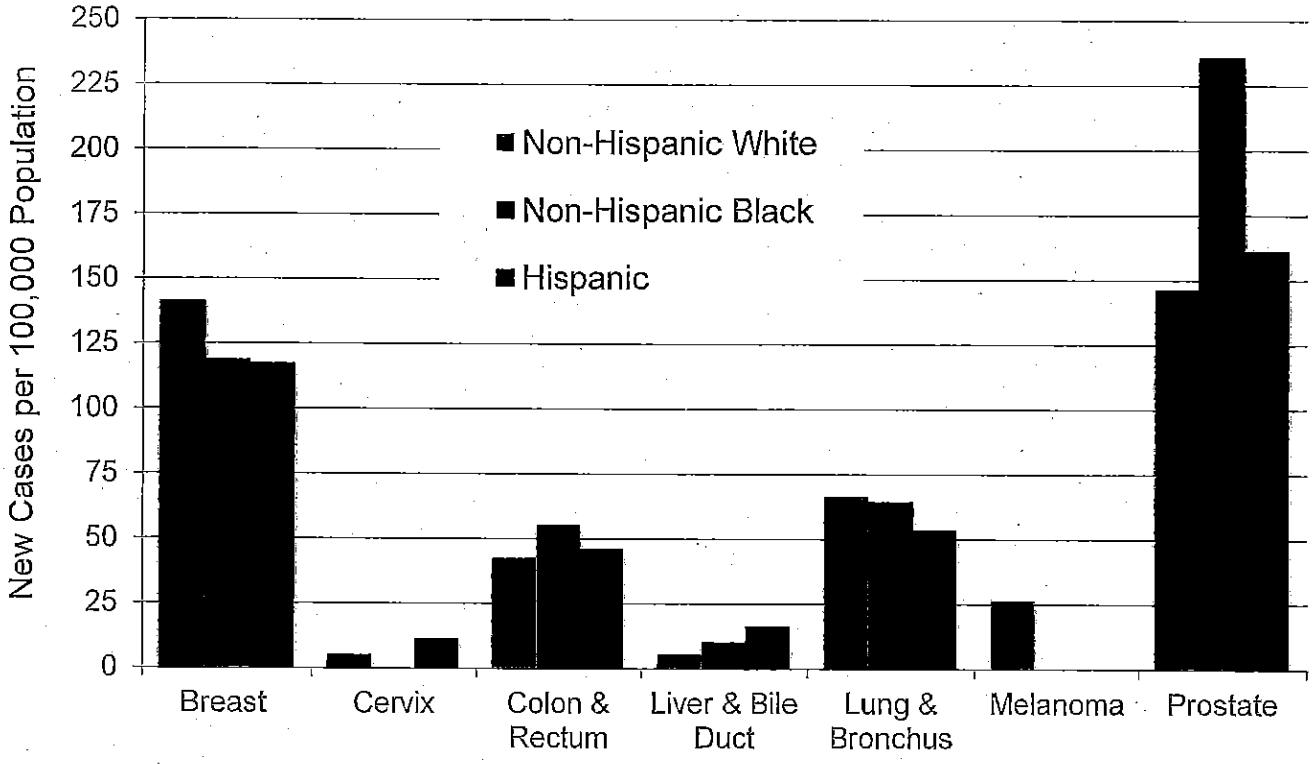


- Breast
- Colon & Rectum
- Cervix
- Lung & Bronchus
- Melanoma
- Liver & Bile Duct

Source: CDC's National Program of Cancer Registries Cancer Surveillance System (NPCR-CSS), 2009, from NCI State Cancer Profiles.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Cancer Incidence Rate by Cancer Site and Race/Ethnicity Connecticut, 2009



Source: CDC's National Program of Cancer Registries Cancer Surveillance System (NPCR-CSS), 2009, from NCI State Cancer Profiles.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

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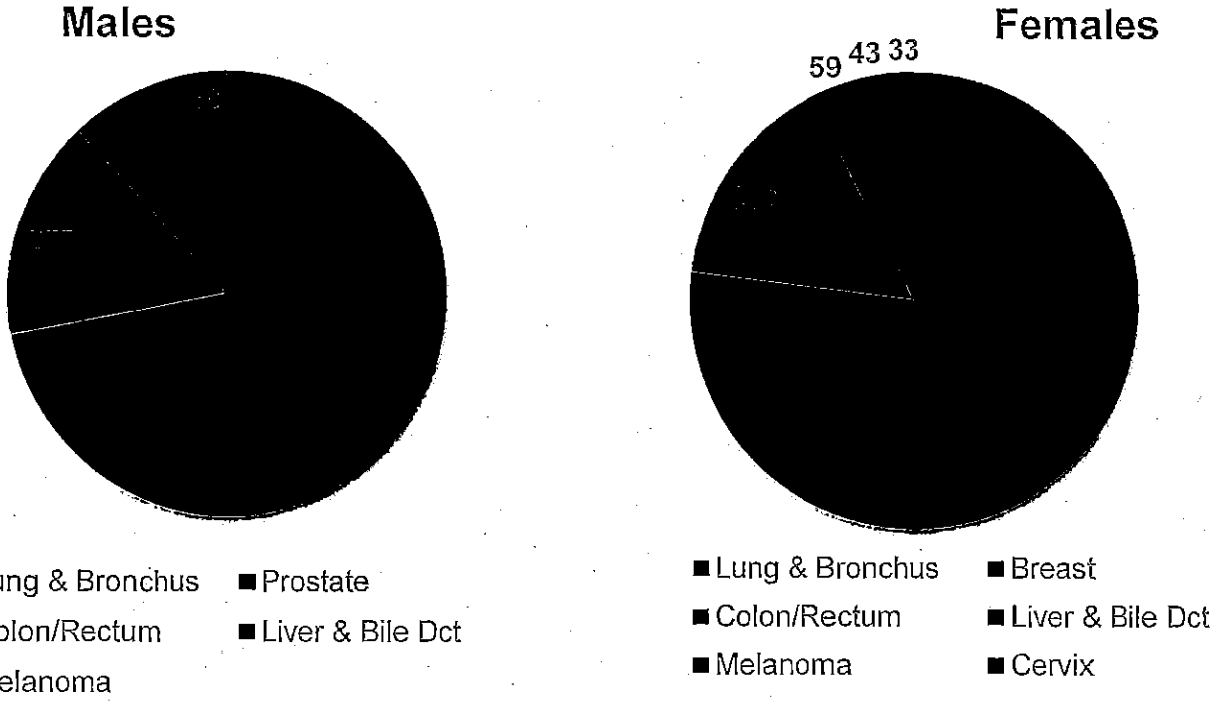
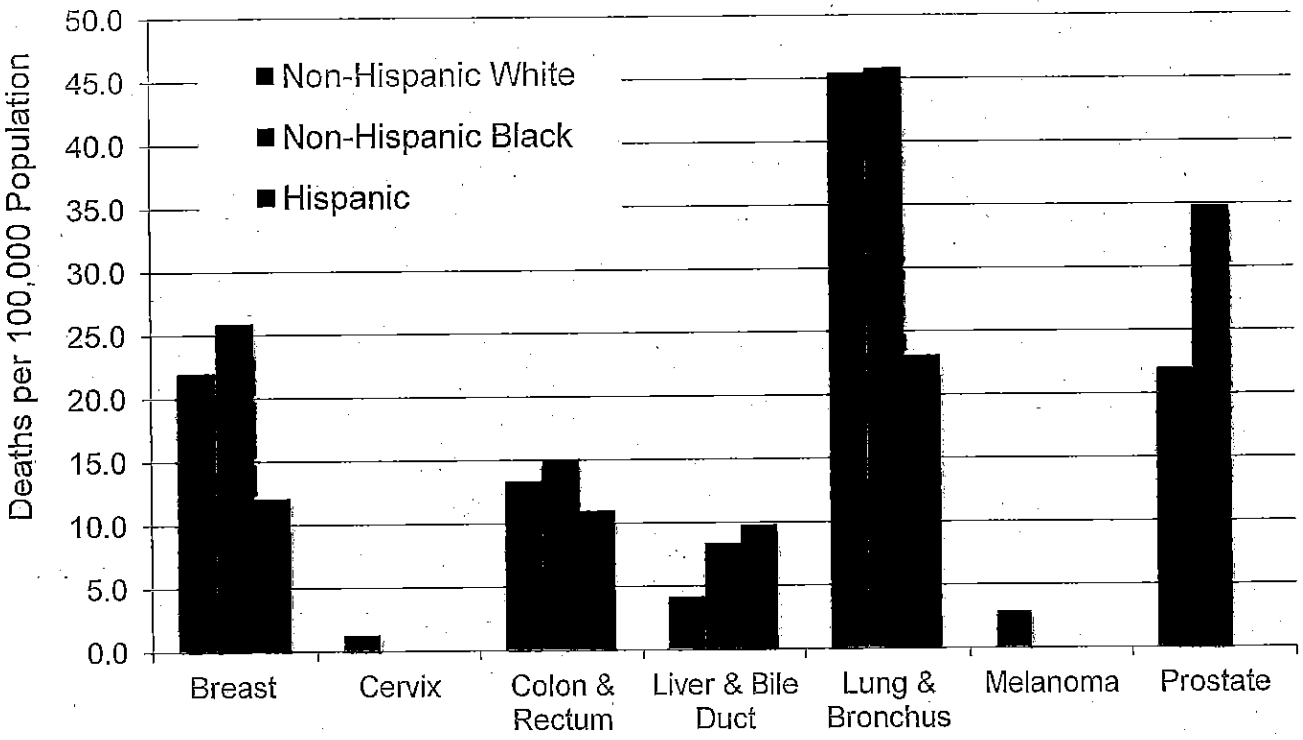
Number of Cancer Deaths by Cancer Site and Sex Connecticut, 2009



Source: CDC's National Program of Cancer Registries Cancer Surveillance System (NPCR-CSS), 2009, from NCI State Cancer Profiles.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Cancer Mortality Rate by Cancer Site and Race/Ethnicity Connecticut, 2009

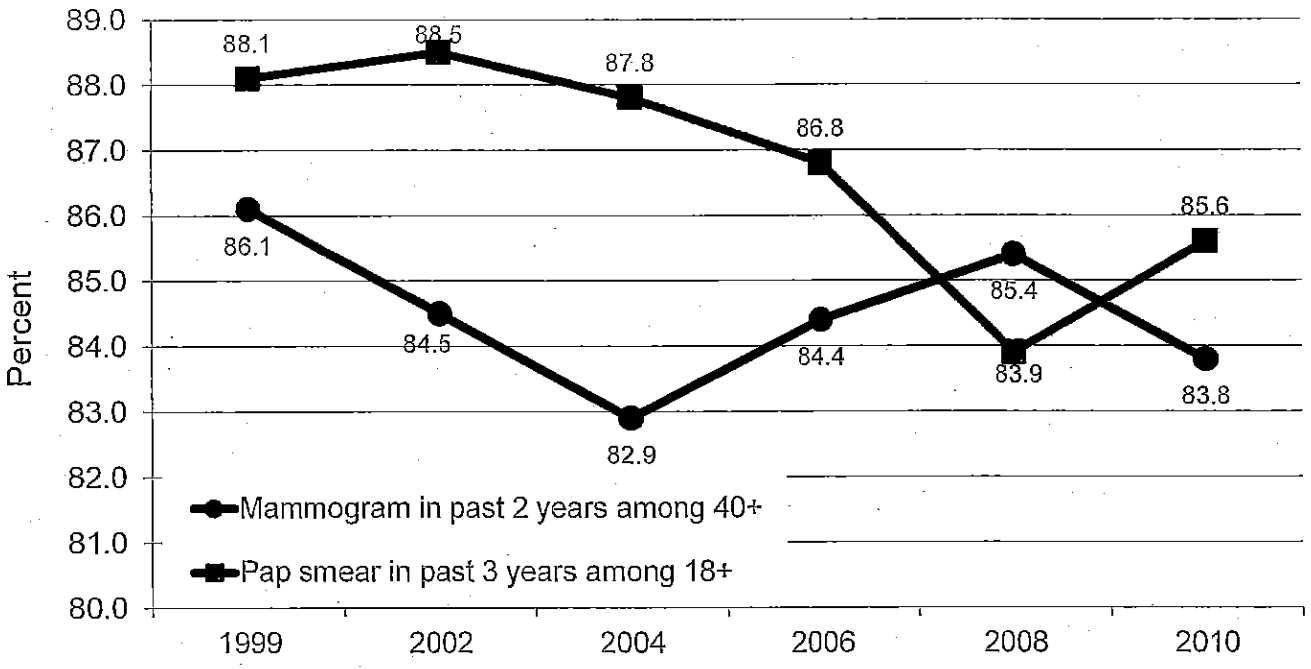


Source: CDC's National Program of Cancer Registries Cancer Surveillance System (NPCR-CSS), 2009, from NCI State Cancer Profiles.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

64

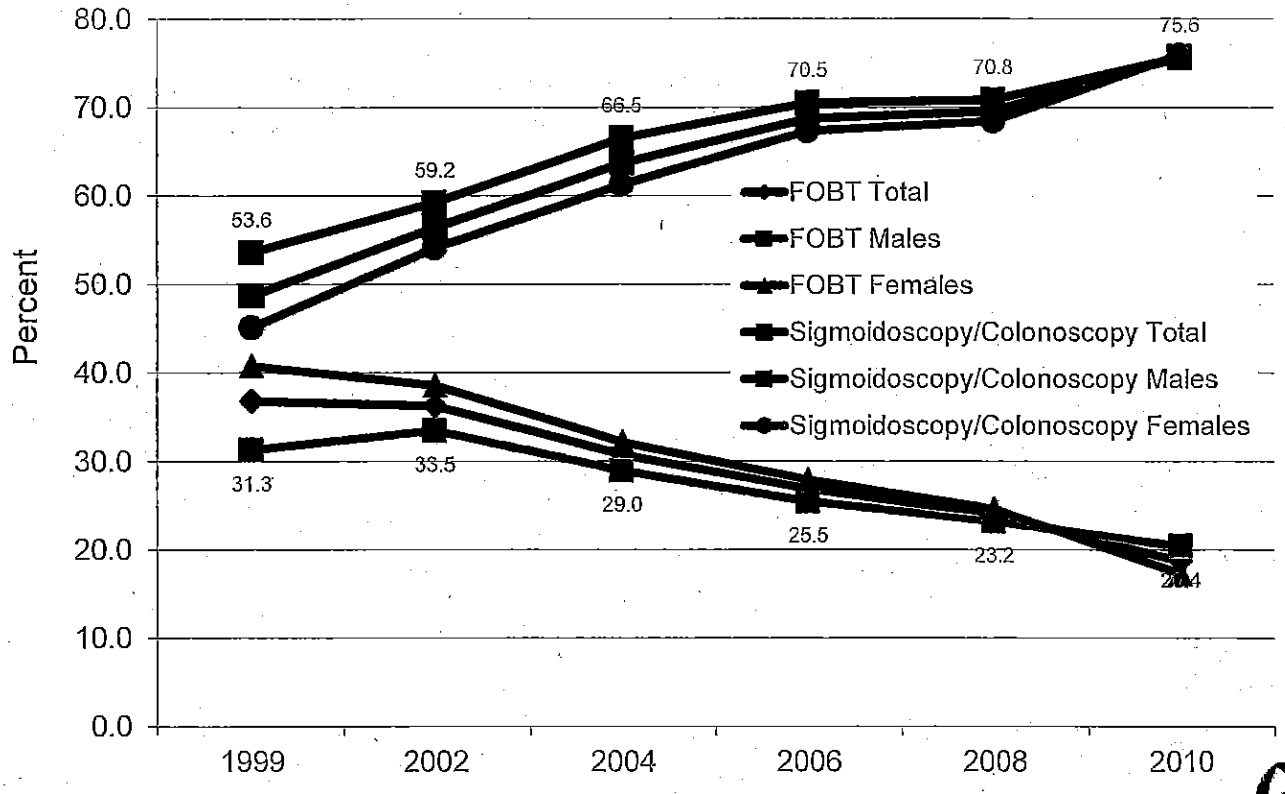
Percent of Women Screened for Breast and Cervical Cancers Connecticut, 1999-2010



Source: Connecticut Behavioral Risk Factor Surveillance System, 1999-2010.
Mammogram for women 40+ years of age and Pap for women 18+ years of age.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

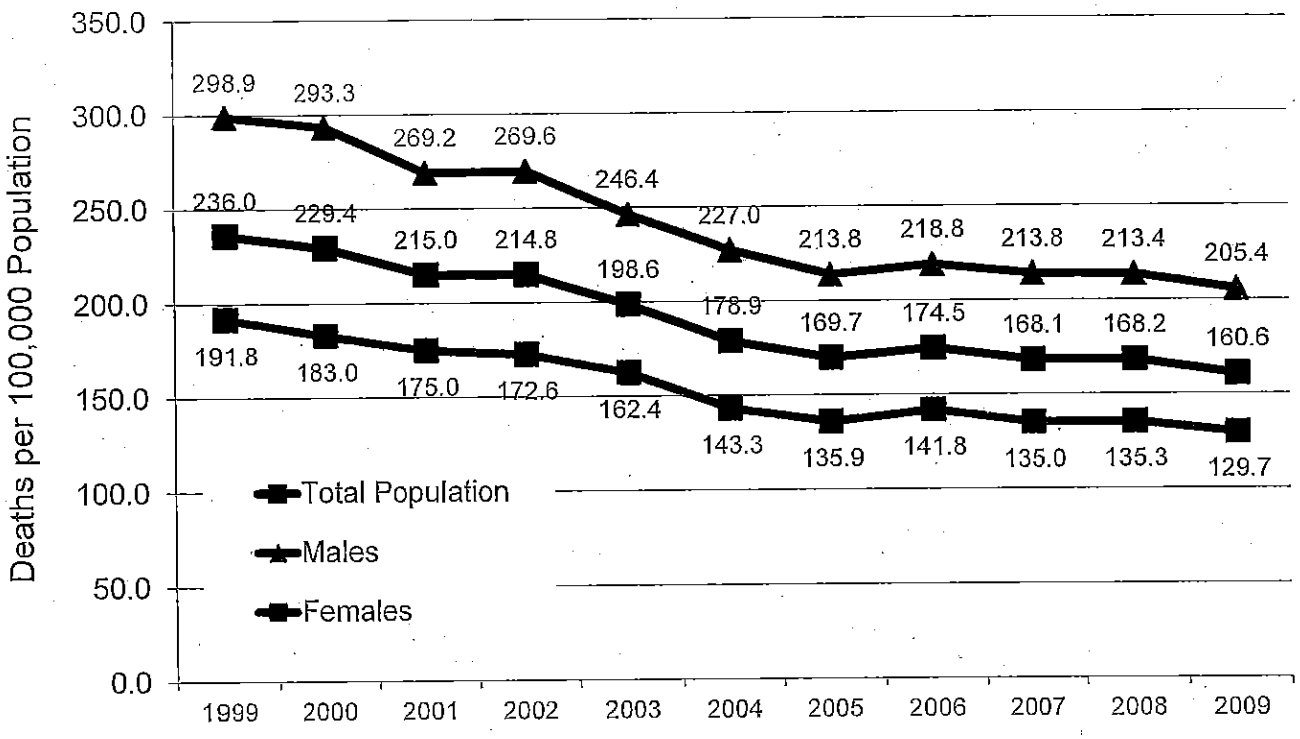
Percent of Adults 50+ Years of Age Screened for Colorectal Cancer Connecticut, 1999-2010



Source: Connecticut Behavioral Risk Factor Surveillance System, 1999-2010.

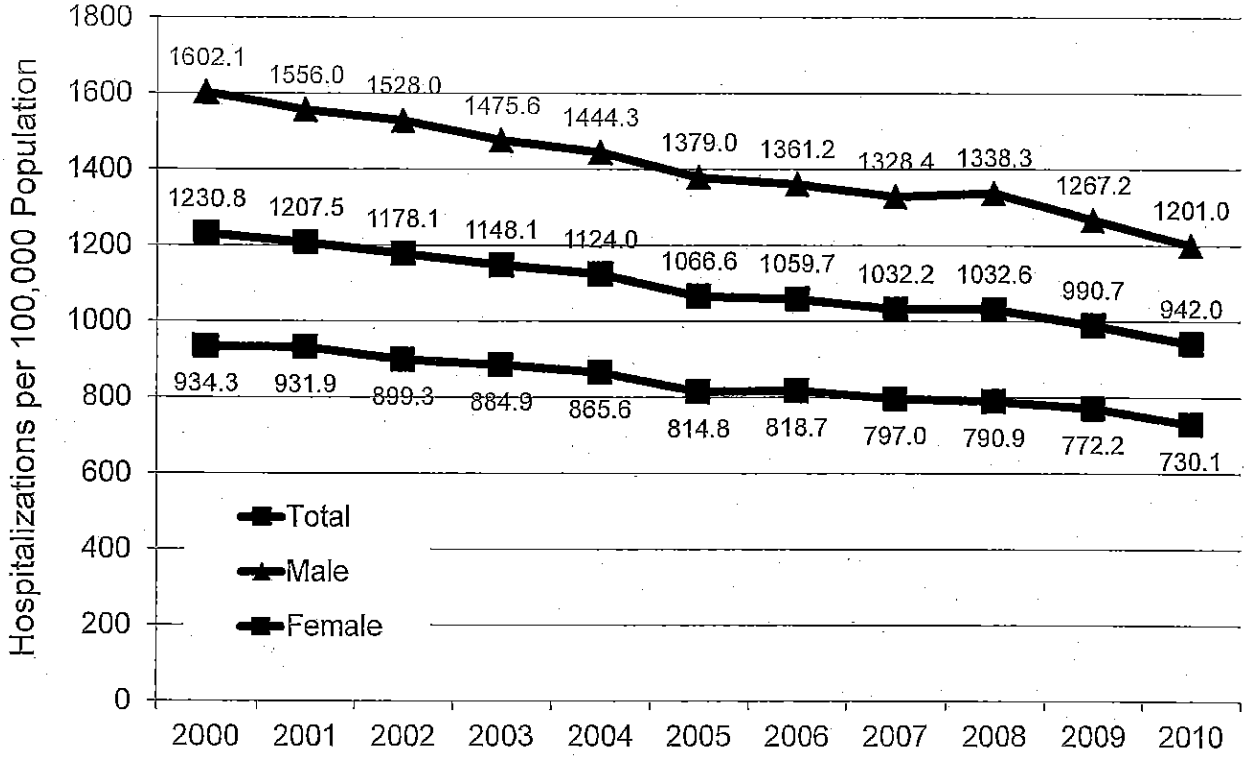
Department of Public Health
ww.ct.gov/dph/SHIPcoalition

Heart Disease Age-adjusted Mortality Rate Connecticut, 1999-2009



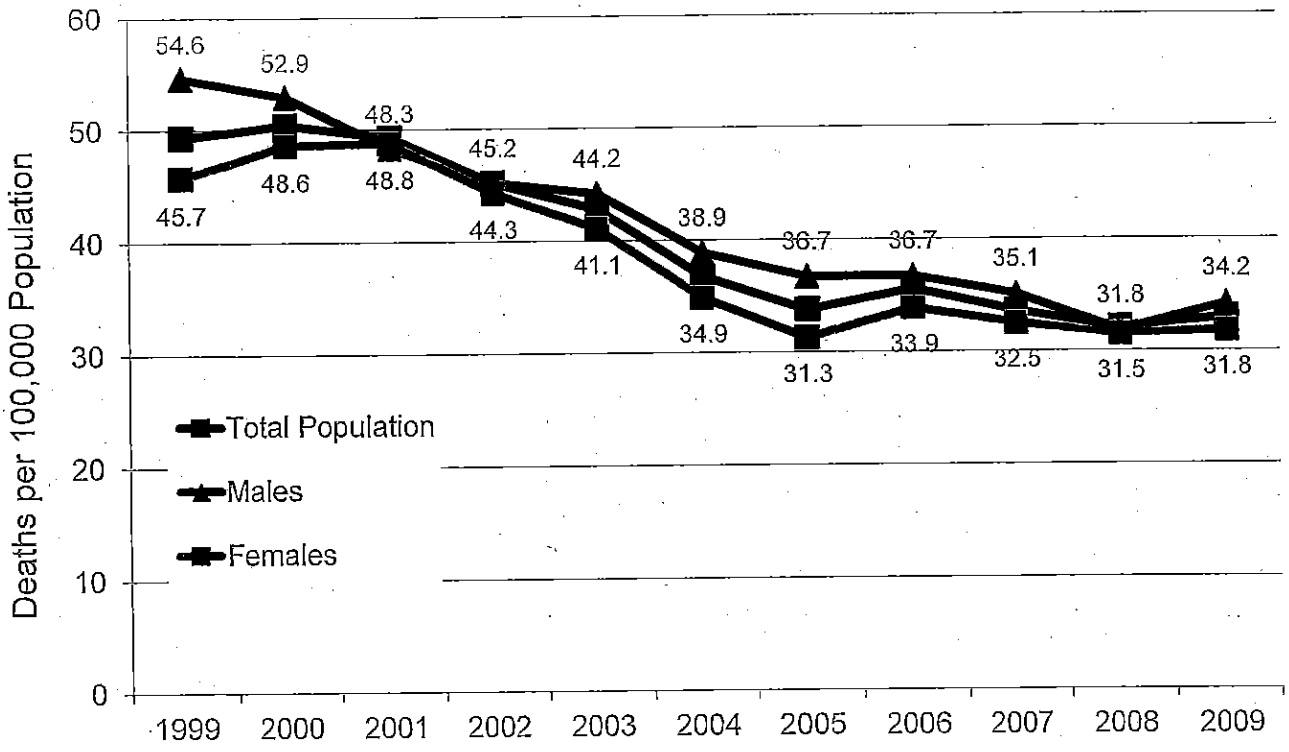
Source: Connecticut Department of Public Health, Vital Statistics (Registration Reports), Mortality Tables Statewide Age-Adjusted Mortality Rates, 1999-2009.

Heart Disease Age-adjusted Hospitalization Rate Connecticut, 2000-2010



Source: Connecticut Department of Public Health, Hospitalization Tables, 2000-2010, Table H-1.

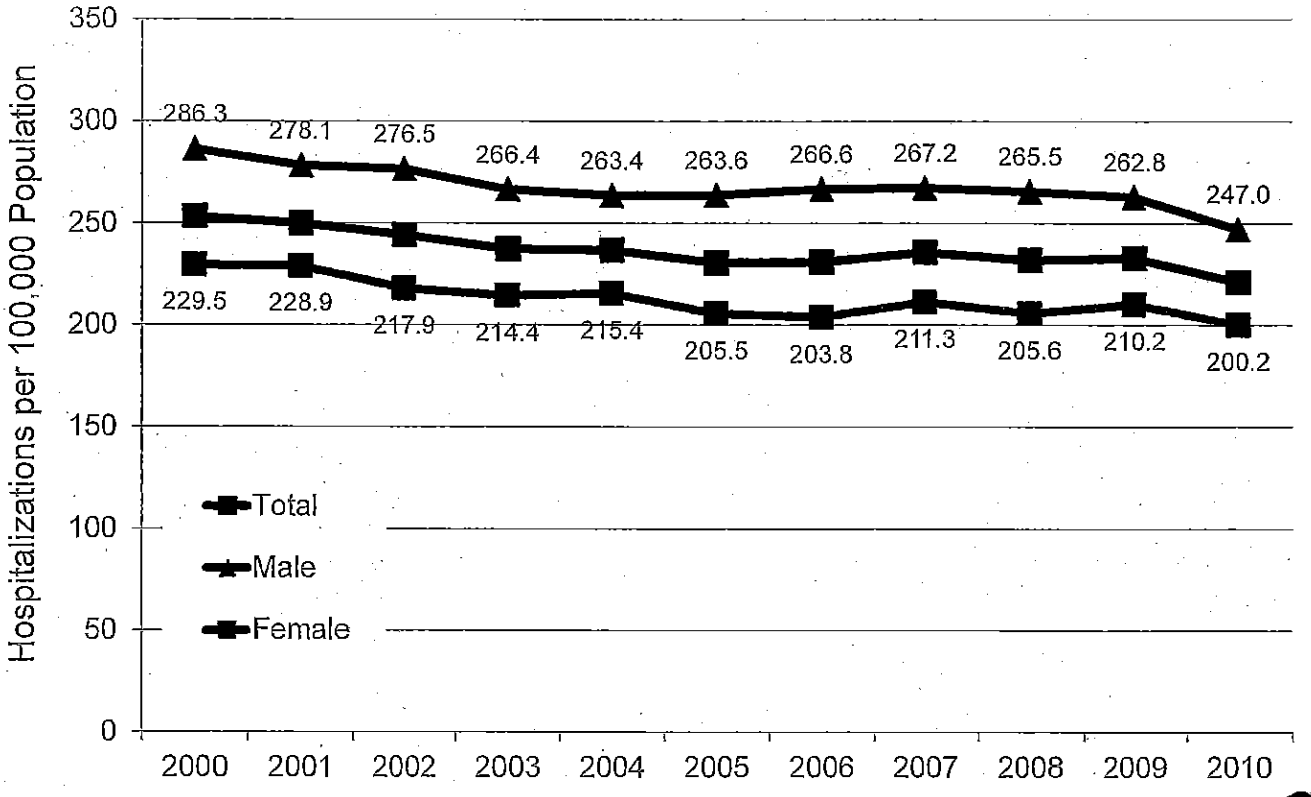
Stroke Age-adjusted Mortality Rate Connecticut, 1999-2009



Source: Connecticut Department of Public Health, Vital Statistics (Registration Reports), Mortality Tables Statewide Age-Adjusted Mortality Rates, 1999-2009.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

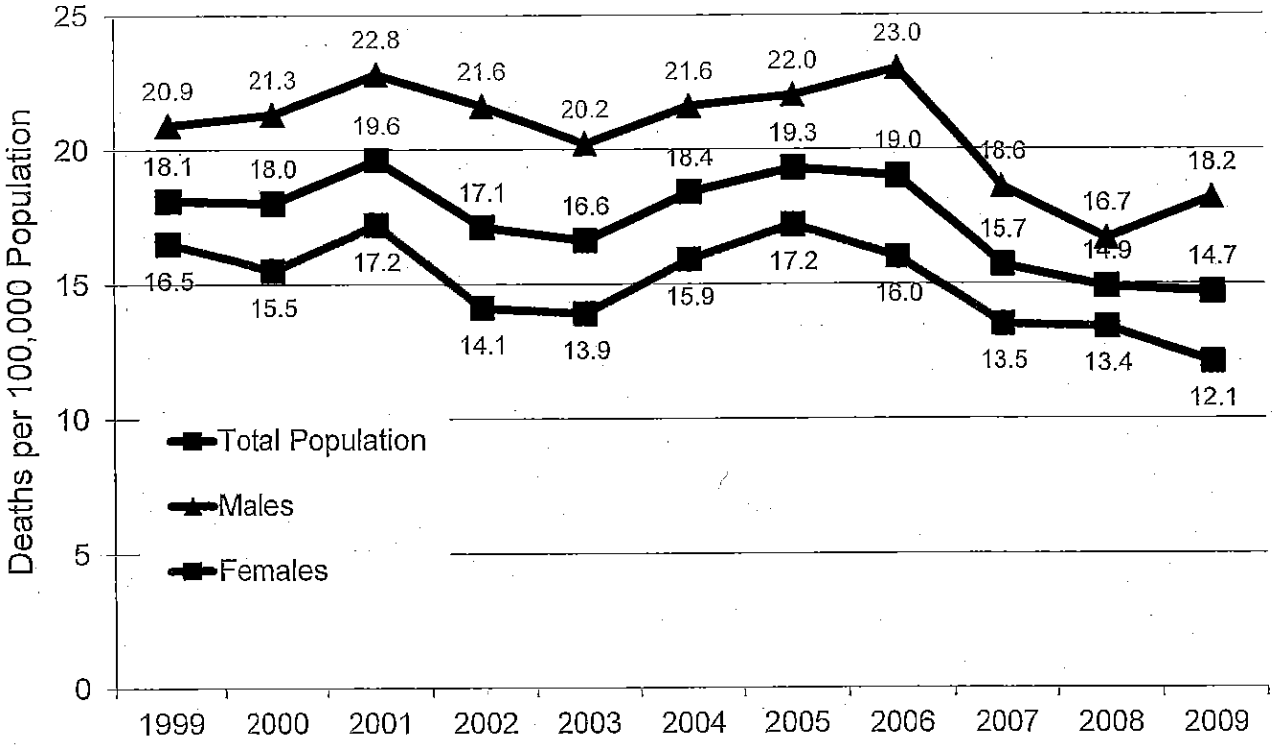
Stroke Age-adjusted Hospitalization Rate Connecticut, 2000-2010



Source: Connecticut Department of Public Health, Hospitalization Tables, 2000-2010, Table H-1.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

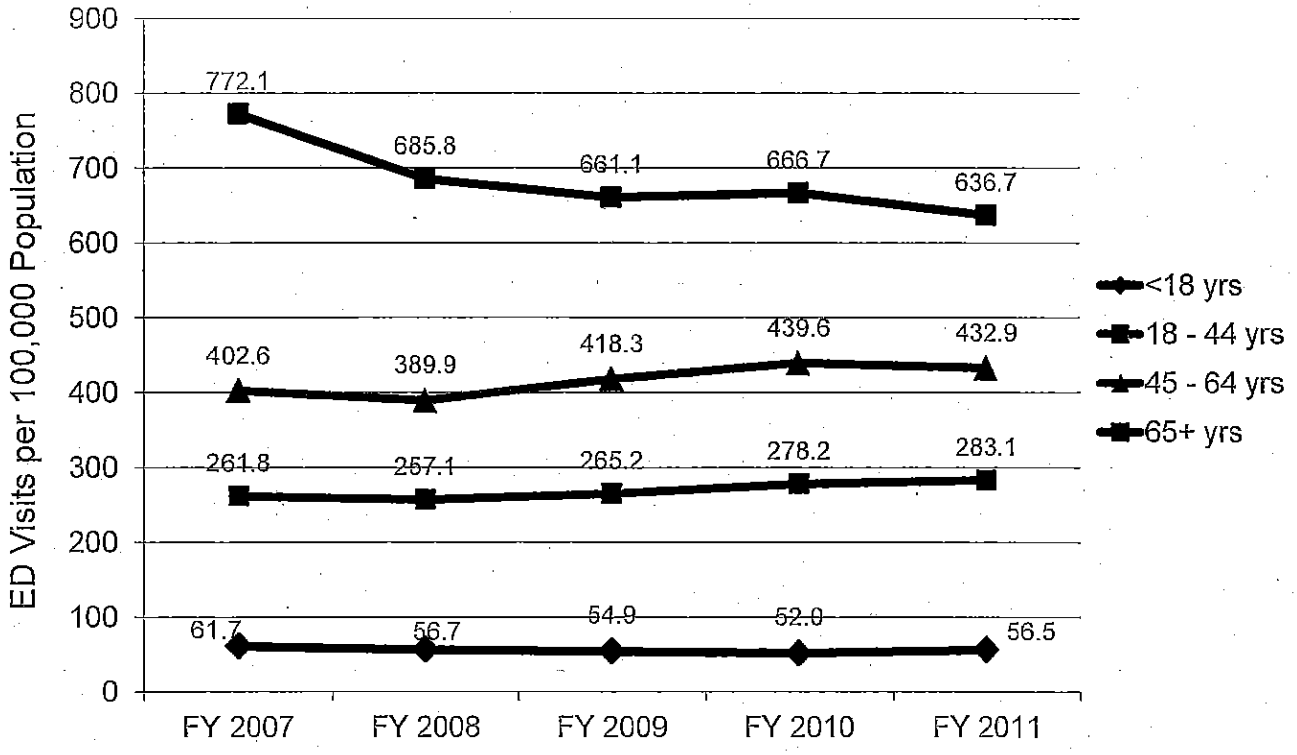
Diabetes Age-adjusted Mortality Rate Connecticut, 1999-2009



Source: Connecticut Department of Public Health,
Vital Statistics, Mortality Tables,
Statewide Age-Adjusted Mortality Rates, 1999-2009.

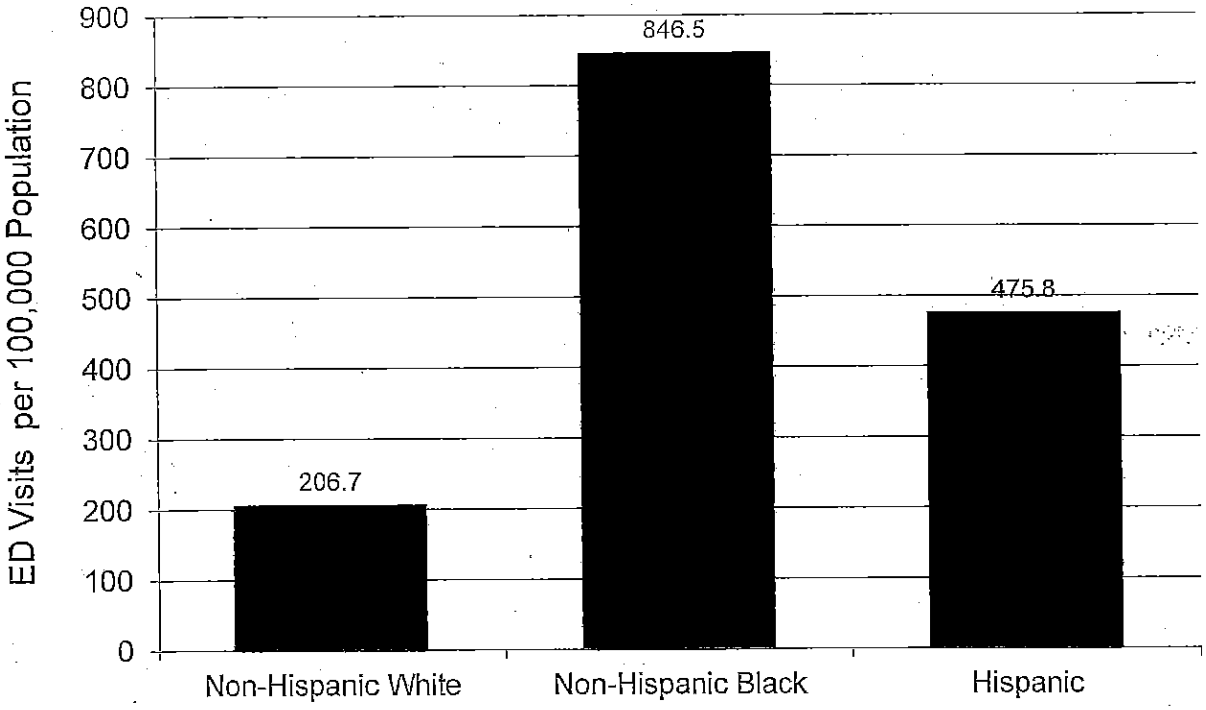
Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Diabetes ED Visits by Age, Connecticut , FY 2007-FY 2011



Source: Connecticut Department of Public Health, OCHA from *Connecticut Hospital Association CHIME, Inc. Emergency Department Database.*

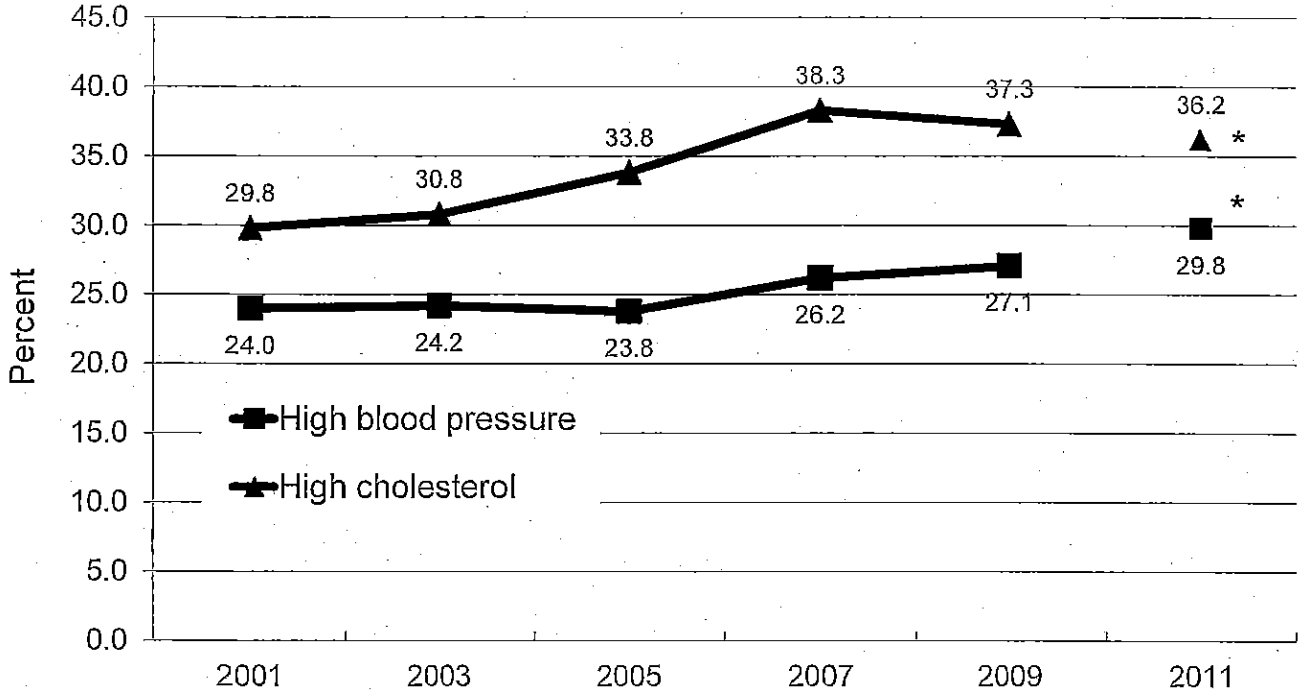
Diabetes ED Visits by Race and Ethnicity Connecticut, FY 2007-FY 2011



Source: Connecticut Department of Public Health, OCHA from *Connecticut Hospital Association CHIME, Inc. Emergency Department Database.*

73

Percent of Adults Ever Told by a Provider They Had High Blood Pressure or High Cholesterol Connecticut, 2001-2011



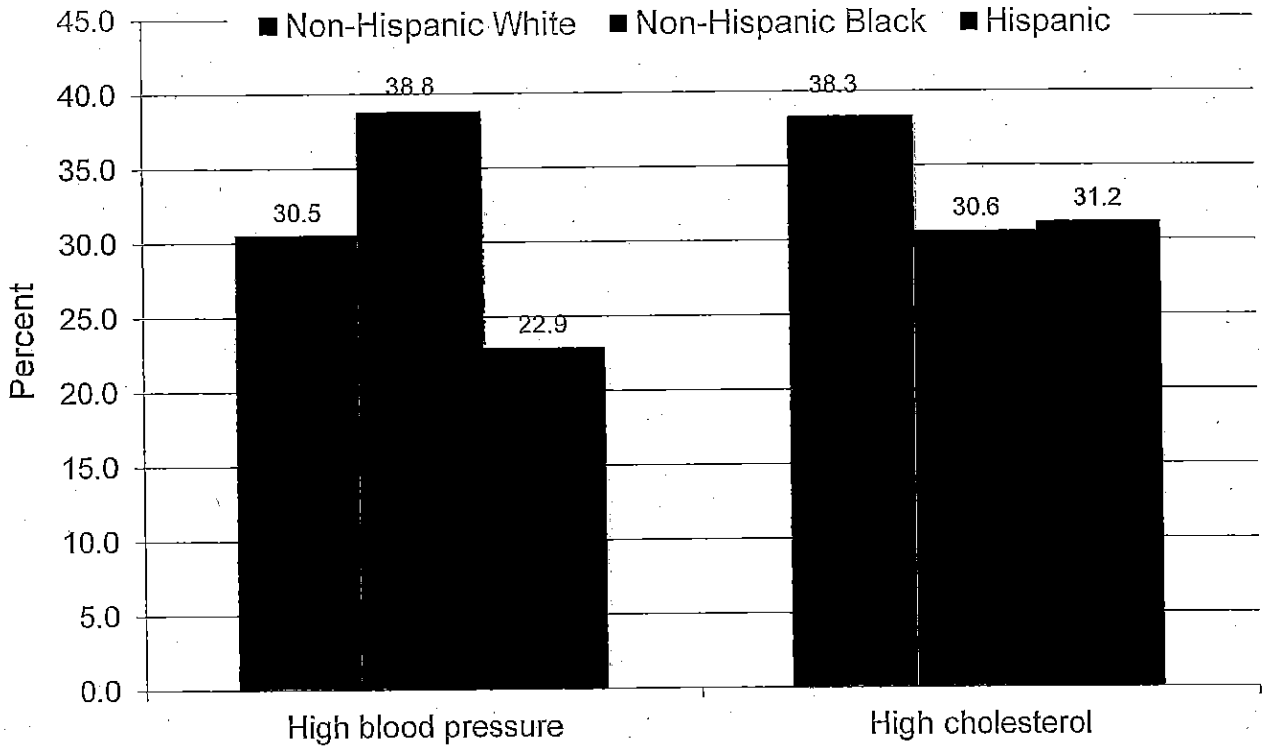
* Break in trend due to new weighting in 2011

Source: Connecticut Behavioral Risk Factor Surveillance System, 2001-2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

74

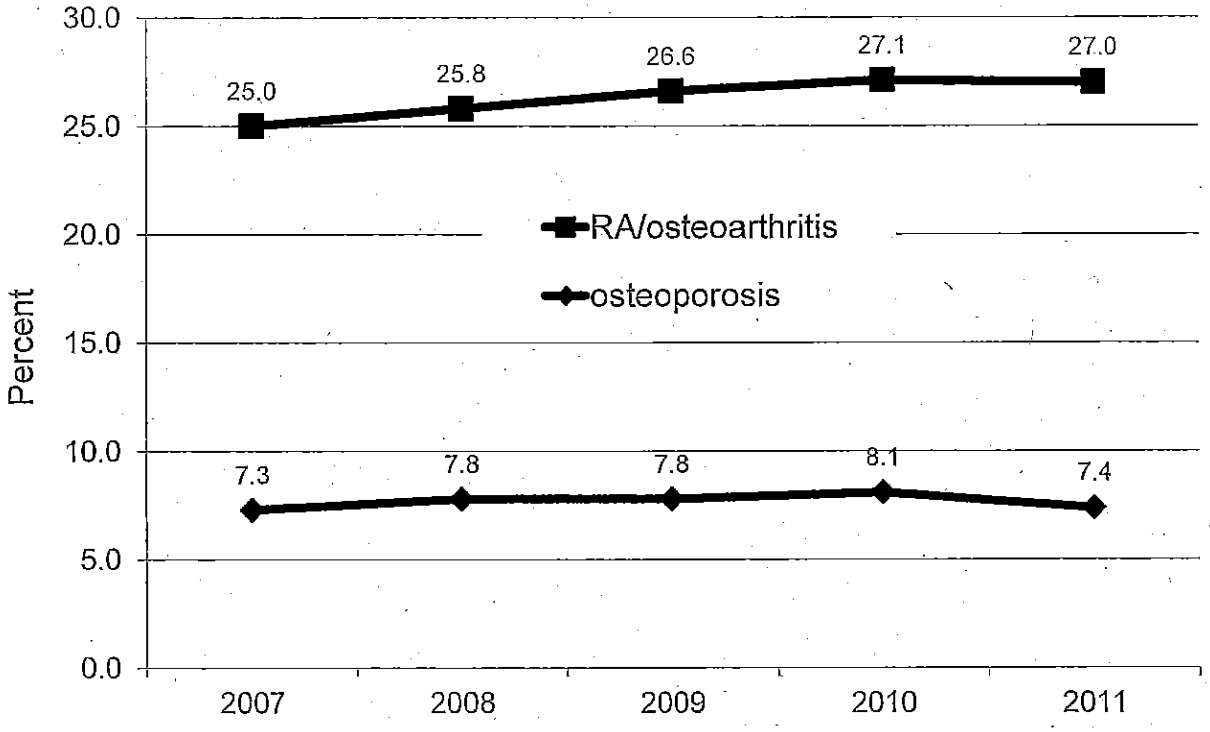
Percent of Adults Ever Told by a Provider They Had High Blood Pressure or Cholesterol, By Race/Ethnicity Connecticut, 2011



Source: Connecticut Behavioral Risk Factor Surveillance System, 2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

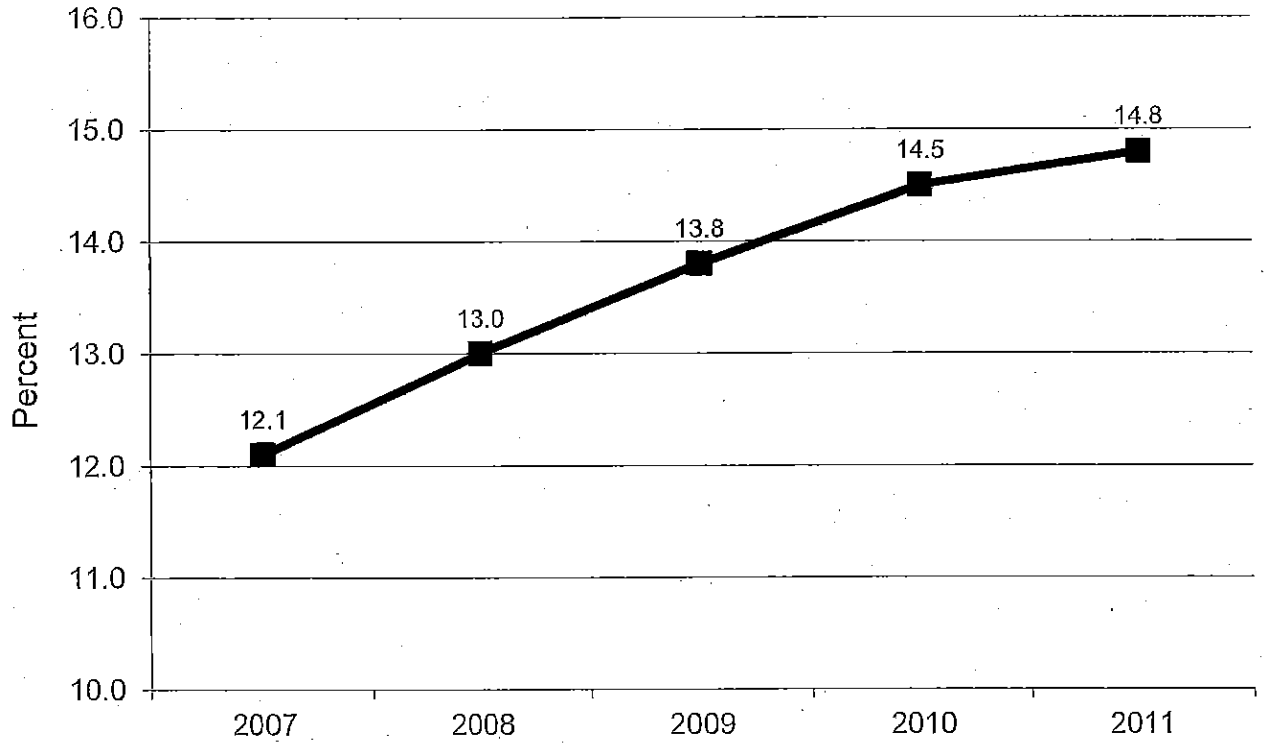
Percent of Medicare Beneficiaries with RA/Osteoarthritis and Osteoporosis Connecticut, 2007-2011



Source: Centers for Medicaid and Medicare Services, State-Level Chronic Conditions Reports, 2007-2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Percent of Medicare Beneficiaries with Chronic Kidney Disease, Connecticut, 2007-2011



Source: Centers for Medicaid and Medicare Services, State-Level Chronic Conditions Reports, 2007-2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

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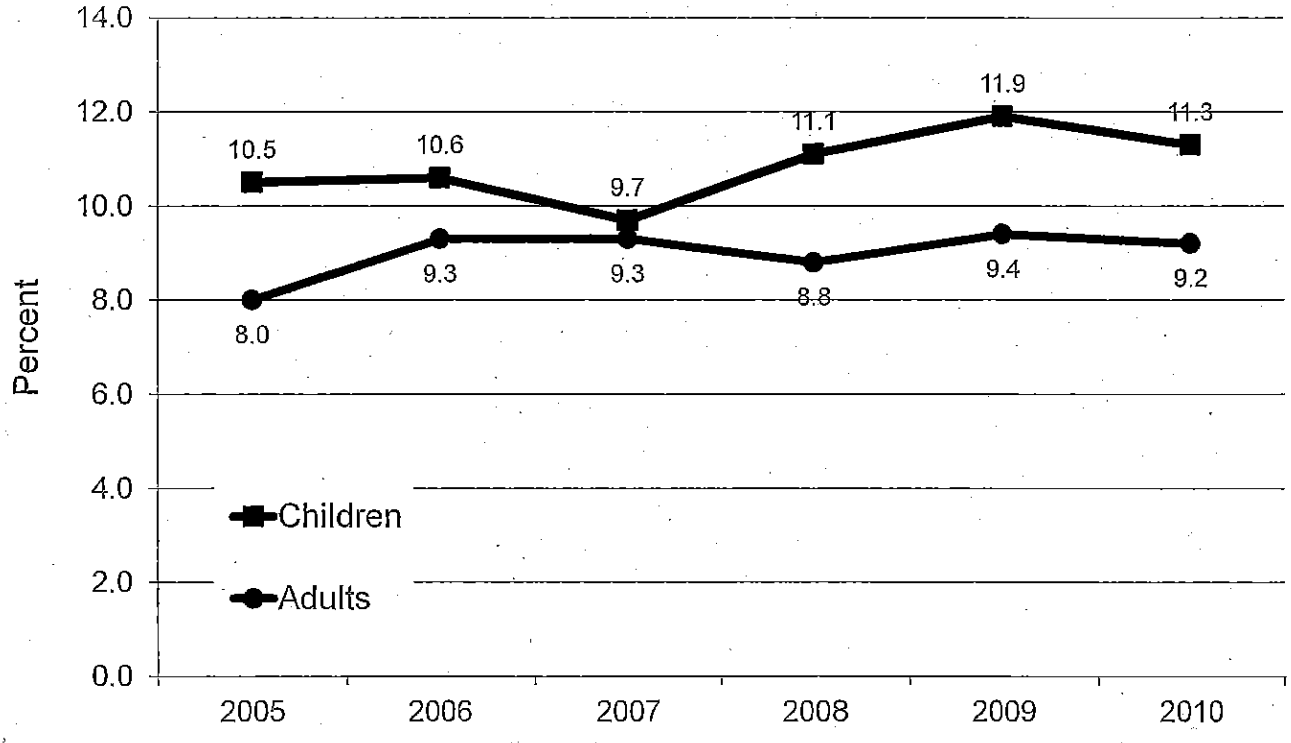
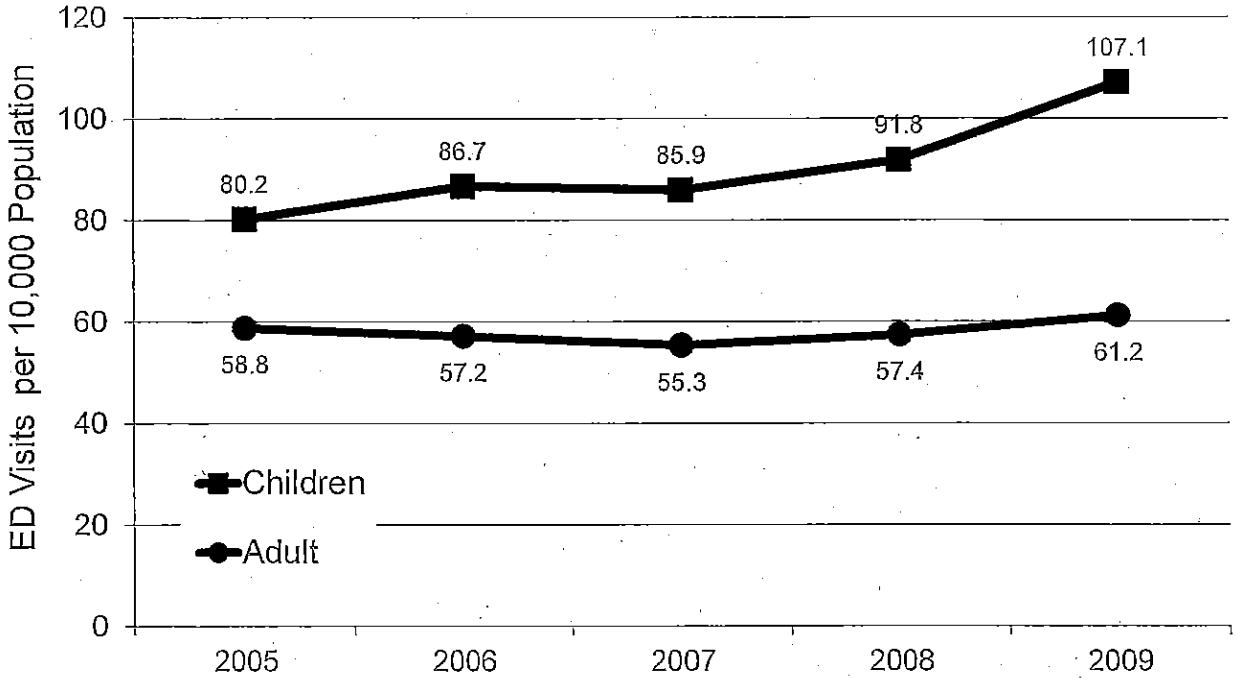
Percent of Children and Adults with Current Asthma Connecticut, 2005-2010



Source: Connecticut Behavioral Risk Factor Surveillance System, 2005-2010.

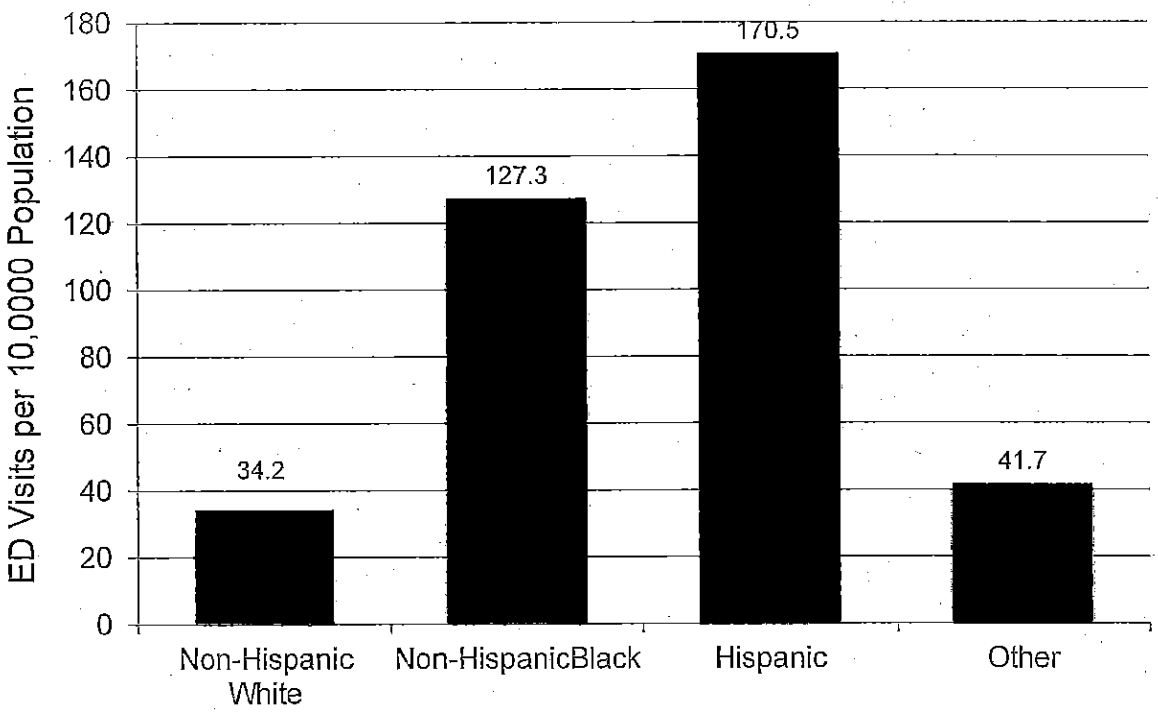
Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Age adjusted Rate of ED Visits for Asthma Connecticut, 2005-2009



Source: Connecticut Department of Public Health Asthma Program, Burden of Asthma in Connecticut 2012 Surveillance Report, Table 7.

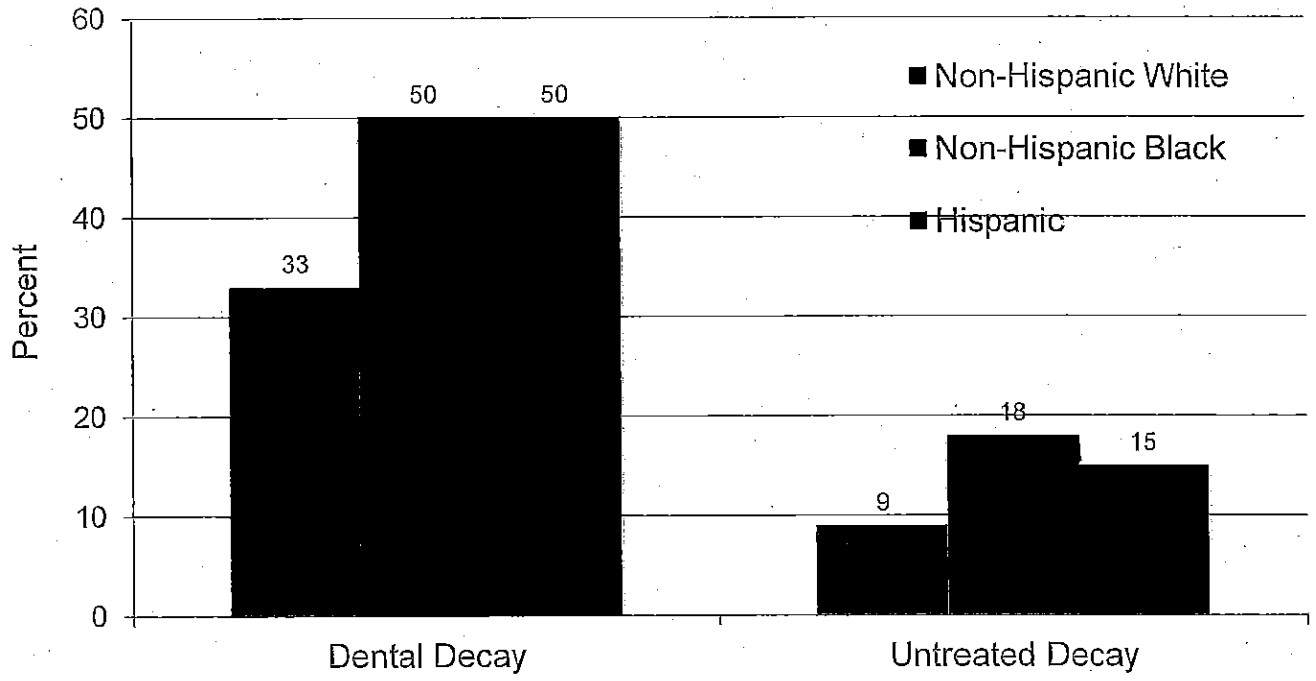
Age adjusted Rate of Asthma ED Visits by Race and Ethnicity Connecticut, 2009



Source: Connecticut Department of Public Health Asthma Program, Burden of Asthma in Connecticut 2012 Surveillance Report, Table 8.

80

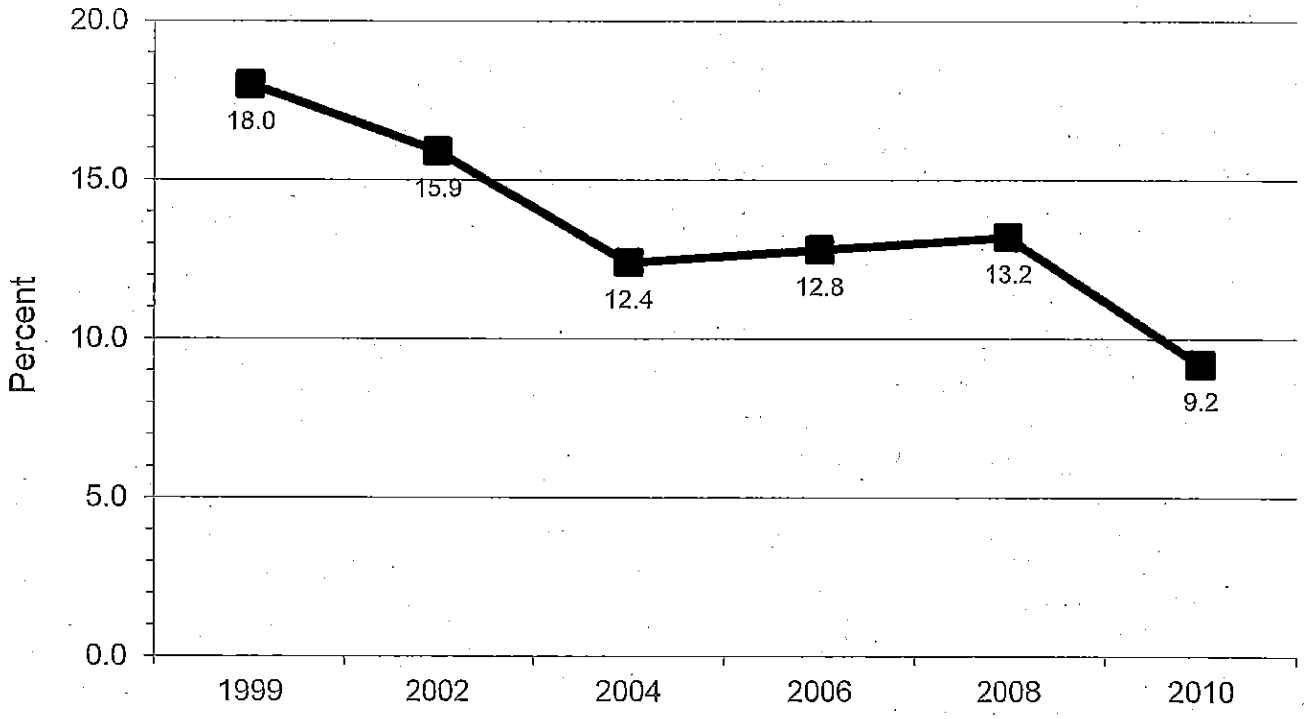
Children Who Experience Dental Decay and Prolonged Untreated Dental Decay, by Race/Ethnicity Connecticut, 2010-2011



Source: Connecticut Department of Public Health,
Every Smile Counts: The Oral Health of Connecticut's Children Draft Report, 2012, Key Finding #4.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Percent of Adults 65+ Years of Age Who Have Had All Their Natural Teeth Extracted Connecticut, 1999-2010



Source: Connecticut Behavioral Risk Factor Surveillance System, 1999-2010.

Connecticut Department of Public Health
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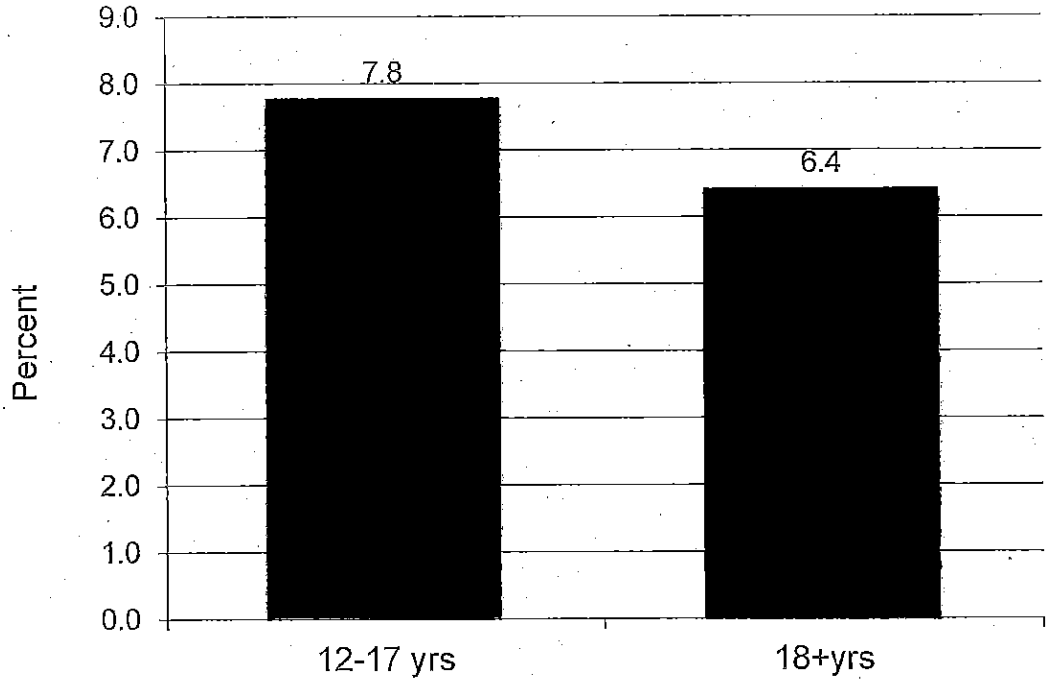
MENTAL HEALTH, ALCOHOL, AND SUBSTANCE ABUSE

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

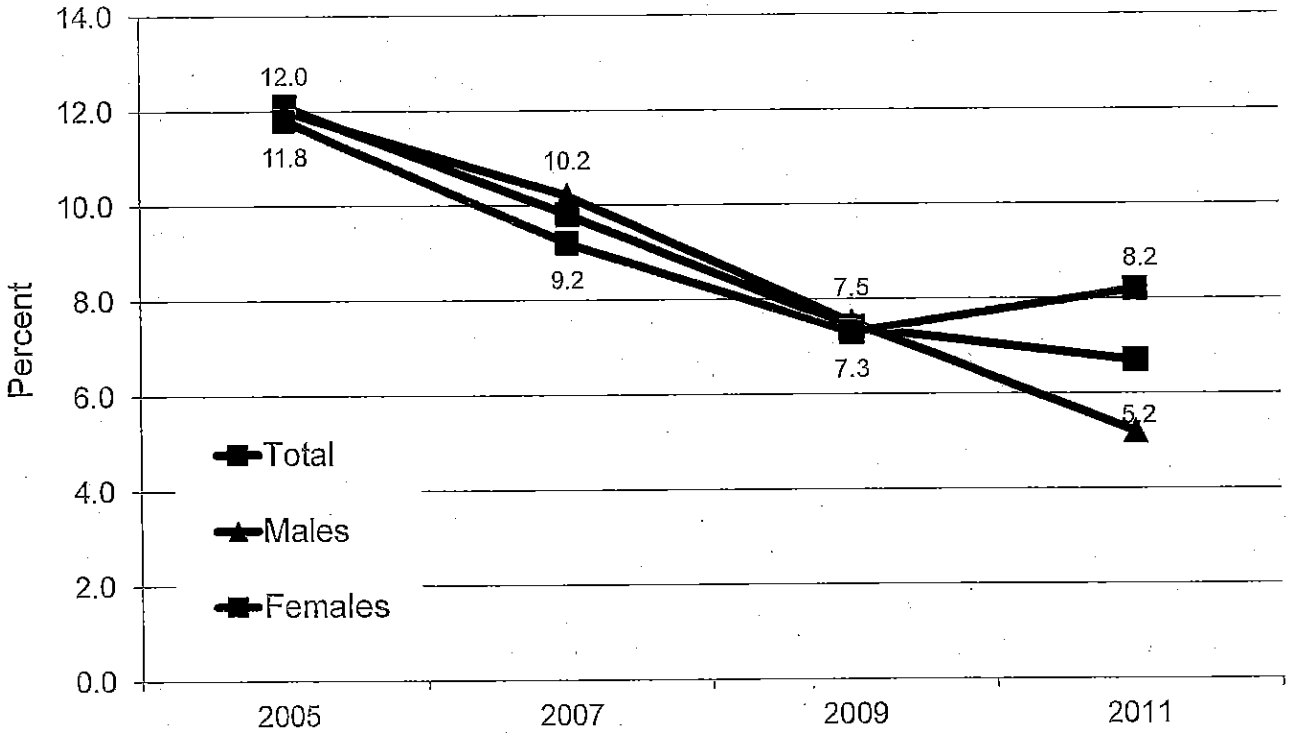
Percent of Persons Who Had at Least One Major Depressive Episode in Past Year, by Age, Connecticut, 2010-2011



Source: Substance Abuse and Mental Health Services Administration (SAMSHA), Survey on Drug Use and Health Model-Based Estimates, 2008-2009 and 2010-2011.

84

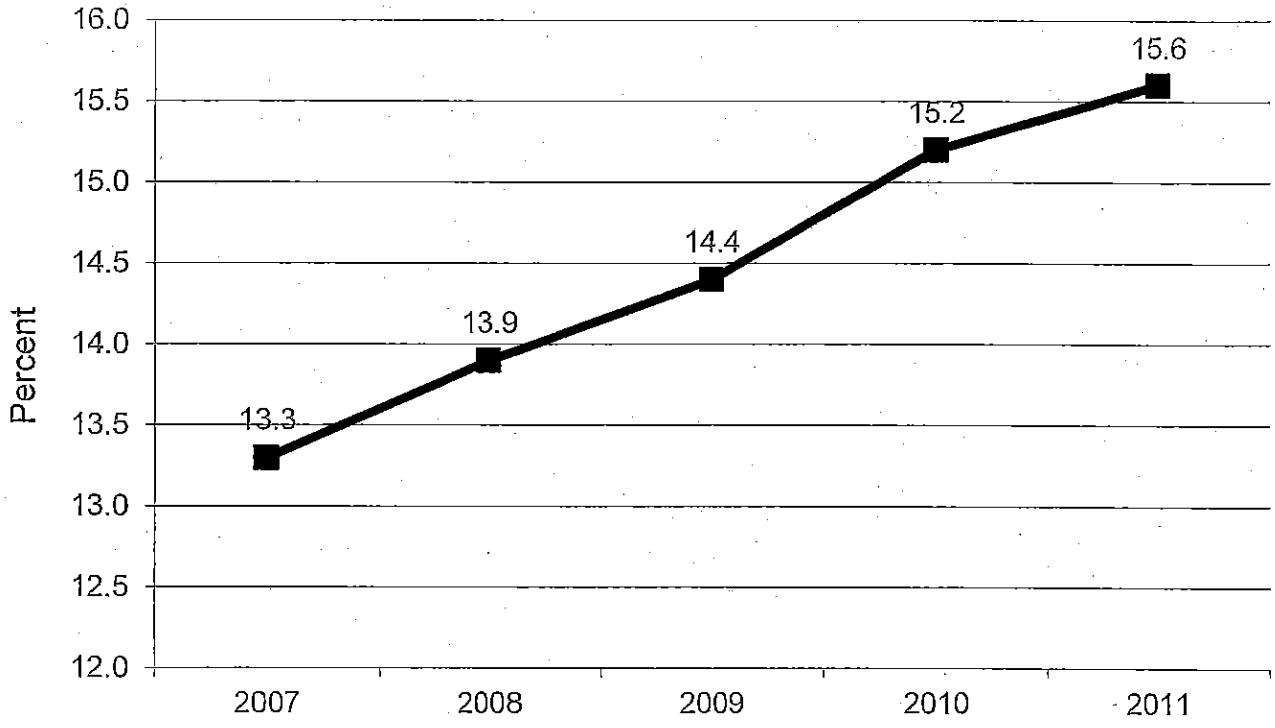
Percent of Students (Grades 9-12) Who Attempted Suicide at Least Once in Past Year, by Sex Connecticut, 2005-2011



Source: Connecticut Youth Risk Behavior Survey, 2005-2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

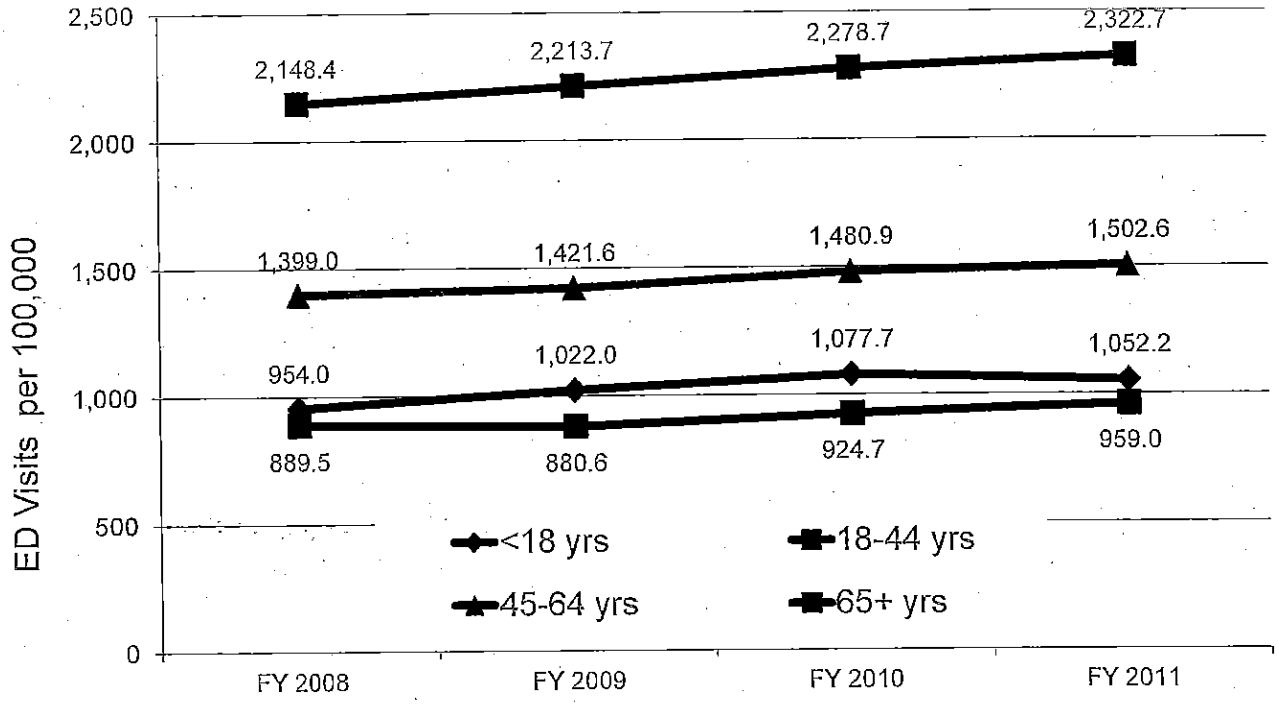
Percent of Medicare Beneficiaries with Depression, Connecticut, 2007-2011



Source: Centers for Medicaid and Medicare Services, State-Level Chronic Conditions Reports, 2007-2011.

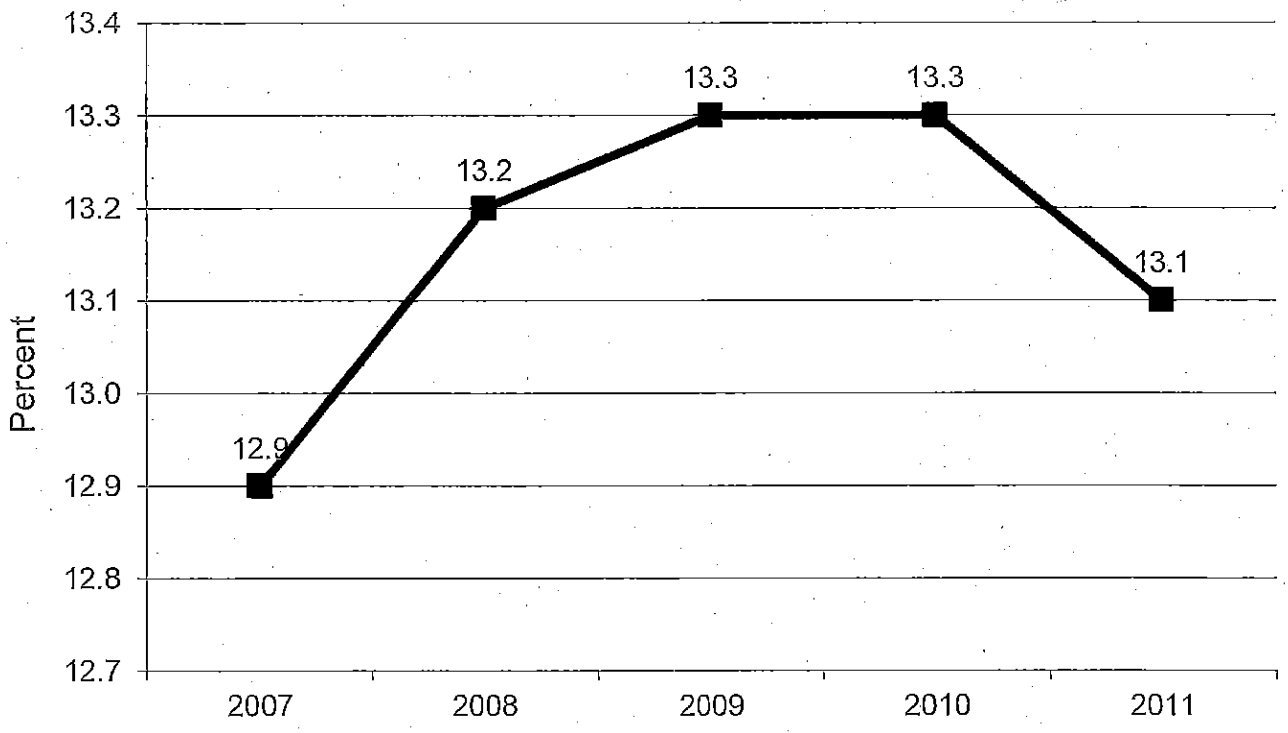
Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Rate of Mental Health ED Visits, by Age Connecticut, FY 2007- FY 2011



Source: Connecticut Department of Public Health, OCHA from *Connecticut Hospital Association CHIME, Inc. Emergency Department Database.*

Percent of Medicare Beneficiaries with Dementia or Alzheimer's Disease Connecticut, 2007-2011

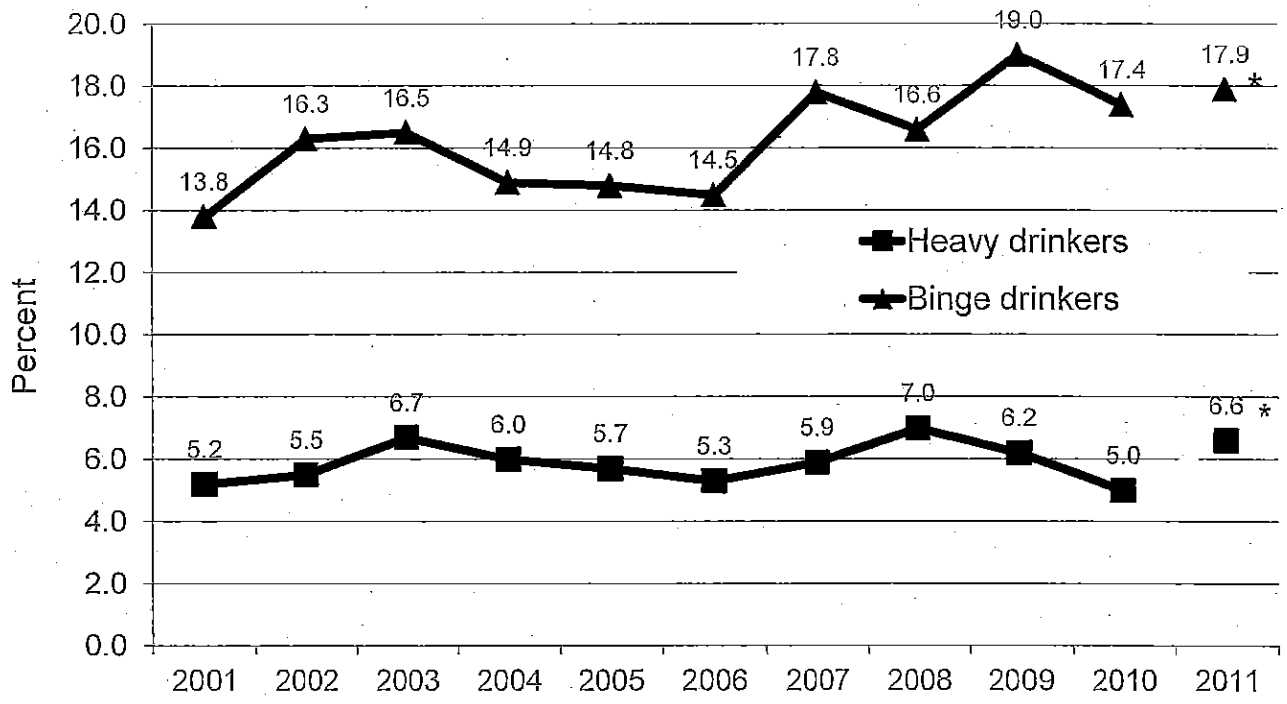


Source: Centers for Medicaid and Medicare Services, State-Level Chronic Conditions Reports, 2007-2011.

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

88

Percent of Adults (18+ Yrs) Who Are Heavy Drinkers or Binge Drinkers Connecticut, 2001-2011

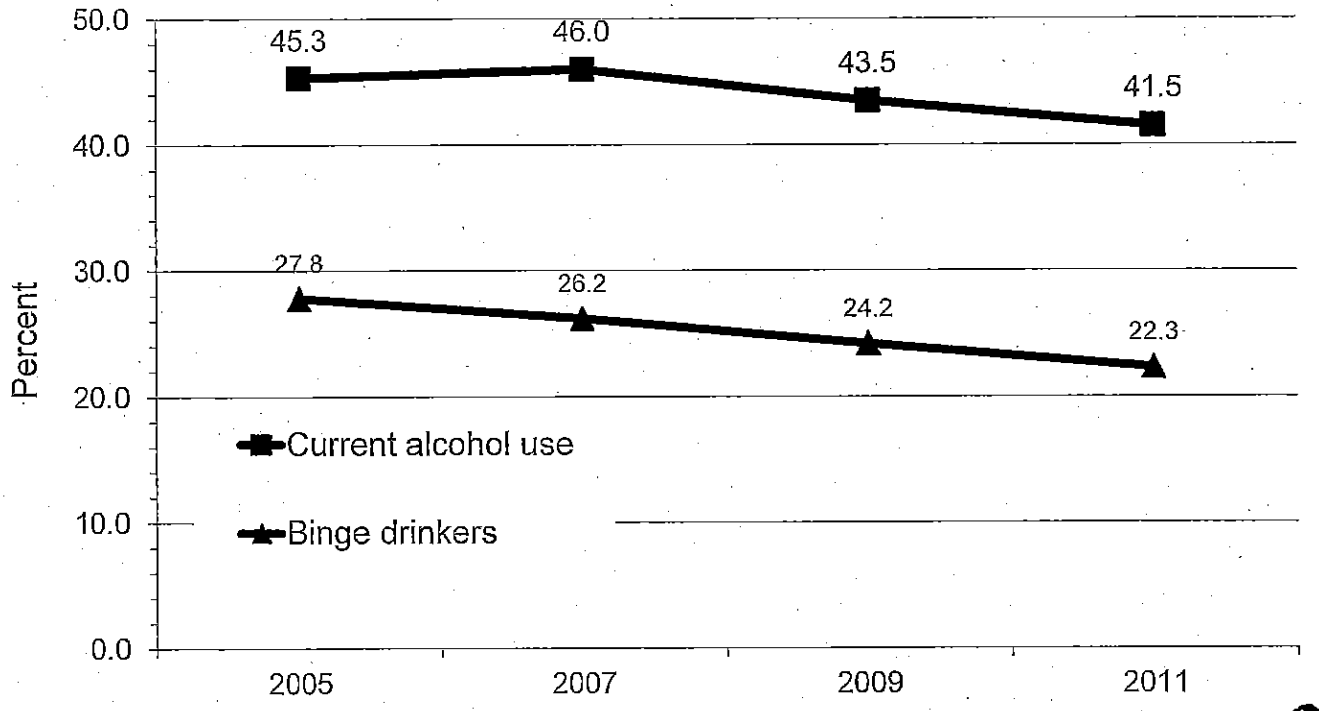


• Break in trend due to new weighting in 2011

Source: Connecticut Behavioral Risk Factor Surveillance System, 2001-2010

Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

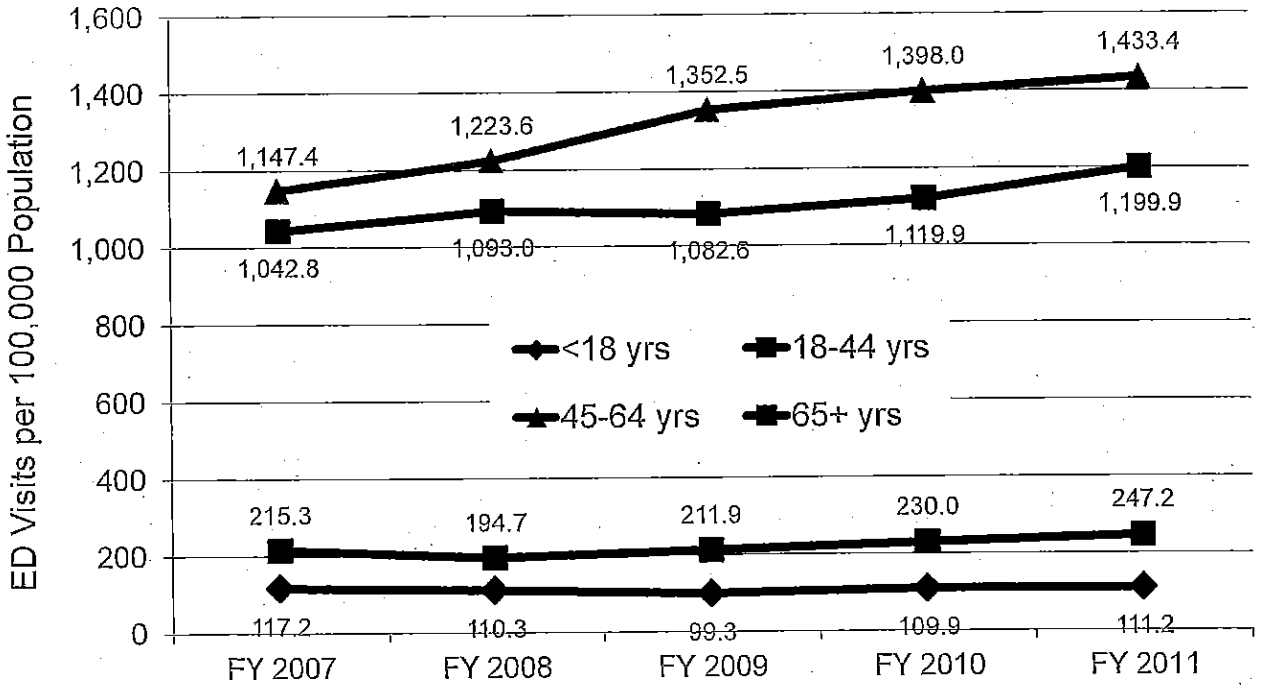
Percent of Students (Grades 9-12) Who Currently Drink Alcohol or Are Binge Drinkers Connecticut, 2005-2011



Source: Connecticut Youth Risk Behavior Survey, 2005-2011.

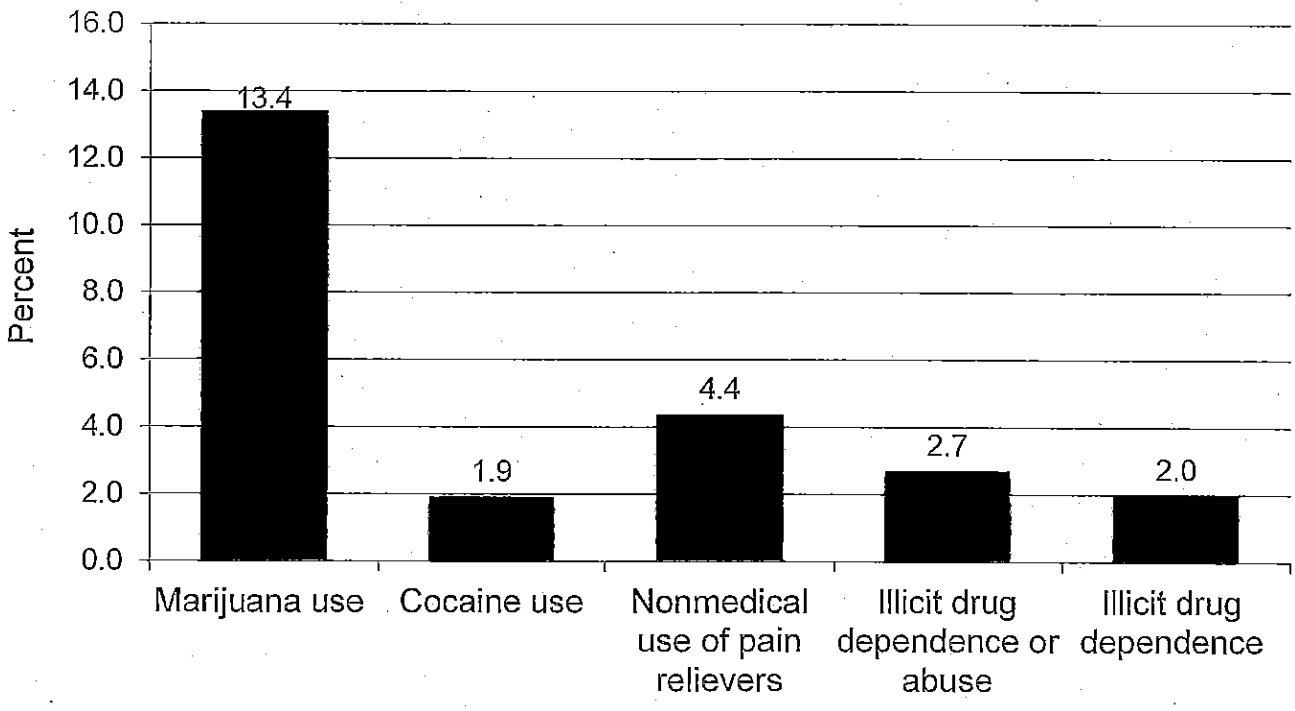
Connecticut Department of Public Health
www.ct.gov/dph/SHIPcoalition

Rate of ED Visits for Alcohol Abuse/Dependence by Age Connecticut, FY 2007-FY 2011



Source: Connecticut Department of Public Health, OCHA from *Connecticut Hospital Association CHIME, Inc. Emergency Department Database.*

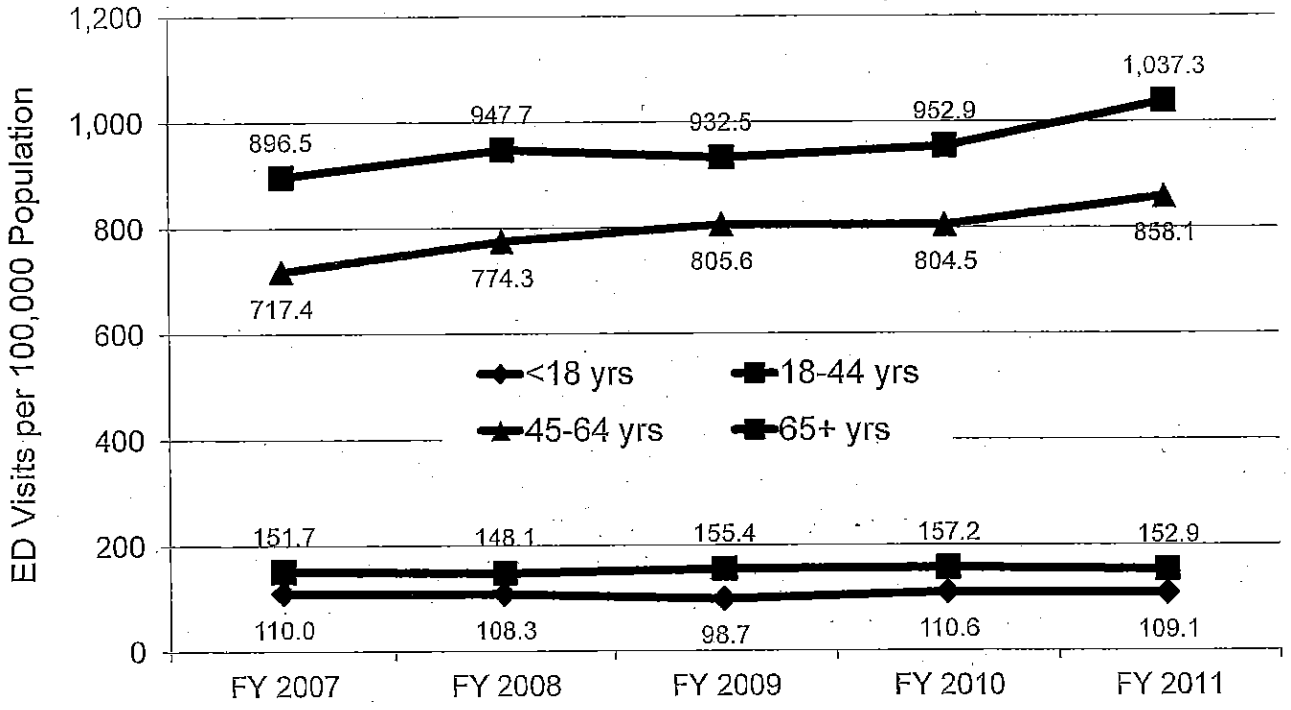
Percent of Individuals 12+ Years of Age Who Used Drugs in Past Year, by Drug Type Connecticut, 2010-2011



Source: US DHHS Substance Abuse and Mental Health Administration, National Survey on Drug Use and Health, 2010-2011.

92

Rate of ED Visits for Substance Abuse/Dependence by Age Connecticut, FY2007-FY2011



Source: Connecticut Department of Public Health, OCHA from *Connecticut Hospital Association CHIME, Inc. Emergency Department Database.*

INJURY AND VIOLENCE PREVENTION

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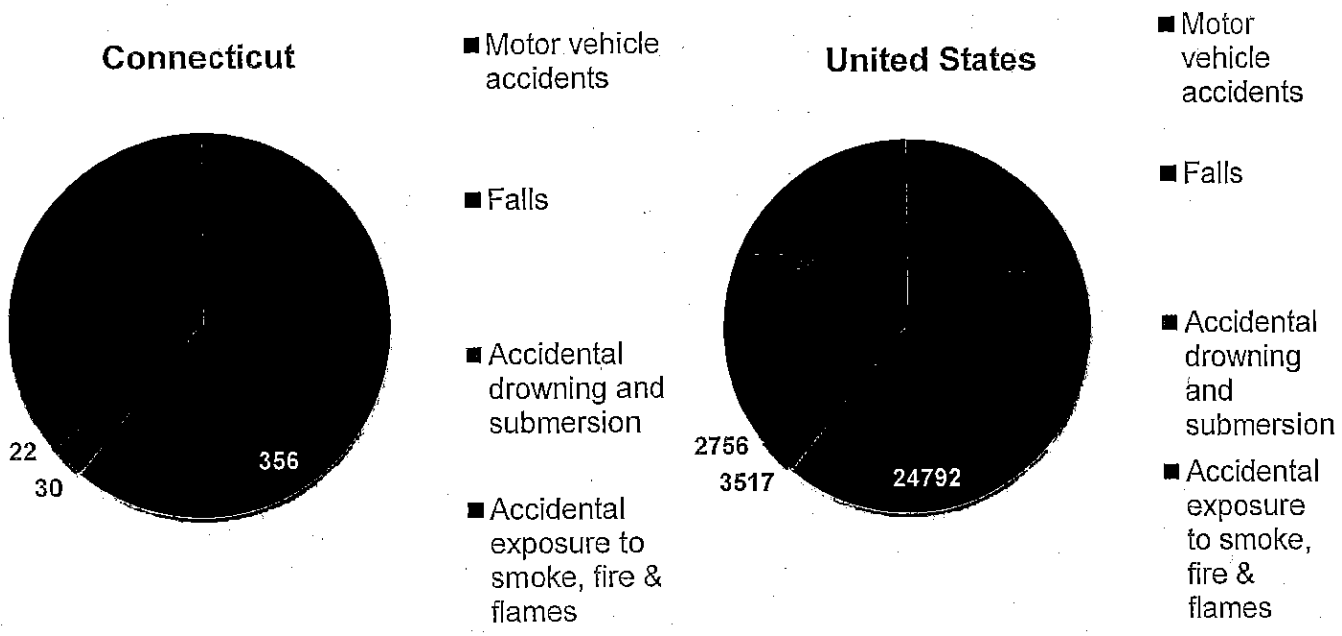
Number of Unintentional Injury Deaths by Cause of Death U.S. vs. Connecticut, 2009



Source: Connecticut Department of Public Health, Vital Statistics, 2009, Table 9; National Vital Statistics Report (2011): Deaths: Final Data for 2009.

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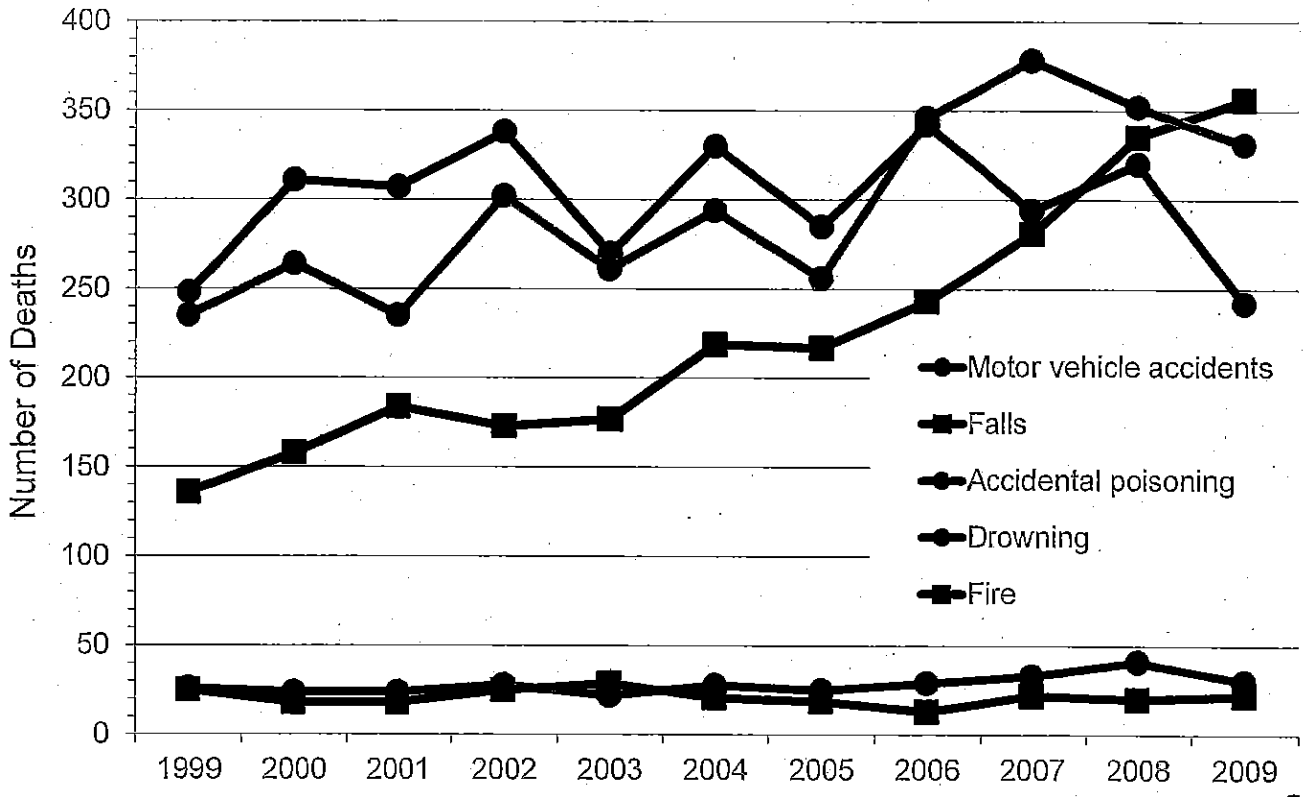
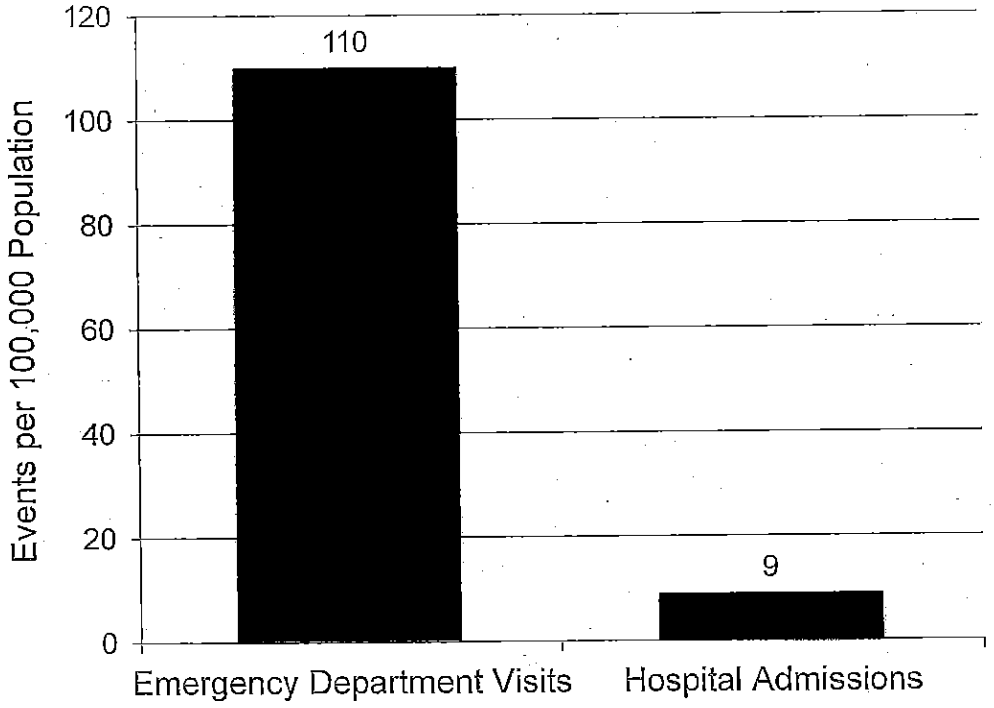
Number of Deaths Due to Unintentional Injuries Connecticut, 1999-2009



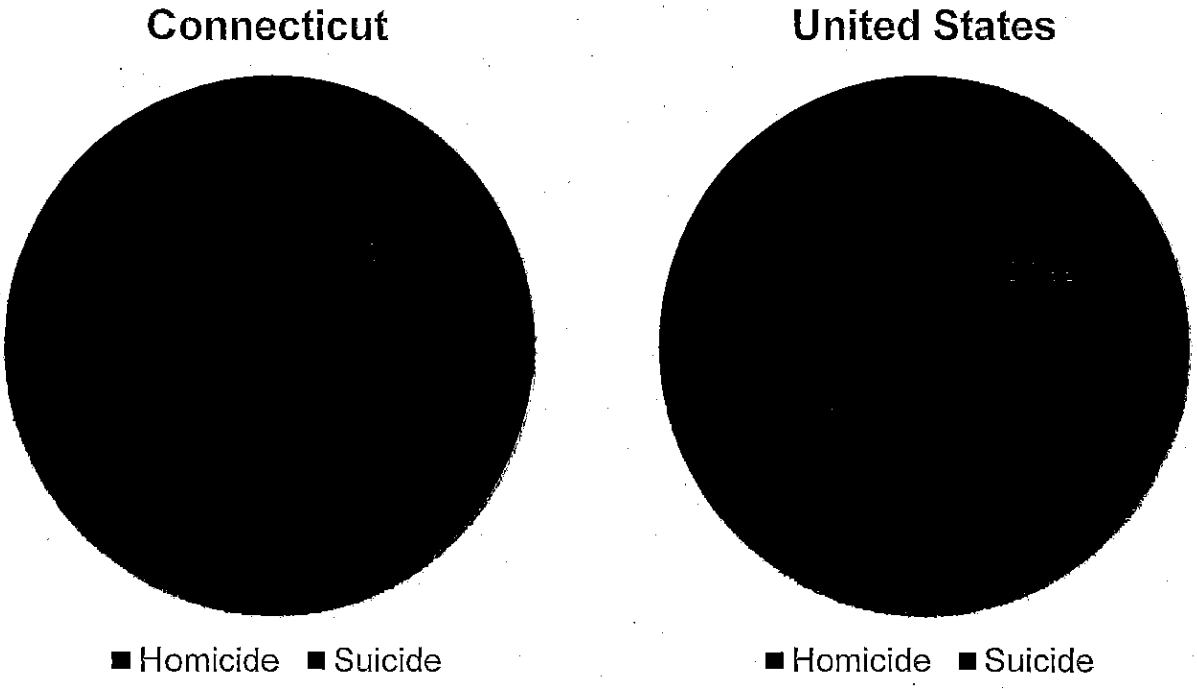
Source: Connecticut Department of Public Health, Vital Statistics, 2009, Table 9

Rate of ED Visits and Hospitalizations for Unintentional Injuries Connecticut, 2009



Source: Connecticut Department of Public Health, OCHA, Injuries Resulting in ED Visits or Hospitalizations

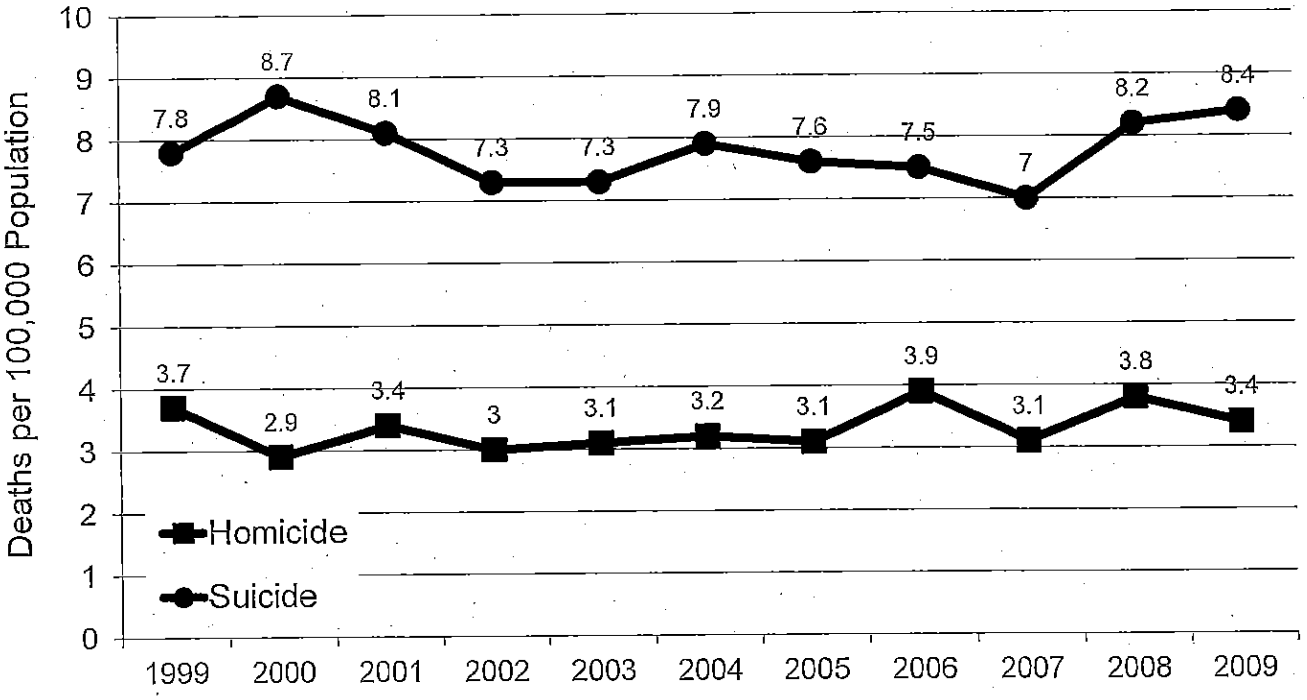
Number of Intentional Injury Deaths by Cause of Death Connecticut vs. U.S., 2009



Source: Connecticut Department of Public Health, Vital Statistics, 2009, Table 9; National Vital Statistics Report (2011): Deaths: Final Data for 2009.

98

Age-adjusted Mortality Rates for Intentional Injury, Connecticut, 1999-2009



Source: Connecticut Department of Public Health, Mortality Tables, Age-Adjusted Mortality Rate, 2000-2009.

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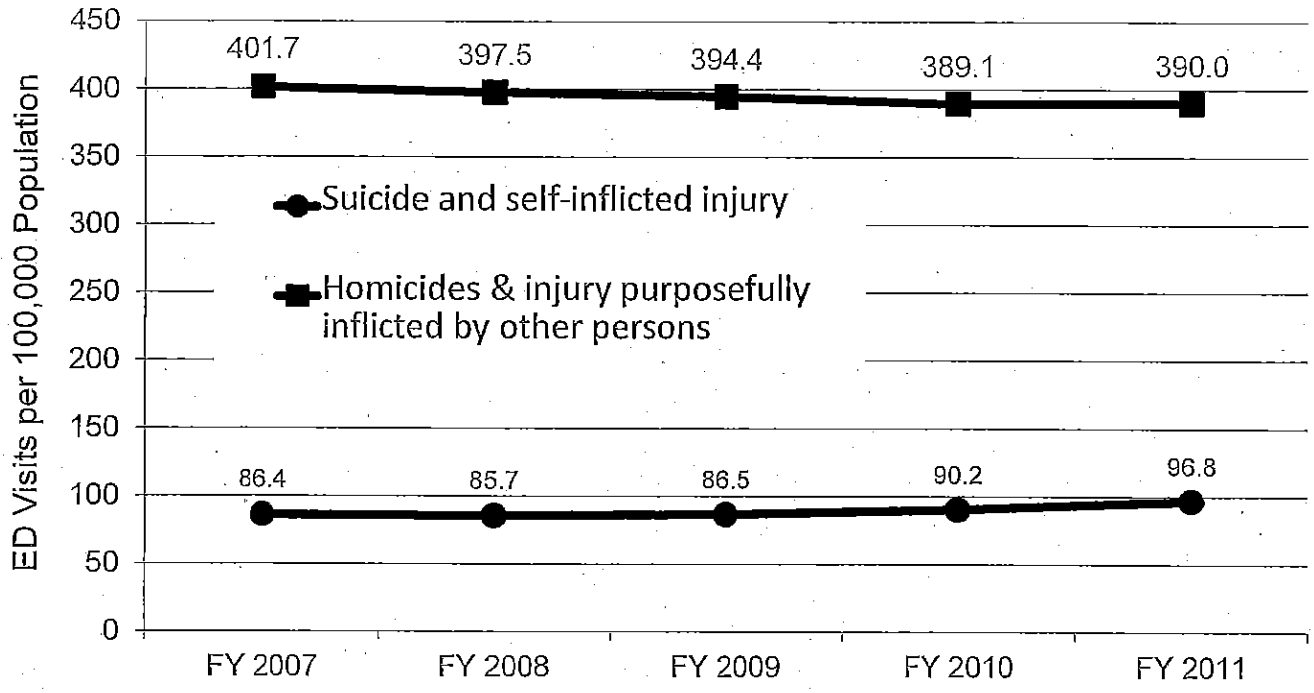
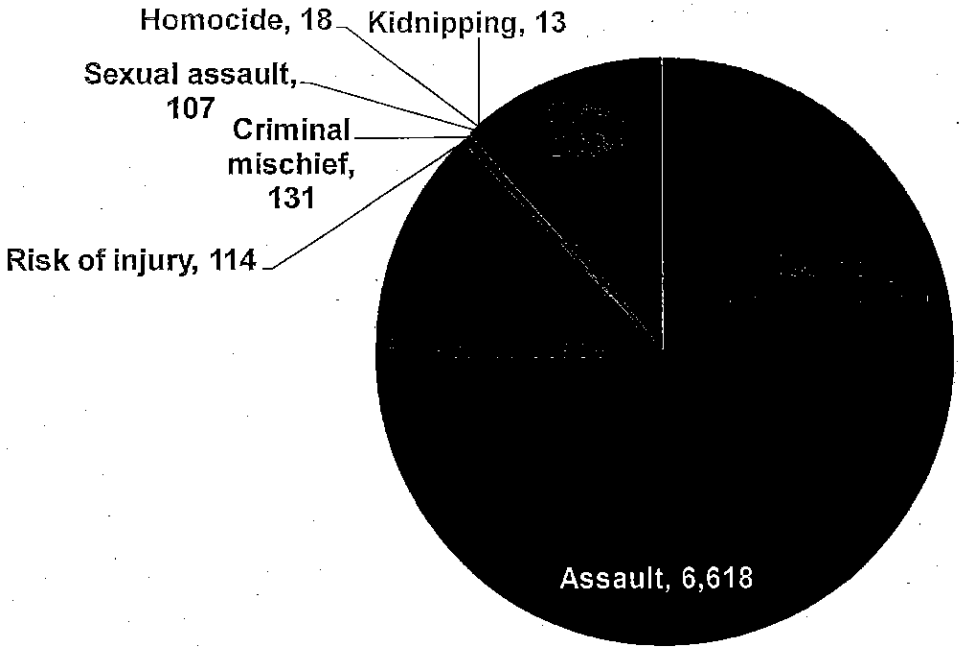
Rate of Injury ED Visits for Intentional Injuries Connecticut, FY 2007-FY 2011



Source: Connecticut Department of Public Health, OCHA from *Connecticut Hospital Association CHIME, Inc. Emergency Department Database.*

100

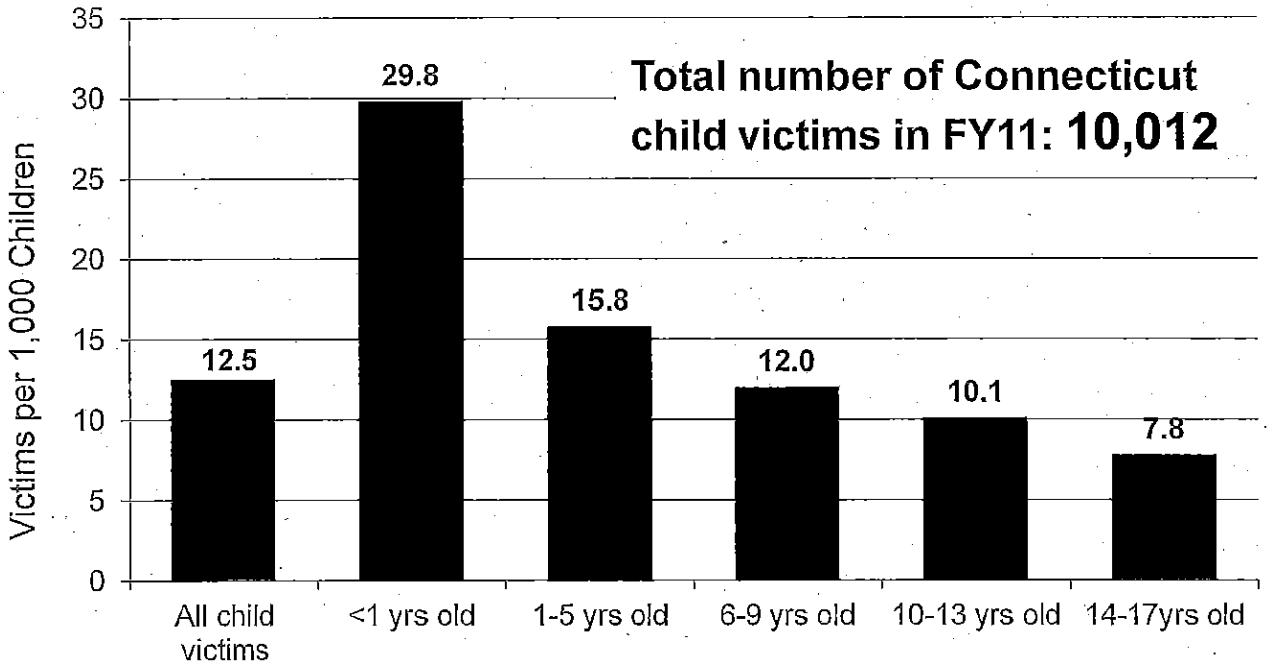
Number of Family Violence Arrests by Type of Incident Connecticut, 2011



Source: State of Connecticut, Department of Emergency Services and Public Protection, Family Violence Arrests Annual Report, 2011

101

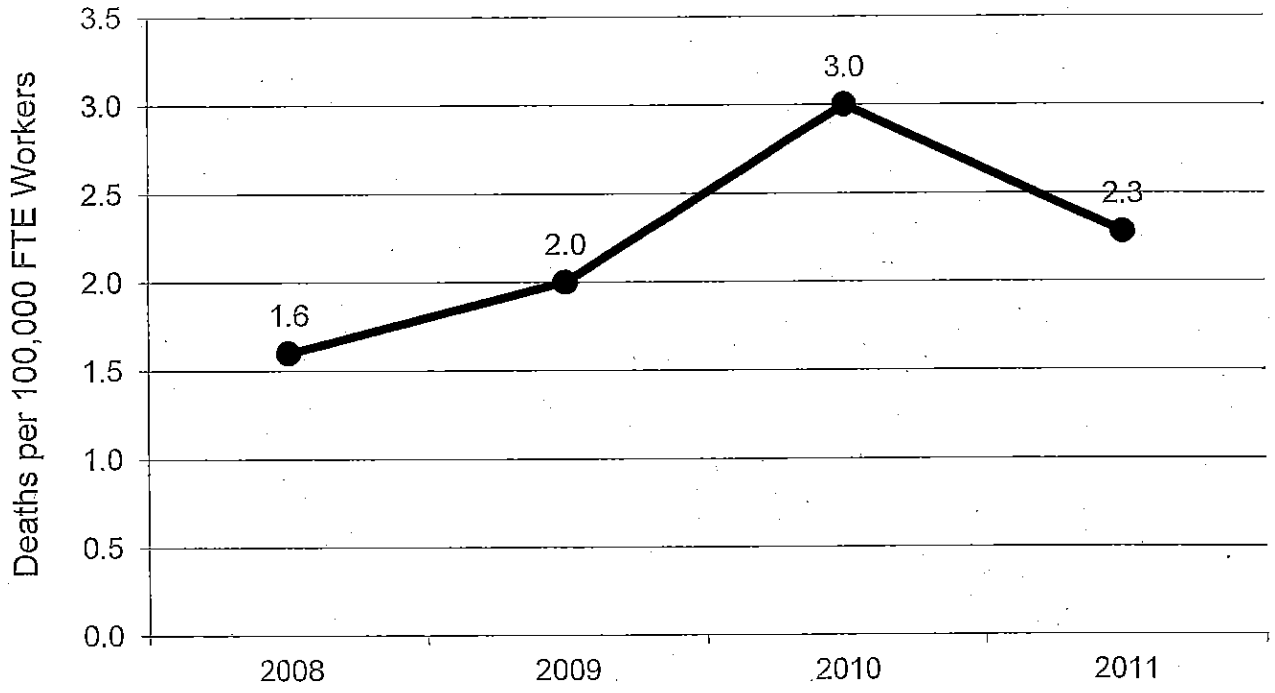
Proportion of Child Abuse or Neglect Victims by Age Group Connecticut, FY 2011



Source: US DHHS, Administration for Children and Families, Administration on Children, Youth, and Families, Children's Bureau, 2012. *Child Maltreatment 2011*
Note: Data are for unique cases

102

Mortality Rate for Work-related Injuries, Connecticut, 2008-2011



Source: Bureau of Labor Statistics, *Census of Fatal Occupational Injuries. Fatal Work Injury Rates. Connecticut*, 2008-2011.

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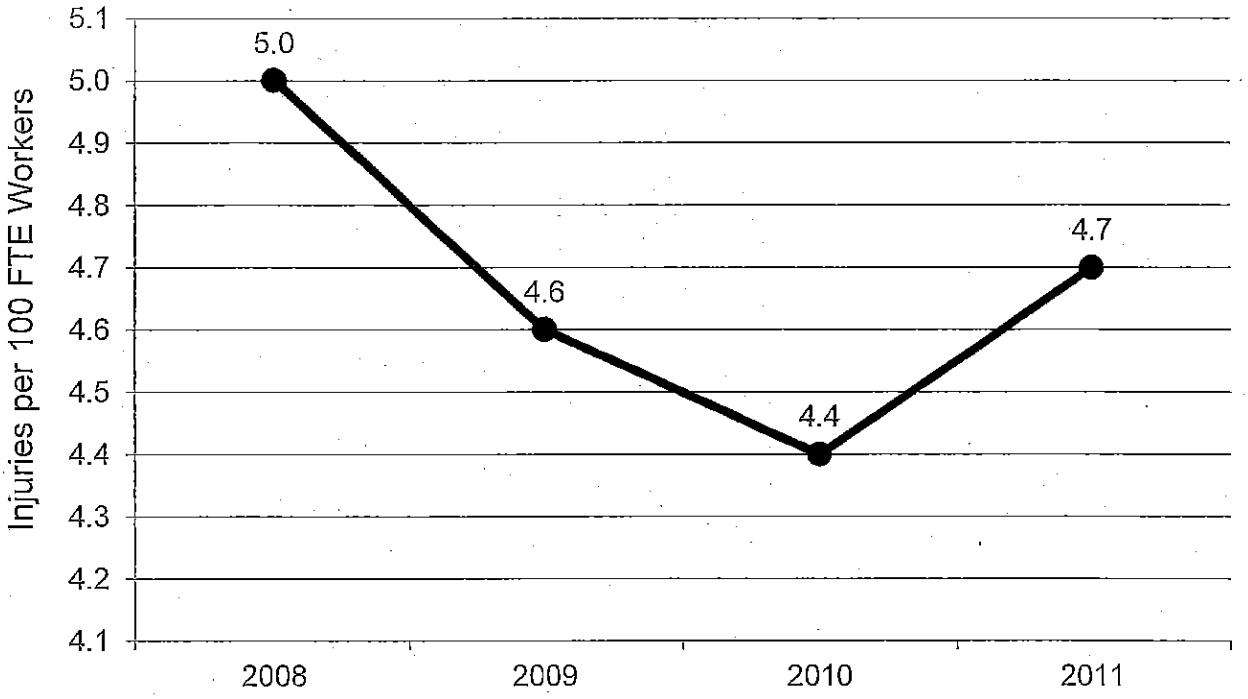
Incidence Rate for Work-related Injuries Connecticut, 2008-2011



Source: Bureau of Labor Statistics, Table 6,
Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, Connecticut, 2008-2011.

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INFECTIOUS DISEASE PREVENTION AND CONTROL

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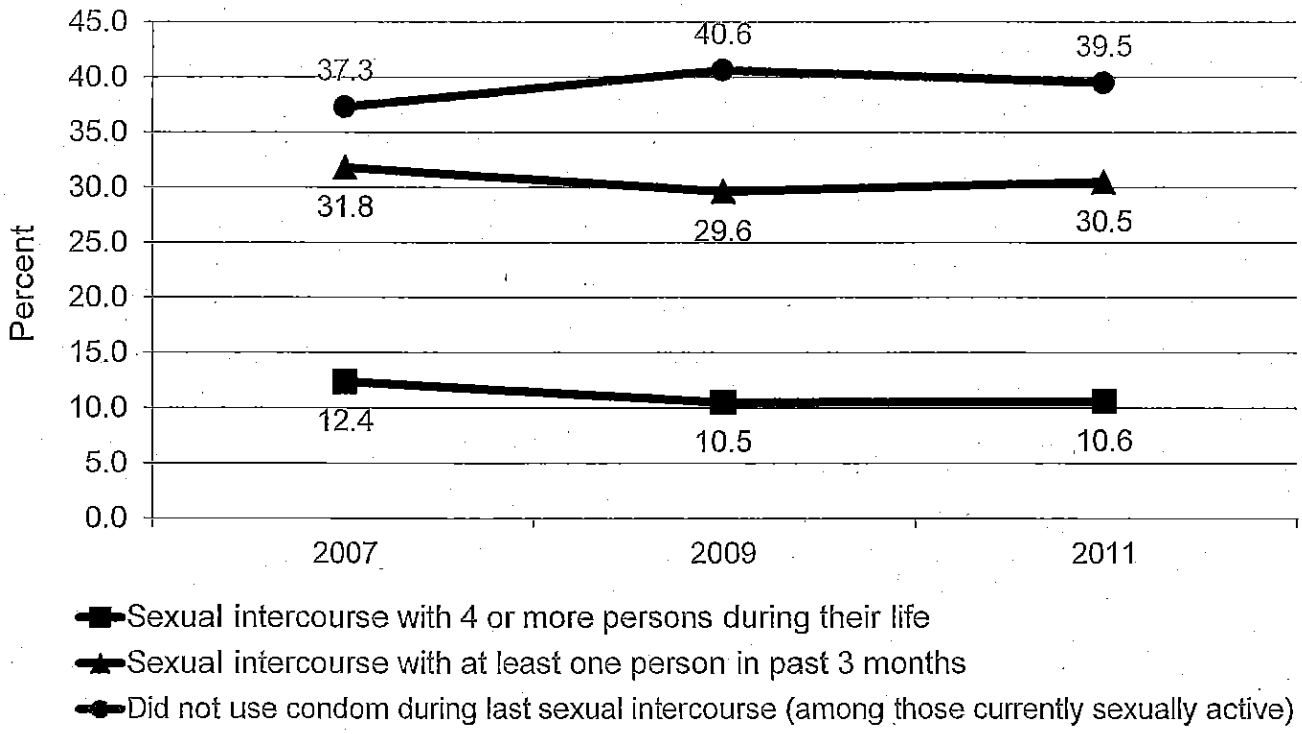
Prevalence of Sexual Risk Behaviors among Students in Grades 9-12 Connecticut, 2007-2011



Source: Connecticut Youth Risk Behavior Survey, 2005-2011.

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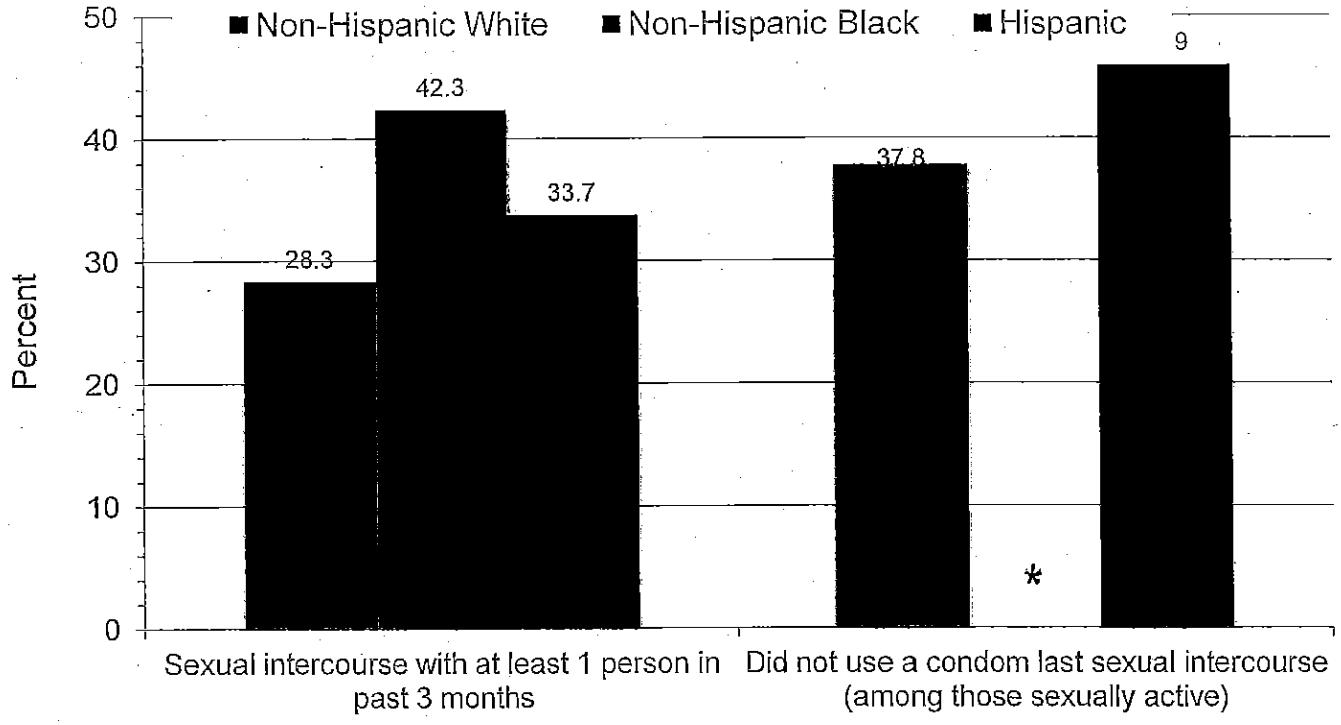
Prevalence of Sexual Risk Behaviors among Students in Grades 9-12, by Race/Ethnicity Connecticut, 2011



* Insufficient sample size for non-Hispanic blacks

Source: Connecticut Youth Risk Behavior Survey, 2011.

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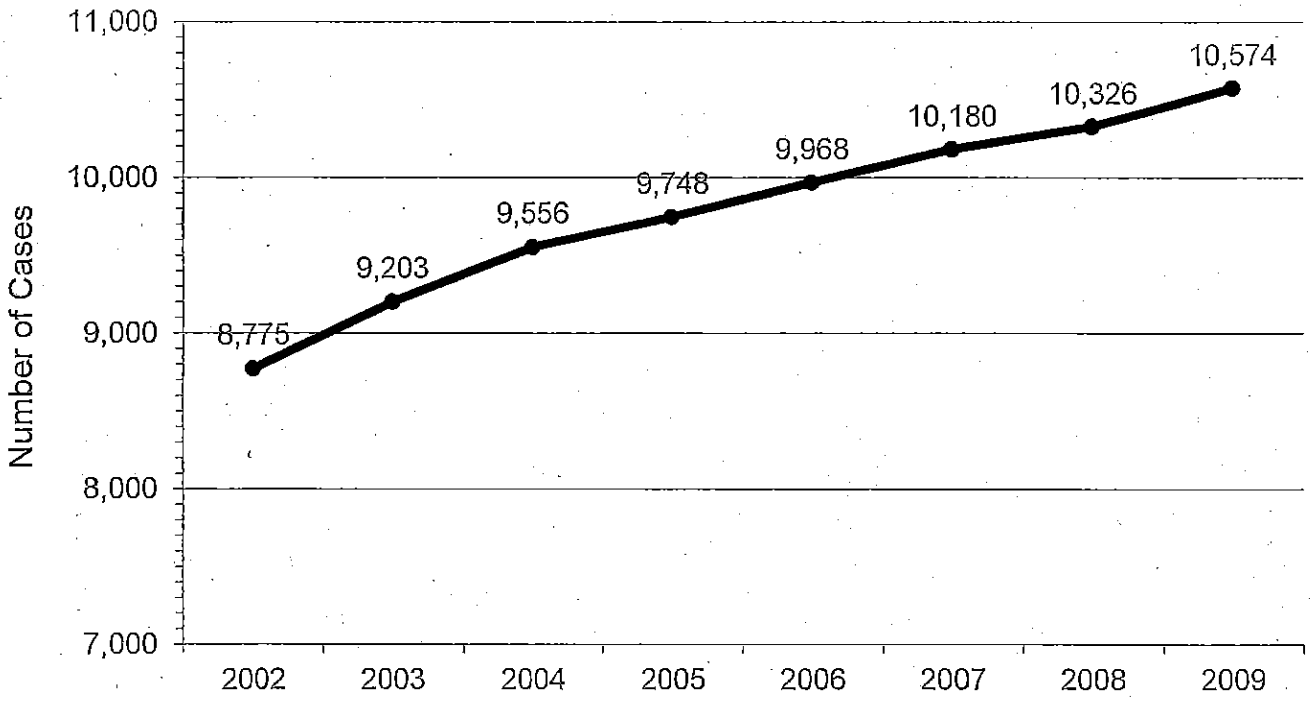
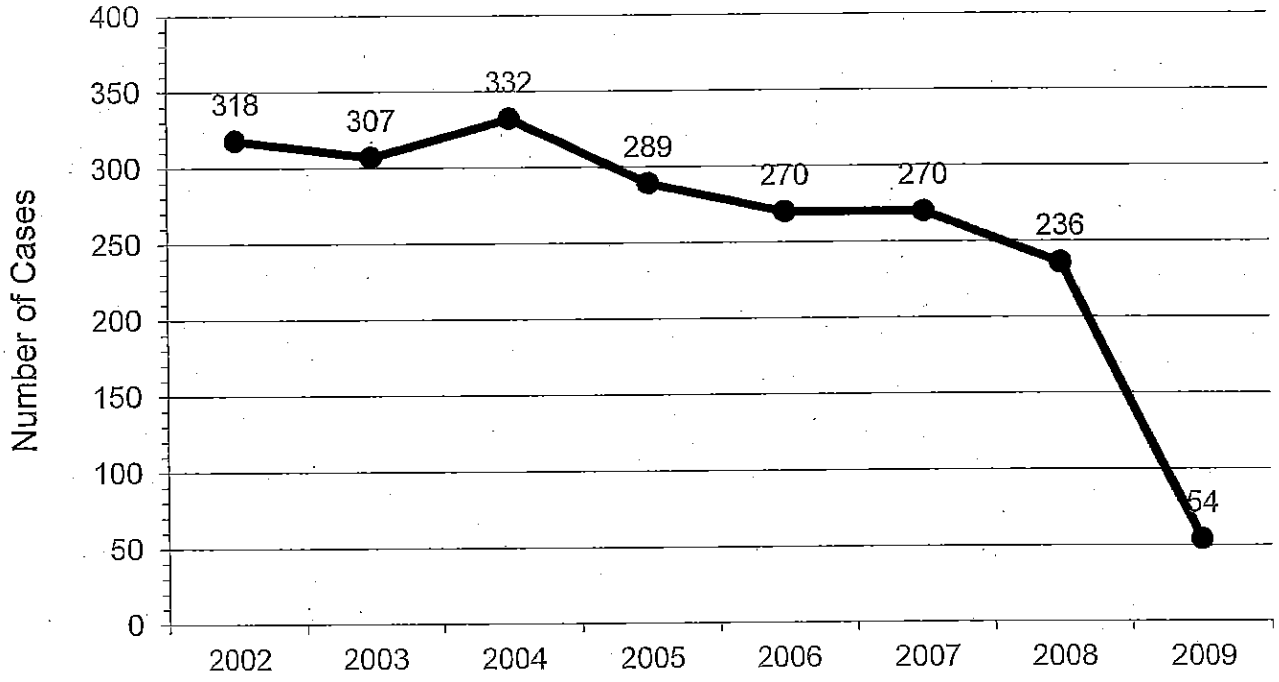
Number of People Living with HIV Connecticut, 2002-2009



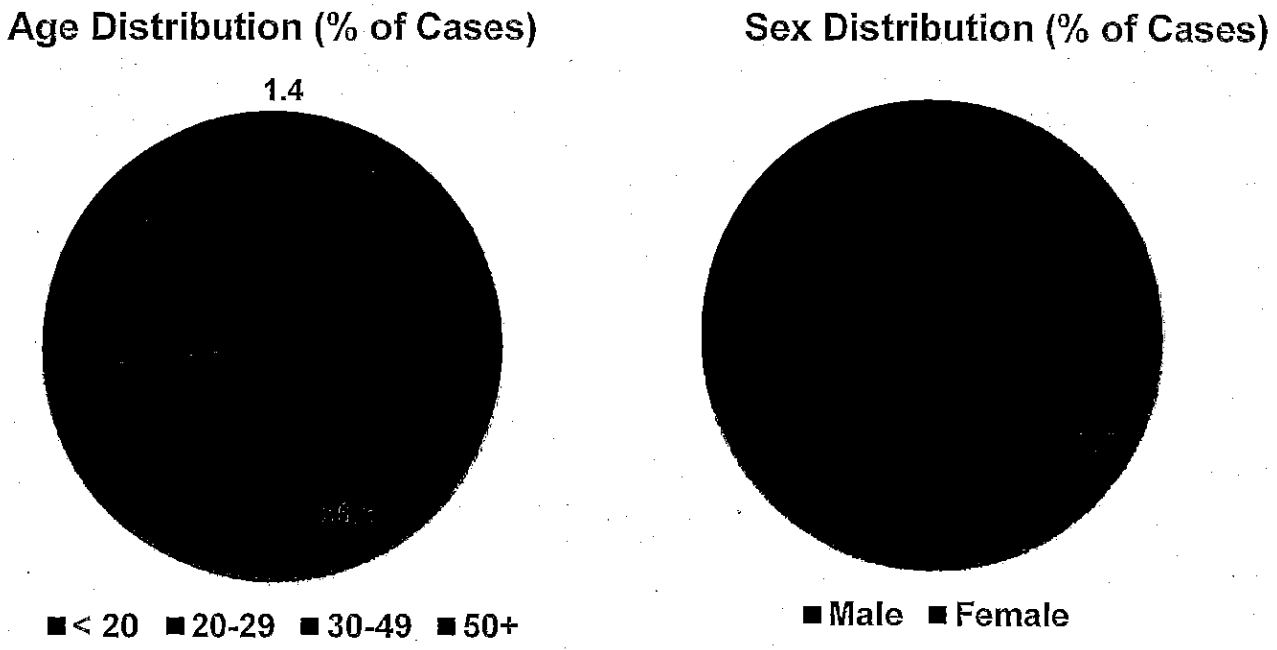
Source: Connecticut Department of Public Health AIDS and Chronic Diseases Section. *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Table 2.1.2.

Number of Deaths among People Known to be Living with HIV Connecticut, 2002-2009



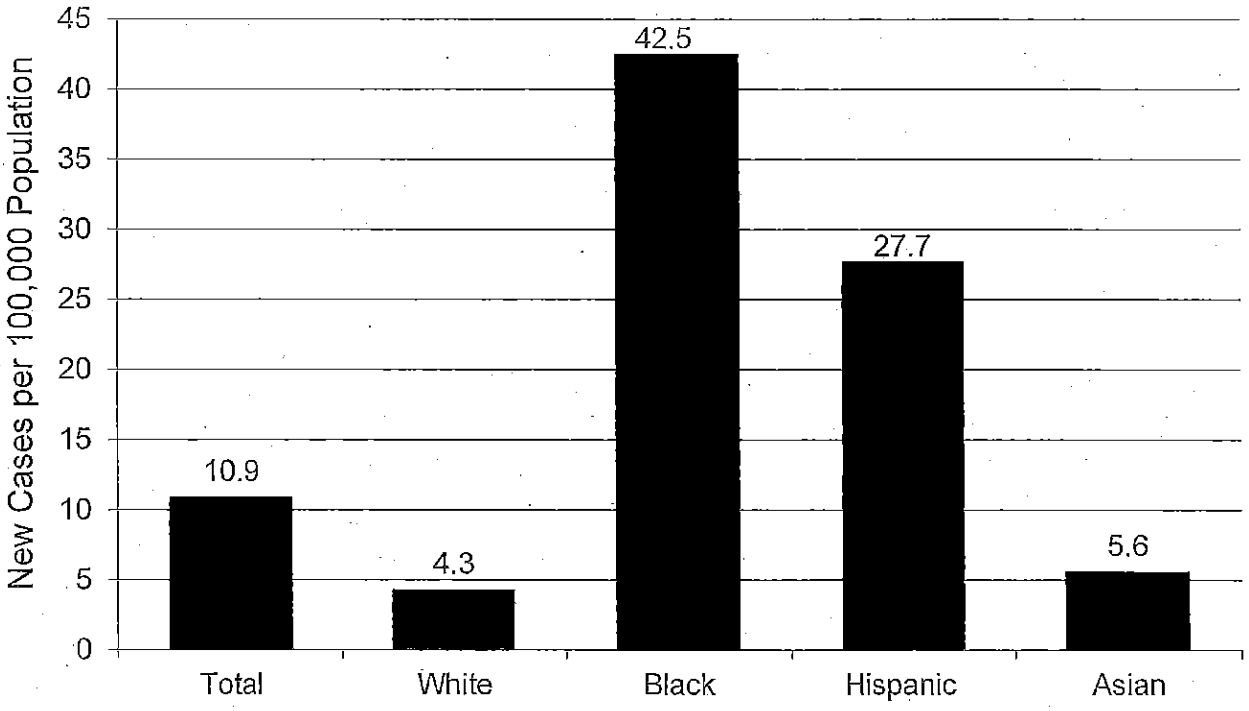
Source: Connecticut Department of Public Health AIDS and Chronic Diseases Section, *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Table 2.1.2.

Distribution by Age and Sex of New HIV/AIDS Cases Connecticut, 2005-2009



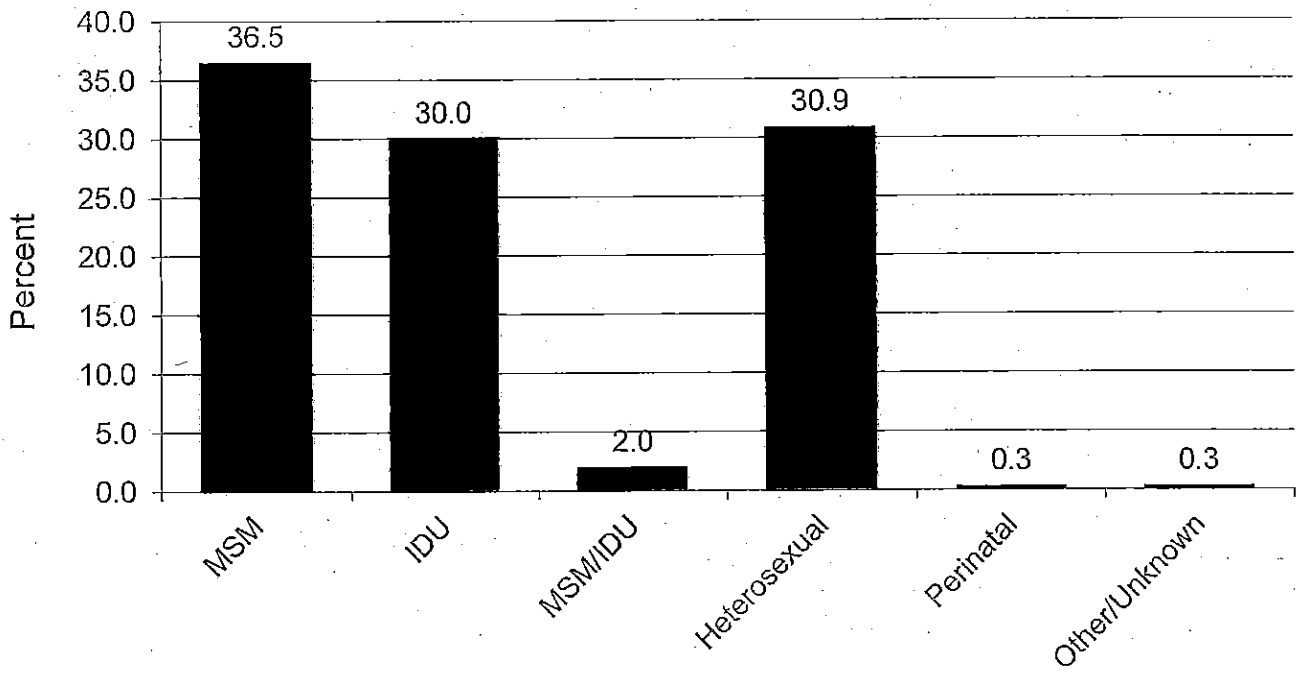
Source: Connecticut Department of Public Health AIDS and Chronic Diseases Section, *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Section 2.3.

Rate of New HIV/AIDS Cases by Race and Ethnicity Connecticut, 2008



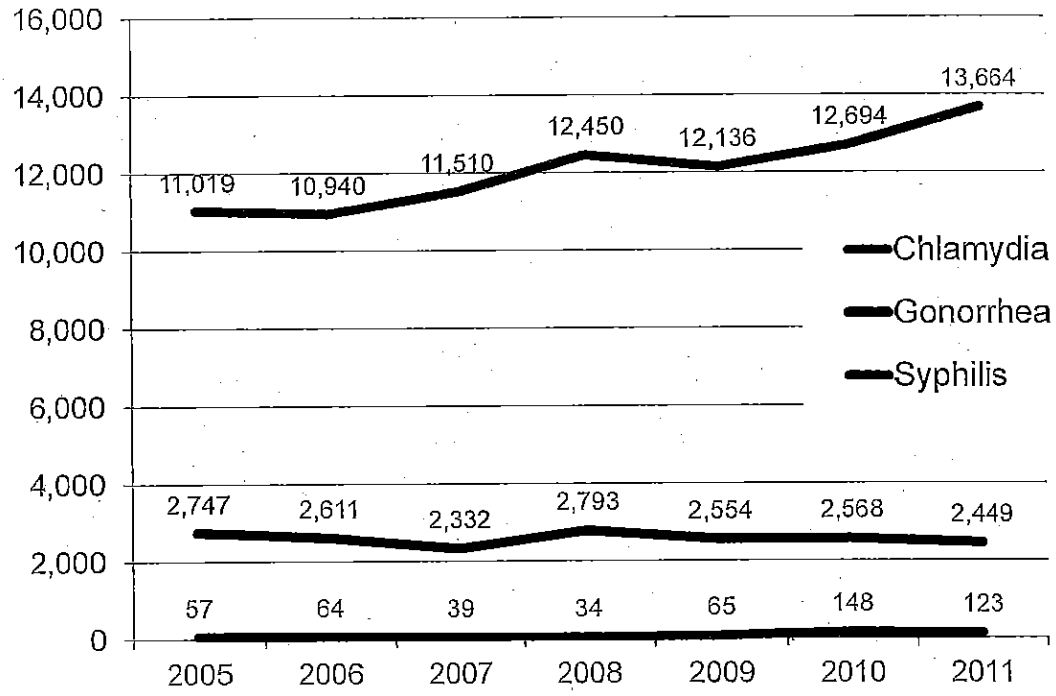
Source: Connecticut Department of Public Health
AIDS and Chronic Diseases Section, *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Table 2.4.1.

Percent of New HIV/AIDS Cases by Transmission Category Connecticut, 2005-2009



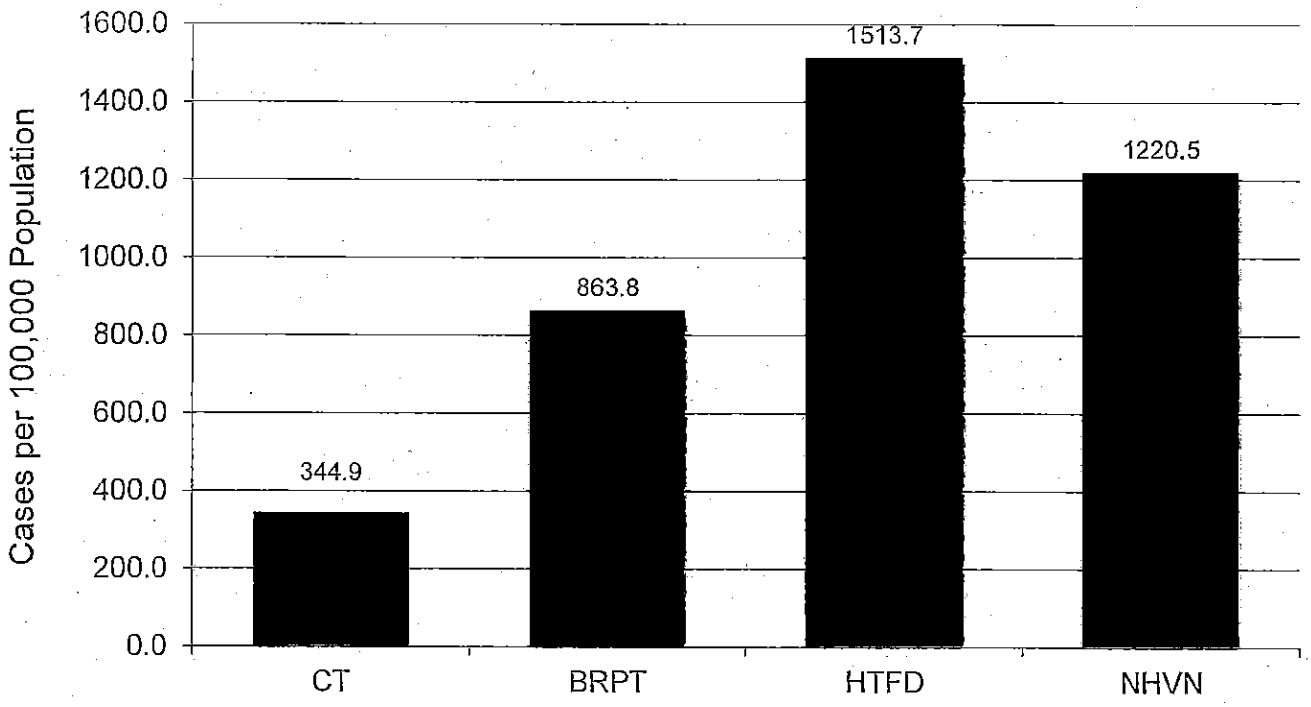
Source: Connecticut Department of Public Health
AIDS and Chronic Diseases Section, Epidemiologic Profile of HIV/AIDS in Connecticut, 2010, Table 2.3.2.

Numbers of New Cases of Chlamydia, Gonorrhea, and Syphilis Connecticut, 2005-2011



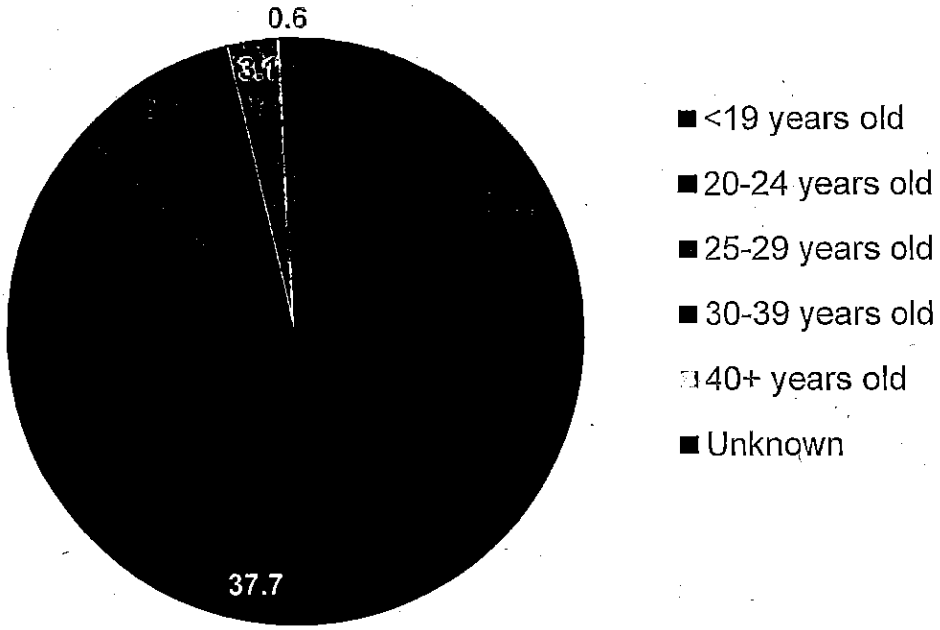
Source: Connecticut Department of Public Health AIDS and Chronic Diseases Section, Epidemiologic Profile of HIV/AIDS in Connecticut, 2010 (2005-2009 data) and Reported Cases of Disease by County, 2010 and 2011

Chlamydia Case Rates
Connecticut and Its Largest Towns, 2009



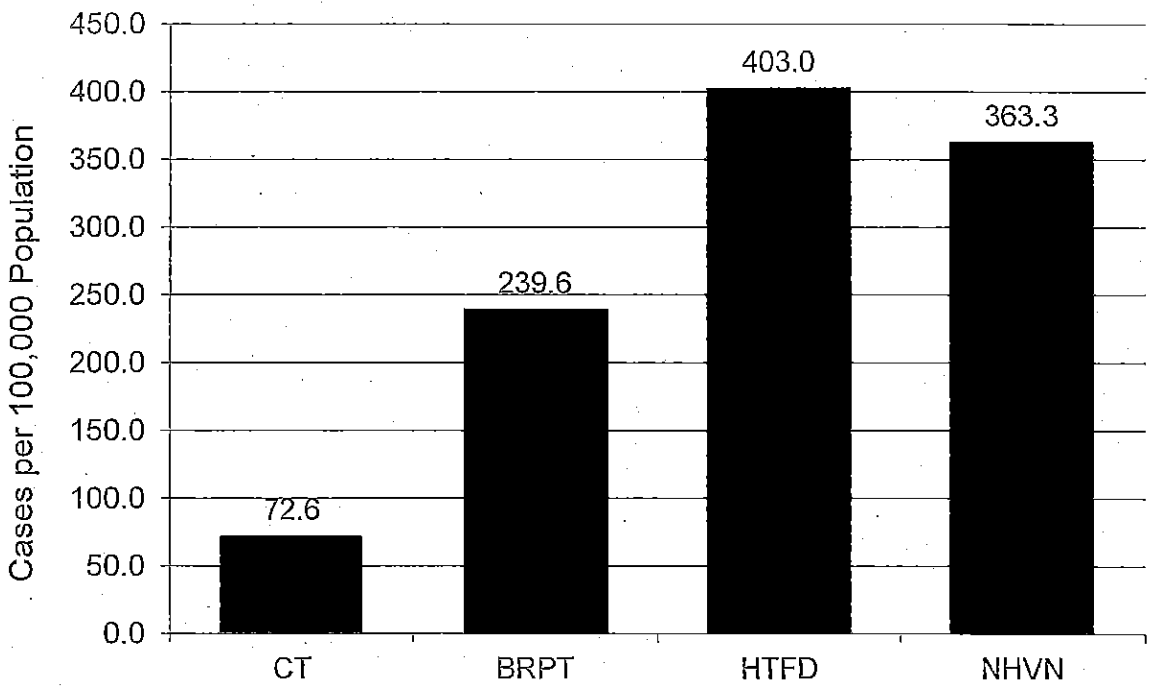
Source: Connecticut Department of Public Health
AIDS and Chronic Diseases Section, *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Table 5.2.

Percentage of Chlamydia Cases by Age Connecticut, 2009



Source: Connecticut Department of Public Health AIDS and Chronic Diseases Section, *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Table 5.3.

Gonorrhea Case Rates
Connecticut and Its Largest Towns, 2009



Source: Connecticut Department of Public Health
AIDS and Chronic Diseases Section, *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Table 5.1.1.

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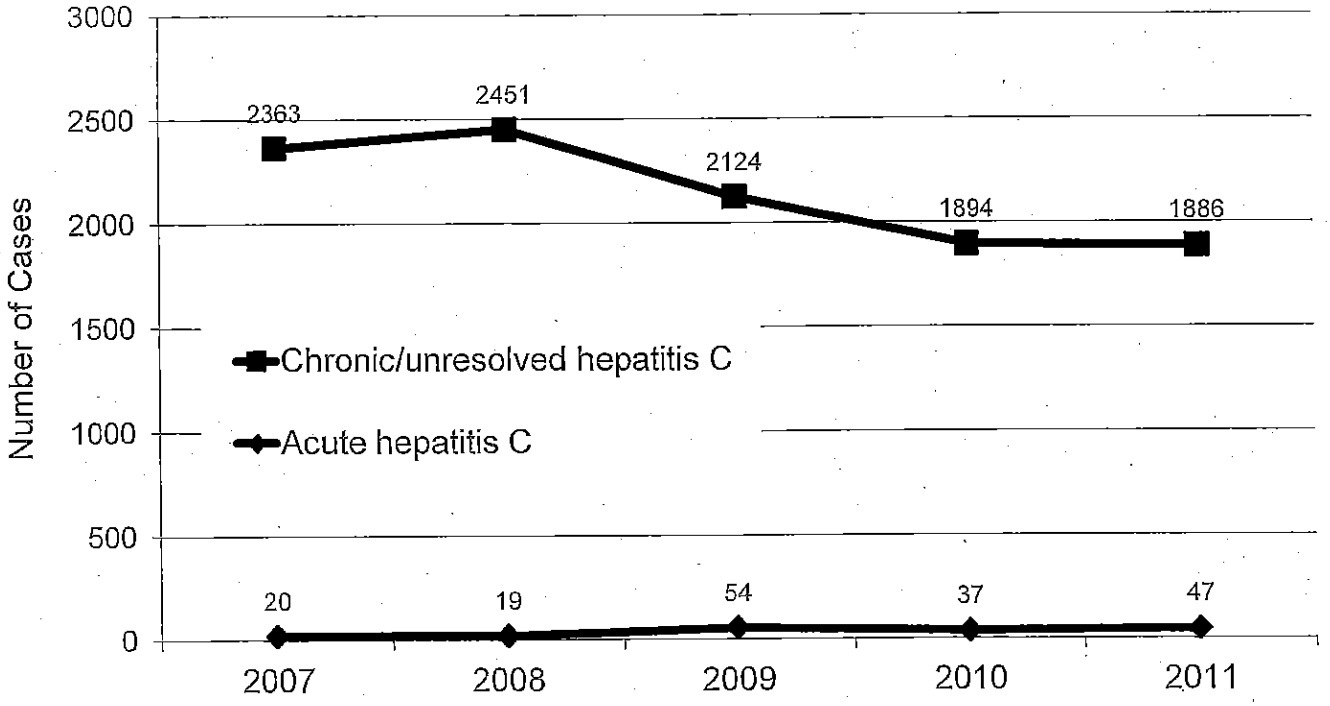
Numbers of Cases of Chronic/Unresolved and Acute Hepatitis C Connecticut, 2004-2009



Source: Connecticut Department of Public Health
Reported Cases of Disease by County, 2007-2011.

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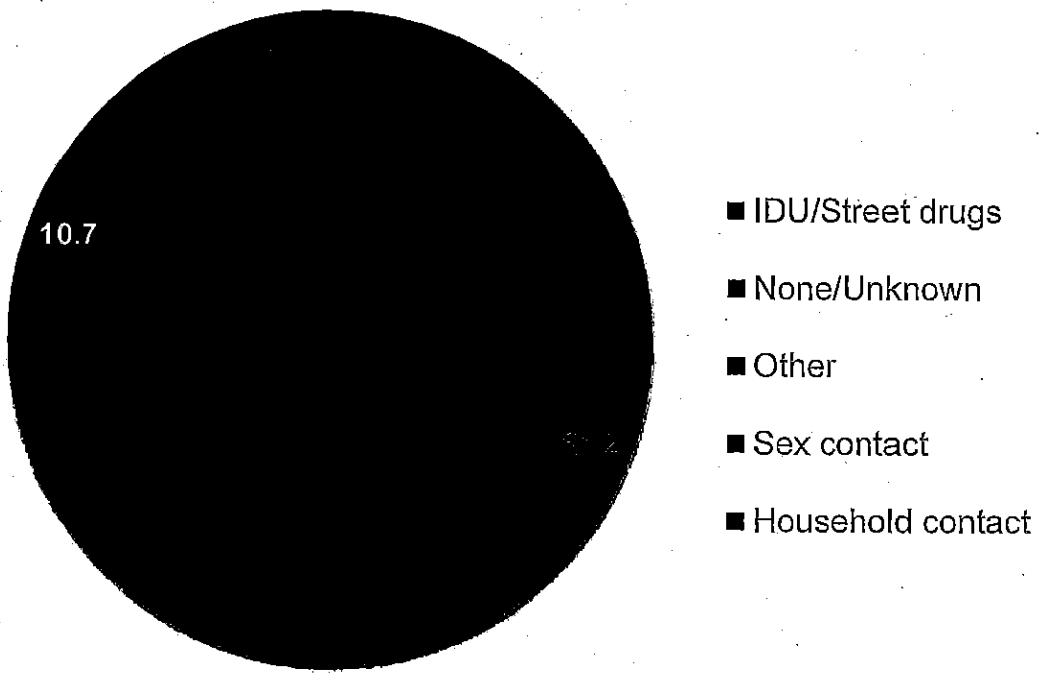
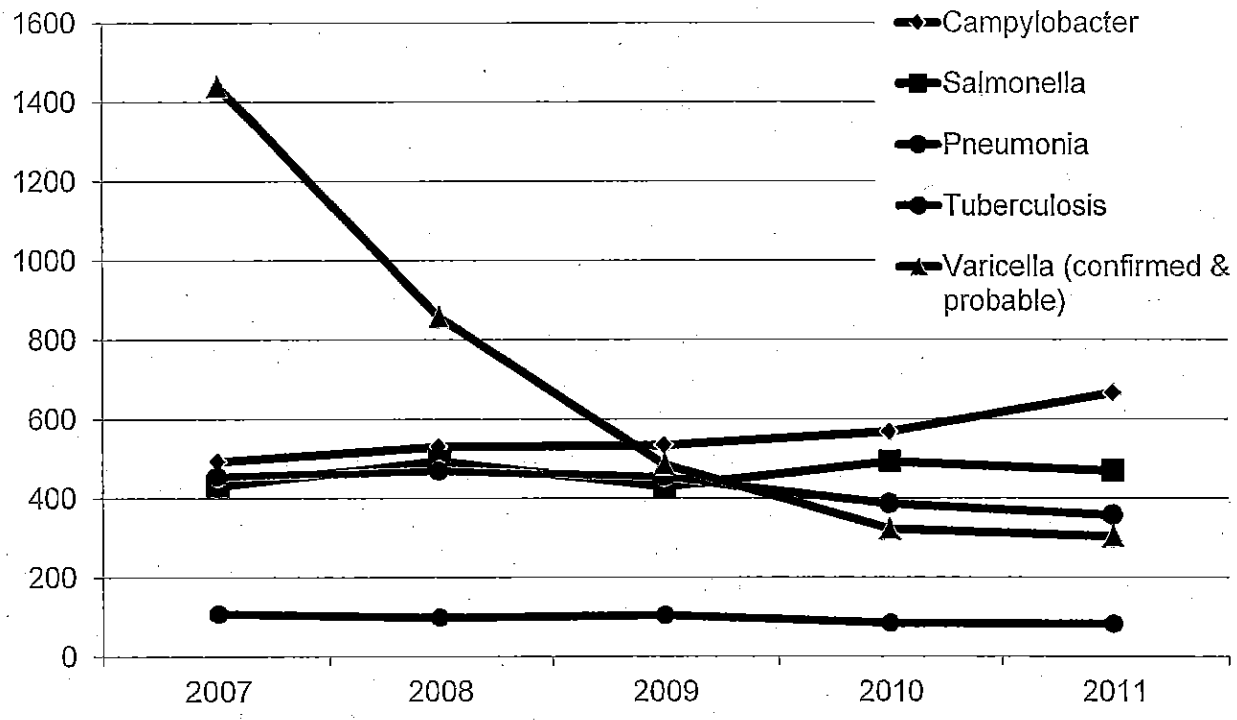
Percent of Persons Contracting Acute Hepatitis C by Transmission Method Connecticut, 2004-2009



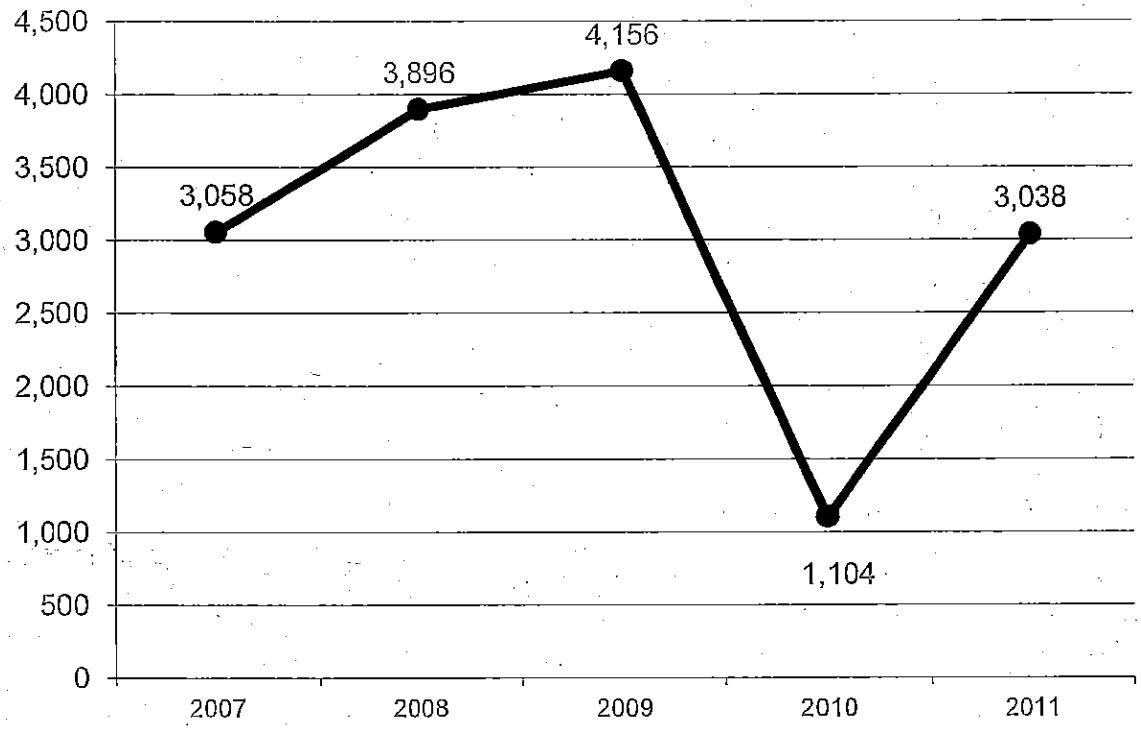
Source: Connecticut Department of Public Health AIDS and Chronic Diseases Section, *Epidemiologic Profile of HIV/AIDS in Connecticut*, 2010, Table 6.2.1.

Number of New Cases of Selected Reported Infections Connecticut, 2007-2011



Source: Connecticut Department of Public Health
Reported Cases of Disease by County, 2007-2011.

Number of New Cases (Confirmed and Probable) of Lyme Disease Connecticut, 2007-2011



Source: Connecticut Department of Public Health
Reported Cases of Disease by County, 2007-2011.

Select Healthcare-associated Infections, Connecticut, 2011-2012

Infection	Number
Central line associated bloodstream infection (CLABSI) July 2011- June 2012	67 central line infections
Methicillin-resistant *Staphylococcus aureus* (MRSA) (transmission site unknown), January – December 2011	925 cases

Source: Connecticut Department of Public Health, 2012 Connecticut Healthcare Associated Infections (HAIs) Hospital-specific Report ,and CT Department of Public Health, Reported Cases of Disease by County, 2011.

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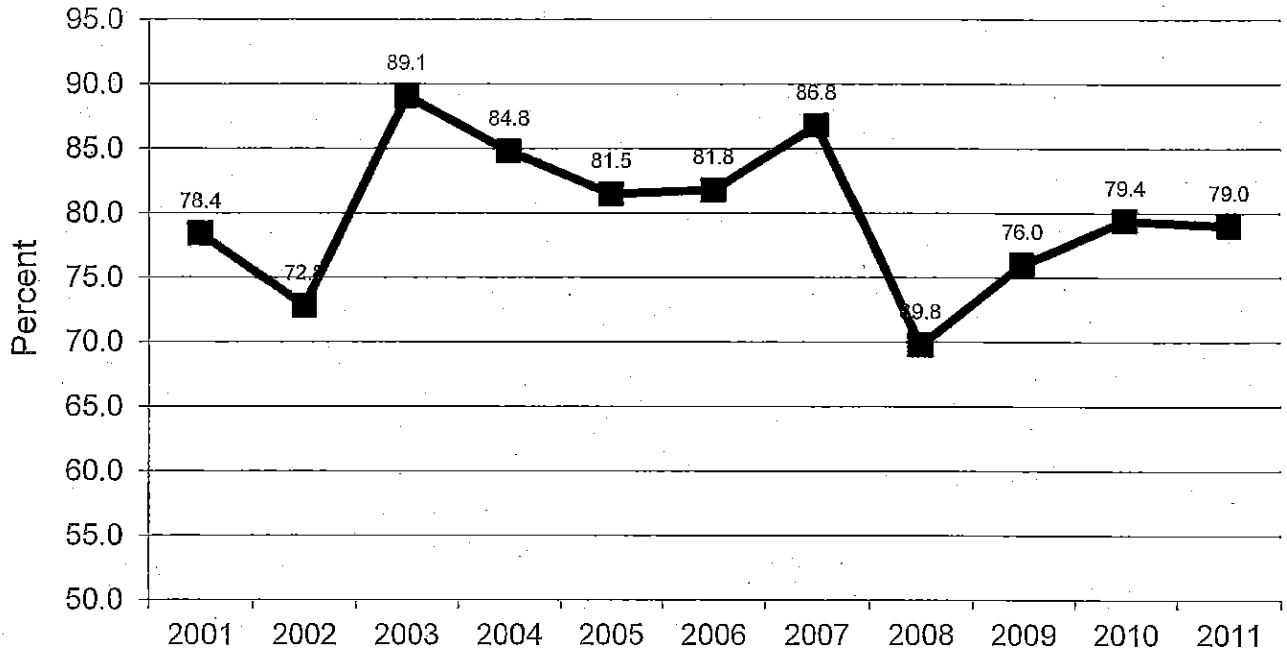
Percent of Children (19-35 Months of Age) Who Completed Vaccine Series Connecticut, 2001-2011



Source: Connecticut Department of Public Health, *Healthy Connecticut 2010 Final Report*; CDC, National Immunization Survey; Morbidity and Mortality Weekly Reports, *National, State, and Local Area Vaccination Coverage among Children Aged 19-35 Months, United States* – 2009-2011, Table 3.

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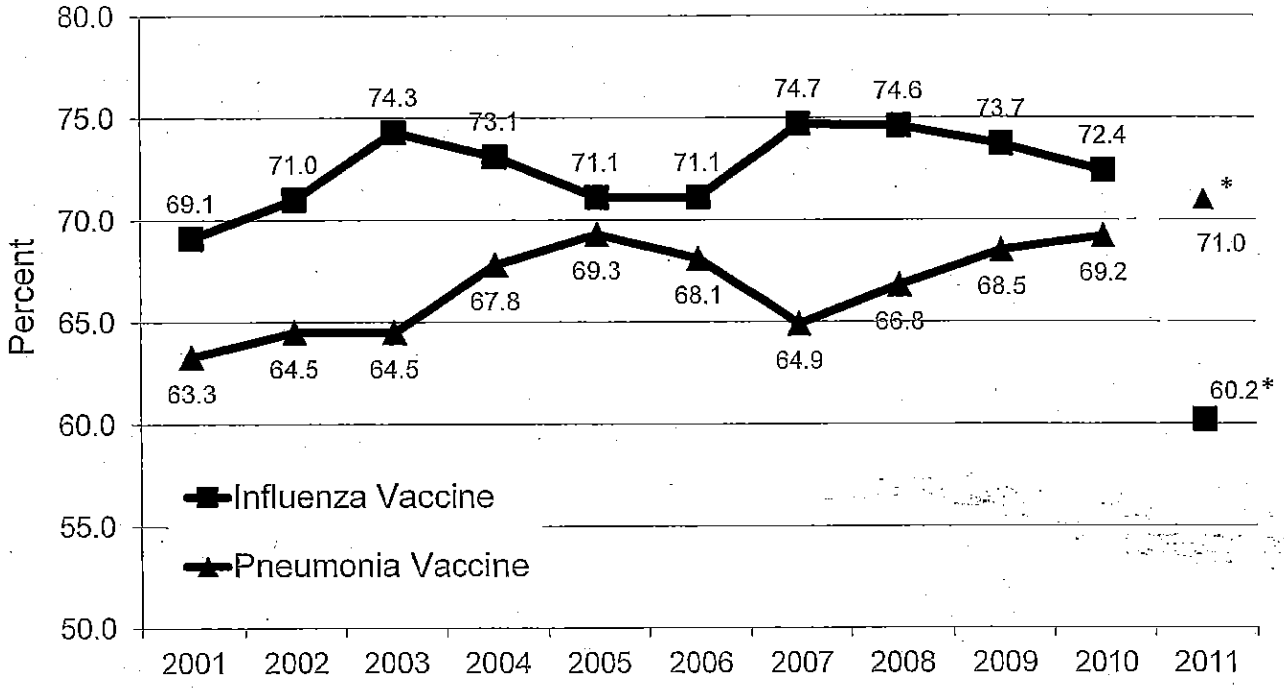
Percent of Adults 65+ Years of Age Who Received Flu Shot in Past Year and Ever Received Pneumonia Vaccine Connecticut, 2001-2011



* Break in trend due to new weighting in 2011

Source: Connecticut Behavioral Risk Factor Surveillance System, 2001-2011.

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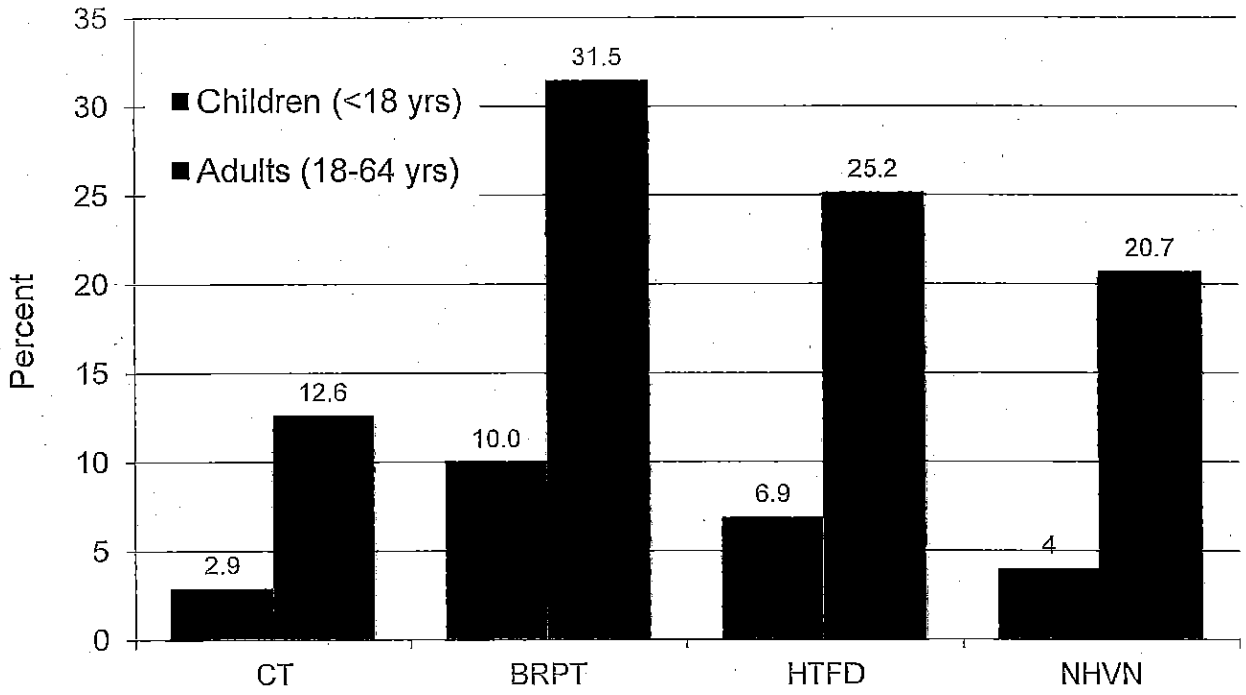
HEALTH SYSTEMS

Percent of Uninsured Children and Adults Connecticut and Its Largest Towns, 2011



Source: US Census Bureau, American Community Survey, 1-Year Estimates, 2011, DP03 File.

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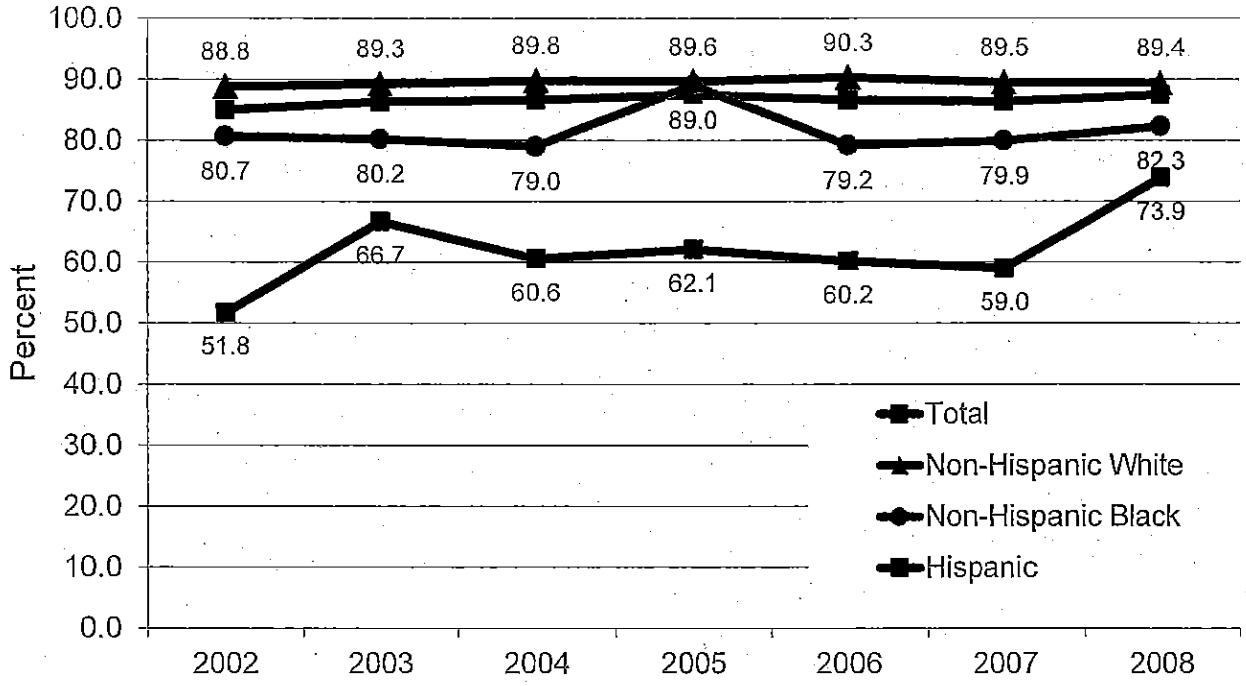
Adults (18+ Years of Age) with Specific Source of Ongoing Care by Race and Ethnicity Connecticut, 2002-2008



Source: Connecticut Department of Public Health, Healthy Connecticut 2010 Final Report, Connecticut Behavioral Risk Factor Surveillance System Core Questions Data Report, 2002-2008.

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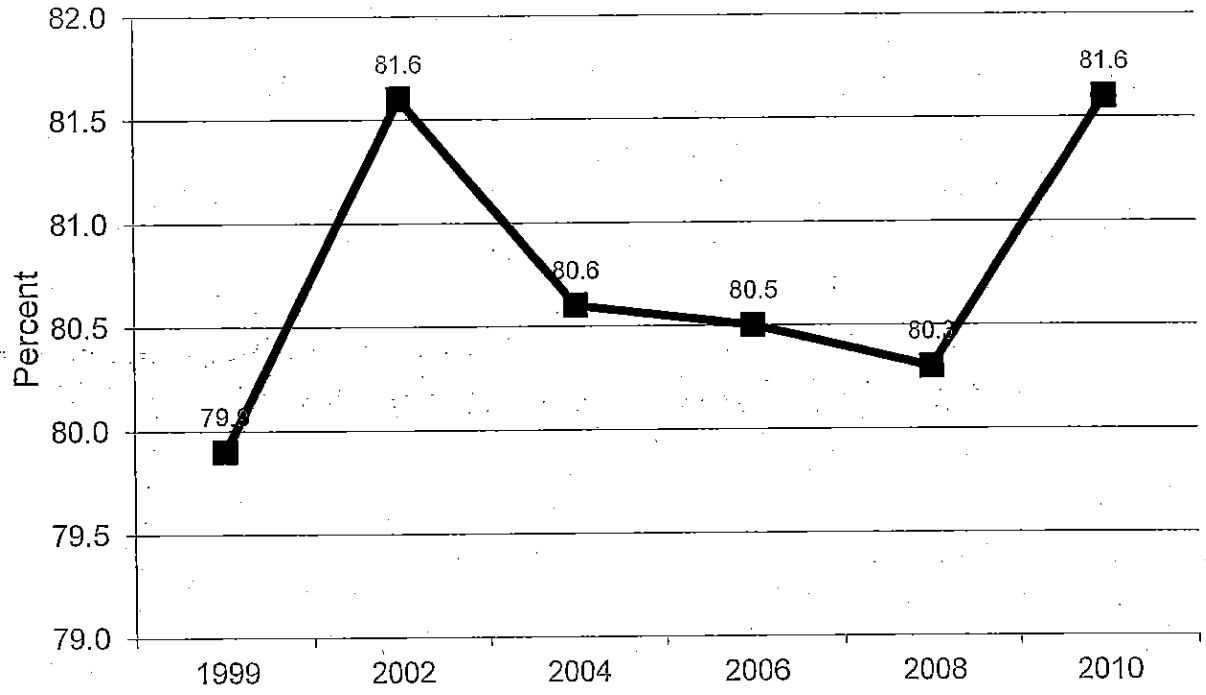
Percent of Adults Who Visited the Dentist in Past Year for Any Reason Connecticut, 1999-2010



Source: Connecticut Behavioral Risk Factor Surveillance System, 1999-2010.

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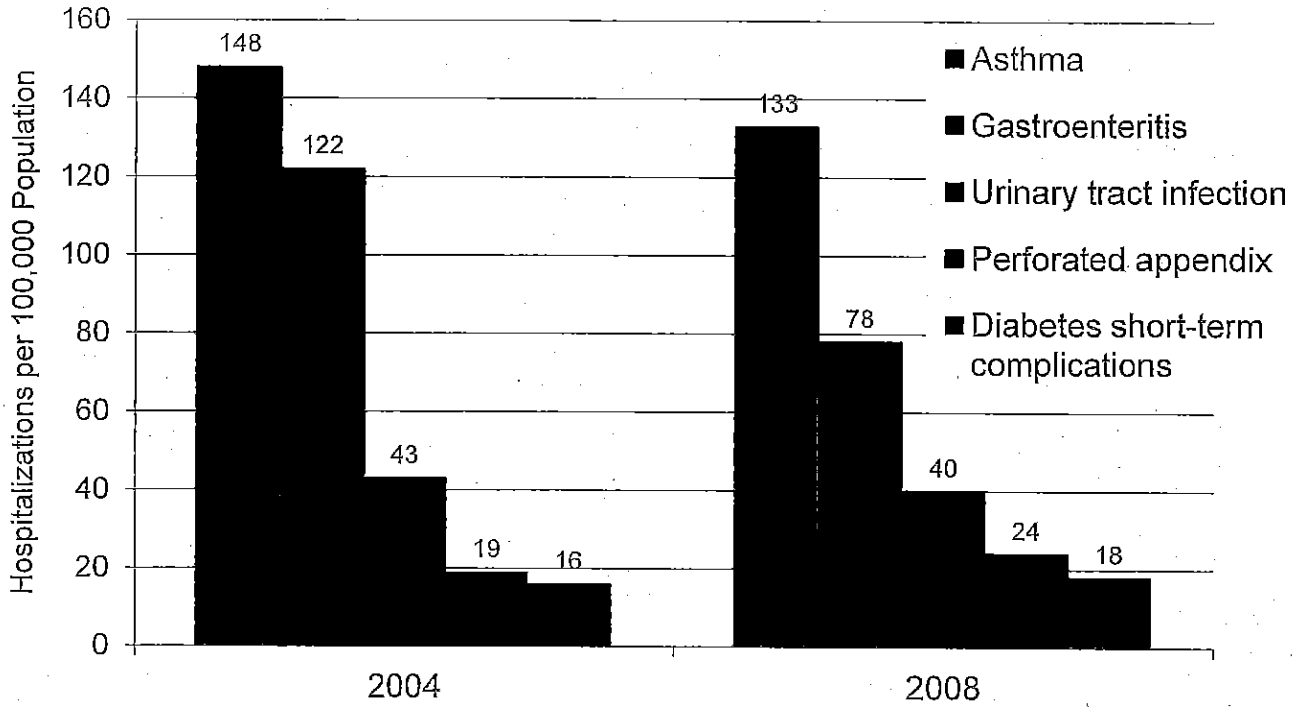
Pediatric Preventable Hospitalization Rates Connecticut, 2004 and 2008



Source: Connecticut Department of Public Health, OCHA, *Preventable Hospitalizations in Connecticut: A Current Assessment of Access to Community Health Services*, Table 1.

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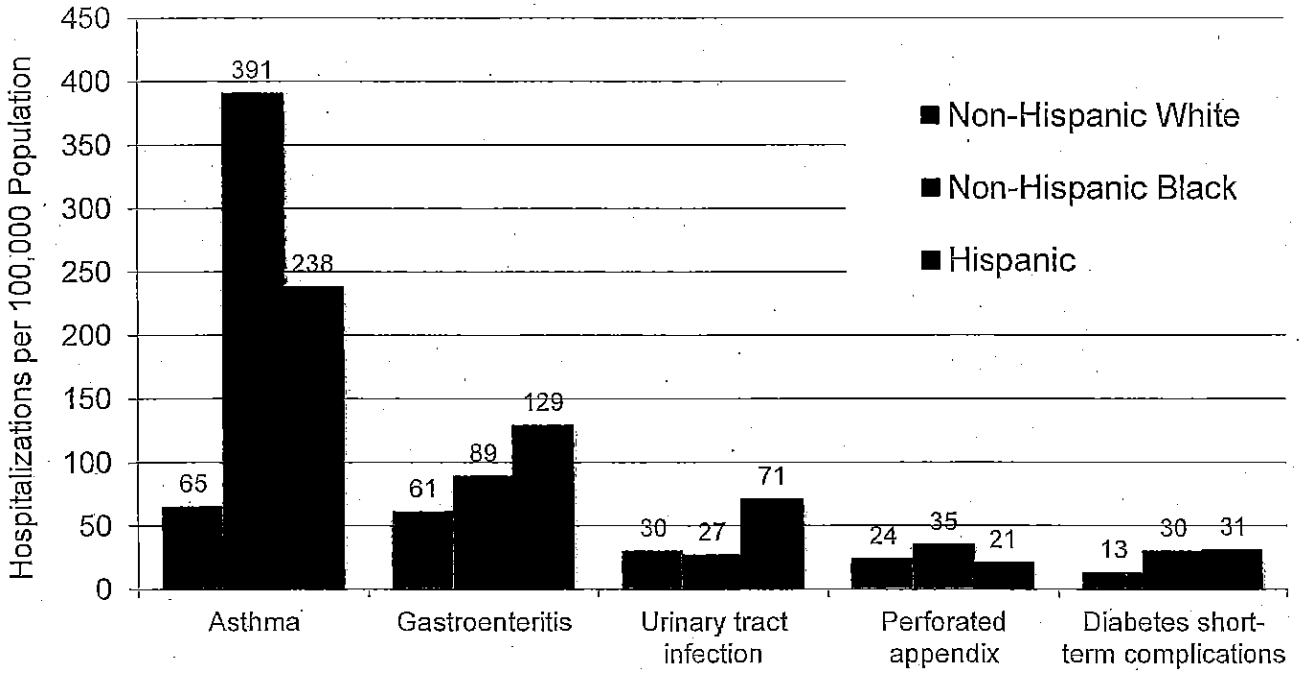
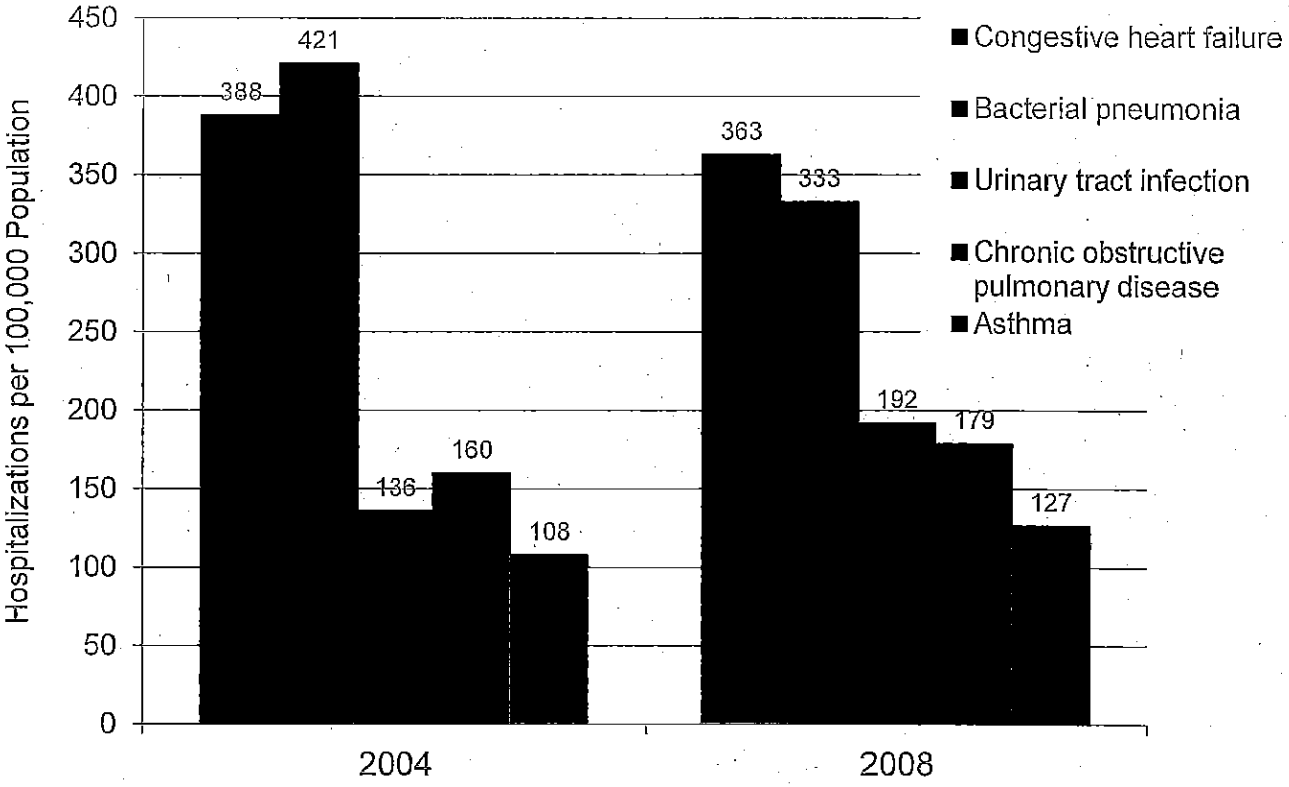
Pediatric Preventable Hospitalization Rates by Race and Ethnicity Connecticut, 2008



Source: Connecticut Department of Public Health, OCHA, *Preventable Hospitalizations in Connecticut: A Current Assessment of Access to Community Health Services*, Table 8.

Adult Preventable Hospitalizations Rates Connecticut, 2004 and 2008



Source: Connecticut Department of Public Health, OCHA, *Preventable Hospitalizations in Connecticut: A Current Assessment of Access to Community Health Services*, Table 1.

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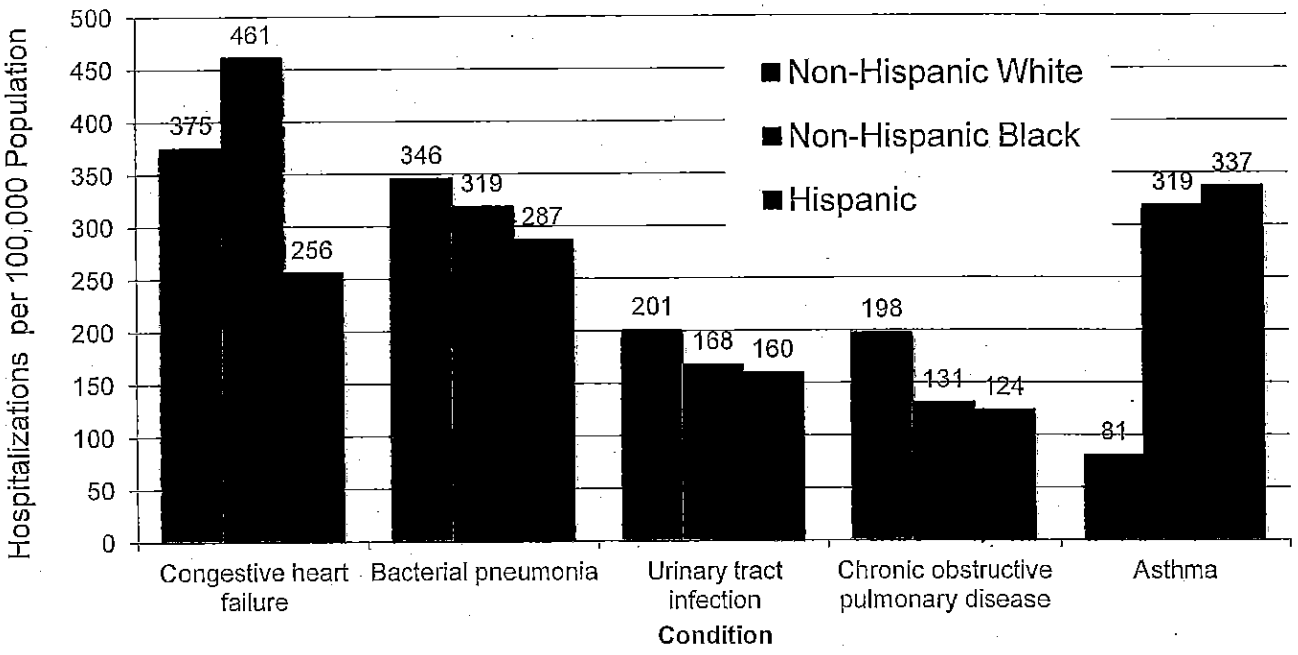
Adult Preventable Hospitalization Rates by Race/Ethnicity Connecticut, 2008



Source: Connecticut Department of Public Health, OCHA, *Preventable Hospitalizations in Connecticut: A Current Assessment of Access to Community Health Services*, Table 8.

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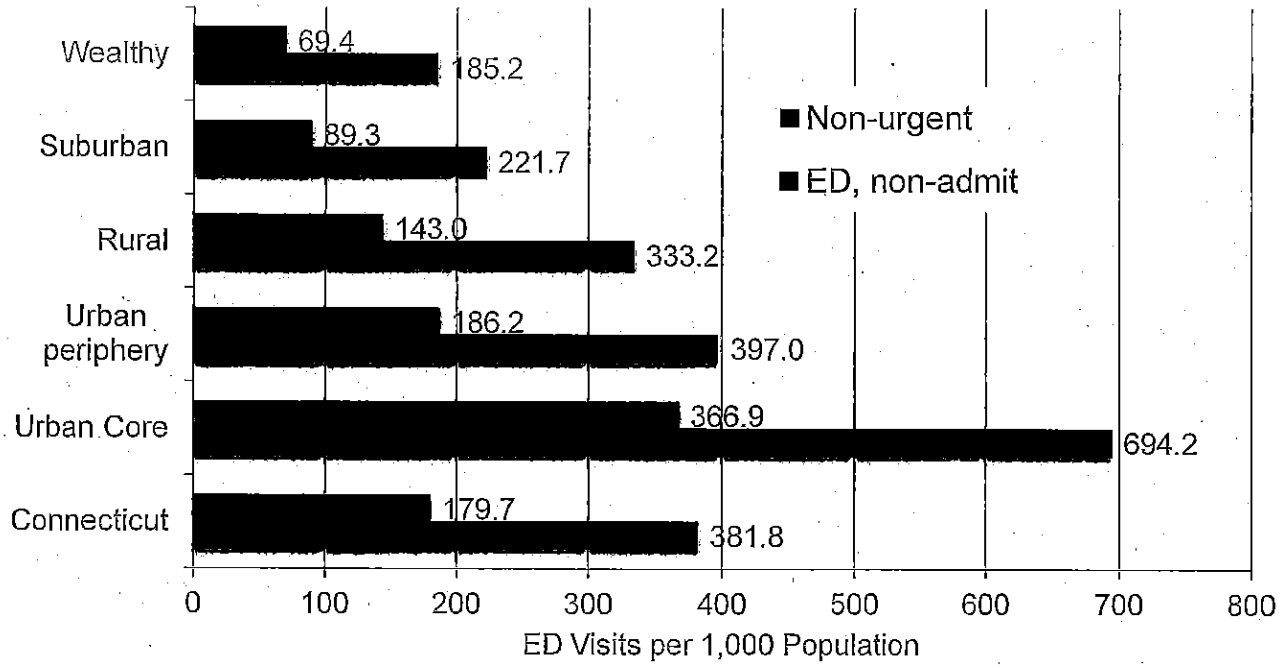
Rates of ED Non-urgent Visits and Non-admits for Connecticut and Towns in "The Five Connecticuts" * Town Groupings, FY 2009



* Groupings of towns based on socioeconomic factors (CT State Data Center.)

Source: Connecticut Department of Public Health, OCHA. 2010. *Profile in Emergency Department Visits Not Requiring Inpatient Admission to a Connecticut Acute Care Hospital Fiscal Year 2006-2009,* Chart 7.

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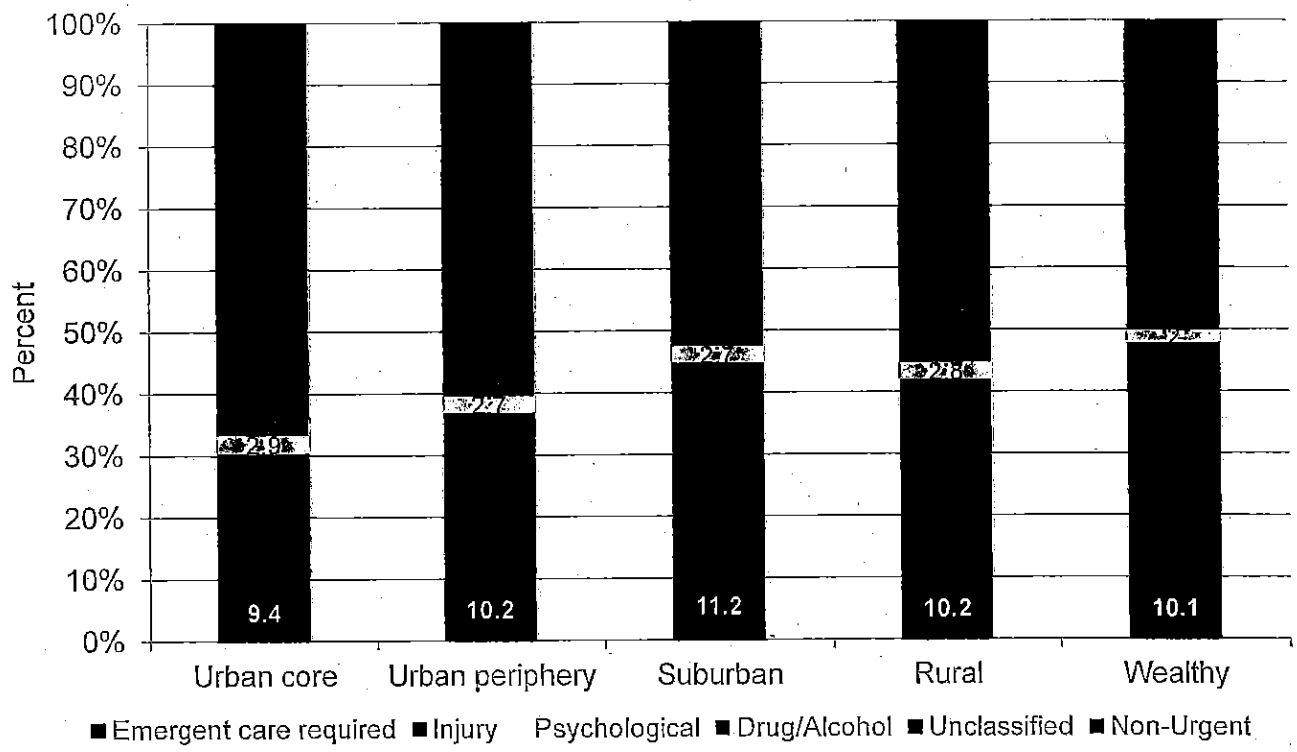
Percent of ED Non-admits by Visit Classification and "The Five Connecticuts" Town Groupings Connecticut, FY 2009



Source: Connecticut Department of Public Health, OCHA, Issue Brief December 2010, *Profile in Emergency Department Visits Not Requiring Inpatient Admission to a Connecticut Acute Care Hospital Fiscal Year 2006-2009,* Chart 8.

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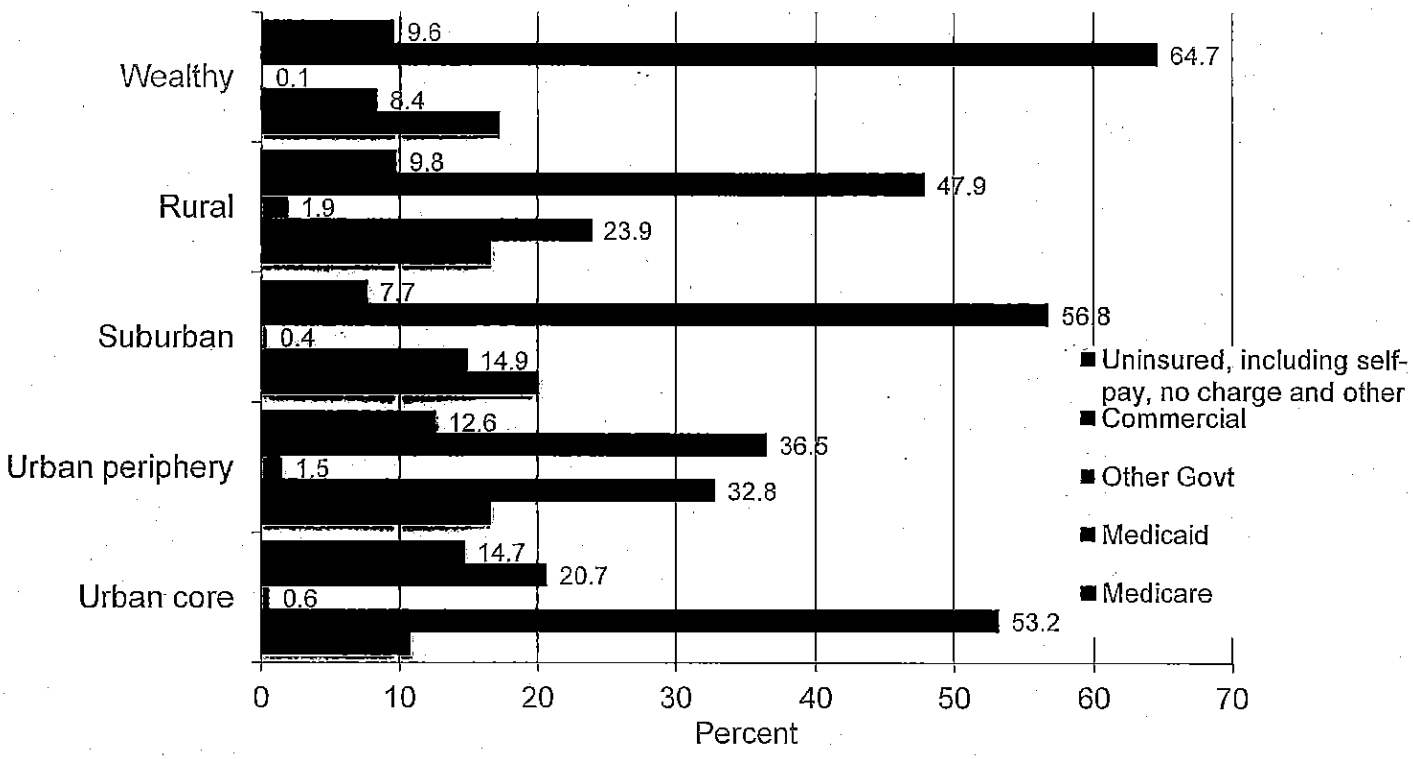
Percent of ED Non-admits by Payer Type for Towns in "The Five Connecticuts" Town Groupings Connecticut, FY 2009



Source: Connecticut Department of Public Health, OCHA, Issue Brief December 2010, *Profile in Emergency Department Visits Not Requiring Inpatient Admission to a Connecticut Acute Care. Hospital Fiscal Year 2006-2009,* Chart 10.

Connecticut Department of Public Health
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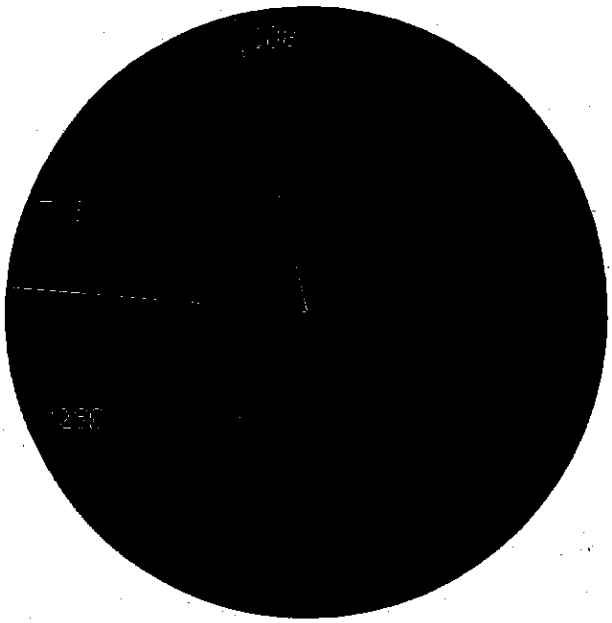
Supply of Primary Care Practitioners Connecticut, 2012

Primary care practitioner type	Number with current license	Ratio per 100,000 population
Physicians (MD and DO)	7,302	204.3
Licensed nurse midwives	217	6.1
Advanced practice registered nurses	3,664	102.5
Physician assistants	1867	52.2
TOTAL	13,050	365.1

Source: CT Department of Public Health, Office of Health Care Access, Statewide Health Care Facilities and Services Plan, October 2012, Chapter 9, Table 9.1. (Rate calculated)

Number of Primary Care Physicians by Type Connecticut, 2012



- Internal medicine
- Pediatrics
- Ob/gyn
- Family practice
- Naturopathic physicians & homeopathic medicine

Source: CT Department of Public Health, Office of Health Care Access, Statewide Health Care Facilities and Services Plan, October 2012, Chapter 9, Table 9.1.

Medically Underserved Areas or Populations (MUA/P) and Health Professional Shortage Areas (HPSA) Connecticut, April, 2012

County	Number of MUA/P Designations	Number of HPSA Designations		
		Dental	Primary Care	Mental Health
Fairfield	6	8	9	7
Hartford	7	10	9	4
Litchfield	1	2	2	2
Middlesex	1	3	1	1
New Haven	8	7	8	6
New London	3	4	3	3
Tolland	1	2	2	1
Windham	2	3	3	2
Tribal Nation	*	1	2	1
Connecticut	29	40	39	27

*Tribal nations have their own special designation.

Source: CT Department of Public Health, Office of Health Care Access, Statewide Health Care Facilities and Services Plan, October 2012, Chapter 9, Table 9.2.

Conclusions

- Racial/ethnic minority groups suffer from many conditions at disproportionately higher rates.
- Trends over time show differing patterns; however, few conditions experienced recent stark increases.
- Specific age groups such as youth/young adults and older adults are more at-risk for certain conditions.
- Chronic diseases and injuries are leading causes of premature death and morbidity.
- Yet, opportunities exist to address modifiable risk factors and preventable diseases and conditions.

Connecticut Comprehensive Cancer Control PLAN 2005-2008

Connecticut
CANCER
Partnership

The Power of Unity

Connecticut Comprehensive Cancer Control PLAN 2005-2008

Connecticut CANCER Partnership

The Power of Unity

CONNECTICUT COMPREHENSIVE CANCER CONTROL PLAN
2005-2008

An electronic version of this Plan is available on the Internet at www.CTCancerPartnership.org

2005

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PREFACE

The *Connecticut Comprehensive Cancer Control Plan, 2005-2008* is the product of the knowledge commitment, and collaboration of more than 100 members of the Connecticut Cancer Partnership. The Partnership's Core Committee directed the entire planning process--defining and creating subcommittees and work groups, guiding assessment and evaluation, and growing the Partnership. The individuals named below were members of the Core Committee throughout or at any stage of the Plan's development.

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ACKNOWLEDGEMENTS

The Connecticut Cancer Partnership's Core Committee gratefully acknowledges the valuable contributions of many other individuals to the development of the Plan.

Members of the Partnership's priority area planning committees dedicated countless hours to researching and assessing needs, developing goals and objectives, setting targets, and creating strategies for achieving objectives. Their names are listed at the beginning of the sections on Prevention, Early Detection, Treatment, Survivorship, and Palliative and Hospice Care.

Anita Ruff, Maine Comprehensive Cancer Control Coordinator, and Polly Hager, Michigan Public Health Institute Cancer Control Services Project provided formative advice that set us on solid track.

Federico Amadeo, Chris Andreson, Diane Aye, Renée Coleman-Mitchell, Meg Hooper, Margaret Hynes, Jon Olsen, Anil Shah, and Carol Stone of the Connecticut Department of Public Health, and Mary Adams of On Target Health Data provided data and analysis and reviewed the manuscript for the Plan as it evolved.

Susan Dombroski of the American Cancer Society, New England Division, Charlene Gross and Mattie Adgers of the Connecticut Department of Public Health, and Barbara Lumpkin of the Cancer Information Service of New England provided administrative support.

CONTENTS

1. The Connecticut Cancer Partnership

THE CONNECTICUT CANCER PARTNERSHIP

OVERALL GOAL OF THE CONNECTICUT CANCER PARTNERSHIP

To reduce the burden of cancer (incidence, morbidity, mortality, and disability) and to improve the quality of life of people with cancer in Connecticut

INTRODUCTION

The face of cancer in Connecticut is changing. More people are adopting healthy practices that reduce their risk of developing cancer and help ensure that new cancers are detected early, when they are the most treatable. The overall rate of new cancer cases in Connecticut has stabilized, and the death rate has been decreasing, due in large part to earlier detection and improved treatments.

Still, each year about 18,000 new cases of cancer are diagnosed and 7,000 Connecticut residents die of cancer. Four types of cancer (lung, colorectal, breast, and prostate) account for more than half of both total new cancers and total cancer deaths in Connecticut, and many of these could be prevented by lifestyle modification (e.g., smoking cessation, changes in diet), or by early detection through screenings (e.g., colonoscopy/sigmoidoscopy, mammography) with timely follow-up and treatment.

The prominence of cancer in the health of Connecticut residents is not likely to change; indeed, as our population ages, numbers of new cancer cases and deaths likely will increase, as will the number of cancer survivors; some cancers have become largely curable, whereas others are now manageable chronic diseases, thanks to early diagnosis and more effective treatments. While it is not yet possible to eradicate cancer, strategies can be developed to prevent or delay the onset of many cancers and to reduce or eliminate the outcomes of the disease--suffering and death. Much work is still needed in all areas of the continuum of cancer care--prevention, early detection, treatment, survivorship, and palliative and hospice care.

In 1998 the U.S. Centers for Disease Control and Prevention (CDC) created a model program for Comprehensive Cancer Control, and began to fund planning for state programs. Comprehensive cancer control is aimed at delivering public health messages and services related to cancer more efficiently. It integrates and coordinates existing programs focused on specific cancer sites or risk factors with one another and with health education, health promotion, and outreach activities, to maximize use of available resources.

The Connecticut Cancer Partnership was created to develop a statewide comprehensive cancer program--to assess the burden of cancer, set priorities, and formulate and carry out a comprehensive cancer control plan for our state.

SELECTED HIGHLIGHTS OF CANCER CONTROL IN CONNECTICUT

Connecticut has some of the best resources in the nation for documenting cancer and its risk factors among state residents, along with a rich history of research, development and implementation of successful cancer prevention and control programs. Some highlights of the cancer control resources and achievements in Connecticut are noted below.

Resources

- The Connecticut Tumor Registry, located at the Connecticut Department of Public Health (DPH), is the oldest of its kind in the United States, and contains information on the incidence, vital status, and treatment of all cancers diagnosed in Connecticut since 1935 . It is one of only five statewide registries included in the National Cancer Institute's acclaimed SEER (Surveillance, Epidemiology, and End Results) cancer surveillance program.
- The Connecticut Death Registry, part of the DPH Vital Records division, is the second oldest in the nation and has records of cancer deaths dating from 1848.
- The Connecticut Hospital Discharge and Billing Data Base, which is managed by the Office of Health Care Access and shared with DPH, contains records of cancer hospitalizations and charges since 1989.
- Three surveys conducted by DPH—the Connecticut Behavioral Risk Factor Surveillance System (BRFSS), Connecticut Youth Risk Behavior Surveillance (YRBS), and the Connecticut Youth Tobacco Survey (CYTS)—have collected information on cancer risk factors since 1988, 1995, and 2000, respectively. In 2005, the Connecticut YRBS and CYTS will be administered together as the CT School Health Survey.
- The Yale Cancer Center (YCC) at Yale University School of Medicine has been an NCI-designated Comprehensive Cancer Center since 1974.
- The Cancer Information Service (CIS) of New England (1-800-4-CANCER) has been funded by NCI since its opening in 1975.

Achievements

- DPH was one of five states funded in 1987 by the NCI Cancer Control Technical Development in Health Agencies Program, to provide critical baseline data for statewide comprehensive cancer prevention and control program planning.
- The Connecticut Susan G. Komen Foundation Race for the Cure funded low-cost breast screening to uninsured women in 1994. This was the predecessor to the Connecticut Breast and Cervical Cancer Early Detection program (CBCCED), which was first funded by the CDC in 1995. CBCCED has 18 contracted health care providers, more than 100 clinic-based satellite sites, and several community agencies committed to educating and referring women for program services.

- Since 1996, DPH and ACS have cooperated in a Primary Care Project, which enhances cancer screening in community practices.
- DPH received a 5-year IMPACT (Initiatives to Mobilize for the Prevention and Control of Tobacco) grant from the CDC in 1994, to support collaboration with partners on two statewide coalitions working against tobacco control.
- In 1999, DPH received a 5-year Cooperative Agreement from the CDC Comprehensive State-based Tobacco Use Prevention and Control Program to reduce initiation among youths, promote cessation among youths and adults, eliminate exposure to environmental tobacco smoke, and identify and eliminate disparities. Connecticut Youth Tobacco Surveys were conducted in 2000 and 2002.
- Since 2000, the Federal Preventive Health and Health Services Block Grant Program has funded skin cancer prevention and education in childcare settings.
- The WISEWOMAN cooperative agreement (Well-Integrated Screening and Evaluation for Women Across the Nation) uses CBCCED sites to deliver health screening for cardiovascular disease along with breast and cervical cancers.
- A Comprehensive Breast Cancer Needs Assessment was funded by DPH and conducted by the UCHC Department of Community Medicine. It inventoried resources and projects throughout Connecticut dedicated to reducing the impact of breast cancer on the population through basic research, public health surveillance, clinical and ancillary services, and public policy advocacy. It serves as a model assessment for other priority cancers selected for cancer plan development.
- The Connecticut Colorectal Cancer Workgroup was established with representatives from DPH, ACS, and the American College of Gastroenterology. It achieved passage of state legislation that mandated third party reimbursement for colonoscopy as a screening tool in the prevention of cancer.

HISTORY OF THE CONNECTICUT CANCER PARTNERSHIP

In May 2002, a Leadership Institute for New England state leaders in cancer control was held in Quincy, MA, sponsored by the CDC, ACS, and NCI. Additional representatives at the meeting included the American College of Surgeons, Commission on Cancer (ACoS, CoC), the Association of Chronic Disease Directors (ACDD), the Intercultural Cancer Council (ICC), the National Dialogue on Cancer (now called C-Change) and North American Association of Central Cancer Registries (NAACCR).

The Connecticut leaders represented the Connecticut Cancer Partnership's five founding members--state agencies and organizations that had collaborated in the past on cancer control: ACS, DPH, UCHC, YCC, and CSMS. The 2-day leadership institute featured a workshop on creating a "building blocks" framework for comprehensive planning. This framework is based on meaningful collaboration among a broad range of partners, using a public-health-oriented approach to service delivery and a long-range perspective. Partnerships capable of implementing a plan and evaluating the outcomes were recommended. Upon returning to Connecticut, the leadership group agreed to support DPH's application to the CDC for funding to begin the state's comprehensive cancer planning initiative.

In October, 2002, DPH was awarded a cooperative agreement from the CDC to begin cancer planning. The leadership group, renamed the Core Committee of the Connecticut Cancer Partnership (CCP), became responsible for directing the planning process, defining and creating subcommittees and work groups, guiding the assessment and evaluation processes, and expanding the Partnership, all in accordance with the CDC's *Guidance for Comprehensive Cancer Control Planning* and building blocks.

In March, 2003, the Core Committee held a statewide conference on comprehensive cancer planning to which potential partners were invited. More than 100 people attended, representing a racially, ethnically, and geographically diverse cross-section of stakeholders in cancer prevention and control from throughout Connecticut: state and local public health agencies, other programs funded by CDC and NCI (Table 1), academic institutions, volunteer organizations, community

Table 1
CDC- and NCI-Funded Connecticut Programs Involved in Planning

Program (Organization or Agency)
Connecticut Breast and Cervical Cancer Early Detection Program (DPH)
Cancer Information Service of New England (YCC)
Connecticut Tumor Registry (DPH)
Extended Food and Nutrition Education Program (UConn Extension Service)
5-A-Day Program (DPH)
Obesity Prevention and Control Program (DPH)
Tobacco control program (DPH)
Connecticut Department of Education
Yale-Griffin Hospital Prevention Research Unit

groups, faith-based organizations, hospitals, cancer centers, professional organizations (oncology nurses, physicians and social workers), insurers, health care providers, researchers, patient care services, cancer survivors, and consumers.

Conference speakers were Kevin Brady, CDC Acting Director of Cancer Prevention and Control; experts from two states that had already finished their state cancer plans (Anita Ruff, Maine Comprehensive Cancer Control Coordinator; and Polly Hager, Michigan Public Health Institute Cancer Control Services Project); DPH Deputy Commissioner Norma Gyle and DPH cancer program staff; and members of the Partnership's Core Committee. Later in the meeting, attendees broke into committees corresponding to priority areas of the comprehensive cancer plan (Prevention, Early Detection, Treatment, Survivorship, Palliative and Hospice Care), and began developing vision statements and goal statements.

After the conference, the committees met frequently from March to June, to refine their goals and formulate objectives and strategies for achieving them. They reviewed literature and data, looked at existing programs and identified gaps, and considered issues that cut across all priority areas: health disparities, advocacy, communications, research, data, surveillance, and evaluation. Previous Connecticut cancer plans that were reviewed included: *Connecticut Cancer Control Plan 2001-2004; Connecticut Tobacco Use, Prevention, and Control Plan, 2002; Comprehensive Cancer Breast Cancer Needs Assessment, 2002;* and *NECON (New England Coalition for Health Promotion and Disease Prevention) Task Force on Prevention and Control of Cancer, 1998.* The ACS 2015 planning documents and *Healthy People 2010* (U.S. Department of Health and Human

Services), a national health promotion and disease prevention agenda, were key reference materials.

The goals, objectives, and strategies of each subcommittee were submitted to the Core Committee for review, and two additional subcommittees--one on Governance and another on Data, Surveillance, and Evaluation--were created. Goals and objectives were discussed, and prioritized during a second day-long Partnership conference held in June, 2003. The objectives were reviewed by the Data, Surveillance, and Evaluation Committee, and refined to make them SMART (specific, measurable, achievable, relevant, and time bound) to the greatest possible extent.

THE CONNECTICUT CANCER PARTNERSHIP TODAY

Today, the Connecticut Cancer Partnership is a broad, vital consortium of more than 100 public and private partners working to fight cancer and improve the quality of life of Connecticut's residents. It currently is governed by a 22-member Core Committee (slated to transition to an elected Board of Directors later this year), and has nine standing committees representing the five major priority areas (Prevention, Early Detection, Treatment, Survivorship, and Palliative and Hospice Care), along with committees on Advocacy, Communications, Governance, and Data, Surveillance, and Evaluation. *Ad hoc* committees and work groups are convened as needed. The progress of the Partnership to date in comprehensive cancer control planning, according to the CDC's "building blocks" model, is shown in Table 2.

An open organization, the Partnership seeks broad representation in its membership. There are two membership categories, organizational and individual. Any organization in Connecticut interested in any aspect of cancer prevention and control can become a member. The organization designates a representative to attend Partnership meetings. Any individual interested in working in cancer prevention and control also can join the Partnership.

The Connecticut Cancer Partnership welcomes new members. We invite you to join with us in this important effort. If you would like information about the Partnership and how you can become involved, or if you have questions, please let us know.
Phone: 860-509-7804
E-mail: CTCancerPartnership@po.state.ct.us
Internet: www.CTCancerPartnership.org

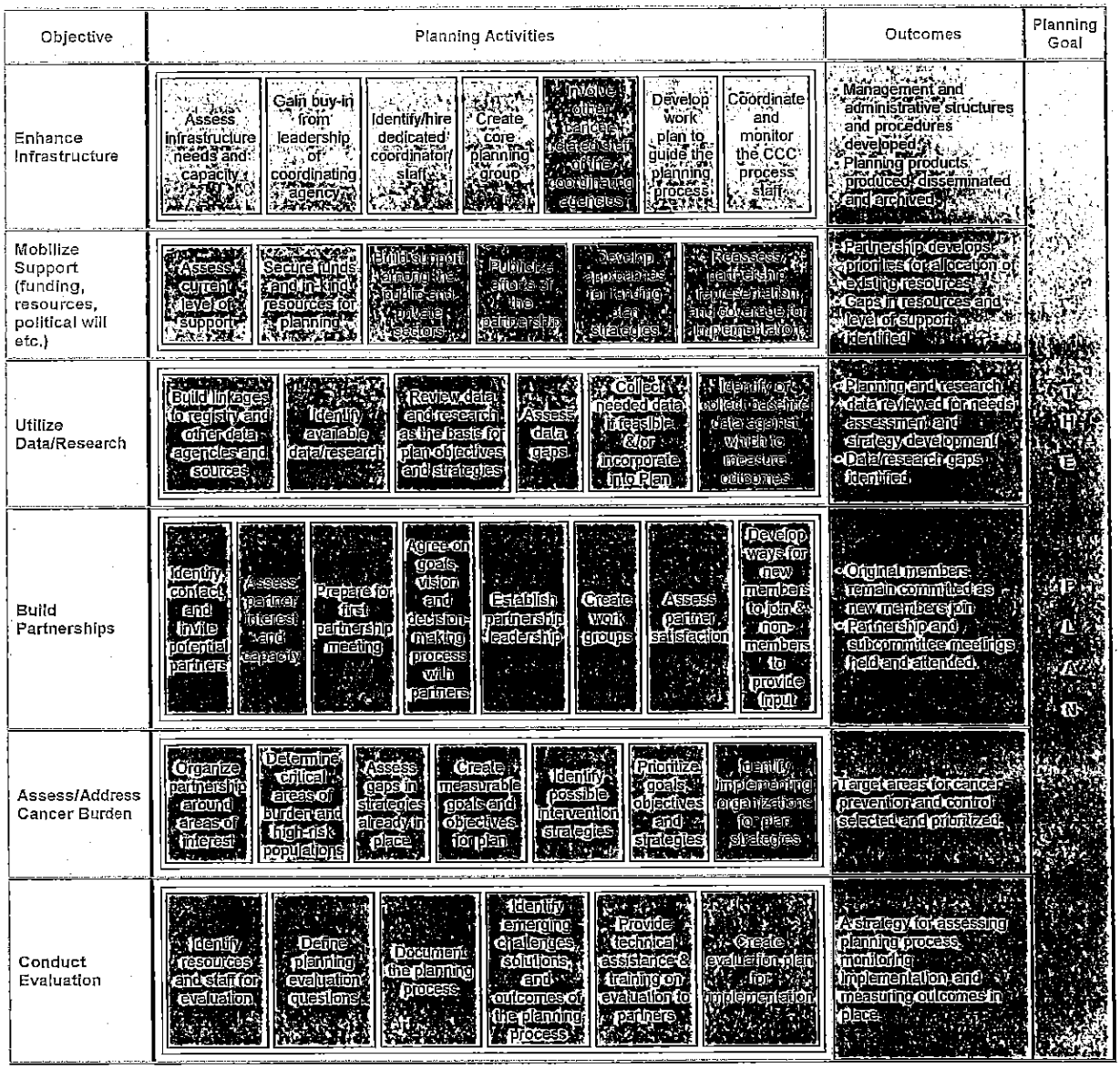
NEXT STEPS

The *Connecticut Comprehensive Cancer Control Plan, 2005-2008* is intended to be an agenda for cancer control and prevention in our state. Organizations throughout Connecticut can use it to earmark specific goals and objectives to incorporate into their own implementation activities. The next steps are outlined below.

1. Submit the Plan to the CDC with a request for implementation funding
2. Broaden the Partnership, particularly in terms of geographic diversity and to include more corporate partners
3. Move from planning subcommittee structure to action subcommittees, and restructure present membership accordingly
4. Transition governance structure from a Core Committee to a Board of Directors
5. Begin first-year implementation activities

Table 2

Building Blocks for Comprehensive Cancer Planning: Connecticut's Progress to Date



2. Connecticut, Its Population, and Cancer

CONNECTICUT, ITS POPULATION, AND CANCER

INTRODUCTION

Connecticut is the southernmost New England state, bordered by Massachusetts to the north, Long Island Sound to the south, Rhode Island to the east, and New York to the west. Much of Connecticut's population lives in the larger cities along the coastal plain and in the river valley of the Connecticut River, which bisects the state from north to south.

Connecticut is characterized by high social and economic contrast and racial and ethnic diversity. It is the third smallest in area, but fourth most densely populated state in the U.S.; about 88% of its population lives in urban areas.[1] Whether in terms of health status, income, poverty, racial composition, or almost any other factor, statewide averages for Connecticut often are misleading. Striking disparities appear across town lines, among racial and ethnic groups, and between urban and rural populations. These differences have engendered the concept of "two Connecticuts,"[2]--one for people who live in the wealthiest state in the nation, and the other for those living in some of the most severe and concentrated pockets of poverty in the U.S. Recently the notion of "five Connecticuts" based on disparate social and economic factors has been proposed.[3] The overall health of Connecticut's people varies dramatically between its wealthiest and poorest communities.

Connecticut's population is changing, and the demographic changes are reflected in both numbers and patterns of cancer and evolving needs for health care and support services. Disparities in cancer in relation to incidence, mortality, and treatment were fundamental considerations in the development of the *Connecticut Comprehensive Cancer Control Plan.*

CONNECTICUT'S PEOPLE

The Aging of the Population

Connecticut's population is older, on average, compared to the U.S. population as a whole. Older adults are the fastest growing segment of our population. Between 1990 and 2000, the median age of Connecticut residents increased from 34.4 years to 37.4 years, or 2.1 years greater than the national median age.[4] During the same period, the number of people 65 years of age and older grew by more than 24,000 (Table 3).

Shifts in Racial and Ethnic Composition

Cancer rates and patterns vary across demographic groups, including racial and ethnic groups. From 1990 to 2000, the number and proportion of white persons in Connecticut decreased, whereas minority populations increased, in some cases by 50% or more (Table 3). Connecticut's population is still predominately white (81.6%) and non-Hispanic (90.6%); however, the racial and ethnic composition is dramatically different in the state's largest cities. Non-whites account for 72% of the population in Hartford, 57% in New Haven, and 55% in Bridgeport, and Hispanics (of any race) represent 41%, 21%, and 32%, respectively, of the population in these three cities.[5] Hispanics are now the largest minority group in Connecticut and the United States, with the trend expected to continue.

Table 3
Population Changes for Certain Groups
Connecticut, 1990 to 2000[6]

Population Group	1990		2000		Change from 1990 to 2000	
	Number	% of Total	Number	% of Total	Number	%
Total Population (all races and ages)	3,287,116	100	3,405,565	100	118,449	3.6
White	2,859,353	87.0	2,780,355	81.6	-78,988	-2.8
African American[a]	274,269	8.3	309,843	9.1	35,574	13.0
Asian American/Pacific Islander	50,698	1.5	83,679	2.5	32,981	65.1
American Indian/Alaskan Native	6,654	0.2	9,639	0.3	2,985	44.9
Hispanic/Latino (any race)	213,116	6.5	320,323	9.4	107,207	50.3
Older adults (65+ years of age)	445,907	13.6	470,183	13.8	24,276	5.4

Source: U.S. Census Bureau, 2000

[a] "African American" refers to African Americans and individuals who consider themselves Black.

Social and Economic Characteristics

Education Level

Compared to the American population as a whole, Connecticut residents have achieved higher levels of education (Table 4). In 2000, 84% of state residents 25 years of age and older were high school graduates or higher, 31% had completed a bachelor's degree or more, and less than 6% had less than a 9th grade education. In contrast, in the cities of Hartford and Bridgeport, only 61% and 65% of residents, respectively, were high school graduates, only about 12% had a bachelor's degree or higher, and 17% and 15%, respectively had less than a 9th grade education.

Table 4
Changes in Selected Social and Economic Characteristics
Connecticut, 1990 and 2000 and United States, 2000

Characteristic	Connecticut		U.S.
	1990[7]	2000[8]	(2000)[9]
Less than 9th grade education (age 25+)	8.4%	5.8%	7.5%
High school graduates (age 25+)	79.2%	84.0%	80.4%
Bachelor's degree or higher	27.2%	31.4%	24.4%
Speak language other than English	15.2%	18.3%	17.9%
Do not speak English "very well"	6.0%	7.4%	8.1%
Per capita income[7]	$20,198	$28,766	$21,587
Persons living below poverty level[10]	6.6%	7.6%	12.4%

Source: U.S. Census Bureau, 2000

Language Spoken at Home

In 2000, nearly one in five Connecticut residents over 5 years of age spoke a language other than English, and more than 7% did not speak English "very well" (Table 4). In Hartford and Bridgeport, more

than 40% of the population spoke a language other than English, and more than one in five of them spoke English less than "very well."

People with a poor ability to read, write and speak English often have a poor understanding of medical information and advice. As a result, they are more likely to engage in risky behaviors like smoking, they are less likely to access health services such as screenings for cancer, and they end up with poor health outcomes, compared to people with high English literacy.[11]

Income and Poverty

Connecticut is the wealthiest state in the nation, but the gap between its rich and poor is growing. Between 1990 and 2000 the *per capita* income[a] of Connecticut residents rose by 42.5% to $28,766 (Table 7). This figure was more than double the income defined by the federal government as "poverty level" for a family of three ($13,740).[12] During the same period, while the poverty rate declined nationally, the number of people living below the poverty level in Connecticut rose from 217,347 to 259,514--an increase of nearly 20%--representing 7.6% of the state's population ((Table 4)

Nowhere are disparities among Connecticut's 169 towns more evident than those for income and poverty. In 2000, *per capita* income ranged from $15,000 in Hartford to nearly $94,000 in New Canaan, and poverty rates ranged from 0.7% in Killingworth to 30.6% in Hartford.[13] Hartford, the capital of the wealthiest state in the nation, had the second highest poverty rate of all U.S. cities.[14]

Compared to Connecticut residents of white race, who had the highest *per capita* income of any racial or ethnic group ($31,505), *per capita* income was 58% lower for Hispanics and 47% lower for African Americans.[15] Connecticut poverty rates were 7% for whites, 28% for African Americans, and 32% for Hispanics in 2002-2003.[16]

The U.S. Census Bureau may be undercounting actual poverty in Connecticut. The cost of living in our state is higher than the national average, so though an individual's or family's income may be above the national threshold for poverty, they might still be living in stressed financial conditions by Connecticut standards.[17]

Health Insurance

Connecticut has one of the lowest percentages in the U.S. of people lacking health insurance.[18] In 2004, 5.8% of the Connecticut population had no health insurance at the time they were surveyed, and 9.4% said they had been uninsured at some time during the prior year. Twenty-one percent of Hispanics, 7% of African Americans, and 3% of whites were uninsured, and these disparities were found to be related to low income and lack of permanent, full-time employment.[19]

Compared to people with health insurance coverage, those without health insurance have more difficulty accessing personal health services such as cancer screenings, use less medical services, receive less outpatient and inpatient care, and, as a result, tend to have worse health.[20] They often seek care at a later or more advanced stage of disease, leading to higher death rates.[21]

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[a] *Per capita* income is the average income for every man, woman, and child in a geographic area. It is computed by dividing the total income of all the area's people 15 years of age and over by the area's total population.

TRACKING CANCER AND ITS RISK FACTORS

Connecticut has some of the best resources in the nation for documenting cancer trends and risk factors among state residents. The Connecticut Tumor Registry, housed within the Department of Public Health (DPH), is the oldest of its kind in the U.S. and contains information on incidence,[b] mortality,[c] and first course of treatment for all reported cancer cases diagnosed in Connecticut since 1935. The Registry has a national distinction in being one of only five statewide registries in the U.S. that are included in the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program. The registries were selected for their ability to manage a cancer reporting system and, as a whole, to provide a representative subset of the United States population.

The Death Registry, part of the DPH Vital Records section, is the second oldest in the nation and has records of cancer deaths in Connecticut since 1848. The Connecticut Hospital Discharge and Billing Data Base (managed by the Office of Health Care Access and shared with DPH) contains records on cancer hospitalizations and charges since 1989. Three surveys conducted by DPH—the Connecticut Behavioral Risk Factor Surveillance System, Connecticut Youth Risk Behavior Surveillance System, and Connecticut Youth Tobacco Survey--have collected information on cancer risk factors among state residents since as early as 1988. In 2005 the Youth Risk Behavior Survey and Youth Tobacco Survey will be administered together as the Connecticut School Health Survey.

THE BURDEN OF CANCER IN CONNECTICUT

New Cancer Cases

More than 18,000 new cases of invasive cancer were diagnosed in Connecticut in 2001.[22] In 2001 our state had the sixth highest rate in the U.S. overall, the fourth highest rate for females, and the tenth highest rate for males.[23]

The ten sites of invasive cancers most frequently diagnosed among Connecticut males and females in Connecticut in 2001 are shown in Table 5. Prostate, breast, lung, and colorectal cancers, together with melanoma of the skin, accounted for 60% of cancers. A substantial number of these cancers either can be prevented by lifestyle changes (i.e., lung cancer and melanoma), or may be detected early through screening (i.e., breast, prostate, and colorectal cancers).

[b] Cancer incidence is the number of new cases diagnosed or reported. Throughout this plan, all reported incidence rates are age-standardized. All hospitals and private pathology laboratories in Connecticut are required by law to report cancer cases to the Connecticut Tumor Registry.

[c] Mortality means deaths. Throughout this Plan, all reported death rates are age-adjusted.

Table 5
Ten Most Frequently Diagnosed Invasive[a] Cancers in Males and Females
Connecticut, 2001[24]
(Excludes *in-situ* cancers, except bladder cancer)

Males			Females		
Type	Number	Percent	Type	Number	Percent
1. Prostate	2,895	31.0%	1. Breast	2,935	31.8%
2. Lung	1,322	14.2%	2. Colorectal	1,126	12.2%
3. Colorectal	1,066	11.4%	3. Lung	1,113	12.1%
4. Bladder	673	7.2%	4. Uterus	553	6.0%
5. Melanoma (skin)	425	4.6%	5. Non-Hodgkin's lymphoma	336	3.6%
6. Non-Hodgkin's lymphoma	382	4.1%	6. Melanoma (skin)	333	3.6%
7. Kidney	321	3.4%	7. Ovary	299	3.2%
8. Leukemia	223	2.4%	8. Bladder	273	3.0%
9. Oral cavity, pharynx	219	2.3%	9. Thyroid	245	2.7%
10. Stomach	209	2.2%	10. Kidney	211	2.3%
All other cancers	1,595	17.1%	All other cancers	1,796	19.5%
TOTAL	9,330	100.0%	TOTAL	9,220	100.0%

Source: Connecticut Tumor Registry, 2004
[a] Invasive cancers are those that have penetrated into cells beyond the layer of tissue in which they developed, or have spread to distant parts of the body.

Age and Cancer Incidence

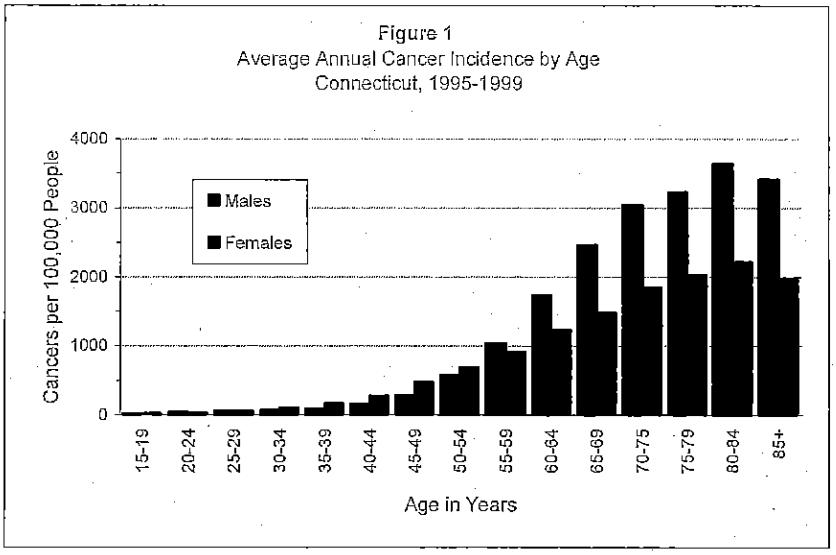
Most cancers tend to develop slowly and sometimes do not appear until decades after exposure to a carcinogen. Carcinogens are chemical, physical, or biological agents that can damage the genetic material in cells and can cause mutations. A number of mutations usually must occur for cancer to arise. The chances of developing cancer increase as a person gets older, because more mutations are likely to accumulate over time.

The odds of getting cancer are 1 in 71 for males and 1 in 51 for females from birth through age 39. But over the course of one's lifetime, the odds increase to about 1 in 2 for males and 1 in 3 for females.[26] In Connecticut in 2001, 59% of new cancer cases occurred in older adults (65 years of age and older),[27] and the median age at diagnosis was 68 years.[28] The distribution of new cancer cases by age is shown in Figure 1.

Trends in Cancer Incidence

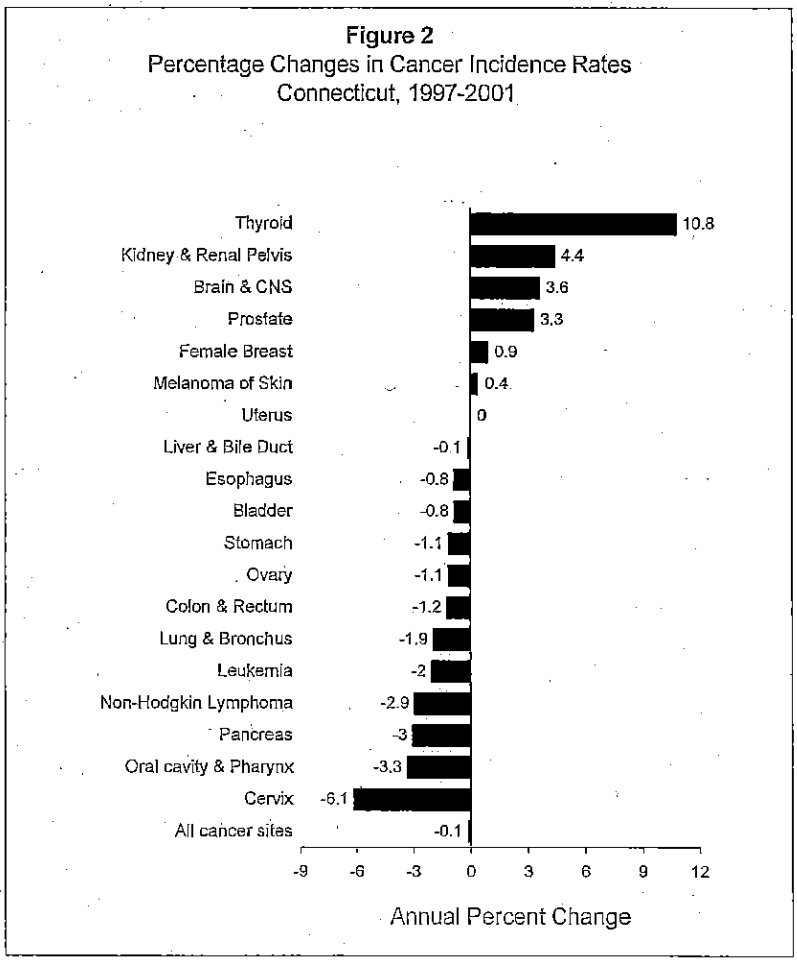
Changes in the rates of new cancers diagnosed among Connecticut residents from 1997 to 2001 are shown in Figure 2.[29] The average annual rate of new cases decreased by 0.1% overall, increased most for thyroid cancer and decreased most for cervical cancer. Lung, breast, colorectal, prostate, melanoma, and ovarian cancers are discussed later in this section.

Figure 1
Average Annual Cancer Incidence by Age
Connecticut, 1995-1999



Source: Connecticut Tumor Registry, 2002

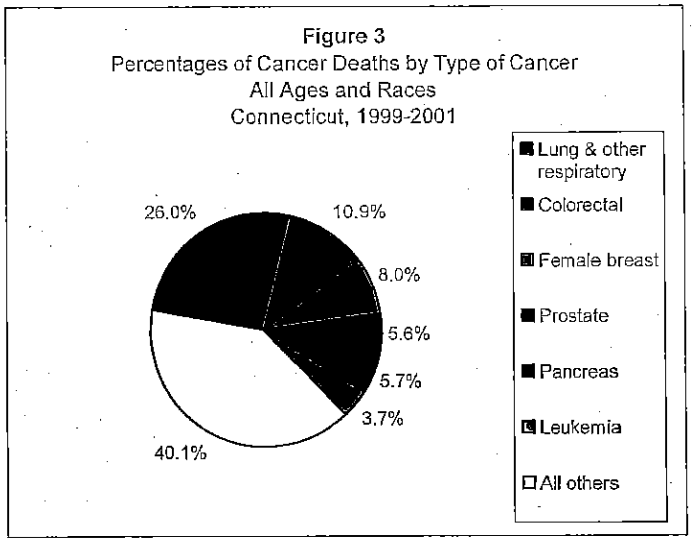
Figure 2
Percentage Changes in Cancer Incidence Rates
Connecticut, 1997-2001



Source: National Cancer Institute, 2004

Cancer Deaths

Cancer is the second leading cause of death in Connecticut, following heart disease. In 2001, more than 7,000 state residents died of cancer. Although Connecticut has one of the highest rates of new cancer cases in the U.S., in 2001 it had the 11th lowest death rate overall (eighth lowest for males and 25th lowest for females).[30] More than half of all cancer deaths in Connecticut are due to cancers of the lung, colon/rectum, female breast, and prostate (Figure 3).[31]



Source: Connecticut Department of Public Health, 2005.

The leading causes of cancer death in Connecticut are similar for different racial and ethnic groups, but vary between males and females (Table 6).

Table 6

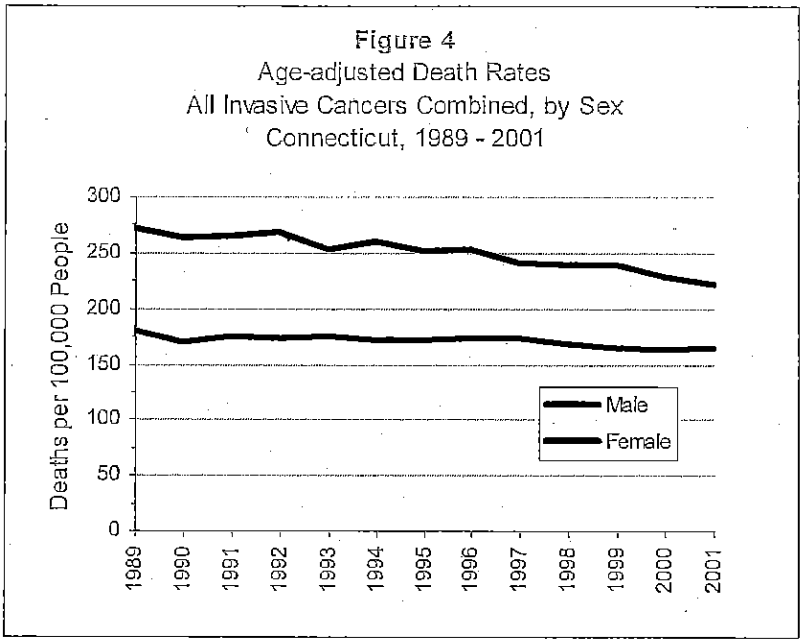
Leading Causes of Cancer Death in Different Population Groups.[32]
Connecticut, 1999-2001

	Sex		Race/Ethnicity (Males and Females Combined)		
Rank	Males (All races)	Females (All races)	White Non-Hispanic	African American Non-Hispanic	Hispanic
1	Lung	Lung	Lung	Lung	Lung
2	Prostate	Breast	Colorectal	Colorectal	Colorectal
3	Colorectal	Colorectal	Female breast	Female breast	Female breast
4	Leukemia	Pancreatic	Prostate	Prostate	Prostate
5	Pancreatic	Ovarian	Leukemia	Pancreatic	Leukemia

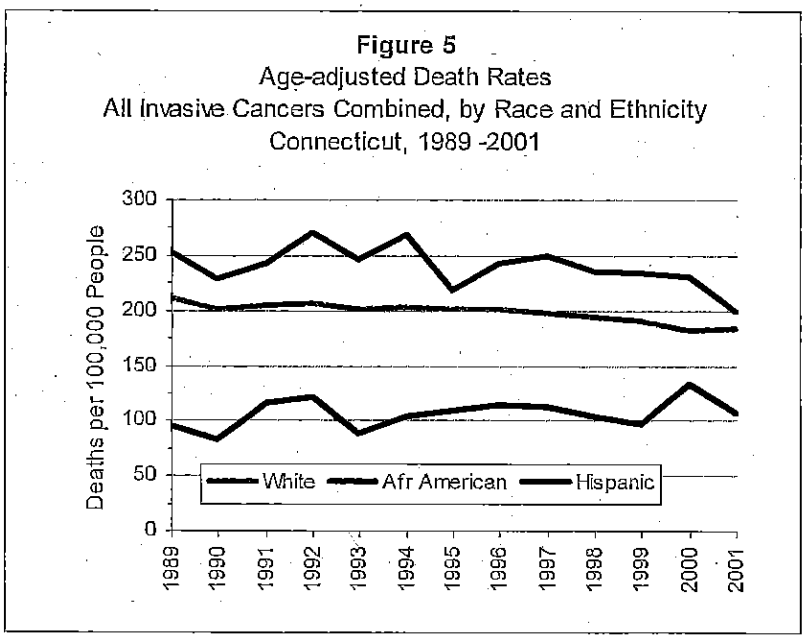
Source: Connecticut Department of Public Health, 2005.

From 1989-1991 and 1996-1998, age-adjusted death rates[d] for cancer in Connecticut declined significantly for males and for whites, but not for other groups.[33] Death rates for all invasive cancers (1989-2001) by sex and race/ethnicity are shown in Figures 4 and 5.

[d] Except for rates for specific age groups, overall death rates used in this Plan are age-adjusted to the U.S. 2000 standard population.



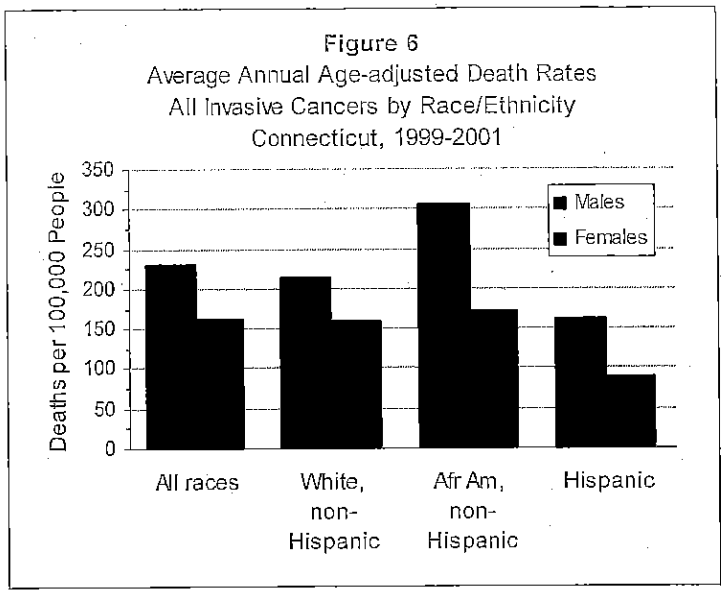
Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for "all cancers" after 1998 are about 0.68% higher than if coded by earlier definitions and rules.



Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for "all cancers" after 1998 are about 0.68% higher than if coded by earlier definitions and rules.

In 1999-2001, the Connecticut average annual age-adjusted death rate[e] for all invasive cancers combined was 188.3 deaths per 100,000 people. Non-Hispanic African Americans had the highest death rates, whereas Hispanics had the lowest death rates (Figure 6).[34] The national target for the cancer death rate for all populations by 2010 is 159.9 deaths per 100,000 people.[35]

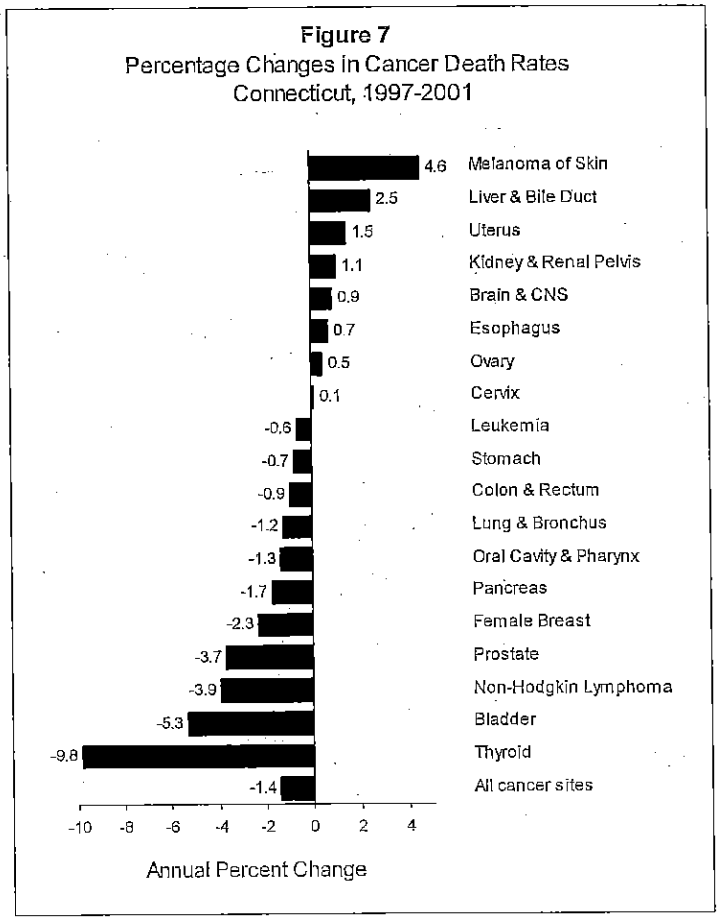
[e] Except for rates for specific age groups, overall death rates used in this Plan are age-adjusted to the U.S. 2000 standard population.



Source: Connecticut Department of Public Health, 2005

Trends in Cancer Deaths

The average annual percent changes in death rates from 1997-2001 for various types of cancer are shown in Figure 7[36] and are discussed under specific cancer types. The death rate for



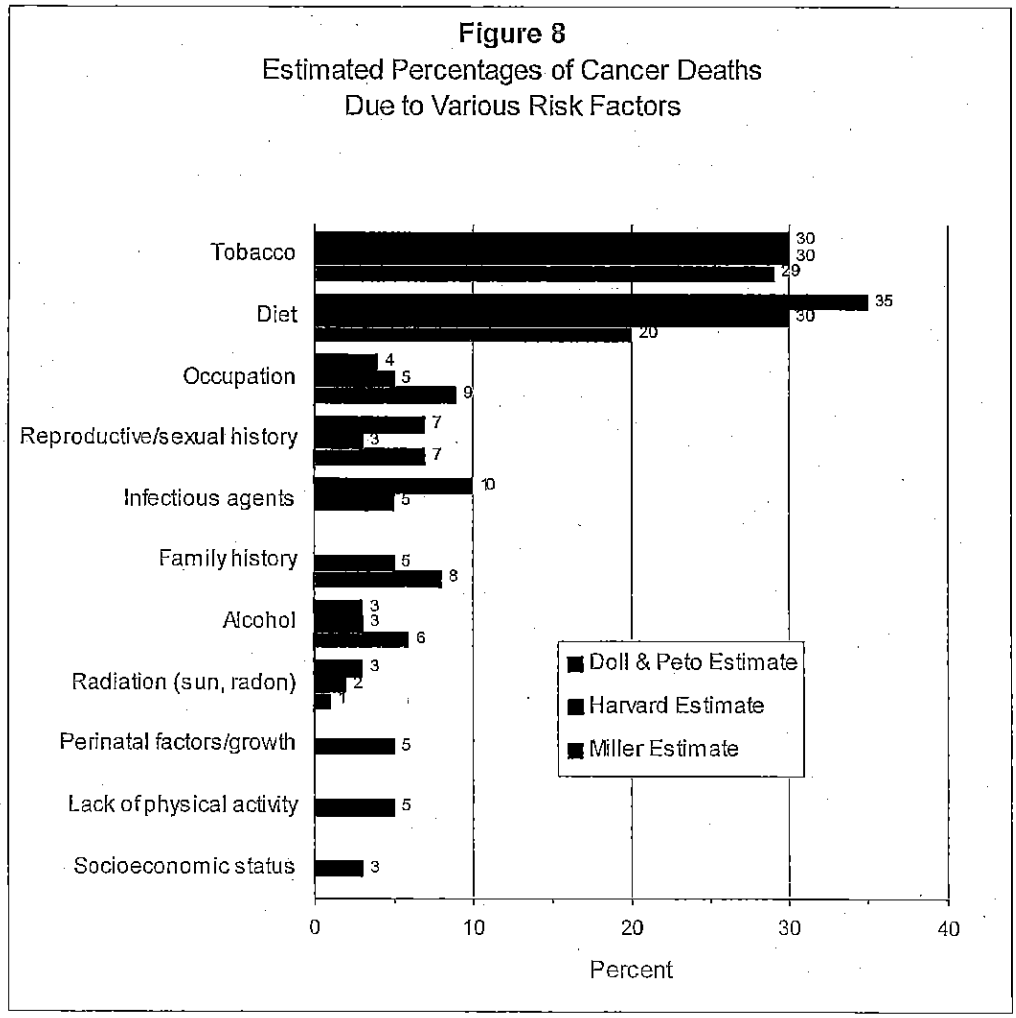
Source: State Cancer Profiles, 2004

all cancers combined (both sexes) declined by 1.4% per year during this period. Death rates for specific cancers, however, showed a wide range of increases and decreases. (See sections below on lung, female breast, colorectal, prostate, melanoma of skin, and ovarian cancers for discussions of specific death rates.)

Risk Factors for Cancer

It has been estimated that at least half of all cancer cases could be avoided or delayed if knowledge about causes and risk factors could be put into practice, but there is no general agreement about the proportion of cancers due to specific risks.[37] The contributions of various risk factors to cancer deaths have been estimated by different methods (Figure 8).[38] These estimates are helpful for identifying where cancer prevention activities should be focused. Some risk factors are modifiable (e.g., smoking, diet, and physical activity), whereas others (e.g., family history, reproductive history) cannot be altered. Some modifiable risk factors are discussed briefly below and in the *Prevention* chapter of this Plan.

Figure 8
Estimated Percentages of Cancer Deaths
Due to Various Risk Factors



Source: Drawn from data summarized by Brownson, Reif, Alavanja, and Bal, 1998

The prevalence of some key modifiable risk factors among Connecticut adults and adolescents is summarized in Table 7.

Table 7
Percentages of Connecticut Residents with Risks for Cancer

Risk Factor	Percentage of Persons at Risk*	
	Adults[39]	Students[40]
Current cigarette smoking (2003)	18.6%	22.5%
Eating less than 5 servings of fruits/vegetables a day (2003)	70.2%	78.4%
Physical activity:		
No leisure time physical activity (2003)	21.0%	N/A
No vigorous physical activity (2003)	69.4%	40.3%
No moderate physical activity (2003)	48.3%	73.9%
Body weight:		
Overweight (2003)	35.7%	N/A
Obese (2003)	19.1%	N/A
Heavy drinking (Adults, 2002; Students, 2003)	6.7%	27.2%
Did not use a condom during last intercourse (2003)	N/A	38.1%
Had sexual intercourse with 4 or more people in lifetime (2003)	N/A	13.7%
Never/almost never use condom during intercourse (1998)	29.4%	N/A
Males with multiple sex partners (1998)	23.6%	N/A
Females with multiple sex partners (1998)	41.0%	N/A

Sources: Behavioral Risk Factor Surveillance System and Youth Risk Behavior Survey (see references).
* Adults 18+ years of age; students in grades 9-12.

Tobacco

Nearly 90% of lung cancer deaths among men and 75-80% of deaths among women are related to cigarette smoking.[41] In 1989 it was estimated that 1,970 cancer deaths in Connecticut each year (about 28% of cancer deaths) are associated with cigarette smoking; women lose about 16 years of expected life, and men lose about 13 years.[42] In 2003, 18.6% of Connecticut adults reported they smoked every day or some days--about half the percentage that smoked in 1989 (Table 7). Younger adults (18-24 years of age) and those with lower incomes and education levels had the highest smoking rates (about twice the overall rate),[43] and high school students were the most likely of all to smoke (22.5%).[44]

Diet

In some studies, cancers of the stomach, esophagus, oral cavity, larynx, rectum, bladder, colon, cervix, and lung have been associated with low consumption of fruits and vegetables. High levels of fat intake, especially from red meat, have been associated with colorectal cancer.[45] In 2003, seven out of ten Connecticut adults ate less than 5 servings of fruits and vegetables a day (Table 7).[46] African Americans and Hispanics were less likely than whites to consume the recommended amount of servings, but the differences were not statistically significant.[47] About 17% of Connecticut adults and 33.2% of students in grades 9-12 ate two or more servings of high-fat foods daily in 1996 and 1997, respectively (the most recent years for which data are available).[48]

Alcohol

The combination of heavy alcohol consumption and tobacco smoke tends to increase the risk of cancers of the mouth, larynx, pharynx, and esophagus. Heavy alcohol consumption, alone, has been associated with cancers of the mouth, pharynx, larynx, esophagus, and liver. Alcohol consumption may also be associated with a modest increase in breast cancer.[49] In 2002, 16.3% of Connecticut were at risk for heavy drinking (greater than 2 drinks per day for males and 1 drink per day for females),[50] and in 2003, 27.2% of high school students reported drinking five or more drinks on one occasion (Table 7). Compared to other population groups, males and younger adults (18-24 years of age) were significantly more likely to report heavy alcohol consumption.[51]

Physical Activity

Regular physical activity has been associated with reduced risk of colon cancer, and it may decrease the risk of breast and prostate cancers.[52] In 2003, 48.3% of Connecticut adults did not meet the recommendations for moderate physical activity,[f] and 69.4% did not meet the recommended guidelines for vigorous[g] physical activity (Table 7).[53] Students were the most active, and older adults (65+ years of age) were the least active. In 2001-2003, African Americans and Hispanics were significantly more likely than whites to report having no leisure time physical activity.[54]

Obesity

Obesity means having an abnormally high and unhealthy proportion of body fat. It is measured in terms of Body Mass Index (BMI).[h] While obesity is a well established risk factor for diabetes, stroke, and cardiovascular disease, its relationship to cancer is less clear and is complex. Cancers of the colon, breast (postmenopausal), endometrium, kidney, and esophagus are associated with obesity, and in some studies links with other cancers also have been found.[55] In Connecticut in 2003, more than half of Connecticut adults were overweight or obese, and about one in five was obese (Table 7). African Americans and Hispanics were significantly more likely than whites to be obese.[56]

Infectious Agents

Viruses, bacteria, and parasites may account for up to 10% of total cancer deaths in the U.S. Infection with *Helicobacter pylori* (*H. pylori*) bacteria causes stomach ulcers and increases the risk of stomach cancer,[57] and infection with hepatitis B or hepatitis C viruses increases the risk of liver cancer.[58]

Human papillomavirus (HPV) is a sexually transmitted agent that has been determined to cause almost all cervical cancers.[59] It is less clear, however, what percentage of individuals with HPV infection go on to develop cervical cancer. In one study, about 60% of sexually active female college students were found to be infected with HPV at some time during the 3-year observation period. In this group, increased risk of infection was associated most strongly with number of lifetime sexual

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[f] Brisk walking, bicycling, vacuuming, gardening, or anything else that causes small increases in breathing or heart rate for 30 minutes or more per day 5 or more days a week.

[g] Running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate or 20 minutes or more per day 3 or more days a week.

[h] Body Mass Index is calculated as a person's weight in pounds divided by height in inches squared multiplied by 703, or as weight in kilograms divided by height in meters squared. An online BMI calculator is available at the following Internet web site: http://www.cdc.gov/nccdphp/dnpa/bmi/calc-bmi.htm. Overweight = BMI 25.0 to 29.9. Obese = BMI ≥ 30.0.

partners of main regular partner, number of male sex partners in the past year, frequent alcohol consumption, African American race, and Hispanic ethnicity.[60]

Condoms may prevent the transmission of HPV and other sexually transmitted infections. While there is no consistent evidence that condoms protect against HPV transmission, condom use is associated with lower rates of cervical cancer.[61] In 1998, 29% of Connecticut adults with more than one sex partner--24% of males and 41% of females--reported they never or almost never used condoms.[62] In 1999, more than half of high school students (61.2% of males and 48.5% of females) said they did not use a condom during their last sexual intercourse.[63]

Radiation Exposure (Sunlight, Tanning Booth and Radon)

There is substantial evidence that exposure to ultraviolet radiation (UV) radiation, mainly from sunlight, is related to all types of skin cancer, including malignant melanoma of the skin.[64] UV exposure from sunlamps and tanning booths also increases risk of skin cancers.[65] In 2003, 34.4% of Connecticut adults reported they had been sunburned in the past year; of these people, 64.4% had two or more sunburns during that period.[66]

Radon is a radioactive gas that arises naturally within soil and rock from the decay of radium. It can enter buildings through cracks in foundations, and accounts for about 10% of lung cancers. In 1986-1987, the only period for which data are available, 19% of Connecticut homes, or nearly one in five, had radon levels above the U.S. Environmental Protection Agency maximum exposure guideline; it was estimated that radon exposure may account for 280 of total lung cancer cases[i] in Connecticut each year.[67]

Social and Economic Factors

Several social and economic factors, including level of education, ability to speak English, income, and poverty are closely related to health status, including developing cancer. (See *Connecticut's People: Social and Economic Characteristics*, earlier in this chapter.) Many cancers, including cancers of the lung, stomach, and uterine cervix, are more common among poor and underserved groups.[68] Low socioeconomic status (SES) is associated with increased smoking, alcoholism, poor nutrition, and reduced access to health care.[69] Low SES is also associated with later diagnosis, reduced access to treatment opportunities, and reduced survival.[70] In contrast, the risk of developing female breast cancer and melanoma of the skin is greater among persons with higher socioeconomic status (see below).

Prevention and Early Detection of Specific Cancers

The organization of the Connecticut Comprehensive Cancer Control Plan is based on the continuum of cancer care, from prevention through end-of-life, rather than on specific cancer sites. The cancers discussed below, however, figure importantly in planning for improvements in each of the priority areas, because they are preventable, effective screening methods are available, or more education about risk factors and early symptoms is needed.

[i] In 2001 2,435 new cases of lung cancer were reported in Connecticut.

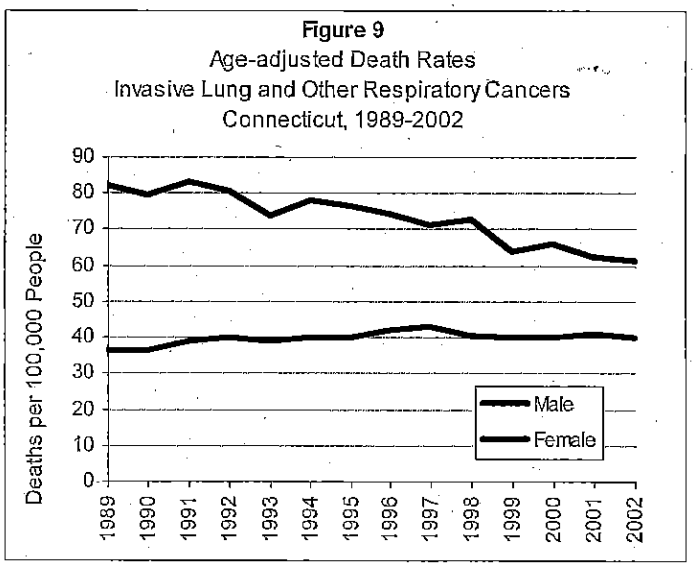
Lung Cancer

Lung cancer is one of the most preventable cancers. Nearly 90% of lung cancer deaths among men and 75-80% among women could be avoided if people never used tobacco products.[71] In the past century, lung cancer has progressed from being a medical rarity to one of the most common forms of cancer. In 1914, for example, only 371 cases of lung cancer were reported in the entire U.S., whereas in 2002 it caused the deaths of five times that number of people in Connecticut alone.

Today, lung cancer, accounts for more than one in eight new cancer cases and more than one-fourth of all cancer deaths in Connecticut. It is the second most frequently diagnosed cancer and the leading cause of cancer deaths for both women and men. Incidence rates and mortality rates for lung cancer are lower in women than in men because of differences in smoking rates in the past; however, the gap between the sexes is narrowing. Between 1980-1984 and 1995-1999, the incidence rates for lung cancer in Connecticut fell by 11% for men but rose by nearly 50% for women.[72] While death rates have been declining for men, they have been increasing for women (Figure 9),[73] and in 1988, lung cancer overtook breast cancer as the leading cause of cancer deaths among Connecticut women and still holds that rank.

Disparities also exist in lung cancer incidence and death rates for different racial and ethnic groups. Among males, African Americans have the highest rates and Hispanics have the lowest rates.[74]

Figure 9
Age-adjusted Death Rates
Invasive Lung and Other Respiratory Cancers
Connecticut, 1989-2002



Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for lung cancer after 1998 are about 1.63% lower than if coded by earlier definitions and rules.

The survival of a person with cancer is strongly affected by the extent or anatomical "stage" of the disease at the time it is diagnosed. Generally, cancers that are detected early, before they have spread, are more treatable than advanced cancers, but there is no validated screening method for early detection of lung cancer among high-risk individuals. Based on 1995-2001 data from

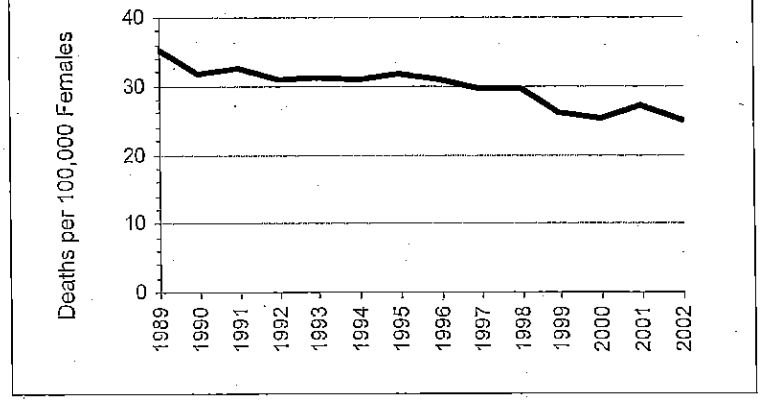
U.S. cancer registries,[75] only 16% of lung cancers are diagnosed at "local" stages, when they are confined entirely to the lung and have not spread into nearby tissues or lymph nodes. The 5-year SEER relative survival rate for local stage lung cancer diagnosed in 1995-2001 was 49.4%. When diagnosed at the "distant" stage, when the cancer has metastasized, the 5-year relative survival rate was 2.1%.[76]

Breast Cancer

Breast cancer is the most frequently diagnosed invasive cancer and the second leading cause of cancer death among women in Connecticut and the U.S. In 2001, Connecticut had the second highest incidence rate for invasive breast cancer in the nation.[77] While incidence rates for breast cancer have been rising, death rates have been decreasing. From 1980-1984 to 1995-1999, the age-standardized incidence rate for new cases of invasive female breast cancer in Connecticut rose by 27.5%, from 97.5 to 124.3 cases per 100,000 women,[78] partly associated with increased screening and detection.[79] There was an average annual increase of 0.9% per year from 1997 to 2001 (Figure 2).

From 1989 to 2000 the age-adjusted death rate for female breast cancer in Connecticut decreased by 30% (Figure 10). Breast cancer incidence rates tend to be higher for white females compared to African Americans or Hispanics, whereas death rates tend to be significantly higher for African Americans.[80]

Figure 10
Age-adjusted Death Rates
Female Breast Cancer
Connecticut, 1989-2002



Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for breast cancer after 1998 are about 0.56% higher than if coded by earlier definitions and rules.

Age is the greatest risk factor for female breast cancer; about 80% of new cases and nearly 90% of deaths occur in women 50 years of age and older.[81] Other risk factors include a family history of breast cancer (especially in a mother or sister) or a previous breast cancer, carrying

certain genetic mutations, and reproductive and hormonal factors (early age at first menstrual period, no children, first pregnancy after 30 years of age, late age at menopause). Overweight, a sedentary lifestyle, alcohol consumption, and exposure to ionizing radiation during adolescence also might increase a woman's risk of developing breast cancer. Despite the long list of possible risk factors, few are strongly associated with the development of breast cancer, and together, they explain only about one-fourth of all breast cancers.[82]

Higher than expected incidence rates for female breast cancer were noted for several Connecticut towns during the time periods 1990-1994 and 1995-2000[83] Incidence rates for breast cancer tend to be associated with age at first birth, with risk increasing with increasing age.[84] Higher socioeconomic status is related to higher age at first birth, because women with higher incomes, educational attainment, and employment activity are more likely to delay childbearing.[85] In 2000, the average age of Connecticut women at first births--27.2 years--was the second highest in the U.S.[86]

Regular professional screening (mammograms, clinical breast exams) may detect breast cancer at an earlier stage. In Connecticut, more than half of breast cancers are diagnosed at the local stage (Table 8). The 5-year relative survival rate (SEER) for breast cancer diagnosed in 1995-2001 was 88.2% overall--97.9% if found at local stages and 26.1% if found at the distant stage.[87]

Table 8
Stage at Diagnosis for Selected Cancers[88]
Connecticut, 1999

Cancer Site	Stage at Diagnosis*				
		Invasive			
	In situ	Local	Regional	Distant	Unknown
Breast (female)	20%	53%	21%	4%	3%
Colon-rectum	9%	38%	32%	14%	6%
Prostate	0%	90% (local/regional)		4%	5%
Melanoma of skin	42%	50%	4%	2%	3%

Source: SEER General Summary Staging System, Connecticut Tumor Registry, 2002

* *In situ*: Confined to the layer of cells where it began; not invasive.
Invasive: Has penetrated beyond the layer of cells where it began.
Local: Invasive, but confined entirely within organ of origin.
Regional: Has spread by direct extension to adjacent organs or tissues, and/or to lymph nodes considered regional to the organ of origin, but no further spread has occurred.
Distant : Has spread beyond adjacent organs or tissues and/or to tissues or lymph nodes remote from the primary tumor.

The American Cancer Society recommends yearly mammograms starting at age 40; clinical breast exams about every 3 years for women in their 20's and 30's and every year for women 40 and older; and optional breast self exams for women 20 and older.[89] The U.S. Preventive Services Task Force (USPSTF) recommends screening mammography, with or without clinical breast examination, every 1-2 years for women aged 40 and older.[90] In 2002, 82.4% of Connecticut women 40 years of age and over reported they had a mammogram in the past 2

years, 72.3% reported they had a mammogram in the past year, and 74.8% said they had a clinical breast exam in the prior year.[91]

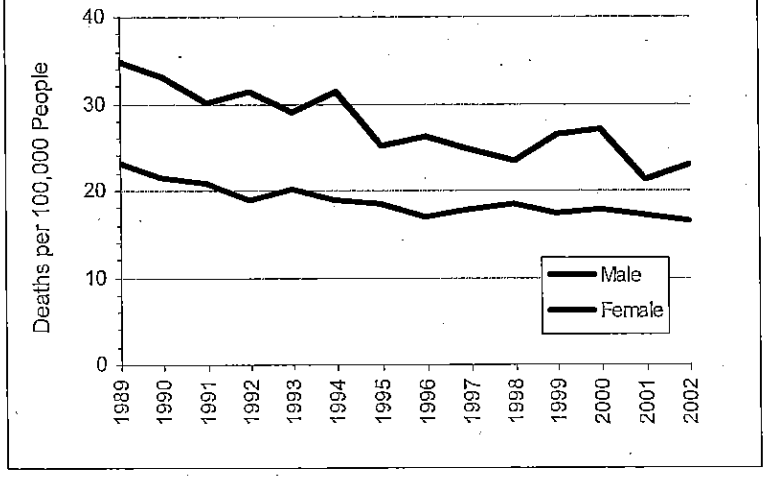
Colorectal Cancer

In Connecticut, colorectal cancer (cancers of the colon and rectum) is the third most frequently diagnosed cancer in men and the second most common cancer in women (Table 5). In 2001, the incidence rate in Connecticut for white males was 1.3 times greater than for African American males; among females, it was 1.1 times greater for African Americans than for whites. Between 1980-1984 and 1995-1999, the age-standardized incidence rate for colorectal cancer among males declined by nearly 20%. The decrease for females was somewhat lower. From 1997 to 2001 the incidence rate for both sexes declined an average of 1.2% per year (Figure 2).[92]

The incidence of colorectal cancer increases sharply with age; nationally, 50% of patients are diagnosed at 72 years of age and older.[93] In 1999, 38% of colorectal cancers were diagnosed at local stages in Connecticut (Table 8). The 5-year relative survival rate (SEER) for colorectal cancer diagnosed in 1995-2001 was 64.1% overall, 90.4% when diagnosed at local stages and 9.7% when diagnosed at the distant stage.[94]

Colorectal cancer was the third leading cause of cancer death among both men and women and accounted for 10% of cancer deaths in Connecticut in 2002.[95] Death rates for colorectal cancer are higher for men than for women (Figure 11), but have been declining for both sexes (Figures 7 and 11),[96] which may reflect advances in screening and detection and improved treatments.

Figure 11
Age-adjusted Death Rates
Colorectal Cancer
Connecticut, 1989-2002



Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for colorectal cancer after 1998 are about 0.07% lower than if coded by earlier definitions and rules.

Risk factors for colorectal cancer include a family history of colorectal cancer, a diet high in animal fat and low in fiber, physical inactivity and obesity, smoking, heavy alcohol consumption,

and a history of inflammatory bowel disease.[97] There is some evidence that the risk of developing colorectal cancer can be reduced by eating less animal fat and red meat, and more fruits, vegetables, fiber, and low-fat dairy products, regular aspirin use, taking folic acid and calcium supplements, and regular physical activity.[98]

The American Cancer Society recommends screening for colorectal cancer beginning at age 50 with one of the following schedules: a yearly fecal occult blood test (FOBT) or fecal immunochemical test (FIT); flexible sigmoidoscopy every 5 years; annual FOBT or FIT, with flexible sigmoidoscopy every 5 years (preferred to either test alone); a double-contrast barium enema every 5 years; or a colonoscopy every 10 years.[99] The USPSTF strongly recommends that clinicians screen men and women 50 years of age and older for colorectal cancer but does not recommend a specific method or schedule.[100] In Connecticut in 2003, 27.2 % of Connecticut residents over 50 years of age reported they had a blood stool test in the last year, and 49.0% reported having a sigmoidoscopy or colonoscopy in the last 5 years.[101]

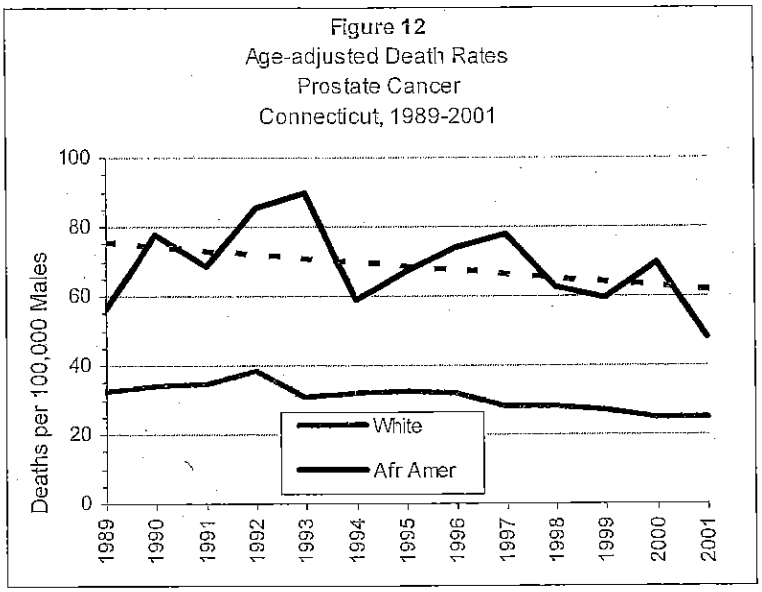
Prostate Cancer

Prostate cancer is the most frequently diagnosed cancer among males in Connecticut and the U.S. In 2001, nearly 3,000 cases were diagnosed in Connecticut, representing just under one-third of total new cancers (Table 5); the incidence rate for African American males was 1.4 times greater than that for white males.[102] From 1980-1984 to 1995-1999, the average annual incidence rate for prostate cancer in Connecticut doubled.[103] Some of this increase is likely due to increased screening using the PSA (prostate specific antigen) test. From 1997 to 2001, the age-adjusted incidence rate rose an average of 3.3% per year (Figure 2). Significantly more cases of prostate cancer than expected have been found in several towns in Fairfield County and in the city of Hartford and many of its surrounding towns.[104]

Risk of prostate cancer rises sharply after age 50. In 2001, 63% of new cases in Connecticut were found in men 65 years of age and over.[105] In 1999 in Connecticut, 90% of prostate cancers were diagnosed at the local and regional stages (Table 8). The 5-year relative survival rate (SEER) for prostate cancer diagnosed in 1995-2001 was greater than 95% when diagnosed at the local/regional stages and 33.5% when diagnosed at the distant stage.[106]

In 2002, prostate cancer was the second leading cause of cancer deaths among Connecticut men, accounting for 12.2% of total cancer deaths.[107] The death rate for African American males in Connecticut consistently has been about twice that of white males.[108] Annual prostate cancer death rates from 1989-2001 for white males compared to African American males are shown in Figure 12.[109] From 1997 to 2001 the overall age-adjusted death rate for prostate cancer fell by an average of about 4% per year (Figure 7).[110]

Little is known about the risk factors for prostate cancer, but it is thought that hormonal and nutritional factors are related to risk. A family history of prostate cancer is also associated with increased risk. Some studies suggest that a diet rich in selenium, vitamin E, and lycopene (e.g., tomato sauce, tomatoes, pink grapefruit, watermelon) may protect against prostate cancer, whereas a diet high in animal fat and saturated fat may increase risk.[111]



Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for prostate cancer after 1998 are about 1.34% higher than if coded by earlier definitions and rules.
Dotted line shows linear trend for African Americans.

There is no general agreement about the value of screening for prostate cancer. The ACS recommends offering annual prostate specific antigen (PSA) blood tests and digital rectal examinations (DRE) to men age 50 and over, and at younger ages for African Americans and other men at high risk for developing prostate cancer.[113] The USPSTF, however, currently does not recommend for or against routine screening for either test.[114] In Connecticut in 2002, 43.4% of men 40 years of age and older reported they had a PSA test in the past 12 months, and 52.0% said they had a DRE in the last year.[115]

Melanoma

Melanoma of the skin accounts for 700-800 new cases of cancer each year in Connecticut. It is the fifth most commonly diagnosed cancer in men and the sixth most common in women (Table 5). The average annual incidence rate for melanoma of the skin among Connecticut males doubled between 1980-1984 and 1995-1999.[116] From 1997 to 2001 the incidence rate rose an average of 0.4% per year (Figure 2). Higher than expected numbers of skin melanomas have been found for certain Connecticut towns on the ocean shoreline and near lakes, suggesting excess exposure to the sun.[117]

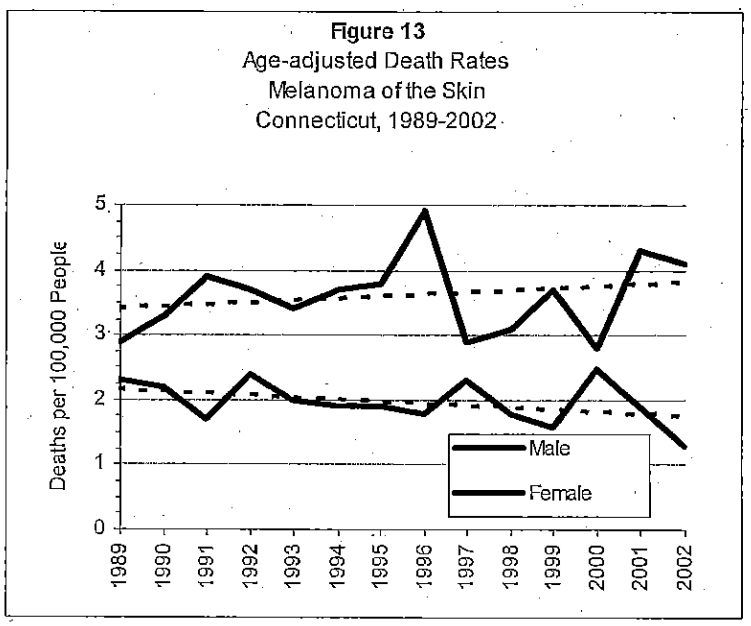
Melanoma of the skin is a disease that affects people of white race almost exclusively; only about 2% of new cases in the U.S. are found in people of color.[118] In Connecticut in 1999, 50% of melanomas were diagnosed at the local stage (Table 8). The 5-year relative survival rate (SEER) for melanomas diagnosed in 1995-2001 was 91.6% overall, 98.3% when diagnosed at local stages, and 16.0% when diagnosed at the distant stage.[119]

Age-adjusted death rates and linear trends in rates for melanoma of the skin among Connecticut males and females are shown in Figure 13. The death rates tend to be higher for males than for females. From 1997 to 2001, the overall age-adjusted death rate for melanoma of the skin increased by an average of 4.6% each year, which was the steepest increase among the selected cancers studied (Figure 7).[120]

Certain risk factors are linked strongly with melanoma of the skin. Risk is greatest for fair-skinned people who freckle or sunburn easily, and for those with a family history of melanoma. People who have multiple moles or large moles have an increased risk. Excessive exposure to UV radiation from the sun or from tanning lamps and beds, and a history of severe sunburns, especially during childhood, also increase risk. Protection from sun exposure and avoidance of artificial sources of UV radiation may help to prevent melanoma. In 2003, 34.4% of Connecticut adults reported they had a sunburn in the past year, and of this group, 64.5% reported two or more burns.[121]

Neither the ACS nor the USPSTF currently has specific screening recommendations for the early detection of melanoma of the skin.

Figure 13
Age-adjusted Death Rates
Melanoma of the Skin
Connecticut, 1989-2002



Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for melanoma of the skin after 1998 are about 3.2% lower than if coded by earlier definitions and rules.
Dotted lines show linear trends for males and females.

Ovarian Cancer

Ovarian cancer is the seventh most frequently diagnosed cancer among Connecticut women and accounts for about 300 new cancers annually (Table 5). The age-standardized incidence rate for ovarian cancer in Connecticut rose by 4.9% between 1980-1984 and 1995-1999,[122] and from 1997 to 2001 it declined by an average of 1.1% per year (Figure 2). Nationally, the incidence rate for ovarian cancer is about one-third lower for African American females than for whites.[123]

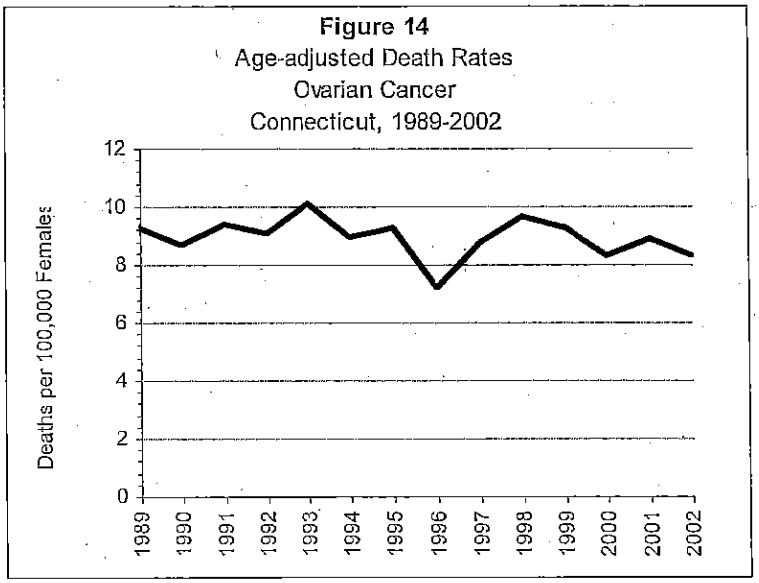
When detected at localized stages, the 5-year relative survival rate (SEER) for ovarian cancer is 93.6%; however, the early stages of ovarian cancer have no specific symptoms, so in 1995-2001, only 19% were diagnosed at local stages. The majority of ovarian tumors (68.1% in 1995-2001), are detected at the distant stage, when the 5-year relative survival rate is about 29%.[124]

In Connecticut, ovarian cancer is the fifth leading cause of cancer death among females and the fourth leading cause of cancer death among white females.[125] Age-adjusted death rates for ovarian cancer in Connecticut have fluctuated between about 8 and 10 deaths per 100,000 females from 1989-2002 (Figure 14), and from 1997-2001 rates declined by about 0.5% annually (Figure 7).[126]

The risk factors for ovarian cancer are not well understood. Although several risk factors (e.g., having no children) may increase the likelihood that a woman will develop ovarian cancer, most women who develop the disease have no known risk factors, and only a small proportion of women with risk factors ever develop the disease.[127] The risk of developing ovarian cancer increases with age, and in Connecticut in 2001, 56% of diagnosed ovarian cancers were found in women 60 years of age and over.[128]

Transvaginal sonography and the CA-125 blood test often are used to screen for ovarian cancer in women considered to be at high risk, but it is not known whether these tests are helpful.[129] Because of the low prevalence of ovarian cancer and the invasive nature of diagnostic testing after positive screening, the USPSTF recommends against routine screening for it.[130]

Figure 14
Age-adjusted Death Rates
Ovarian Cancer
Connecticut, 1989-2002



Source: Connecticut Department of Public Health, 2005
Note: Because of changes in cause-of-death coding in 1999, death rates for ovarian cancer after 1998 are about 0.46% lower than if coded by earlier definitions and rules.

REFERENCES

[1] U.S. Census Bureau. American FactFinder, Table P-2. Urban and rural [6] – Universe: Total Population, Data Set: Census 2000 Summary File 1 (SF-1). http://factfinder.csunsu.gov.

[2] Miringoff, M.L., M-L Miringoff, and S. Opkycke. 1996. *The Social State of Connecticut '96.* Tarrytown, NY: Fordham Institute for Innovation in Social Policy.

[3] Levy, D., O. Rodriguez, and W. Villemez. 2004. *The Changing Demographics of Connecticut–1990-2000. Part 2: The Five Connecticuts.* Storrs, CT: University of Connecticut, Center for Population Research, CPR Series, no. OP 2004-01.

[4] U.S. Census Bureau. Connecticut QuickFacts. http://quickfacts.census.gov/qfd/states/09000.html.

[5] U.S. Census Bureau. American FactFinder. Hartford City, New Haven City, and Bridgeport City, CT: Census 2000 Demographic Profile Highlights. http://factfinder.census.gov.

[6] U.S. Census Bureau. Table DP-1. Profile of General Demographic Characteristics: 2000. Census 2000 Summary File 1 (SF-1). http://factfinder.census.gov

[7] U.S. Census Bureau. Table DP-2. Social Characteristics: 1990. 1990 Summary Tape File 3 (STF3) – Sample Data.

[8] U.S. Census Bureau. Table DP-2. Profile of Selected Social Characteristics: 2000. Census 2000 Summary File 3 (SF3) – Sample Data: Connecticut. http://factfinder.census.gov

[9] U.S. Census Bureau. QTP-20. Educational Attainment by Sex: 2000. Census 2000 Summary File 3 (SF3) – Sample Data: United States. http://factfinder.census.gov

[10] Rodriguez, O., D. Levy, and W. Villermez. 2003. .2003. The Changing Demographics of Connecticut – 1990 to 2000. Part 1: Comparing Connecticut to National Averages. Storrs, CT: University of Connecticut, Center for Population Research. Occasional Paper No. OP 2003-01.

[11] Agency for Healthcare Research and Quality. 2004. *Literacy and Health Outcomes. Summary.* Evidence Report/Technology Assessment No. 87. AHRQ Publication No. 04-E007-1. http://www.ahrq.gov/clinic/epcsums/litsum.htm.

[12] U.S. Census Bureau. 2004. *Historical Poverty Tables.* Table 1. Weighted average poverty thresholds for families of specified size, 1959-2003. http://www.census.gov/hhes/poverty/histpov/hstpov1.html.

[13] U.S. Census Bureau. Table DP-1. Profile of General Demographic Characteristics: 2000. Census 2000 Summary File 1 (SF-1).

[14] Bishaw, A. and J. Iceland. *Poverty 1999. Census 2000 Brief.* http://www.census.gov/prod/2003pubs/c2kbr-19.pdf

[15] Per Capita Income by Race or Ethnicity. 2005. http://www.epodunk.com/cgi-bin/incomeOverview.php?locIndex=7

[16] Connecticut: Poverty Rate by Race/Ethnicity, State Data 2002-2003, U.S. 2003. Kaiser State Health Facts. http://www.statehealthfacts.kff.org.

[17] Rodriguez et al., *op. cit.*, p. 3.

[18] United Health Foundation. 2005. America's Health: State health Rankings – 2004 Edition. http://www.unitedhealthfoundation.org/shr2004/states/Connecticut.html

[19] Office of Health Care Access. 2005. *SNAPSHOT: Connecticut's Health Insurance Coverage.* Results of the Office of Health Care Access 2004 Household Survey. Hartford, CT: Office of Health Care Access. http://www.ct.gov/ohca/lib/ohca/publications/snapshotfinal.pdf

[20] Davis, K. and D. Rowland. 1983. Uninsured and underserved: inequities in health care in the United States. *Milbank Memorial Fund Quarterly* 61: 149-175.

[21] Franks, P., C.M Clancy, and M.R. Gold. 1993. Health insurance and mortality. *Journal of the American Medical Association* 270: 737-741.

[22] National Cancer Institute. www.cancer.gov/statecancerprofiles, April, 2003.

[23] National Cancer Institute. State Cancer Profiles. Latest Rates, Percents, and Counts. http://statecancerprofiles.cancer.gov/micromaps/

[24] Connecticut Tumor Registry. 2004. *Cancer Incidence in Connecticut 2001.* Hartford, CT: CT Department of Public Health. http://www.dph.state.ct.us/OPPE/pdfs/CancerIncidenceinCT2001.pdf

[25] Burns, E.A. and E.A. Leventhal. 2000. Aging, immunity, and cancer. *Cancer Control* 7: 13-522.

[26] American Cancer Society. 2005. Probability of Developing Invasive Cancers Over Selected Age Intervals, by Sex, U.S., 1999-2001. *Cancer Facts & Figures 2005.* Atlanta: American Cancer Society.

[27] Connecticut Tumor Registry, 2004, *op. cit.*

[28] Connecticut Tumor Registry. 2005. Unpublished data.

[29] National Cancer Institute. Quick Profile - State Cancer Profiles. 5-year Rate Changes. Incidence. Connecticut, 1997-2001. All ages, both sexes, all races. http://statecancerprofiles.cancer.gov/recenttrend/recenttrend.html

[30] National Cancer Institute. State Cancer Profiles. Latest Rates, Percents, and Counts. http://statecancerprofiles.cancer.gov/micromaps/

[31] Connecticut Department of Public Health. 2004. *Mortality and Its Risk Factors in Connecticut, 1989-1998.* Hartford, CT: CT Department of Public Health. http://www.dph.state.ct.us/OPPE/Mortality/chapt04bchronic2.pdf

[32] Connecticut Department of Public Health. 2005. Connecticut Resident Deaths, 1999-2001. Hartford, CT: CT Department of Public Health. (Unpublished data sheet.)

[33] Connecticut Department of Public Health, 2004, *op. cit.*

[34] Connecticut Department of Public Health, 2005, *op. cit.*

[35] U.S. Department of Health and Human Services. *Healthy People 2010, Volume I.* Washington D.C., 2000.

[36] National Cancer Institute. Quick Profile - State cancer profiles. 5-year rate changes. Incidence. Connecticut, 1997-2001. All ages, both sexes, all races. http://statecancerprofiles.cancer.gov/recenttrend/recenttrend.html

[37] Tomatis, L., J. Huff, [illegible] et al. 1997. Avoided and avoidable risks of cancer. *Carcinogenesis* 18: 97[illegible]

[38] Adapted from: Brownson, R.C., J.S. Reif, M.C. Alavanja, and D.G. Bal. 1998. Cancer. Pages 336-373 in: *Chronic Disease Epidemiology and Control*, 2nd Ed. R.C. Brownson, P.L. Remington, and J.R. Davis, editors. Washington, DC: American Public Health Association.

[39] *Except for condom use, data for adults are from*:
Centers for Disease Control and Prevention. 2004. Behavioral Risk Factor Surveillance System. Prevalence Data--Connecticut, 2003. http://apps.nccd.cdc.gov/brfss/page.asp?cat=XX&yr=2003&state=CT#XX

Data on condom use are from:
Connecticut Department of Public Health. 2000. Behavioral Risk Factor Surveillance System, 1998. Unpublished data from state-added questions on HIV/AIDS.

[40] *Except for condom use, data for students are from*:
Connecticut Department of Public Health. 2005. Youth Risk Behavior Surveillance Survey, 2003. Hartford, CT: Connecticut Department of Public Health.

Data on condom use are from:
Kann, L., S.A. Kinchen, B.I. Williams, et al. 2000. Youth Risk Behavior Surveillance—United States, 1999. *Morbidity and Mortality Weekly Report* 49(SS-5), 94 pp.

[41] van Zandwijk, N. 2001. Chemoprevention of lung cancer. *Lung Cancer* 34 (Supplement 3): S91-S94.

[42] Adams, M.L. 1994. The public health impact and economic cost of smoking in Connecticut—1989. *Connecticut Medicine* 58: 195-198.

[43] Centers for Disease Control and Prevention. 2005. Behavioral Risk Factor Surveillance System. Prevalence Data, Connecticut 2003. Tobacco Use: Four Level Smoking Status. http://apps.nccd.cdc.gov/brfss/display.asp?cat=TU&yr=2003&qkey=4394&state=CT

[44] Kann, L., S.A. Kinchen, B.I. Williams, et al. 2000. Youth Risk Behavior Surveillance—United States, 1999. *Morbidity and Mortality Weekly Report* 49(SS-5), 94 pp.

[45] Brownson, R.C., J.S. Reif, M.C.R. Alavanja, and D.G. Bal. 1998. Cancer. Pages 336-373 in: *Chronic Disease Epidemiology and Control,* 2nd Ed. R.C. Brownson, P.L. Remington, and J.R. Davis, editors. Washington, DC: American Public Health Association.

[46] Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Prevalence Data. Connecticut--2003. Fruits and Vegetables. http://apps.nccd.cdc.gov/brfss/display.asp?cat=FV&yr=2003&qkey=4415&state=CT

[47] Connecticut Department of Public Health. 2005. Analysis of Aggregated Data from the Behavioral Risk Factor Surveillance System, 2001-2003. Unpublished.

[48] Adams, M. 2000. Connecticut Behavioral Health Risks: Factors Related to Cancer. Hartford, CT: Connecticut Department of Public Health. 48 pp.

[49] American Cancer Society. 2004. *Cancer Facts & Figures 2004.* Atlanta: American Cancer Society. 58 pp.

[50] Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Prevalence Data. Connecticut--2002. Risk Factor for Heavy Drinking. http://apps.nccd.cdc.gov/brfss/display.asp?cat=RF&yr=2002&qkey=4413&state=CT

[51] *Ibid.*

[52] Friedenreich, C. 1999. Cancer prevention and physical activity. *Active Review*, vol. 2, no. 2. http://www.centre4activeliving.ca/Publications/ActiveReview/Cancer.html

[53] Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Prevalence Data. Connecticut—2003. Physical Activity.

[54] Connecticut Department of Public Health. 2005. Analysis of Aggregated Data from the Behavioral Risk Factor Surveillance System, 2001-2003. Unpublished.

[55] National Cancer Institute. 2005. Obesity and Cancer: Questions and Answers. Cancer Facts 3.70. http://cis.nci.nih.gov/fact/3_70.htm

[56] Connecticut Department of Public Health. 2005. Analysis of Aggregated Data from the Behavioral Risk Factor Surveillance System, 2001-2003. Unpublished.

[57] Marshall, B.J. and H.M. Windsor. 2005. The relation of *Helicobacter pylori* to gastric adenocarcinoma and lymphoma: pathophysiology, epidemiology, screening, clinical presentation, treatment, and prevention. *Medical Clinics of North America* 89: 313-344.

[58] Fattovich, G., T. Stroffolini, I. Zagni, and F. Donato. 2004. Hepatocellular carcinoma in cirrhosis: incidence and risk factors. Gastroenterology 127(5 Suppl. 1):S35-50.

[59] Franceschi, S. 2005. The IARC commitment to cancer prevention: the example of papillomavirus and cervical cancer. *Recent Results in Cancer Research* 166:277-297.

[60] Ho, G.Y.F., R. Bierman, L. Beardsley, et al. 1998. Natural history of cervicovaginal papillomavirus infection in young women. *New England Journal of Medicine* 338: 423-428.

[61] Manhart, L.E. and L.A. Koutsky. 2002. Do condoms prevent genital HPV infection, external genital warts, or cervical neoplasia? A meta-analysis. Sexually Transmitted Diseases 29: 725-735/

[62] Connecticut Department of Public Health, AIDS Counseling and Testing Program. 2001. Analysis of supplemental questions from the 1998 Connecticut BRFSS survey. Unpublished.

[63] Kann, L., S.A. Kinchen, B.I. Williams, et al. 2000. Youth Risk Behavior Surveillance -- United States, 1999. Morbidity and Mortality Weekly Report. 49(SS-5). 96 pp.

[64] International Agency For Research on Cancer. 1992. *IARC Monographs on the Evaluation of Carcinogenic Risk to Humans.* Vol. 55. Solar and ultraviolet radiation. Lyon: IARC Press.

[65] Gallagher, R.P., J.J. Spinelli, and T.K. Lee. 2005. Tanning beds, sunlamps, and risk of cutaneous malignant melanoma. *Cancer Epidemiology, Biomarkers & Prevention* 14(3):562-566.

National Cancer Institute. 2005. NCI health information tip sheet for writers. Artificial tanning booths and cancer. http://www.nci.nih.gov/newscenter/tip-sheet-tanning-booths

[66] Centers for Disease Control and Prevention. 2004. Behavioral Risk Factor Surveillance System. Connecticut 2003 Core Variables Report, Section 13: Excess Sun Exposure, Tables 1 and 4

[67] Toal, B.F., C.J. Dupuy, L.M. Rothney, et al. 1989. Epidemiologic notes and reports. Radon exposure assessment--Connecticut. *Morbidity and Mortality Weekly Report* 38: 713-714.

[68] Harvard Center for Cancer Prevention. 1996. Harvard Report on Cancer Prevention. Volume 1: Causes of Human Cancer. *Cancer Causes and Control* 7(Supplement). http://www.hsph.harvard.edu/cancer/publications/reports/vol1_full_text/vol1_ses.html

[69] American Cancer Society. 2001. *Cancer Control, State-of-the-Science Guide.* Atlanta, GA.

[70] Singh, G.K., G.A. Miller, B.F. Hankey, and B.K. Edwards. 2003. *Area Socioeconomic Variations in U.S. Cancer Incidence, Mortality, Stage, Treatment, and Survival, 1975-1999.* NCI Cancer Surveillance Monograph Series, No. 4. Bethesda, MD: national Cancer Institute.

[71] van Zandwijk, *op. cit.*

[72] Connecticut Tumor Registry. 2002. *Cancer Incidence in Connecticut, 1995-99.* Hartford, CT: Connecticut Department of Public Health.

[73] Connecticut Department of Public Health. 2005. Connecticut Resident Deaths. Age-adjusted Mortality Rates, 1989-1998. Hartford, CT: CT Department of Public Health. (Unpublished data sheets.)

[74] U.S. Cancer Statistics Working Group. 2004. *United States Cancer Statistics: 2001 Incidence and Mortality.* Atlanta: Department of Health and Human Services, Centers for Disease Control and prevention and National Cancer Institute.

[75] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002.* http://seer.cancer.gov/csr/1975_2001/results_merged/sect_15_lung_bronchus.pdf

[76] *Ibid.*

[77] U.S. Cancer Statistics Working Group, *op cit.*

[78] Polednak, A.P. 2002. Cancer Incidence in Connecticut, 1980-1998. Hartford, CT: Connecticut Tumor Registry.

[79] Polednak, A.P. 2001. Cancer Incidence in Connecticut, 1995-1999. Hartford, CT: Connecticut Tumor Registry.

[80] Connecticut Department of Public Health. Connecticut Resident Deaths, 1989-1998. Unpublished data sheets.

[81] Olsen, J.C. and C.E. Bower. 2001. Breast cancer. Pages 58-68 in *Connecticut Women's Health.* Hartford, CT: Connecticut Department of Public Health.

[82] Brownson, R.C., J.S. Reif, M.C.R. Alavanja, and D.G. Bal. 1998. Cancer. Pages 336-373 in: *Chronic Disease Epidemiology and Control,* 2nd Ed. R.C. Brownson, P.L. Remington, and J.R. Davis, editors. Washington, DC: American Public Health Association.

[83] Connecticut Tumor Registry. 2004. *Connecticut Cancer Surveillance, 1990-2000.* Hartford, CT: Connecticut Department of Public Health.

[84] Henderson, B.E., M.C. Pike, R.K. Ross, et al. 1984. Epidemiology and Risk Factors. Pages 15-33 in: Bonadonna, G., ed. *Breast Cancer: Diagnosis and Management.* Chichester, NY: John Wiley and Sons.

[85] Lochhead, C. 2000. The trend toward delayed first childbirth: health and social implications. *ISUMA (Canadian Journal of Policy Research)* 1(2):41-44.

[86] Mathews, T.J. and B.E. Hamilton. 2002. Mean age of mother, 1970-2000. *National Vital Statistics Reports* 51(1):1-16.

[87] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002.* http://seer.cancer.gov/csr/1975_2002/results_merged/sect_04_breast.pdf

[88] Connecticut Tumor Registry. 2002. *The Connecticut Tumor Registry*. Hartford, CT: Connecticut Department of Public Health.

[89] American Cancer Society. 2005. Cancer Facts & Figures 2005. http://www.cancer.org/downloads/STT/CAFF2005f4PWSecured.pdf

[90] U.S. Preventive Services Task Force. 2002. Screening for breast cancer: recommendations and rationale. Annals of Internal Medicine 137(5 Part 1):344-6. http://www.guidelines.gov/summary/summary.aspx?doc_id=3419&nbr=2645&string=uspstf

[91] Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Prevalence Data. Connecticut--2002. http://apps.nccd.cdc.gov/brfss/page.asp?cat=WH&yr=2002&state=CT#WH

[92] Connecticut Tumor Registry. 2002. *Cancer Incidence in Connecticut, 1995-1999*. Hartford, CT: Connecticut Department of Public Health.

[93] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002*. http://seer.cancer.gov/csr/1975_2002/results_merged/topic_med_age.pdf

[94] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002*. http://seer.cancer.gov/csr/1975_2002/results_merged/sect_06_colon_rectum.pdf

[95] Connecticut Department of Public Health. Connecticut Resident Deaths, 2002. Unpublished data sheet.

[96] Connecticut Department of Public Health. 2004. *Mortality and Its Risk Factors in Connecticut, 1989-1998*. Hartford, CT: CT Department of Public Health. http://www.dph.state.ct.us/OPPE/Mortality/chapt04bchronic2.pdf

[97] American Cancer Society. 2005. *Detailed Cancer Guide. Colon and Rectum Cancer.* http://www.cancer.org/docroot/CRI/CRI_2_3x.asp?rnav=cridg&dt=10

[98] *Ibid.*

[99] American Cancer Society. *Cancer Facts & Figures 2005.* http://www.cancer.org/downloads/STT/CAFF2005f4PWSecured.pdf

[100] U.S. Preventive Services Task Force. 2002. *Screening for Colorectal Cancer: Recommendations and Rationale*. Agency for Healthcare Research and Quality, Rockville, MD. http://www.ahrq.gov/clinic/3rduspstf/colorectal/colorr.htm

[101] Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Prevalence Data. Connecticut--2002. http://apps.nccd.cdc.gov/brfss/page.asp?cat=WH&yr=2002&state=CT#WH

[102] U.S. Cancer Statistics Working Group, *op cit.*

[103] Connecticut Tumor Registry. 2002. *Cancer Incidence in Connecticut, 1995-1999*. Hartford, CT: Connecticut Department of Public Health.

[104] Connecticut Tumor Registry. 2004. *Connecticut Cancer Surveillance, 1990-2000*. Hartford, CT: Connecticut Department of Public Health.

[105] Connecticut Tumor Registry. 2004. *Cancer Incidence in Connecticut, 2001*. Hartford, CT: Connecticut Department of Public Health.

[106] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002*. http://seer.cancer.gov/csr/1975_2002/results_merged/sect_22_prostate.pdf

[107] Connecticut Department of Public Health. Connecticut Resident Deaths, 2002. Unpublished data sheet.

[108] Connecticut Department of Public Health. 2004. *Mortality and Its Risk Factors in Connecticut, 1989-1998*. Hartford, CT: CT Department of Public Health. http://www.dph.state.ct.us/OPPE/Mortality/chapt04bchronic2.pdf

[109] Connecticut Department of Public Health. Connecticut Resident Deaths. Unpublished data sheets.

[110] National Cancer Institute. State Cancer Profiles. 5-Year Rate Changes. Incidence and Mortality. Connecticut, 1997-2001. http://statecancerprofiles.cancer.gov/cgi-bin/quickprofiles/profile.pl?09&001

[111] Dagnelie, P.C., A.G. Schuurman, R.A. Goldbohm, and P.A. Van den Brandt. 2004. Diet, anthropometric measures and prostate cancer risk: A review of prospective cohort and intervention studies. *BJU International* 93: 1139-1150.

[112] Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Prevalence Data. Connecticut--2003. Fruits and Vegetables. http://apps.nccd.cdc.gov/brfss/sex.asp?cat=FV&yr=2003&qkey=4415&state=CT

[113] American Cancer Society. 2005. ACS Cancer Detection Guidelines. http://www.cancer.org/docroot/PED/content/PED_2_3X_ACS_Cancer_Detection_Guidelines_36.asp

[114] U.S. Preventive Services Task Force. 2002. Prostate Cancer for Screening. Summary of Recommendations. http://www.ahrq.gov/clinic/uspstf/uspsprca.htm

[115] North Carolina State Center for Health Statistics. 2002 BRFSS Survey Results: nationwide Data. Prostate Cancer Screening. http://www.schs.state.nc.us/SCHS/brfss/2002/us/psatest.html

[116] Connecticut Tumor Registry. 2002. *Cancer Incidence in Connecticut, 1995-1999*. Hartford, CT: Connecticut Department of Public Health.

[117] Connecticut Tumor Registry. 2002. *Incidence of Selected Cancers in Connecticut by Town: 1995-1999*. Hartford, CT: Connecticut Department of Public Health. http://www.dph.state.ct.us/OPPE/pdfs/town95to99.pdf

[118] U.S. Cancer Statistics Working Group, *op. cit.*

[119] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002*. http://seer.cancer.gov/csr/1975_2002/results_merged/sect_16_melanoma.pdf

[120] National Cancer Institute. State Cancer Profiles. 5-Year Rate Changes. Incidence and Mortality. Connecticut, 1997-2001. http://statecancerprofiles.cancer.gov/cgi-bin/quickprofiles/profile.pl?09&001

[121] Behavioral Risk Factor Surveillance System. 2004. Connecticut 2003 Core Variables Report.

[122] Connecticut Tumor Registry. 2002. *Cancer Incidence in Connecticut, 1995-1999*. Hartford, CT: Connecticut Department of Public Health.

[123] U.S. Cancer Statistics Working Group, *op. cit.*

[124] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002*. http://seer.cancer.gov/csr/1975_2002/results_merged/sect_16_melanoma.pdf

[125] U.S. Cancer Statistics Working Group, *op. cit.*

[126] National Cancer Institute. State Cancer Profiles. 5-Year Rate Changes. Incidence and Mortality. Connecticut, 1997-2001. http://statecancerprofiles.cancer.gov/cgi-bin/quickprofiles/profile.pl?09&001

[127] American Cancer Society. 2005. Detailed Guide to Cancer. Ovarian Cancer. What Are the Risk Factors for Ovarian Cancer? http://www.cancer.org/docroot/CRI/content/CRI_2_4_2X_What_are_the_risk_factors_for_ovarian_cancer_33.asp?rnav=cri

[128] Connecticut Tumor Registry. 2004. *Cancer Incidence in Connecticut, 2001*. Hartford, CT: Connecticut Department of Public Health.

[129] American Cancer Society. 2005. Detailed Guide: Ovarian Cancer. Can Ovarian Cancer Be Found Early? http://www.cancer.org/docroot/CRI/content/CRI_2_4_3X_Can_ovarian_cancer_be_found_early_33.asp?rnav=cri

[130] U.S. Preventive Services Task Force. 2004. *Screening for Ovarian Cancer*. http://www.ahrq.gov/clinic/uspstf/uspsovar.htm

3. Preventing Cancer Before It Starts

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PREVENTING CANCER BEFORE IT STARTS

VISION

All Connecticut residents will be engaged in the support and practice of individual and community risk reduction behaviors and activities to reduce cancer incidence

The Prevention Committee studied data on the risk factors for the most common types of cancer, determined the critical areas of burden and of high-risk populations, and assessed gaps in present programming to determine prevention goals and objectives for the Connecticut Comprehensive Cancer Control Plan.

GOAL

Reduce cancer risk through promoting healthy lifestyles and risk reduction behaviors among children and adults

WHY THIS GOAL IS IMPORTANT

1. **Tobacco.** About 5,000 Connecticut residents die each year from smoking related illnesses, about 2,000 of which are cancers.[1]
2. **Nutrition and physical activity.** Higher consumption of fruits and vegetables and regular physical activity may lower risk of developing some cancers. Obesity is associated with increased risk for many cancers.
3. **Environmental exposures, especially sun.** Exposure to ultra-violet radiation from the sun and artificial tanning devices is associated with an increase in both melanoma of the skin and the more common non-melanoma skin cancers.
4. **Excessive alcohol use.** Excessive consumption of alcoholic drinks is associated with oral, laryngeal, pharyngeal, liver, and esophageal, cancers and possibly other cancers.
5. **Unprotected sex.** Human papillomavirus (HPV), which is transmitted by sexual contact, is an established cause of cervical cancer in women.

TOBACCO

About a third of all cancer deaths have been attributed to tobacco use. Although smoking rates have declined in recent years in Connecticut, an estimated 500,000 adults (18.6%) still smoke every day or some days.[2] In addition to adult smokers, more than 60,000 middle and high school students currently smoke.[3] This number does not include high school dropouts, who are known to have higher smoking rates compared to students their ages who remain in school. More than 70% of middle and high school smokers think they could quit smoking now if they wanted to, but only half of current smokers in middle school and two-thirds of those in high school want to quit, and more than 60% were unable to remain off cigarettes for at least 30 days during their last quit attempt.

Every year, 48,000 Connecticut students reach the age of 11, which is the current average age of smoking initiation among eighth graders who are smoking. If this trend continues, 56,000 Connecticut youth will eventually die prematurely from smoking.[4]

The CDC's Community Guidelines[5] identified four interventions for which the evidence is strongest for reducing tobacco use:

1. Increasing the unit price for tobacco.
2. Smoking bans and restrictions.
3. Media campaigns with interventions.
4. Comprehensive cessation programs.[6]

Connecticut's tobacco tax and smoking bans are among the nation's most effective and meet the Guidelines, but Connecticut lacks the comprehensive tobacco cessation services and media campaigns that can be expected to dramatically reduce our state's tobacco use. For example, from 2002 to 2003 New York City experienced the most significant one-year drop in tobacco use ever recorded.[7] New York City credited its 11 % reduction to increasing its cigarette tax, its smoke free air act, and its cessation and public education programs. These are the four critical elements identified by the CDC Guidelines. Connecticut has done the first two. By adding the last two we can expect to see significant reductions in smoking, preventing thousands of tobacco-related deaths and saving millions of health dollars.

In 1999 in Connecticut, the economic cost of smoking was $2.14 billion, or about $3,732 per adult[a] smoker. Adult smoking-attributable medical expenditures totaled $1.27 billion or 9% of total expenditures for health care, and lost productivity attributable to smoking among adults cost $859 million.[8] For lung cancer, alone, Connecticut inpatient hospital charges in 2001 were $44.4 million, or more than $21,000 per hospitalization.[9]

Connecticut's tobacco tax of $1.51 now ranks sixth in the country, and an increase of 74 cents has been proposed. Although it is among the highest in the nation, it is in line with our neighboring states, and has much room to grow. Rhode Island currently leads the nation with $2.46, the cigarette tax in Massachusetts is $1.51, New York has a $1.50 tax, with an additional New York City tax of $1.50, and New Jersey's tax is $2.40.

The *Connecticut Tobacco Use Prevention and Control Plan,* produced in 2002 by the Connecticut Department of Public Health and Department of Mental Health and Addiction Services with funding from the State Legislature, is a plan that is comprehensive, sustainable, evidence-based, and data-driven. Its recommendations closely following CDC's *Best Practices for Comprehensive Tobacco Control Programs* call for comprehensive state and local action directed at social and environmental changes. It includes examples of some unique and effective programs, such as regional coalitions, and it addresses the important target population groups whose smoking rates are the highest. The Connecticut Cancer Partnership is committed to supporting the goals and objectives of this plan and advocating for funding its implementation.

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[a] In 1999 there were an estimated 572,053 smokers 18+ years of age in Connecticut. (2001 Behavioral Risk Factor Surveillance System, Connecticut data.)

PREVENTION OBJECTIVE 1:
Decrease the proportion of adults (≥ 18 years) and youths (high school and middle school students) who currently use tobacco, paying special attention to populations experiencing tobacco-related disparities

Baseline

Adults: 18.6% (BRFSS, 2003)
High school: 22.5% (30-day prevalence, CYTS 2002)
Middle school: 5.9% (30-day prevalence, CYTS 2002)

Targets

Adults: 17.5% (BRFSS)
High school: 20.0% (30-day prevalence, CYTS)
Middle school: 5.0 % (30-day prevalence, CYTS)

Strategies

1. Support creating statewide smoking cessation program that meets Public Health Service and National Action Plan guidelines, including evidence-based counseling, pharmacotherapy, and a marketing campaign. These interventions should be available at no charge to the Medicaid and uninsured population
2. Advocate for an increase in the state tobacco tax sufficient to fund the state cancer and tobacco plans
3. Help initiate a statewide tobacco education media campaign like those shown to be effective in other states such as Florida and California
4. Support implementation of "Connecticut Tobacco Use Prevention and Control Plan," through advocating a combination of federal, state, and local funding
5. Advocate for implementation of local tobacco prevention and control plans.
6. Advocate for "Coordinated School Health Councils" throughout the state
7. Develop a forum for pharmaceutical, managed care, and industry (employers) to discuss pilot smoking cessation programs for employees that include pharmacotherapy products
8. Secure funding for Quitline services to continue in the state
9. Increase Smoke-Free College and University programs; identify effective programs and provide a forum and communications link (Partnership web site) for sharing effective programs

How Results Will Be Evaluated

1. Reduced adult and youth tobacco use
2. Increase in state tobacco tax
3. Initiation of statewide tobacco cessation program
4. Funding allocated to support implementation of state tobacco use prevention and control plan
5. Funding allocated to support implementation of local plans
6. Coordinated School Health Councils established throughout the state
7. Forum conducted, policy change language developed; pilot programs identified
8. Funding achieved for Quitline to 2007
9. Smoke Free College and University programs increased; resource list of effective programs and website material produced

NUTRITION, PHYSICAL ACTIVITY, AND OBESITY

Poor nutrition, the lack of physical activity, and obesity are interacting risk factors for several types of cancer. Current patterns of overweight and obesity in the United States could account for an estimated 14% of all deaths from cancer in men and 20% of those in women. In both men and women, body-mass index is significantly associated with higher rates of death due to cancer of the esophagus, colon and rectum, liver, gallbladder, pancreas, and kidney; the same is true for death due to non-Hodgkin's lymphoma and multiple myeloma. Significant trends of increasing risk with higher body-mass-index values have been observed for death from cancers of the stomach and prostate in men and for death from cancers of the breast, uterus, cervix, and ovary in women.[10] (Overweight is defined as having a body mass index (BMI) of 25 to 29.9, and obesity as a BMI of 30 or greater.[11]) Low intake of fruits and vegetables may be associated with an increased risk of several cancers, including colon, laryngeal, oral, and lung. Physical activity is related to both colon and breast cancers; the relationship to other cancers is still being investigated.

During the past decade Americans have been using the *Nutrition Facts* labels to choose healthier packaged foods. Unfortunately, working people increasingly eat meals outside the home where virtually no nutrition information is readily available. Research shows that while the *Nutrition Facts* label has led producers to reduce the amount harmful fat, sugar, salt, and calories in packaged food, the lack of labeling in restaurants has contributed to the steadily higher fat, sugar, salt, and calories observed in restaurant fare. When restaurant menus contain nutritional information, sales of more healthful foods increase.[12] To help people make healthier food choices, the Prevention Committee supports legislation to require large chain restaurants to put simple nutrition information, such as calories and the amount of fat, sugar, and salt, on their menu boards or menus.

It is clear that advocacy and policy change, along with community mobilization, need to be included in our program. Several resources, itemized below, are already being used to develop a coordinated program for Connecticut.

1. CDC's *Active Community Environment Initiative,* promoting walking, bicycling and the development of accessible recreation facilitates
2. Connecticut Department of Public Health's Obesity Program
3. NECON's (New England Coalition of Health Promotion and Disease Prevention) *Plan for Prevention and Control of Overweight and Obesity in New England*
4. AHRQ's (Agency for Healthcare Research and Quality) *Put Prevention into Practice* program, with resources for clinicians, patients, and office systems to increase the delivery of preventive services in primary care settings
5. The new *Dietary Guidelines for Americans 2005* developed by the U.S. Departments of Agriculture and Health and Human Services

Data concerning nutrition, overweight/obesity, and physical activity are being used to guide program development in Connecticut. Some of the pertinent data are highlighted below.[13]

1. Although 60% of New England women and 40% of men believe that eating fruits and vegetables 'very likely' reduces cancer risks, less than one-third of Connecticut adults reported eating five or more fruits and vegetables daily.
2. Although 52% of women and 39% of men rated getting regular physical activity as 'very likely' to reduce one's risk of cancer, 68% of Connecticut adults reported mostly sitting or standing while at work and 21% reported they engage in no leisure time physical activity or exercise.

3. Compared to white non-Hispanics, African American non-Hispanics were 58% more likely and Hispanics were twice as likely to report having no leisure time physical activity (19%, 30%, and 39%, respectively).
4. Although 49% of women and 38% of men rated maintaining a healthy weight as 'very likely' to reduce one's risk of cancer, the proportion of overweight or obese adults in Connecticut has increased progressively during the past decade, and reached its highest levels of about 67% for men and about 44% for women in 2003.
5. The percentages of overweight or obese adults by race and ethnicity were: white, non-Hispanic, 54%; African American non-Hispanic, 70%; and Hispanic, 63%.

PREVENTION OBJECTIVE 2

Increase the proportion of adults (≥ 18 years) and youths (< 18 years) who make healthy food choices, including increasing consumption of fruits and vegetables to meet current HHS and USDA Dietary Guidelines for Americans

Baseline

Adults: 29.8%, consume at least 5 daily servings of fruits and vegetables (BRFSS 2003)
High school students: 21.6%, consume at least 5 daily servings (CT School Health Survey 2003)

Targets

Adults: 35.0% meet current Dietary Guidelines for Americans[b] (BRFSS)
Youth: 40.0% meet current Dietary Guidelines for Americans (CT School Health Survey)

Strategies

1. Advocate for nutrition labeling in chain restaurants
2. Advocate for changes in policies and curriculum to better support healthier eating and education about nutrition in schools
3. Advocate for a program of Coordinated School Health Councils
4. In conjunction with CDC's National Partnership 5-to-9-A-Day plan, develop a coordinated effort to increase consumption of fruits and vegetables to meet current Dietary Guidelines for Americans
5. Develop and implement a campaign targeted to community physicians for discussion with their patients to promote fruits and vegetables as well as guidelines related to calories, fats, and carbohydrates
6. Identify partners in food business and industry that can help make changes
7. Review existing data regarding barriers and motivating factors for healthy nutrition for all age and ethnic groups; identify best practices for implementation
8. Advocate for intervention research

How Results Will Be Evaluated

1. Restaurant labeling law introduced and supported by state leaders
2. New policies and curriculum instituted
3. Coordinated School Health Councils established
4. Partnership on 5-to 9-A-Day and coordinated effort developed
5. Campaign for pediatricians developed and implemented
6. New food industry partners committed to helping
7. Best practices identified and integrated into program

[b] Dietary Guidelines for Americans, Fruit and Vegetable Intake: To meet nutrient adequacy recommendation, a range of 5-13 servings of fruits and vegetables each day is recommended for daily energy intakes of 1,200-3,200 calories. For a 2,000 calorie daily energy intake, 9 servings (4 ½ cups) are recommended.

PREVENTION OBJECTIVE 3
Decrease the proportion of adults (≥ 18 years) and high school students who engage in no leisure time physical activity or exercise

Baseline
Adults: 21.0% (BRFSS 2003)
High school students: 9.7% (CT School Health Survey, 2003)

Targets
Adults: 17.0% (BRFSS)
High school: N/A

Strategies
1. Advocate for changes in policies and curriculum to better support and increase amount of physical activity for all students
2. Advocate for tax breaks for physical activity programs such as building walking trails
3. Develop and implement a campaign targeted to community physicians to encourage discussing need for physical activity with patients
4. Identify partners for long term strategies (DPH Obesity Program, CVD Program)
5. Review existing data regarding barriers and motivating factors for physical activity for all age and ethnic groups; identify best practices for implementation
6. Review materials to identify additional advocacy strategies for implementation
7. Advocate for intervention research in this area

How Results Will Be Evaluated
1. New policies and changes in school programs and curricula
2. Laws regarding physical activity tax breaks passed
3. Program for use with pediatricians developed and implemented
4. Partners identified and recruited; pooled resources and knowledge available
5. Report with findings and recommendations on how to impact change; best practices identified
6. Advocacy strategies identified and implemented
7. Funding for research achieved

PREVENTION OBJECTIVE 4
Reduce the percentage of overweight and obese adults (≥ 18 years) and children

Baseline
Overweight adults: men 45.7%, women 25.9%, (BRFSS 2003)
Obese adults: men 19.9%, women 18.3%, (BRFSS 2003)
High school students: 11.6% (CT School Health Survey, 2003)

Targets
Overweight adults: men 40.0%, women 20.0% (BRFSS)
Obese adults: men 15.0%, women 15.0% (BRFSS)
High school: 6.0% (CT School Health Survey))

Strategies
1. Advocate for nutrition labeling in chain restaurants

2. Advocate for changes in school food programs and curriculum
3. Develop plan to coordinate with ongoing programs and to involve new collaborating partners
4. Advocate for research to find effective intervention strategies
5. Advocate for Connecticut to participate in YRBS questions on this topic

How Results Will Be Evaluated

1. Restaurant labeling law introduced and supported by state leaders
2. Changes made in school food programs and in curriculum
3. New partners involved; plan developed
4. New research results on interventions

ENVIRONMENTAL EXPOSURES

The issues surrounding environmental exposures as risk factors for cancer are complex. Hundreds of chemicals, drugs, and other substances are known, probable, or possible human carcinogens,[14] though most people are unlikely to be exposed to them, and some naturally occurring substances in the environment (e.g., radon) are known to increase the risk of developing cancer. Exposure to ultraviolet (UV) radiation from sunlight and from artificial tanning lamps can damage DNA, the critical genetic material in cells. Damage of DNA in skin cells can sometimes lead to skin cancer.

There are two primary forms of skin cancer: non-melanoma and melanoma. Non-melanoma, the most common form, occurs in either basal or squamous skin cells that are located at the base of the outer layer of the skin, and rarely results in death. Compared to non-melanoma skin cancer, melanoma skin cancers are much less common, develop from the cells that produce skin color, and can be fatal. Higher rates of skin cancer occur in certain affluent communities and ocean shoreline towns of Connecticut, and are believed to be related, at least in part, to differences in recreational sun exposure.[15] Sun-protective behaviors can lead to substantial reductions in sun exposure, thereby reducing the risk of developing either melanoma and non-melanoma skin cancer.

Most occupations in the United States do not present a risk for getting cancers. However, in some industries exposure to a range of carcinogens can present a hazard to workers over time. Protection from cancer risk in the workplace is essential and involves a combination of aggressive, scientifically based regulations, worker education and surveillance.

Some programs that evaluate and regulate environmental toxins and exposures already exist. The Radon Program at the Connecticut Department of Public Health provides educational outreach activities to the general public, and free testing devices are part of its outreach efforts. The Toxic Hazards Assessment Program at DPH evaluates and quantifies health risks from exposures to environmental contaminants, and attempts to decrease these risks by working with the Department of Environmental Protection (DEP) and informing the public and health care professionals about environmental hazards. DEP is the state regulatory agency that reviews and investigates environmental issues and identifies exposure problems. The Environmental Public Health Tracking Program is developing a comprehensive system for linking and reporting environmental, human exposure, and health effects data. The DPH Environmental Epidemiology group is working on a plan to add questions about perception of environment-related risks to the BRFSS survey.

PREVENTION OBJECTIVE 5

Increase the public's awareness of cancer-related environmental exposures and protective measures

Baseline

Not available

Strategies

1. Establish baseline and targets
2. Identify methods and develop program to increase knowledge and understanding of environmental exposures to cancer, especially radon, pesticides, and home use products
3. Improve partnership with federal, state and local governments, business and communities to reduce known exposures and to identify environmental risk factors
4. Identify new partners to support efforts

How Results Will Be Evaluated

1. Baseline established
2. Methods identified and implemented
3. Partnership improved
4. New partners identified and added to effort

PREVENTION OBJECTIVE 6

Increase the practice of sun protection behaviors, especially among youth

Increase awareness of risk of overexposure to ultraviolet light in tanning booths

Baseline

Not available

Strategies

1. Establish baseline and targets.
2. Develop and implement a pilot program for elementary school children and their parents to educate them about the harms from UV exposure, especially to children, and to reduce the children's lifetime risk of skin cancer
3. Advocate for policies such as trees in schoolyards, the wearing of protective clothing and wraparound sunglasses with UV absorption factor
4. Develop and implement a campaign for pediatricians to inform parents about caring for the skin of babies and young children
5. Develop program to develop baseline information including questions in BRFSS
6. Review best practice education and policy models about UV light in tanning booths and develop implementation strategies

How Results Will Be Evaluated

1. Baseline established
2. Pilot program implemented
3. Policy changes made
4. Campaign for pediatricians developed and implemented
5. Questions added to BRFSS; baseline developed
6. Tanning booths program developed

ALCOHOL USE

Excessive alcohol intake is related to several forms of cancer. Alcohol use increases the risk of developing esophageal, mouth, and throat cancers. The combination of smoking and drinking alcohol magnifies this risk. Alcohol is also a significant risk factor for liver cancer and may be associated with a modest increase in breast cancer. Although moderate alcohol consumption may decrease the risk of heart disease and stroke,[16] the benefits and risks of alcohol consumption should be weighed carefully by individuals and viewed in the context of other risk factors. The American Cancer Society's recommendation (for those who drink) is to limit intake to two drinks per day for men and one per day for women.

PREVENTION OBJECTIVE 7

Reduce the percentage of adults and adolescents who engage in excessive drinking, which is defined as greater than 2 drinks per day for males and 1 drink per day for females

Baseline

Males: 7.2% (BRFSS 2003)
Females: 6.3% (BRFSS 2003)
Adolescents: 27.2% (YRBS 2003-- 5 or more drinks on 1 or more occasions in the last month)

Targets

Males: 3.0% (BRFSS)
Females: 3.0% (BRFSS)

Strategies

1. Partner with groups such as MAAD and mental health organizations to help support effort
2. Create program targeting physicians to help support discussion with patients regarding risks associated with alcohol use and cancer
3. Develop forum, through Partnership's web site and other means, to share effective programs

How Results Will Be Evaluated

1. Partnerships with groups organized
2. Program for physicians created
3. Communications forums established

MULTIPLE SEX PARTNERS AND UNPROTECTED SEX

Human papillomavirus (HPV), a sexually transmitted disease, is thought to be necessary for the development of cervical cancer. In many cases, risk for contracting the virus can be reduced by decreasing potential exposure to the virus, such as by limiting the number of lifetime sexual partners, avoiding partners who have had multiple sexual partners, and by women delaying their first sexual experience until they are older.

While there is no consistent evidence that condoms protect against HPV transmission, condom use is associated with lower rates of cervical cancer. The use of condoms should not be substituted, however, for routine screenings with Pap smears to detect and prevent cervical cancer (see Section 4, *Increasing Early Detection*). In Connecticut in 1998, the only year for which data are available, 89% of adults 18 years of age and older (86% of males and 93% of females) reported they had only one sex partner in the past year. Of this group, only 16% said they used condoms every time they had sexual intercourse. Among adults who had multiple sex partners (the higher risk group), 39% (46% of males and 27% of females) said they used a condom every time.[17]

PREVENTION OBJECTIVE 8
Increase to 50% the proportion of adults 18-64 years of age who always use condoms if sexually active with more than one sex partner

Baseline
Females: 26.5% (BRFSS 1998)
Males: 46.0% (BRFSS 1998)

Target
Females: 50.0% (BRFSS)
Males: 50.0% (BRFSS)

Strategies
1. Advocate for implementation of education and control plans
2. Advocate for Coordinated School Health Councils throughout the state

How Results Will Be Evaluated
1. Implement education and control plans
2. Funding allocated to support implementation of plan

PREVENTION OBJECTIVE 9
Increase to 95% the proportion of high school students who abstain from sexual intercourse or use condoms if sexually active

Baseline Data
82.6% (54.2% have never had sexual intercourse; 28.4% sexually active, use condoms) (YRBS, 2003)

Target
95% (YRBS)

Strategies
1. Advocate for implementation of education and control plans
2. Advocate for Coordinated School Health Councils throughout the state

How Results Will Be Evaluated
1. Funding allocated to support implementation of plan
2. Coordinated School Health Councils established throughout state

REFERENCES

[1] Adams, M.L. 1994 The public health impact and economic cost of smoking in Connecticut--1989. *Connecticut Medicine* 58: 195-198.

[2] Bombard, J., et al. 2004. State-specific prevalence of current cigarette smoking among adults, United States, 2003. *Morbidity and Mortality Weekly Report* 53:1035-1037.

[3] Lowery St. John, T., and D. Jarvis. 2003. *Connecticut Youth Tobacco Survey, 2002.* Hartford, CT: Connecticut Department of Public Health.

[4] Connecticut Department of Health. 2002. *Connecticut Tobacco Use Prevention and Control Plan.* Hartford, CT: Connecticut Department of Public Health.

[5] Centers for Disease Control and Prevention. Tobacco Control Program Guidelines and Data. H **http://www.thecommunityguide.org/tobacco/**H

[6] Centers FOR Disease Control And Prevention. 2000. Strategies for reducing exposure to environmental tobacco smoke. Increasing tobacco-use cessation, and reducing initiation in communities and health-care systems. A report on recommendations of the Task Force on Community Preventive Services. *Morbidity and Mortality Weekly Report* 49 (No. RR-12): 1-11.

[7] Press Release: New York City Department of Health and Mental Hygiene, *New York City's Smoking Rate Declines Rapidly*, May 12, 2004

[8] Centers for Disease Control and Prevention. Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC): Adult SAMMEC and Maternal and Child Health SAMMEC software, 2002c. H**http://www.dcd.gov/tobacco/sammec**H

[9] Connecticut Department of Public Health. 2004. Connecticut Resident Hospitalizations, 2001. Unpublished data.

[10] Calle, E.E., C. Rodriguez, K. Walker-Thurmond, and M.J. Thun. 2003. Overweight, obesity, and mortality from cancer in a prospectively studies cohort of U.S. adults. *New England Journal of Medicine* 348:1625-1638.

[11] Centers for Disease Control and Prevention. Defining Overweight and Obesity. H**http://www.cdc.gov/nccdphp/dnpa/obesity/defining.htm**H

[12] Albright, C.L., J.A. Flora, and S.P. Fortmann. 1990. Restaurant menu labeling: impact of nutrition information on entree sales and patron attitudes. *Health Education Quarterly* 17: 157-167.

[13] American Cancer Society. 2002 *Nutrition, Physical Activity Awareness and Knowledge Benchmarking Survey, New England Topline Report.* Atlanta, GA.

[14] IARC. 2004. Overall Evaluations of Carcinogenicity to Humans. H**http://monographs.iarc.fr/monoeval/crthall.html**H

[15] Connecticut Tumor Registry. 2002. *Incidence of Selected Cancers in Connecticut by Town, 1995-1999.* Hartford: Connecticut Department of Health.

[16] American Cancer Society. 2001. *Cancer Control State-of-the-Science Guide.* Atlanta, GA.

[17] Connecticut Department of Public Health. 1998 BRFSS supplemental data analysis. Unpublished.

PREVENTION TIMETABLE

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
1. Reduce cancer risk through promotion of healthy lifestyles and risk reduction behavior							
TOBACCO	1. Decrease adult and youth smoking prevalence	1. Support creating statewide smoking cessation programs					
		2. Advocate for increase in state tobacco tax to pay for state cancer and tobacco plans					
		3. Help initiate statewide tobacco education media campaign					
		4. Advocate for and support implementation of CT Tobacco use and Prevention and Control Plan					
		5. Advocate for implementation of local tobacco plans					
		6. Advocate for Coordinated School Health Councils					
		7. Develop forum for smoking cessation programs					
		8. Secure funding for Quitline					
		9. Increase Smoke-Free College and University programs and provide forum and communications link					
NUTRITION	2. Increase fruit and vegetable consumption	1. Advocate for nutrition labeling in chain restaurants					
		2. Advocate for school policy and curricula changes					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
NUTRITION	2. Increase fruit and vegetable consumption	3. Advocate for Coordinated School Councils					
		4. Develop coordinated 5-to-9-A-Day program					
		5. Develop/implement community physician campaign					
		6. Identify business/industry partners					
		7. Review data on barriers and identify best practices					
		8. Advocate for intervention research					
	3. Increase physical activity	1. Advocate for school policy and curricula changes					
		2. Advocate for tax changes					
		3. Develop/implement community physician campaign					
		4. Identify new partners					
		5. Identify best practices					
		6. Add new advocacy strategies					
		7. Advocate for intervention research					
	4. Reduce overweight and obesity	1. Advocate for nutrition labeling in chain restaurants					
		2. Advocate for changes in school food programs and curriculum					
		3. Develop plan to coordinate w/ existing programs and involve new partners					
		4. Advocate for intervention research					
		5. Advocate for YRBS questions on overweight/obesity					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
ENVIRONMENTAL EXPOSURES	5. Increase public awareness of cancer-related environmental exposures and protective measures	1. Establish baseline					
		2. Identify methods and develop awareness program					
		3. Improve partnerships					
		4. Identify new partners					
	6. Increase practice of sun protection behaviors and awareness of UV overexposure	1. Establish baseline and targets					
		2. Develop/implement pilot program					
		3. Advocate for sun protection policies					
		4. Develop/implement pediatrician campaign					
		5. Develop BRFSS questions					
		6. Review education and policies for UV light in tanning booths					
ALCOHOL USE	7. Reduce excessive alcohol consumption among adults and adolescents	1. Improve partnership					
		2. Create physician program					
		3. Communications forums					
MULTIPLE SEX PARTNERS	8. Increase percent of adults who always use a condom if they have multiple sex partners	1. Advocate for implementation of education and control plans					
		2. Advocate for Coordinated School Health Councils					
	9. Increase proportion of high school students who abstain from sexual intercourse or use condoms	1. Advocate for implementation of education and control plans					
		2. Advocate for Coordinated School Health Councils					

4. Increasing Early Detection

Early Detection Committee

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INCREASING EARLY DETECTION

VISION

Cancer will be detected as early as possible, using quality, accessible, affordable, comprehensive, evidence-based cancer screening methods.

Screening tests that detect cancers early can save lives, because cancers that are detected at early stages are often highly curable. For specific cancers, early detection also can reduce the time and severity of treatment, improve quality of life, and significantly improve survival. For some sites, screening can prevent the cancer from occurring, as when precancerous polyps are detected and removed during colonoscopy procedures used to screen for colorectal cancer.

EVIDENCE-BASED SCREENING TESTS

The Early Detection Committee reviewed data and literature regarding early detection of the major cancers.[1] There presently are recommended, evidence-based screening tests for three major cancers: breast, cervical, and colorectal. Screening procedures also exist for cancers for which early detection could effect outcomes, but the evidence does not yet support widespread screening. Examples of these cancers include: lung, prostate, ovarian, uterine, skin, and oral cancers.

SCREENING RECOMMENDATIONS

Screening recommendations for early detection are strongest for three cancers--breast, cervix, and colon. Regular mammography and clinical breast exams are recommended for women over the age of 40. Cervical cancer deaths have decreased significantly during the past 40 years, in large part due to the Pap test. Screening for colorectal cancer not only can detects it early, but also can prevent it. Screening rates vary in Connecticut between males and females and by race (Table 1). Screening utilization also varies among other ethnic groups in the state.

Despite the existence of proven tests for these three cancers, their use is below the Healthy People 2010 objectives, especially in some ethnic and minority groups and among low-income persons.

Table 1
Screening Rates for Selected Cancers
Connecticut, 2000, 2001

Cancer Site (Screening Test)	Population Group	Percent Screened	
		Females	Males
Female Breast (Mammogram in last 2 years)	White, 40+ years of age	84.6% (2000)	-
	Afr Am, 40+ years of age	84.2% (2000)	-
Colon/rectum (Fecal occult blood test in last 2 years)	White, 50+ years of age	38.4% (2001)	36.7% (2001)
	Afr Am, 50+ years of age	39.0% (2001)	29.5% (2001)
Colon/rectum (Sigmoidoscopy or colonoscopy in last 2 years)	White, 50+ years of age	51.4% (2001)	58.0% (2001)
	Afr Am, 50+ years of age	47.6% (2001)	39.2% (2001)
Prostate (Prostate specific antigen test in last year)	White, 50+ years of age	-	58.5% (2001)
	Afr Am, 50+ years of age	-	64.4% (2001)

Source: Weir, Thun, Hankey, et al. 2004.[2]

The Committee also considered screenings that are not yet recommended, such as for lung, ovarian, and prostate cancers. For most of these, like lung and prostate cancer, the evidence is insufficient to recommend for or against screening, even for individuals at high risk. For some cancers, such as ovarian, the risk of potential harm has been found to outweigh the potential benefit, leading experts to recommend against screening. The Committee decided to weigh the burden of these cancers in Connecticut against the potential benefits and harms of screening, and to develop strategies that best fit the state for early detection of these cancers.

CANCER TRENDS IN CONNECTICUT

Connecticut has one of the highest incidence rates of invasive cancers in the United States. In 2001, Connecticut ranked fourth in the nation for new cancers among females and eleventh for new cancers among males.[3] Data from the Connecticut Tumor Registry show that breast, prostate, lung, and colorectal cancers are the most frequently diagnosed cancers in Connecticut. Because cancer incidence is related to age (about six out of ten new cancers are diagnosed in persons 65 years of age and older), the number of new cancers diagnosed each year is growing, reflecting the aging of our state's population. The incidence of some leading cancers is higher in African Americans than in whites.

Cancer in Men

The incidence of prostate cancer has increased, and it is now the leading cancer found in Connecticut men. This is most likely due to the increased use of the prostate specific antigen (PSA) screening test. New cases of lung cancer are decreasing among Connecticut males, consistent with the trends in the rest of the country. However, more males, regardless of race, are dying from lung cancer than from prostate cancer.

Cancer in Women

Connecticut has the second highest rate of new breast cancer cases in the nation, most likely due to an aggressive screening program. Medicare data show an improvement in the use of screening mammography in all groups of women over 65 years of age. White females have a higher incidence of breast cancer than women of color, but the breast cancer death rate is higher for African American women. Early screening has reduced the incidence of invasive cervical cancer dramatically, particularly from 1995-2000, and in 2002 there were only 35 cervical cancer deaths in Connecticut. Ovarian cancer is the fifth leading cause of cancer death among Connecticut women and the fourth leading cause among white females. It is usually diagnosed in an advanced stage, due to a lack of reliable screening tests and a lack of knowledge about early signs by women and their physicians.

CANCERS ADDRESSED IN THE PLAN

The Early Detection Committee determined that breast, cervical, colorectal, lung, ovarian, prostate, oral, and skin cancers would be addressed in the Connecticut Comprehensive Cancer Control Plan. Accordingly, early detection goals and objectives focus on three areas:

1. Increasing the use of evidence-based cancer screening for colorectal, breast, and cervical cancers.
2. Eliminating racial and ethnic disparities by increasing access to screening.
3. Identifying and promoting the use of evidence-based strategies to educate and detect lung, ovarian, prostate, skin, and oral cancers for which proven early detection tests do not yet exist.

EXISTING PROGRAMS

Several well-established programs in Connecticut are active partners in the Connecticut Cancer Partnership. Among them is one of our state's strongest programs, the CT Breast and Cervical Cancer Early Detection Program (CBCCEDP) funded by the Centers for Disease Control and Prevention (funding for 2003-2004, $1.6 million), with supplemental State funding of $1.6 million in 2003-2004 for expanding the populations served. The Partnership has included this program and other existing programs within its strategies and will help to support and maintain it.

Since 2001 in Connecticut, individual and group health insurance policies have been required to cover colorectal cancer screening, including an annual fecal occult blood test, a colonoscopy, flexible sigmoidoscopy, or radiologic imaging.

Several major cities in Connecticut, including Waterbury, Stamford, Norwalk, and Danbury, have organized Mayors' Crusades Against Cancer (an American Cancer Society community mobilization initiative). Many of this program's screening and early detection priorities are addressed in this Plan. This program is being expanded, under the leadership of the American Cancer Society, and will be supported by the Plan.

GOAL 1

Promote, improve, and optimize the appropriate use of high-quality breast, colorectal, and cervical cancer screening and follow-up services.

WHY THIS GOAL IS IMPORTANT

1. Breast cancer is the most commonly diagnosed cancer among women in Connecticut, which has the second highest incidence rate of breast cancer and the 12th highest breast cancer death rate in the nation.
2. Colorectal cancer is the fourth most common cancer diagnosed and the second leading cause of cancer death in Connecticut.
3. If all women who are over 18 years of age or who are sexually active had a Pap test on a regular basis, the survival rate for cervical cancer would be over 90%.
4. Breast, colorectal, and cervical cancers have evidence-based screening techniques available for both broad and high risk populations, with high risk populations identified.

EARLY DETECTION OBJECTIVE 1-1

Increase to 85% the percentage of women age 40 and over who have had a mammogram in the past two years

Baseline

82.4% (BRFSS, 2002)

Strategies

1. Maintain and promote current Breast and Cervical Cancer Early Detection Program (CBCCEDP) goals and objectives
2. Increase awareness of breast cancer risk factors and the benefits of early detection
3. Implement strategies to reduce economic barriers to access breast cancer screening

How Results Will Be Evaluated

1. Results from CBCCEDP program
2. Amount of provider and consumer education developed and placed
3. Screening among disadvantaged population

EARLY DETECTION OBJECTIVE 1-2

Increase the proportion of patients who receive timely and appropriate follow-up after receiving abnormal breast cancer screening results.

Baseline

Not available

Strategies

1. Establish baseline
2. Develop and implement plan and mechanism to increase follow-up

How Results Will Be Evaluated

1. Baseline established
2. Plan and mechanisms developed and implemented

EARLY DETECTION OBJECTIVE 1-3

Increase to 90% the percentage of women who have had a Pap test within the past year

Baseline

73.4% (BRFSS, 2002)

Strategies

1. Maintain and promote goals and objectives of CBCCEDP program
2. Identify specific populations underutilizing cervical cancer screening for targeted educational activities
3. Develop and implement plan to reach targeted audiences

How Results Will Be Evaluated

1. Goals and objectives of CBCCEDP program maintained and promoted
2. Specific audiences identified for targeted educational activities
3. Plan to reach audience developed and implemented

EARLY DETECTION OBJECTIVE 1-4

Increase the proportion of patients who receive timely and appropriate follow-up on receiving abnormal Pap test screening results

Baseline

Not available

Strategies

1. Establish baseline
2. Increase follow-up, such as reminder and tracking systems

How Results Will Be Evaluated

1. Baseline established
2. Measure increased follow-up

EARLY DETECTION OBJECTIVE 1-5

Increase to 65% the percentage of adults 50 and over who have had a sigmoidoscopy or colonoscopy within the past five years

Baseline

49.0% 2002 (BRFSS)

Strategies

1. Conduct survey of screening facilities
2. Determine best practices
3. Conduct intervention
4. Evaluate results
5. Report findings

How Results Will Be Evaluated

1. Survey completed
2. Best practices determined
3. Intervention conducted
4. Increased usage of screening
5. Findings reported

EARLY DETECTION OBJECTIVE 1-6

Increase to 63% the proportion of adults 50 and over who have had a fecal occult blood test within the past year

Baseline

54.4%, 2002 (BRFSS) Note: The BRFSS reports "home" tests only.

Strategies

1. Conduct consumer education to increase use of fecal occult blood test
2. Reduce barriers to access colorectal cancer screening and follow-up.

How Results Will Be Evaluated

1. Awareness increased
2. Screening by disadvantaged adults increased

EARLY DETECTION OBJECTIVE 1-7

Increase the proportion of patients who receive timely and appropriate follow-up on receiving abnormal colon screening results

Baseline

Not available

Strategies

1. Establish baseline
2. Develop and implement plan and mechanism to increase follow-up, such as reminder and tracking systems

How Results Will Be Evaluated

1. Baseline established
2. Plan developed and implemented to increase follow-up

GOAL 2

Eliminate or decrease racial, ethnic, and socioeconomic disparities in access to and utilization of cancer screening

WHY THIS GOAL IS IMPORTANT

1. There are glaring disparities in rates of new cancer cases and deaths from cancer among different socioeconomic groups, insured and uninsured populations, and certain racial and ethnic groups. These disparities can often be traced to under-use of screening services.[4]
2. People with health insurance are more likely than the uninsured to receive appropriate preventive care, such as cancer screening tests.[4]
3. Screening rates for several cancers, but especially colorectal cancer, are particularly low among minority and low-income populations.[4]

EARLY DETECTION OBJECTIVE 2-1

Increase screening utilization among underserved minority groups (Developmental)

Baseline

Not available

Strategies

1. Establish baselines
2. Identify additional racial and ethnic communities and partners for cancer prevention and screening education and outreach initiatives
3. Research and/or develop evidence-based, multicultural education and outreach materials and programs for targeted communities
4. Working with targeted communities, pilot-test community programs
5. Develop plan to conduct and evaluate program effectiveness
6. Develop plan for wider implementation

How Results Will Be Evaluated

1. Baseline established
2. Number of additional partners identified
3. Number of evidence-based multicultural screening programs identified
4. Pilot test completed
5. Evaluation of effectiveness conducted
6. Plan in place to for wider implementation

EARLY DETECTION OBJECTIVE 2-2
Increase enrollment of underserved populations in cancer screening trials

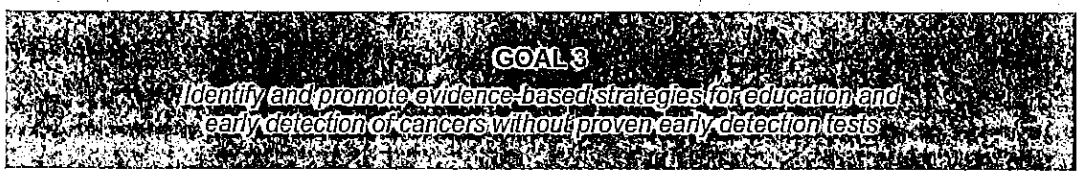
Baseline
Not available

Strategies

1. Establish baseline.
2. Work with clinical trials programs in the state to increase enrollment of underserved populations in cancer screening trials.

How Results Will Be Evaluated

1. Baseline established.
2. Measure enrollment of underserved populations in cancer screening trials.



WHY THIS GOAL IS IMPORTANT

1. Although high risk populations for lung, ovarian, and skin cancers have been identified, evidence to date does not support the use of currently available screening tests.[a]
2. High-risk populations for prostate cancer have been identified and there are screening tests for prostate cancer (PSA or DRE), but the evidence is insufficient to recommend for or against their use in routine screening.
3. Lung cancer is the leading cause of cancer deaths in Connecticut. Skin cancer had the state's largest increase in cancer death rates from 1997-2001. Prostate cancer is the second leading cause of cancer deaths among Connecticut men. Ovarian cancer is the fifth leading cause of cancer deaths among Connecticut women.
4. Connecticut-based health institutions are national leaders in advancing knowledge of the above four cancers and seek to reduce their burden as part of their mission.

[a] For lung cancer: low dose computerized tomography, chest x-ray, or sputum cytology. For ovarian cancer: CA-125 blood test or transvaginal sonography. For skin cancer: total-body skin examination.

EARLY DETECTION OBJECTIVE 3-1

Seek and develop strategies to reduce morbidity and mortality for cancers with high incidence or mortality rates for which effective screening tests are not yet available, including lung, ovarian, and prostate cancers

Baseline

Not available

Strategies

1. Establish baselines.
2. Identify evidence-based education and screening methods.
3. Develop pilot programs to educate and to detect cancers with high state mortality rates, but without proven screening tests, including lung, ovarian, and prostate cancer.
4. Investigate evidence-based strategies to promote education about and participation in clinical trials for cancer screening.

How Results Will Be Evaluated

1. Baseline established
2. Number of evidence-based education and screening modalities identified
3. Pilot programs initiated for lung, ovarian, and prostate cancers
4. Increase in public awareness
5. Number of evidence-based strategies identified and put in place
6. Number of evidence-based screening clinical trials strategies

EARLY DETECTION OBJECTIVE 3-2

Increase awareness of lung, ovarian, prostate, skin, and oral cancers, for which there are no widely accepted, evidence-based, screening modalities, through education about risk factors and symptoms.

Baseline

Not available

Strategies

1. Establish baseline
2. Promote education for healthcare providers about these cancers and their associated risk factors.
3. Increase public and professional awareness regarding current developments in cancer genetics
4. Disseminate guidelines from the National Comprehensive Cancer Network (NCCN) to primary care providers about timely referral of patients at risk for ovarian cancer to a gynecologic oncologist
5. Promote medical student training sessions regarding best detection practices
6. Promote and conduct outreach education activities to increase consumer awareness of risk reduction factors associated with these cancers

How Results Will Be Evaluated

1. Baseline established
2. Percentage increase in educational sessions for healthcare providers.
3. Percentage increase in medical student training sessions
4. Number of programs identified and promoted
5. Number of outreach education activities conducted
6. NCCN guidelines disseminated to primary audiences

EARLY DETECTION OBJECTIVE 3-3
Increase public awareness of risk factors and early signs of skin cancer with emphasis on malignant melanoma

Baseline
Not available

Strategies

1. Establish baseline
2. Develop school-based program to increase awareness and effect behavior of school aged youth
3. Publicize risk factors and early signs of skin cancer, especially malignant melanoma
4. Publicize ACS Sun Safe Communities

How Results Will Be Evaluated

1. Baseline established
2. School-based program implemented
3. Public awareness increased
4. Number of communities implementing ACS Sun Safe Communities initiative

REFERENCES

[1] U.S. Preventive Services Task Force. *Guide to Clinical Preventive Services, 3rd Edition.* (Periodic Updates)

[2] Weir H.K., M.H. Thun, B.F. Hankey, et al. 2004. Annual Report to the Nation on the Status of Cancer, 1975-2000. *Journal of the National Cancer Institutes* 95:1276-1299.

[3] U.S. Cancer Statistics Working Group. 2004. *United States Cancer Statistics: 2001 Incidence and Mortality.* Atlanta, GA: Department of Health and Human Services and National Cancer Institute.

[4] Curry S.J., T. Byers and E. Hewitt, Editors. 2003. *Fulfilling the Potential of Cancer Prevention and Early Detection, Executive Summary.* Washington, D.C.: National Academy of Science. National Academies Press.

EARLY DETECTION TIMETABLE

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
1. Promote, improve and optimize use of breast, colorectal and cervical screening and follow-up	1-1. Increase percentage of women 40+ who have had mammogram in past year to 85%	1. Maintain, expand and promote current CBCCEDP goals and objectives					
		2. Increase awareness					
		3. Implement plan to reduce economic barriers to screening					
	1-2. Increase proportion of patients who receive timely follow-up after an abnormal breast screening	1. Establish baseline					
		2. Increase follow-up					
	1-3. Increase percentage of women with Pap test in two years to 90%	1. Maintain, expand and promote CBCCEDP program					
		2. Identify target populations					
		3. Develop/implement plan					
	1-4. Increase proportion of patients with timely follow-up after receiving abnormal Pap test results	1. Establish baseline					
		2. Implement plan to increase follow-up					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
1. Promote, improve and optimize use of breast, colorectal and cervical screening and follow-up	1-5. Increase the percentage of adults 50+ who have had sigmoidoscopy or colonoscopy to 65%	1. Conduct survey of detection facilities					
		2. Determine best practices					
		3. Conduct intervention					
		4. Evaluate results					
		5. Report findings					
	1-6. Increase percentage of adults 50+ with FOBT to 63%	1. Educate consumers about FOBT					
		2. Reduce barriers to screening and follow-up					
	1-7. Increase awareness of skin cancer risk and early signs	1. Establish baseline					
		2. Develop/implement plan and mechanisms					
		3. Increase awareness					
2. Eliminate or decrease racial, ethnic, and socioeconomic disparities to access to and utilization of cancer screening	2-1. Increase screening utilization among underserved communities	1. Establish baseline					
		2. Identify additional partners					
		3. Research and develop programs and materials					
		4. Pilot test programs					
		5. Develop program evaluation plan					
		6. Develop plan for wider implementation					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
3. Identify and promote evidence-based strategies for early detection of cancers without proven early detection tests	3-1. Seek and develop strategies to reduce morbidity and mortality of cancers lacking effective early detection tests	1. Establish baseline					
		2. Identify methods					
		3. Pilot projects					
		4. Promote awareness of clinical trials					
	3-2. Increase awareness of ovarian, prostate, skin and oral cancers	1. Establish baseline					
		2. Promote education for healthcare providers					
		3. Publicize cancer genetics awareness					
		4. Disseminate NCCN guidelines for ovarian cancer referral					
		5. Promote medical student training					
		6. Promote and conduct outreach education					
	3-3. Increase awareness of risk factors and early signs of skin cancer	1. Establish baseline					
		2. Develop school-based program					
		3. Publicize risk factors and early signs of skin cancer					
		4. Publicize ACS Sun Safe Communities					

5. Assuring Quality Treatment for All Patients

Treatment Committee

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ASSURING QUALITY TREATMENT FOR ALL PATIENTS

VISION

All Connecticut residents will have equal access to high-quality, evidence-based cancer care

As a result of new treatments, many people with cancer are being cured of their disease or are living longer with a good quality of life. Cancer is still a difficult disease to treat, however, requiring complex therapy, often with one or more modalities. It is important that both health care providers and their patients have access to the latest treatment information, so they can better understand treatment choices. Patients need to be assured that services are geographically and financially available, that the treatment they receive is evidence-based and of high quality.

Connecticut's cancer treatment services are relatively well distributed throughout the state. Acute care hospitals, cancer centers, freestanding oncology centers, and physician offices along with appropriate support services are accessible to most Connecticut residents. Several aspects of offering high quality, evidence-based cancer care still need to be addressed, however, to ensure accessibility to all Connecticut residents.

The Treatment Committee of the Connecticut Cancer Partnership believes that cancer treatment outcomes will be improved by identifying barriers and promoting the following in the Connecticut Comprehensive Cancer Control Plan:

- Standards of care
- Participation in clinical trials when appropriate
- A Statewide Clinical Trials Network
- Equal access to treatment resources
- Quality of life support systems
- Education services for patients and the general public
- Education services for health care professionals
- Accreditation of hospitals by the American College of Surgeons Commission on Cancer

STANDARDS OF CARE

Guidelines for cancer treatment and care have been formulated and published by several national organizations, such as the National Comprehensive Cancer Network (NCCN). These guidelines, when used, help health care professionals to offer standardized care to their patients. Coupled with up-to-date treatment information, treatment guidelines are essential for providing quality care. Although such guidelines are available, many oncology providers, patients, and their families and friends either are not aware of the available information or do not know where and how to find it. Providing treatment information and guidelines that are consumer friendly and making information on related subjects available to multiple audiences is a goal of the Treatment Committee.

Studies conducted by the Connecticut Tumor Registry, alone or with SEER (the National Cancer Institute's Surveillance Epidemiology, and End Results program),[a] can be used to monitor outcomes in quality standards. The Committee will review data from two SEER Patterns of Care (POC) studies that include Connecticut-specific data regarding use of state-of-the-art care. POC studies provide valuable information on cancer treatments that are documented in hospital records. The goal of the SEER POC studies are to: 1) evaluate the diffusion of state-of-the-art cancer therapy into community practice, 2) disseminate findings in scientific journals and through professional meetings, and 3) work with professional organizations to develop educational opportunities to increase the use of state-of-the-art cancer therapy and quality of care in community practice.

The SEER POC studies show that there is room for improvement in care in Connecticut. In a study of breast cancer, use of guideline therapy for node positive women was 66% in Connecticut versus 70-75% in the United States.[1] With colorectal cancer, 49% of Connecticut patients received standard adjuvant treatment compared to 57% in the United States.[2] The Prostate Cancer Outcomes Study (PCOS), which includes Connecticut data, has detailed information about how prostate cancer is treated in the U.S. (and Connecticut) and the various effects of these treatments on men's functioning and overall quality of life. Results from PCOS also have been used to assess racial differences in stage of diagnosis and treatment to help explain the significantly higher death rates from prostate cancer among African American men in the United States.[3]

CLINICAL TRIALS

Access to clinical trials is considered another indicator or quality of care. Many advances in cancer treatment have been a result of clinical trials. Despite efforts by the National Cancer Institute and national patient advocacy groups, the proportion of adult cancer patients who participate in clinical trials continues to be low. There are many barriers to participation, such as unwillingness of physicians to enroll patients, refusal of eligible patients to participate, misunderstanding of the nature and reasons for the trials, and social, cultural and economic issues, especially for minority patients.

A recent poll conducted by Harris Interactive[4] showed that 32% of adults would be very willing to participate in a clinical cancer trial if asked to do so. Another 38% said they would seriously consider participation if asked. Seventy-five percent of respondents thought clinical trials were associated with "high-quality clinical care."

Access to clinical trials is important in offering quality treatment to Connecticut patients. Patients should be informed about new therapies being studied, to gain a better understanding of the relative advantages and drawbacks of treatment alternatives and conventional therapies. Increased physician awareness and commitment to enrolling patients is needed. Important objectives of this Plan are to ensure access to all clinical trials open in Connecticut, help promote the value of clinical trial participation, and assure that all oncology physicians have access to participation.

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[a] The SEER program of the National Cancer Institute is the most authoritative source of information on cancer incidence and survival in the U.S. It currently collects and publishes cancer incidence and survival data from 11 population-based cancer registries and three supplemental registries, representing about 14% of the U.S. population.

The clinical trial infrastructure in Connecticut also needs to be improved, to stimulate and translate cancer research. More needs to be done to accelerate new therapeutic strategies and to make "cutting edge" cancer therapies available to all Connecticut residents. Three types of clinical trials are generally available in the state: NCI-sponsored trials, drug-company-sponsored trials, and investigator-initiated clinical trials. The latter type is where Connecticut scientists most need assistance to develop the novel, significant therapies that will eventually cure most cancers. To do so, a system is needed to ensure that investigator-initiated trials sponsored by the state's cancer scientists accrue the patients necessary to enable them to advance cancer treatment and care.

The Treatment Committee proposes establishing a new statewide clinical trials network to support Connecticut investigator-initiated clinical trials. The network will establish needed central research and administrative infrastructure, and it would add data managers and research nurses--the infantry of clinical trials--across Connecticut. This would enable cancer doctors in every area of the state to access promising new therapies. The network would serve as a model for other states to develop similar networks.

EQUAL ACCESS TO TREATMENT

The extent of barriers and gaps in equal access to treatment services has not been clearly defined in Connecticut. Barriers include the complexity and fragmentation of the health care system, lack of available providers and services, including support services, lack of cultural competence or cultural sensitivity among health care providers, geographic isolation, childcare, transportation, finances, lack of personal resources and a personal support system, and social and cultural barriers such as language, individual perceptions and values, racial, ethnic, or gender discrimination.

Lack of knowledge is also a barrier to access. Before they can receive appropriate treatment, patients must be aware of the availability of treatment services. Education is an important component of treatment and can be helpful to patients and their families in making decisions about cancer treatment options, support services, and other aspects of care. It is also important to document what services are being provided geographically, and to determine service patterns and whether finances are influencing treatment choices.

This Plan calls for an assessment of the extent of gaps and barriers to cancer treatment services in Connecticut. After the needs have been identified, strategies will be developed to address them. A resource guide will be developed for multimedia use to help patients, families, and providers identify where services are available. In addition, all activities will take into consideration the diverse cultural, literacy, and access needs of Connecticut's population groups. Educational and informational resources will be appropriately developed, implemented, and marketed to ensure cultural appropriateness.

SUPPORT SYSTEM FOR QUALITY-OF-LIFE

Cancer diagnosis and treatment can alter quality of life dramatically by creating psychosocial and emotional needs in addition to physical needs and treatment-related adverse effects. Many

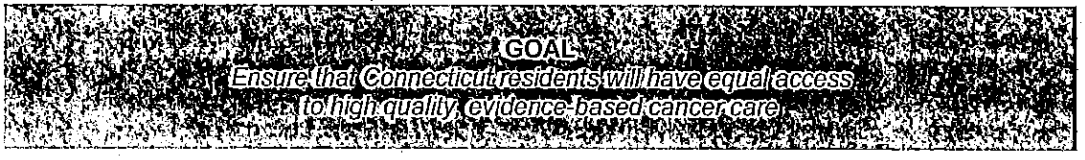
cancer patients experience pain or other symptoms during their treatment phase, which require management by experts. Not all patients have access to adequate pain control methodologies or to adequate symptom management during treatment. Furthermore, information on evidence-based complementary medicine for cancer patients is not readily available. This Plan addresses the need to identify barriers to patient access to symptom and pain management, develop strategies to overcome the barriers, and promote existing pain and symptom management standards and resources. It also addresses the identification of existing resources for evidence-based complementary and alternative treatment information.

EDUCATION OF HEALTH PROFESSIONALS

Numerous educational opportunities for health care professionals regarding cancer management issues occur in Connecticut each year. However, there is no central source for this information, for use either in planning activities or in promoting them. The Plan calls for the development of a central web-based resource that cancer clinicians can access easily to learn about educational activities in a comprehensive way.

ACCREDITATION: AMERICAN COLLEGE OF SURGEONS COMMISSION ON CANCER

To receive accreditation, hospitals must achieve American College of Surgeons (ACoS) standards for access to multidisciplinary consultation and treatment, ongoing quality assessment that monitors treatment effectiveness and outcomes, and the availability of modern technology. Currently, 21 of Connecticut's 31 acute care hospitals (68%) have ACoS-approved cancer programs. Several strategies are outlined to increase the percentage of accredited hospitals to 90%.



WHY THIS GOAL IS IMPORTANT

1. There is no single readily available place to access treatment guidelines and information.
2. Only 67% of acute care hospitals in Connecticut are ACoS accredited.
3. Only about 5% of adult patients participate in cancer clinical trials.
4. There are barriers, both for patients and providers, to participate and enroll in cancer clinical trials.
5. Barriers exist in assuring equal access to treatment.
6. Support systems and standards for pain and symptom control are not accessible to all patients and families.

TREATMENT OBJECTIVE 1

Increase the proportion of cancer care providers and cancer patients with access to treatment information and evidence-based quality standards of care, taking into consideration cultural, literacy, and access needs (Developmental)

Baseline

Not available

Strategies

1. Develop and promote a Connecticut Cancer Partnership web site as a vehicle for information dissemination throughout the state
2. Encourage use of 800 numbers as information lines
3. Encourage use of grand rounds as a way of providing professional education
4. Develop content on treatment information and guidelines. Identify appropriate viable web sites as link sources (e.g., NCI, ACS), taking into account needs of diverse populations
5. Develop mechanism for all organizations that sponsor educational activities for cancer care professionals to relay information to central data base
6. Develop and implement marketing plan, including measurement tools
7. Conduct surveys of available non-web based resources for the public (telephone lines, written information, etc.), taking in account needs of diverse populations
8. Develop, implement and market patient educational resources to diverse populations

How Results Will Be Evaluated

1. Web site developed; funding assured
2. Number of calls received
3. Number of physicians attending grand rounds sessions
4. Number and type of web sites; appropriate cancer guidelines availability
5. Number and mechanisms in place for organizations to list professional education; use of mechanisms
6. Marketing plan developed; measurement tools developed
7. Surveys completed; gaps identified; agreements made with other organizations for links; and web site use tracked
8. Cancer treatment public information materials available which meet needs of all Connecticut residents

TREATMENT OBJECTIVE 2

Increase the proportion of cancer care providers and cancer patients with access to comprehensive information on clinical treatment trials (Developmental)

Baseline

Not available

Strategies

1. Identify all health care providers who are involved with cancer care
2. List all open Connecticut clinical trials in Connecticut hospitals, cancer centers and oncology offices on the CCP web site and provide link to NCI's PDQ information
3. Develop system for updating information
4. Review available patient education materials on clinical trials (what trial is, how to discuss with physician, how to access availability for specific diagnosis) for cultural sensitivity and literacy appropriateness; if needed, develop culturally and literacy appropriate materials
5. Promote available literature

How Results Will Be Evaluated

1. Health care providers identified
2. Web materials developed; number of hits to pages
3. System for updating developed
4. Patient materials reviewed and if needed new materials developed
5. Marketing plan developed

TREATMENT OBJECTIVE 3

Build a statewide clinical trials network supporting investigator-initiated trials and removing barriers, to allow more clinicians to enroll patients easily into clinical trials

Baseline

Not available

Strategies

1. Help establish a statewide clinical trials network to support state investigator-initiated trials and remove barriers for community oncologists to enroll patients in clinical trials
2. Support adding research nurses and data managers to enable community oncologists to easily add patients to state clinical trials
3. Establish an alliance among the state, university, and in-state pharmaceutical private sector to develop prevention and therapeutic trials that will contribute to a better understanding of the biology of cancer, provide access to novel therapeutics to patients in Connecticut, and strengthen the proposed trials network
4. Create inventory of private practice oncologists and clinicians with an oncology subspecialty who presently participate in clinical trials; assess number and location of non-participating physicians interested in forming a linkage to data collection and analysis resources
5. Collaborate with other local, regional and statewide organizations to decrease barriers for small private practices to participate in clinical trials
6. Facilitate multidisciplinary research programs in specific cancer areas

How Results Will Be Evaluated

1. Statewide clinical trials network created
2. Research nurses and data managers added to remove barriers for community oncologists to enroll patients in state clinical trials
3. Alliance formed
4. Inventory built; linkages formed
5. Collaboration strategies developed and put into effect; number of private practice physicians participating
6. Multidisciplinary research programs facilitated

TREATMENT OBJECTIVE 4

Reduce the proportion of cancer patients who experience difficulty or delays in accessing treatment or who do not receive needed treatment (Developmental)

Baseline

Not available

Strategies

1. Conduct literature search on gaps and barriers to treatment. Conduct focus groups to determine if Connecticut barriers and gaps differ
2. Form Subcommittee to address issues such as cost of treatment and ancillary needs and to develop strategies to lessen and/or eliminate barriers and gaps
3. Develop cancer treatment resource guide to assist patients, families and clinicians in identifying financial, cultural, and support services
4. Utilize data from development of guide to enhance systems for comprehensive cancer care
5. Conduct a study, in collaboration with appropriate organizations and agencies, of cancer treatment modalities currently being used and the resulting treatment outcomes, based on data from the Connecticut Tumor-Registry

How Results Will Be Evaluated

1. Literature search and focus groups conducted; barriers and gaps identified
2. Subcommittee formed; strategies developed
3. Resource guide developed; number of hits on web site; number of laws passed to close gaps
4. System for comprehensive care developed for patients in need of special services
5. Tumor Registry study conducted

TREATMENT OBJECTIVE 5

Increase the proportion of cancer patients and their families who have access to support systems, including psychosocial support and evidence-based complementary medicine (Developmental)

Baseline

Not available

Strategies

1. Establish baseline
2. Assess available support services within the state
3. Determine data base(s) containing evidenced-based complementary/alternative medicine information for cancer patients and families

How Results Will Be Evaluated

1. Baseline established.
2. List of support services and gaps
3. List of databases that will be linked on the web site for complementary/alternative medical information

TREATMENT OBJECTIVE 6

Increase the proportion of cancer patients who have access to pain and symptom management during treatment (Developmental)

Baseline

Not available

Strategies

1. Identify barriers to accessing pain and symptom management during treatment, by conducting literature searches, focus groups and surveys of patients, families and health professionals
2. Build through the Partnership a coalition of health care providers to develop strategies to assist patients in overcoming barriers to quality pain and symptom management
3. Identify and offer professional education opportunities focused on pain management and quality of life issues
4. List and promote national symptom and pain management standards on CCP web site

How Results Will Be Evaluated

1. Barriers to accessing pain and symptom management during treatment identified
2. Collaboration among health care professionals developed and strategies identified
3. Professional education opportunities identified and offered
4. Material listed on CCP web site

TREATMENT OBJECTIVE 7

Increase to 28 the number of Connecticut acute care hospitals that are accredited by the American College of Surgeons (ACoS)

Baseline

24 of Connecticut's 31 acute care hospitals are accredited sites (2005)

Target

28 of Connecticut's 31 acute care hospitals are accredited sites

Strategies

1. Develop mechanisms to identify barriers and benefits to Connecticut hospitals in ACoS accreditation
2. Determine strategies to overcome barriers and highlight benefits and implement program
3. Develop and implement a professional education plan regarding all aspects of ACoS accreditation for professionals

How Results Will Be Evaluated

1. Survey developed and conducted; barriers identified; marketing plan developed
2. Educational plan developed and implemented
3. 28 acute care hospitals with ACoS accreditation

REFERENCES

[1] Harlan, L.C. et al. 2002. Adjuvant therapy for breast cancer: practice patterns of community physicians. *Journal of Clinical Oncology* 20:1809-1817.

[2] Potosky, A.L. et al. 2002. Age, sex, and racial differences in the use of standard adjuvant therapy for colorectal cancer. *Journal of Clinical Oncology* 20:1192-1202.

[3] Hoffman, R.M. et al. 2001. Racial and ethnic differences in advanced-stage prostate cancer: the Prostate Cancer Outcomes Study. *Journal of the National Cancer Institute* 93:388-395.

Potosky, A.L. et al. 1999. Prostate cancer practice patterns and quality of life: the Prostate Cancer outcomes Study. *Journal of the National Cancer Institute* 91: 1719-1724.

[4] Peck P. Americans Say They Are Reading and Willing to Participate in Clinical Trials. *Oncology Times,* p. 25-26, June 10, 2003

TREATMENT TIMETABLE

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
Ensure equal access to high quality, evidence-based cancer care	1. Increase treatment information and evidence-based standards of care	1. Develop and promote Connecticut Cancer Partnership web site					
		2. Encourage 800 number use					
		3. Encourage grand rounds for education					
		4. Content development					
		5. Database for organizations					
		6. Develop and implement marketing plan					
		7. Surveys of other resources					
		8. Materials for other populations.					
	2. Increase access to clinical trials information	1. Identify health care providers					
		2. Web site listings					
		3. System for updating info					
		4. Review/develop culturally sensitive patient materials					
		5. Promote available literature					
	3. Build statewide clinical trials network	1. Help establish clinical trials network					
		2. Support adding nurses and data managers					
		3. Establish alliance					
		4. Build inventory, assess interest					
		5. Collaborate w/ other agencies					
		6. Facilitate research programs					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
	4. Reduce difficulty and delays in obtaining treatment	1. Conduct literature search, focus groups on barriers and gaps					
		2. Create subcommittee to address issues, strategies					
		3. Develop resource guide					
		4. Utilize data from guide					
		5. Conduct study on treatment modalities and outcomes					
	5. Increase access to support	1. Establish baseline					
		2. Assess support services					
		3. Complementary databases					
	6. Increase access to pain and symptom management	1. Identify barriers					
		2. Collaborative partnership					
		3. Educate health care professionals					
		4. Promote symptom and pain management standards					
	7. Increase to 28 the number of ACoS accredited hospitals	1. Identify barriers to and benefits of accreditation					
		2. Overcome barriers, and highlight benefits					
		3. Develop/implement education plan on accreditation					

6. Empowering Survivors and Their Families

Survivorship Committee

Co-Chairs:
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Oncology Nursing
Yale School of Nursing
New Haven

Susan Richter, RN
Vice President, Quality of Life
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Doreen Donahue, LCSW
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Maureen Gianni
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Marion Morra, MA, ScD
President
Morra Communications
Milford

Irma Nelson
IBM Corporation
Bloomfield

Arlene Quinlan
Patient Support Programs Manager
American Cancer Society
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Sheila Judge Santacroce, PhD, APRN
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Yale University School of Nursing
New Haven

Melissa Seres MSW
Leever Cancer Center
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Maureen Smith
Office of Managed Care
Ombudsman, State of CT
Hartford

Rosemary Spinelli-Reyes, LCSW
Hospital of Saint Raphael
Father Michael J. McGivney Center for Cancer Care
New Haven

EMPOWERING SURVIVORS AND THEIR FAMILIES

VISION

Working together to assure a positive quality of life for Connecticut cancer survivors and their families

INTRODUCTION

Completing cancer treatment is a challenge for many cancer patients and their families. Although they are relieved to have ended this phase, they are leaving the health care team with whom they have long been associated and have many concerns about what their next steps should be. "Those who have lived through treatment talk about the first few months as a time of change. It is not so much 'getting back to normal' as it is finding out what is normal for... now."[1]

Cancer patients and their families need to be empowered to make effective choices not only during treatment but also after it has been completed. With the passage of time, the needs and problems of people who have had cancer change, with some requiring few services while others find it difficult to continue without support and many resources to help them.

In 2004, the Centers for Disease Control and Prevention in partnership with the Lance Armstrong Foundation produced a national action plan for the public health community to address cancer survivorship.[2] Some of its key objectives are to increase awareness of cancer survivorship and its impact, train health care professionals to improve delivery of services and increase awareness of issues faced by cancer survivors, and ensure that all cancer survivors have adequate access to post-treatment follow-up services. The Connecticut Cancer Partnership's Committee on Survivorship studied many survivorship issues and independently formulated goals and objectives for Connecticut that interface well with those of the national action plan.

RISING NUMBER OF SURVIVORS

Improvements in early detection and treatment together with successful prevention efforts have ensured that more people in the United States live with cancer than die from the disease. The 5-year relative survival rate for all invasive cancers combined rose significantly from about 50% for those who were diagnosed in the mid-1970s to 65% for those diagnosed in 1995-2001.[3] In the U.S., the number of persons living with cancer rose from 3.0 million (1.5% of the population) in 1971 to 9.8 million (3.5%) in 2001, and it is estimated to reach 11.3 million by the year 2015.[4]

While some cancer survivors are free of the disease, others continue to struggle with active cancers, and many are affected by long-term and late side effects. According to a recent study, cancer survivors have worse health, more lost work days, and a poorer quality life, compared to people who have never had cancer. Even long-term cancer survivors (11 or more years after diagnosis) had substantially more health problems than others.[5]

The growing number of persons living with cancer presents challenges to public health practitioners--to understand and address the needs of cancer survivors and to develop programs that promote their health and well being.

THE AGING OF THE POPULATION.

Not only are more people surviving cancer, but also elderly populations in the U.S. and Connecticut are growing. The number of Americans 65 and over grew by 3.75 million from 1990-2000, and the number of elderly in Connecticut increased by more than 24,000.[6] In 2000 Connecticut ranked tenth among states having the highest percent of elderly (13.8%).[7] Cancer occurs more frequently with age, and the number of people over 65 years with cancer is expected to double within the next 30 years to 6 million.[8]

For many older Americans, cancer and other health problems combine with the aging process to make the tasks of daily living harder to accomplish. As the Connecticut population ages, increased efforts will likely be needed to plan for the optimal health of older persons, many of whom will become cancer survivors. (See Section 2, *Connecticut, Its Population, and Cancer* for a detailed discussion of our state's demographics in relation to cancer.)

INCREASING DIVERSITY OF THE POPULATION

The population of the United States and Connecticut is also becoming more racially and ethnically diverse. Whereas whites made up almost 75% of the population in 2000, the U.S. Census Bureau estimates that by 2050, Hispanics will account for almost 25% of the population[9] and African Americans, Asian Americans, and Native Americans will combine to total almost 25% of the population.[10]

These and other minority population groups will face more barriers in overcoming the long-term residual side effects of treatment because of cultural and language differences; these differences may also affect outcomes. In Connecticut, African Americans have the highest cancer death rate. They are more likely than persons of any other racial or ethnic group to develop cancer, and are about 33% more likely to die of cancer than persons of white race. (See Section 2, *Connecticut, Its Population, and Cancer,* for a detailed discussion of diversity in relation to cancer in Connecticut.)

GROWING NUMBER OF HOME CAREGIVERS

Cancer affects not only the person with the disease but also family members, friends, and caregivers. The number of families and friends who have had to assume responsibilities for caring for cancer patients continues to increase. Home caregivers are usually untrained and unprepared to assume their new, complex role. Because caregivers are likely to be older persons, they often have their own health problems that limit the support they can provide. Reduced income, economic stress, limited or diminishing social support networks, loss of loved ones, and changing living arrangements can all interfere with the ability to cope with the residual effects of treatment.

Although family caregivers think that information is critical to helping them cope with their responsibilities, they have difficulty obtaining information about what to expect and what to do, and they feel they receive inadequate education from health care professionals. Also, while support for patients is abundant, caregiver support is lacking.[11] These concerns are central to Connecticut's goals and objectives for survivorship.

GOAL

To ensure a high quality of life and care for all Connecticut residents living with cancer and for their families

WHY THIS GOAL IS IMPORTANT

1. The number of cancer survivors is growing rapidly; it will increase from 9.6 million today to an estimated 11.3 million in 2015.
2. Although the majority of survivors successfully adapt to gradual physical and psychological recovery during the first year after treatment ends, about 20-25% report depressive symptoms.
3. Some survivors struggle with persistent and late physical effects of treatment for many years, if not throughout their lifetimes.
4. The few national guidelines for follow-up that do exist are not well known or used by the average practitioner.
5. There is often a lack of continuity of care for survivors across and within specialty care practice.
6. Resources for supportive interventions are limited in ambulatory care settings, where most survivors have received their treatment and care.
7. No one--neither patients and their families nor the health care professionals--knows who is responsible for what.
8. No one knows the scope of existing services or if the services meet the needs.

SURVIVORSHIP OBJECTIVE 1

Increase the proportion of cancer survivors and cancer care providers who access and utilize survivor support services (Developmental)

Baseline

Not available

Strategies

1. Develop baseline
2. Identify organizations currently providing survivorship services in state
3. Identify criteria for deciding how to assess the quality of each service organization prior to including it in the centralized information data base
4. Develop and maintain centralized information clearinghouse of survivorship services and survivor organizations that will be housed on the Connecticut Cancer Partnership's web site
5. Create alternative communications vehicles to assist those unable to utilize web-based information, such as 800 numbers, public libraries, VNAs, and area agencies on aging
6. Develop a decision-making tool for use by survivors when selecting an organization that will best serve their needs

7. Promote the availability of services to survivors and health care providers, utilizing expertise of the Partnership's Communications Committee
8. Develop and implement a plan to improve access to information about services for underserved cancer survivor populations, including the elderly, children, minorities and the uninsured
9. Evaluate the impact and benefits of existing survivor services on the quality of life of Connecticut cancer survivors

How Results Will Be Evaluated

1. Baseline developed
2. Number of organizations identified
3. Criteria developed
4. Clearinghouse developed and published to Partnership web site; use of web site: number of hits, number of pages reviewed, type of user, on-line satisfaction survey results with organizations
5. Communications vehicles created
6. Decision-making tool developed
7. Promotion of services completed
8. Number of underserved survivors who access support services
9. Evaluation results

SURVIVORSHIP OBJECTIVE 2

Increase the proportion of cancer survivors who are knowledgeable about published guidelines for survivorship care (Developmental)

Baseline

Not available

Strategies

1. Identify current survivorship care guidelines and make them available to survivors
2. Define "high quality care" for cancer survivors
3. Identify barriers to quality cancer care and gaps in services
4. Utilize this information on barriers and gaps to promote public policy change
5. Survey survivors to determine the baseline number of survivors aware of guidelines for survivorship care
6. Determine future survey needs

How Results Will Be Evaluated

1. Current guidelines identified
2. Definition established for "high quality care"
3. Barriers and gaps identified
4. Number of public policy changes made
5. Baseline survivor survey completed; number of survivors aware of guidelines identified
6. Increased awareness and use of services by survivors

SURVIVORSHIP OBJECTIVE 3

Increase the proportion of health care providers who are knowledgeable about evidence-based survivorship care (Developmental)

Baseline

Not available

Strategies

1. Identify national guidelines (evidence-based) for survivorship care
2. Conduct a survey of health care providers to determine the baseline number of providers aware of available guidelines for survivorship care
3. Educate health care professionals about existing research and survivorship studies/issues for cancer survivors
4. Advocate for increased funding that will expand survivorship research
5. Identify future survey needs

How Results Will Be Evaluated

1. National guidelines identified
2. Survey completed; baseline determined
3. Educational activities conducted
4. Advocacy activities/increased funding
5. Increased number of providers providing evidence-based survivorship care

REFERENCES

[1] National Cancer Institute. 2002. *Facing Forward: Life After Cancer Treatment.*, Bethesda, MD: National Cancer Institute.

[2] Centers for Disease Control and Prevention and Lance Armstrong Foundation. 2004. *A National Action Plan for Cancer Survivorship: Advancing Public Health Strategies*. Atlanta, GA: Centers for Disease Control and Prevention.

[3] National Cancer Institute. Surveillance, Epidemiology, and End Results. *Seer Cancer Statistics Review, 1975-2002*. All sites. **http://seer.cancer.gov/csr/1975_2002/results_merged/sect_02_all_sites.pdf**

[4] U.S. Department of Health and Human Services. National Cancer Institute. 2003. NCI Commitment to the MI/CCP Program. **http://minorityopportunities.nci.nih.gov/resources/clanton.ppt**

[5] Yabroff, K.R., W.F. Lawrence, S. Clauser, et al. 2004. Burden of illness in cancer survivors: Findings from a population-based national sample. *Journal of the National Cancer Institute* 96: 1322-1330.

[6] U.S. Census Bureau. 2000. American Fact Finder. **http://factfinder.census.gov/home/saff/main.html?_lang=en**

[7] Hetzel, L. and A. Smith. 2001. The 65 years and over population: 2000. *Census 2000 Brief*, C2KBR/01-10. U.S. Census Bureau. **http://www.census.gov/prod/2001pubs/c2kbr01-10.pdf**

[8] Merrill, R.M. and D.L.Weed. 2001. Measuring the public health burden of cancer in the United States through lifetime and age-conditional risk estimates. *Annals of Epidemiology and Prevention* 11: 547-553.

[9] Intercultural Cancer Council. Cancer Fact Sheets for Medically Underserved Populations, May 2001. **http://iccnetwork.org/cancerfacts/**

[10] Pollard K.M. and W.P. O'Hare. 1999. America's Racial and Ethnic Minorities. *Population Bulletin*, (Population Reference Bureau) 54(3)1-48. **http://www.prb.org/Template.cfm?Section=Population_Bulletin1&template=PopulationBulletin.cfm&BeginYear=1999**

[11] McCorkle, R., and J.V. Pasacreta. 2001. Enhancing caregiver outcomes in palliative care. *Cancer Control* 8: 36-45.

SURVIVORSHIP TIMETABLE

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
Ensure high quality of life and care	1. Increase access and use of support services by survivors and providers	1. Develop baseline					
		2. Identify organizations					
		3. Identify criteria for quality					
		4. Develop/maintain information clearinghouse					
		5. Other communications					
		6. Decision making tool					
		7. Promotion plan					
		8. Access for underserved					
		9. Evaluate impact/benefit					
	2. Increase proportion of survivors knowledgeable about published guidelines giving evidence-based survivorship care	1. Identify national guidelines for survivorship care and disseminate					
		2. Define 'high quality care'					
		3. Identify barriers and gaps					
		4. Survey survivors to determine baseline					
		5. Determine future survey needs					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
	3. Increase proportion of health care providers knowledgeable about survivorship care	1. Identify survivorship care guidelines					
		2. Conduct survey of health care providers					
		3. Educate health professionals					
		4. Advocate for increased funding					
		5. Identify future survey needs					

7. Help at the End of Life

Palliative and Hospice Care Committee

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Past President, Connecticut Council for Hospice and Palliative Care
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HELP AT THE END OF LIFE

VISION

All Connecticut residents will be informed of and have access to palliative and hospice care services

Few people are ready to make the hard choices that are needed at the end of life. However, palliative and hospice care--offering the best quality of life during the time that remains by taking care of the body, mind, and spirit--can ease the pain and make life better for those who are dying of cancer, and for their family and friends.

AVAILABILITY AND ACCESSIBILITY OF CARE

Many patients do not receive adequate palliative and hospice care services, even when the services are requested. This is the result of several factors. First, the kind, quality, and amount of palliative and hospice care received varies with the setting in which terminally ill patients reside (at home, long-term care facilities, assisted-living facilities, hospitals, or prisons). Second, health care professionals are often inadequately trained in palliative or end-of-life care. Third, there are often financial barriers. Medicare and some insurance plans cover hospice care, whereas palliative care is often covered indirectly, if at all. Finally cultural backgrounds, religious beliefs, and socioeconomic status can affect both the use and delivery of palliative and hospice care.

In 2002, Last Acts, the nation's largest coalition to improve care and caring near the end of life, issued the nation's first state-by-state report card on the availability and use of care at the end of life.[1] Connecticut's grades varied greatly, with residents who are terminally ill and dying found to be well served in some aspects but not in others (Table 1). It is the intent of the Committee on Palliative and Hospice Care to improve Connecticut's performance, using the same or similar criteria as those used by Last Acts.

Connecticut residents would like their health professionals to communicate better with patients and families about death and dying, provide referrals to hospice and palliative care more readily, offer more counseling to dying patients, and make spiritual support more available.[2] A need and an interest also exist to develop hospice programs in Connecticut's correctional facilities.[3]

Table 1
End-of-Life Care in Connecticut
Strengths and Challenges

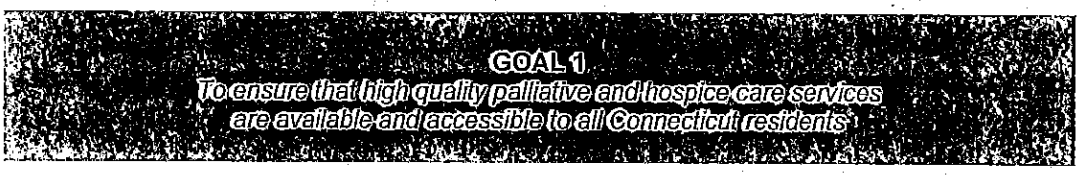
Strengths	Challenges
• The majority of hospitals offer pain management programs • Policies regarding advance directives, such as living wills and medical powers of attorney, are strong • Hospice care is geographically available	• Policies on pain management do not do a good job of ensuring good pain control for the dying • 41.5% of Connecticut nursing home residents with cancer report persistent severe pain • Hospice care is not widely used • Only 21% of Connecticut's cancer patients die at home, even though most Americans say they prefer to die at home

Source: Last Acts, 2002.[1]

PALLIATIVE AND HOSPICE CARE IN CONNECTICUT

Hospice care has a long history involving many partners in Connecticut. The first inpatient hospice in the United States was established in New Haven in 1974, inaugurating the national hospice movement. Three local organizations in the state, the Connecticut Cancer Pain Initiative, Qualidigm (the Quality Improvement Organization for Connecticut), and the Connecticut Chapter of the National Prison Hospice Association have issued recommendations about pain and/or end-of-life care in Connecticut and have begun improvement initiatives. The Connecticut Comprehensive Cancer Control Plan supports these organizations and their recommendations in its goals and objectives. These organizations have agreed to work collaboratively with the Connecticut Cancer Partnership on strategies to further their identified priorities and initiatives. The Connecticut Council for Hospice and Palliative Care, which represents most of the hospice programs in the state, is one of the major partners. The Coalition to Improve End-of-Life Care, funded by Robert Wood Johnson, has completed a study of residents' views of death and dying, among its projects.

Although the data from the *Last Acts* documents and other reports have been useful in establishing some goals and objectives, much information is still missing. Few data are available on the use of palliative and hospice services in Connecticut by underserved populations, such as racial and ethnic minority groups. Activities during the first two years of implementation of this plan will include a search for ways of collecting the additional information at a reasonable cost.



WHY THIS GOAL IS IMPORTANT

1. In 2000, only 0.23% of Connecticut's primary care and primary care subspecialty physicians were certified in palliative care. (Grade C--Last Acts Report, 2002[1])
2. In 2000, only 0.48% of Connecticut's full time registered nurses were certified in palliative care. (Grade C--Last Acts[1])
3. Connecticut residents would like better communications with providers about death and dying, more prompt referrals to hospice and palliative care, better coordination of care, more counseling to dying patients, and more access to spiritual care.
4. Minorities, religious, and ethnic residents would like providers to have a better understanding of the cultural context (diet, language, and religion) of their patients.
5. Poor and medically underserved populations may have less access to palliative and hospice care services.
6. Minorities may be less informed about services due to language or cultural barriers.
7. Only 32.5% of Connecticut hospitals self-report palliative care programs. (Grade D--Last Acts[1])
8. 57.5% of hospitals self-report hospice programs. (Grade C--Last Acts[1])
9. Few hospice and palliative care services are available to long term care facilities and prisons.

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-1

Increase the number of health care professionals (physicians, nurses, social workers, and spiritual counselors) who are knowledgeable about palliative and hospice care (Developmental)

Baseline

Not available

Strategies

1. Identify organizations that offer palliative or hospice care education programs and facilitate collaboration to increase end-of-life-educational opportunities in Connecticut.
2. Investigate best practices to increase amount of palliative and hospice care included in curricula in medical, nursing, counseling and pastoral care schools in Connecticut
3. Work with health professional groups to develop continuing education programs
4. Develop mentoring programs
5. Write articles for and publish articles in state journals and professional newsletters; distribute appropriate national publications
6. Create a centralized database of information and resources for healthcare professionals
7. Disseminate information to providers on Medicare hospice benefits and end-of-life resources available in state
8. Work with health professional groups to provide interactive workshops on communicating with patients and families about end-of-life care, particularly for physicians
9. Work with health professional groups and faith communities to educate health care providers on cultural practices/preferences at end of life, including what choices religious traditions permit
10. Develop programs to educate hospital chaplains and community clergy on care of the dying

How Results Will Be Evaluated

1. Organizations identified; number of collaborative programs initiated
2. Number of schools with curriculum content
3. Number of health professionals attending CEU programs
4. Increased numbers of mentors/mentoring programs
5. Number of articles published
6. Database developed
7. Amount of material disseminated
8. Number of workshops provided; attendance numbers, evaluation of learning
9. Program developed; numbers given
10. Number of clergy educated

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-2
Increase the number of health professionals who are board certified in palliative and hospice care

Baseline
18 certified physicians (2004--American Board of Hospice and Palliative Medicine)
65 certified nurses (2004--National Board for Certification of Hospice and Palliative Nurses)

Target
25 certified physicians (American Board of Hospice and Palliative Medicine)
95 certified nurses (National Board for Certification of Hospice and Palliative Nurses)

Strategies
1. Assess geographic distribution of Connecticut physicians and nurses board certified in palliative and hospice care
2. Develop and offer educational opportunities and incentives to becoming certified to physicians and nurses working in hospice and palliative care settings
3. Implement best practices to recruit more health care professionals into palliative and hospice care, targeting underserved areas

How Results Will Be Evaluated
1. Assessment completed, distribution baseline determined
2. Number of educational opportunities offered
3. Number of professionals recruited from underserved areas
4. Number of physicians and nurses board certified in palliative and hospice care

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-3
Increase the number of health insurance programs that provide coverage for pain and palliative/hospice services. (Developmental)

Baseline
Not available

Strategies
1. Assess current coverage offered by Medicare, Medicaid and private insurance companies; establish baseline
2. Develop and implement a program to educate third-party payers regarding compassionate, cost-effective palliative and hospice care
3. Work with stakeholder organizations to improve benefits for pain or palliative and hospice services as appropriate
4. Advocate for adoption of a Medicaid benefit for hospice and palliative care for Connecticut

How Results Will Be Evaluated
1. Assessment completed; baseline set
2. Payer education program developed; number of payers educated
3. Amount of improvement in benefits
4. Medicaid hospice benefit added

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-4
Increase the proportion of facilities that self-report palliative care programs

Baseline

32.5% of hospitals self-report palliative care programs (2000--American Hospital Association annual survey)

Data not available for long term care (LTC) facilities

Target

50% of hospitals self-report palliative care programs (American Hospital Association annual survey)

Target for LTC to be determined

Strategies

1. Assess current status of palliative care services in long-term care facilities; establish baseline
2. Disseminate information on programs designed to help educate hospitals and long-term care facilities in integrating palliative care into clinical services

How Results Will Be Evaluated

1. Assessment completed; baseline established.
2. Program to educate hospitals and LTC facilities identified and disseminated
3. Increase in percentage of hospitals and long term care facilities self reporting palliative care program

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-5
Increase the number of hospitals and long term care facilities that have contractual agreements with Medicare-certified hospice programs (Developmental)

Baseline

Not available

Strategies

1. Assess current status of hospital and long term care contracts with Medicare-certified hospice programs; establish baseline
2. Identify and implement best practices to facilitate identified non-affiliated entities to contract with Medicare-certified programs
3. Use best practices to create ongoing program

How Results Will Be Evaluated

1. Assessment completed; baseline established.
2. Best practices identified
3. Increase in number of entities with contractual agreements with Medicare-certified hospice programs

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-6
Improve end-of-life care in Connecticut State correctional facilities

Baseline
2 Connecticut prisons with volunteers trained in palliative and hospice care[1]

Target
Provide education on end-of-life care to prison staff and inmate hospice volunteers in Connecticut

Strategies
1. Support efforts of Connecticut Chapter of the National Prison Hospice Association and the Connecticut Prison Hospice Initiative to work in conjunction with the Connecticut Department of Correction's Hospice and Palliative Care Program to train prison staff at new staff orientation (Staff Academy) and annual staff trainings
2. Support efforts to train inmate hospice volunteers as needed

How Results Will Be Evaluated
1. Number of educational programs presented
2. Number of prison inmates trained as hospice volunteers
3. Number of prison staff trained on end-of-life care
4. Number of prison inmates who receive support services from hospice volunteers
5. Number of inmates who die with hospice support

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-7
Assess patient and family satisfaction with palliative and hospice services (Developmental)

Baseline
Not available

Strategies
1. Obtain statewide and local annual survey data from National Hospice and Palliative Care Organization (NHPCO) to determine baseline
2. Develop strategies to increase survey participation by Medicare-certified hospice programs in Connecticut

How Results Will Be Evaluated
1. Data obtained; baseline determined
2. Increase in number of hospices participating in NHPCO survey

[1] Inmate hospice volunteers have been trained at two Connecticut prisons--49 at one facility and 35 at the other. Together, the two programs have serviced 25 inmates, of which 13 have died (*Brief History*, 2003, and personal communication from Connecticut Chapter of the National Prison Hospice Association, December, 2004).

PALLIATIVE & HOSPICE CARE OBJECTIVE 1-8
Improve end-of-life care services in State Veterans Home (Developmental)

Baseline
Not available

Strategies
1. Partner with State Veterans Home administrators and staff to assess end-of-life needs
2. Develop educational and support plan to address Veteran residents' needs for palliative and hospice care services

How Results Will Be Evaluated
1. Needs identified
2. Plan developed

GOAL 2
Ensure that Connecticut residents have improved quality of life through effective management of pain and other symptoms

WHY THIS GOAL IS IMPORTANT
1. Connecticut earned a grade of D+ for the extent that state policies contain language that potentially enhances or impedes pain management[4]
2. 62.5% of Connecticut hospitals self-report pain management programs (Grade B--Last Acts[1])
3. 38.1% of Connecticut nursing home residents have persistent pain (Grade C--Last Acts)
4. 41.5% of Connecticut nursing home residents with a cancer diagnosis have persistent severe pain[5]
5. 43.6% of terminally ill Connecticut nursing home residents have persistent severe pain[5]
6. 53% of primary care physicians and 46% of specialists in Connecticut rated their own ability to treat patients' pain as no better than fair to poor[6]

PALLIATIVE & HOSPICE CARE OBJECTIVE 2-1
Increase legislation and public policy supporting pain, palliative, and hospice care services to achieve Grade C in strength of pain policies in Connecticut

Baseline
Grade D+ for strength of pain policies (2003--Pain and Policies Studies Group)

Target
Grade C for strength of pain policies (Pain and Policies Studies Group)

Strategies

1. Develop program to support goals of Connecticut Pain Initiatives recommendations from the March, 2003 Connecticut Pain Summit (see *Additional Resources* at end of this section)

How Results Will Be Evaluated

1. Program in place to support recommendations of Pain Summit
2. Grade C on PPSG report

PALLIATIVE & HOSPICE CARE OBJECTIVE 2-2

Decrease the prevalence of pain among Connecticut nursing home residents

Baseline

8.5% prevalence of pain among Connecticut nursing home residents (Centers for Medicare and Medicaid Services [CMMS], 2002)

Target

7.8% prevalence of pain among Connecticut nursing home residents. (CMMS, 2005)

Strategies

1. Implement program to support efforts of Qualidigm to improve quality of pain management in Connecticut nursing homes

How Results Will Be Evaluated

1. Quality improvement goals of Qualidigm achieved

PALLIATIVE & HOSPICE CARE OBJECTIVE 2-3

Demonstrate an increase in patient and family satisfaction with management of pain and symptoms (Developmental)

Baseline

Not available

Strategies

1. Monitor patient/family satisfaction with pain and symptom management through yearly surveys by Connecticut Council for Hospice and Palliative Care
2. Survey cancer survivors' pain experience through American Cancer Society Navigation program
3. Investigate and adopt best practices to support efforts of Connecticut health care organizations to comply with JCAHO pain standards of care
4. Review and disseminate data on compliance with JCAHO pain standards in Connecticut health care institutions

How Results Will Be Evaluated

1. Increased patient/family satisfaction scores
2. Improved cancer survivor pain experience documented by ACS Navigation program
3. Improved compliance with JCAHO pain standards in health care institutions

GOAL 3

Ensure that Connecticut residents are more aware of, better prepared for, and more willing to seek palliative and hospice care

WHY THIS GOAL IS IMPORTANT

1. In 2000, only 19.4% of Connecticut residents died while on the Medicare hospice benefit (Grade D--Last Acts[1])
2. The median length of stay in hospice in Connecticut in 2001 was 21.5 days (Grade D--Last Acts[1])
3. 17.3% of Connecticut resident deaths (all causes) occurred at home in 2002 (Connecticut Department of Public Health, provisional death data)
4. 26.6% of cancer deaths among Connecticut residents occurred at home in 2002 (Connecticut Department of Public Health, provisional death data)
5. Connecticut residents want and need more information and open discussion about death and dying[2]

PALLIATIVE & HOSPICE CARE OBJECTIVE 3-1

Increase utilization of palliative and hospice care

Baseline

19.4% of deaths while on Medicare hospice benefit (2000--Dartmouth Atlas of Health Care Working Group)

21.5 days median length of hospice stay (2001--National Hospice and Palliative Care Organization)

26.6% cancer deaths at home (2002--Connecticut death data)

Targets

25% of all deaths while on Medicare hospice benefit (Medicare)

35 days median length of stay on hospice (NHPCO)

40% of cancer deaths at home. (Connecticut death data)

Strategies

1. Investigate and implement best practices to educate public on benefits and availability of palliative and hospice care
2. Adopt best practices to target education on hospice and palliative care to clergy and parish nurses, elderly service providers, minority populations/immigrant groups, corporations, community health centers, and schools
3. Sponsor public forums in communities, churches, and businesses on death planning
4. Working with religious leaders, develop and disseminate statements that educate members of religious communities on permitted choices at end of life
5. Support changes in Connecticut's advanced directive legislation to make procedures easier to understand and implement

How Results Will Be Evaluated

1. Increase in number of patients who die with hospice care; increase in number of cancer patients who die at home; increase in medium length of stay on hospice
2. Best practices identified and adopted; number of programs, and number of participants attending targeted educational programs
3. Number of programs and number of participants in public forums
4. Number of positive changes in legislation

PALLIATIVE & HOSPICE CARE OBJECTIVE 3-2

Increase the number of referrals to hospice and palliative care, especially among persons from minority and medically underserved populations (Developmental)

Baseline

Not available

Strategies

1. Obtain baseline data on annual number of referrals to hospice, including sub-analysis by demographic criteria
2. Conduct needs assessment to identify barriers to access for all residents, particularly minority/underserved populations; develop program to overcome barriers
3. Identify and establish priority partnerships (African-American, Hispanic and other minority church leaders, senior citizen groups and public health departments) to increase palliative and hospice care outreach to minority and underserved populations.
4. Advocate for adoption of Medicaid benefit for hospice and palliative care in Connecticut
5. Adopt and disseminate Local Medical Review Policy (LMRP) for hospice care

How Results Will Be Evaluated

1. Assessment of hospice referral patterns completed; baseline established
2. Needs assessment conducted and barriers identified
3. Priority partnerships identified and established to reach minority and underserved populations
4. Medicaid hospice benefit adopted in Connecticut
5. LMRP adopted; number disseminated
6. Increase in number of referrals to hospice especially among minority and underserved populations

ADDITIONAL RESOURCES

1. *Connecticut Pain Summit, Promoting Proper Use of Opioid Analgesics. Report and Recommendations, March 31, 2003.*
   See also: http://www.aacpi.wisc.edu/regulatory/CTrep.pdf

2. *Nursing Home Quality Improvement Initiative*
   See also: http://cms.hhs.gov/quality/nhqi/

   As part of the Nursing Home Quality Initiative (NHQI), launched by the Centers for Medicare and Medicaid Services (CMS) in November 2002, Qualidigm, the Quality Improvement Organization for Connecticut has been working collaboratively with stakeholders to decrease the pain experienced by nursing home residents.

   The data on the prevalence of pain is derived from the Minimum Data Set (MDS) collected on all nursing home residents and is defined as moderate pain on a daily basis or severe pain within a seven-day period. Baseline data for CT, reported in November 2002, reveals the prevalence of pain among CT nursing home residents to be at 8.5%. The goal of this initiative is to decrease the prevalence of pain experienced by nursing home residents.

3. ***Brief history of the State of Connecticut Department of Correction Hospice and Palliative Care Program.*** See also http://www.npha.org/brochurect.htm

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REFERENCES

[1] Last Acts. 2002. *Means to a Better End: A Report on Dying in America Today.* http://www.rwjf.org/news/special/meansReport.pdf

[2] McGraw SA, E. Dobihal, R. Baggish,and E.H. Bradly. 2002. How can we improve care at the end of life in Connecticut? Recommendations from focus groups. *Connecticut Medicine* 11:655-664.

[3] Zimmermann, N., F.S. Wald, and A.S. Thompson. 1998. *Finding Common Ground for Hospice Care in Connecticut Prisons.* National Prison Hospice Association. http://www.npha.org/brochurect.htm

[4] Pain and Policy Studies Group. 2003. *Achieving Balance in State Pain Policy: A Progress Report Card.* http://www.medsch.wisc.edu/painpolicy/2003_balance/

[5] Brown University School of Medicine, Center for Gerontology and Health Care Research. 2005. *Facts on Dying: Policy Relevant Data on Care at The End of Life. Connecticut State Profile.* http://as800.chcr.brown.edu/dying/ctpspdata.htm

[6] Patrick and Catherine Weldon Donaghue Medical Research Foundation and the American Society of Law, Medicine and Ethics. *Connecticut Statewide Management Study.* 12/2000 (Unpublished report.)

PALLIATIVE AND HOSPICE CARE TIMETABLE

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
1. Ensure high quality palliative and hospice services	1-1. Increase number of health professionals knowledgeable	1. Identify organizations offering end-of-life education; facilitate collaborations					
		2. Investigate best practices for curricula					
		3. Develop continuing education programs					
		4. Develop mentoring programs					
		5. Publish articles					
		6. Created centralized database for web site					
		7. Disseminate Medicate hospice benefits information					
		8. Provide interactive workshops					
		9. Communicate cultural practices					
		10. Educate clergy					
	1-2. Increase number of health professionals certified	1. Assess distribution of board certified physicians and nurses					
		2. Educational opportunities and incentives					
		3. Recruit for underserved area					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
	1-3. Increase number of plans that provide coverage for palliative and hospice services	1. Assess current coverage; establish baseline					
		2. Educate third-party payers					
		3. Work with stakeholder organizations to improve benefits					
		4. Advocate Medicaid hospice benefit					
	1-4. Increase proportion of facilities that self-report palliative care programs	1. Assess current status and establish baseline					
		2. Disseminate program information					
	1-5. Increase number of hospitals and long term care facilities with Medicare-certified program	1. Assess current status; establish baseline					
		2. Facilitate non-affiliates to contract					
		3. Create ongoing program					
	1-6. Increase number of prisons offering palliative and hospice care	1. Support staff training programs					
		2. Support volunteer training					
	1-7. Increase patient/family satisfaction with pain/symptom management	1. Obtain statewide surveys from NHPCO					
		2. Increase survey participation					
	1-8. Improve end-of-life care services in State Veterans Home	1. Assess needs and develop educational and support program					
2. Ensure quality of life through pain and symptom management	2-1. Increase legislation and public policy supporting pain, palliative and hospice care	1. Support goals and recommendations of Connecticut Pain Initiative					

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
2. Ensure quality of life through pain and symptom management	2-2. Decrease prevalence of pain among nursing home residents	1. Support Qualidigm quality improvement program					
	2-3. Increase patient and family satisfaction of symptom relief	1. Monitor satisfaction through yearly surveys					
		2. Survey pain experiences through ACS Navigation program					
		3. Support efforts to meet JCAHO pain standards					
		4. Disseminate data on JCAHO compliance					
3. Ensure residents more aware, better prepared and more willing to seek care	3-1. Increase utilization	1. Educate public on benefits and availability					
		2. Target education					
		3. Sponsor public forums					
		4. Develop and disseminate materials on religious choices					
		5. Advance directive legislation changes					
	3-2. Increase number of referrals	1. Obtain data on number of referrals					
		2. Conduct needs assessment to identify barriers					
		3. Establish priority partners					
		4. Advocate for Medicaid hospice benefit					
		5. Adopt/disseminate LMPR					

8. Cross-Cutting Issues

ADVOCATING FOR QUALITY PROGRAMS AND ACCESS

VISION

An active coordinated advocacy program and quality tracking system to address issues covered in the Connecticut Comprehensive Cancer Control Plan

Each day local, state, and national legislative decisions are made that influence the lives of cancer patients and survivors. Connecticut has a long tradition of organizations and agencies working together to enact legislation and to formulate and implement policies regarding cancer. Advocacy at all levels will be needed for successful implementation of the Connecticut Comprehensive Cancer Control Plan.

Advocacy strategies have been delineated in each area of the Plan (Table 1). The Advocacy Committee of the Connecticut Cancer Partnership will work to build a collaborative program, taking into account the needs of each of the other committees. It will promote beneficial laws, regulations, and policies, and will coordinate advocacy efforts needed for the Plan as a whole. Together with the Core Committee and the organizations most involved in advocacy in the state, it will help set priorities for the advocacy program.

OBJECTIVE 1

Develop internal structure and tracking instruments to coordinate advocacy efforts for the Connecticut Comprehensive Cancer Control Plan.

Strategies

1. Support advocacy issues identified in the Plan (Table 1)
2. Build cancer advocacy capacity through recruitment of key decision-makers, such as legislators, insurers, lobbyists, pharmaceutical companies, corporations, state agencies, families, survivors
3. Identify, engage, and involve interested public/private companies and agencies to garner ongoing support for the Plan
4. Create programs to educate legislators and their staff about important issues in the Plan
5. Create tracking system and data base of persons and legislation, to monitor progress on advocacy
6. Create and publish a data base of enacted laws and policies related to cancer
7. Create an expanded grassroots effort, working with organizations already in the field

Table 1
Connecticut Comprehensive Cancer Control Plan
Strategies from Each Priority Area Related to Advocacy

Prevention

- ✓ Advocate for increase in state tobacco tax sufficient to fund state cancer and tobacco plan implementation
- ✓ Advocate for statewide smoking cessation program that meets Public Health Service and National Action Plan guidelines, including evidence-based counseling, pharmacotherapy, and a marketing campaign. These interventions should be available at no charge to the Medicaid and uninsured population
- ✓ Advocate for and support implementation of the State Tobacco Use Prevention and Control Plan, including funding through federal, state, and local sources
- ✓ Advocate for and support implementation of local tobacco prevention and control plans
- ✓ Advocate for nutrition labeling in chain restaurants
- ✓ Advocate for changes in policies and curricula to better support healthier eating in schools and education about nutrition
- ✓ Advocate for program of coordinated school health councils
- ✓ Advocate for intervention research in nutrition, obesity and physical activity
- ✓ Advocate for changes in policies and curricula to better support and increase amount of physical activity for all students
- ✓ Advocate for tax breaks for physical activity programs such as building walking trails
- ✓ Advocate for Connecticut to participate in Youth Risk Behavior Surveillance questions on obesity
- ✓ Advocate for a pilot school-based program to educate children about the dangers of the sun
- ✓ Advocate for sun protection policies such as trees in schoolyards, the wearing of protective clothing and wrap-around sunglasses with UV absorption factor
- ✓ Support sound legislation that reduces the risk of exposure to UV light in tanning facilities

Early Detection

- ✓ Advocate for breast, cervical, and colorectal screening the meets or exceeds American Cancer Society and U.S. Preventive Services Task Force guidelines
- ✓ Advocate for the Breast and Cervical Cancer Early Detection Program
- ✓ Develop and implement methods to reduce economic barriers to access breast cancer screening
- ✓ Advocate for pilot programs to improve meaningful early detection of cancers without proven screening tests, such as lung, ovarian, and prostate cancer.

Treatment

- ✓ Advocate for a Statewide Cancer Clinical Trials Network to bring state investigator-initiated trials to Connecticut's cancer patients
- ✓ Form statewide collaborative effort to address issues such as cost of treatment and ancillary needs and to develop methods of lessening and/or eliminating barriers and gaps in treatment

Survivorship

- ✓ Identify barriers to quality cancer care and gaps in survivorship services
- ✓ Utilizing information on barriers and gaps to promote public policy change
- ✓ Advocate for increased funding to expand survivorship research

Palliative and Hospice Care

- ✓ Support changes in Connecticut's advanced directive legislation to make procedures easier to understand and implement
- ✓ Advocate for adoption of Medicaid benefit for hospice and palliative care
- ✓ Advocate for legislation and public policy supporting pain, palliative, and hospice care services.

ADDRESSING HEALTH DISPARITIES

VISION

Every person in Connecticut--regardless of age, gender, race, ethnicity, income, education, geographic location, disability, or sexual orientation-- will have equal access to cancer resources and care

It is a troubling fact that certain population groups are more likely than others to develop cancer and less likely to survive it. As discussed in Section 2, *Connecticut, Its Population, and Cancer*, the burden of cancer is often greatest for low-income people from racial and ethnic minority groups.

DISPARITIES IN NEW CANCER CASES AND DEATHS

In the U.S.,[a] African American males have the highest rate of new cancer cases overall (Table 2), and both males and females of African American race have the highest death rates (Table 3). American Indian males and African American females have the lowest cancer survival rates of any population group in the U.S.[1]

Table 2
Cancer Incidence Rates, All Sites, by Racial and Ethnic Group
U.S. 1997-2001

Population Group	New Cases per 100,000 Persons	
	Males	Females
White	556.5	429.8
African American	689.2	400.1
Asian American/Pacific Islander	385.9	302.8
American Indian/Alaska Native	263.2	222.5
Hispanic/Latino	419.8	309.9

Source: SEER Cancer Statistics Review, 1975-2001[2]

Even greater disparities exist for specific types of cancer. In the U.S., African American women are 15% less likely than whites to develop breast cancer, but they are 34% more likely to die from it.[b] African American males are 62% more likely than white males to develop prostate cancer, and more than twice as likely to die from it. Asian Americans/Pacific Islanders have comparatively low incidence rates for the major cancer sites, but they have the highest incidence and death rates of all population groups for stomach and liver cancers; the incidence rate for liver

[a] Connecticut statistics are available for Hispanics and African Americans, but numbers are too small to be reliable for other population groups.

[b] In Connecticut, compared to whites, African American women are 30% less likely to develop breast cancer and 15% more likely to die from it.

cancer in this group is nearly three times that of whites, and the death rate is 2.5 times greater. For cervical cancer, Hispanic women have the highest rate of new cases (nearly double that of whites), and African Americans and Hispanics have the highest death rates.[3]

Table 3
Cancer Death Rates, All Sites, by Racial and Ethnic Group
U.S., 1997-2001

Population Group	Deaths per 100,000 Persons	
	Males	Females
White	245.5	165.5
African American	347.3	196.5
Asian American/Pacific Islander	151.2	100.5
American Indian/Alaska Native	167.0	113.4
Hispanic/Latino	174.0	111.6

Source: SEER Cancer Statistics Review, 1975-2001[4]

Trends in cancer incidence and deaths also differ among population groups. While lung cancer incidence rates, for example, have been falling for males and females in all other population groups, from 1992-2002 rates rose an average of 0.5% per year among African American females. Similarly, the incidence rate for uterine cancer fell for whites but rose for African American, Asian American/Pacific Islander, and Hispanic women. During the same period, the colorectal cancer death rate increased for American Indians/Alaska Natives, while it decreased for other population groups.[5]

There is no simple explanation for these and other disparities. The reasons behind them are complex and may be related to lifestyle practices such as smoking and diet, and to socioeconomic factors like income, education, health insurance status, and level of access to primary and preventive care. Although population diversity is one of our greatest assets, it also presents myriad health challenges that need to be addressed. Creative interventions are needed to reach and serve higher risk populations.

DISPARITIES IN PREVALENCE OF RISK FACTORS FOR CANCER

Tobacco smoking, fruit and vegetable consumption, lack of exercise, overweight, and obesity all are established or suspected risk factors for many types of cancer. In the U.S., African Americans are more likely than whites or Hispanics to smoke. Compared to whites, African Americans and Hispanics are less likely to meet guidelines for physical activity or to eat five or more servings of fruits and vegetables daily.[6] African Americans and Hispanics also have higher prevalence of overweight and obesity, compared to whites.[7]

BARRIERS TO HEALTH CARE ACCESS

There are numerous barriers to health care access for the prevention, early detection, and treatment of cancers among different population groups, and all barriers are potential contributors to disparities in cancer incidence and deaths. Many of these have been discussed in some detail

in Section 2 of this Plan (*Connecticut, Its Population, and Cancer*). Certain groups, especially the uninsured or underinsured, lower socioeconomic groups, and racial and ethnic minorities are particularly vulnerable and face unique barriers.

Health Insurance

Among Connecticut residents in 2004, 21% of Hispanics, 7% of African Americans, and 3% of whites were without health insurance.[8] Although they represent less than 10% of Connecticut's population, Hispanics constituted 40% of its uninsured.[9] It is well documented that the uninsured and Medicaid recipients are more likely to be diagnosed with cancer at a later stage, leading to poor outcomes compared to those with insurance.[10]

Socioeconomic Status

Connecticut poverty rates in 2002-2003 were 7% for whites, 28% for African Americans, and 32% for Hispanics.[11] Compared to white non-Hispanics, the *per capita* income of Hispanics was 59% lower and that of African Americans was 48% lower in 2000.[12] Relative to those from higher social classes, people from lower social classes are less likely to receive cancer screenings, and their survival rates also are lower, even when they have health care coverage. Uncovered costs for transportation, child care, and medical supplies can drain resources and cut treatment time short. Compared to more advantaged patients, those from lower social classes also receive less adequate treatment and have more difficulty obtaining palliative and supportive care.[13]

Race and Ethnicity (Language and Culture)

Race and ethnicity, in themselves, are not barriers to care or causes of disparities. On an individual level, however, race or ethnicity might affect access in terms of language, cultural attitudes and perceptions, poverty, or inadequate training and sensitivity among health care providers to understand and meet the needs of specific population groups.

The inability to speak and read English well is associated with lower use of health care services, such as screening services, and less compliance with recommended procedures.[14] Problems result not only from the use of English by providers, but also from variation in educational opportunities for providers (in culturally competent communication) and for patients (in both general literacy and health literacy).

Sensitivity to cultural issues that make it difficult for some underserved populations to receive screening and treatment is important in planning cancer control programs. Social and cultural barriers to care have been identified at the level of the health care system (i.e., access to care, diversity in leadership/workforce), processes of care (i.e., receipt of appropriate screening and treatment), and the individual (provider-patient encounter) levels. Insufficient minority recruitment into the health professions, and a general lack of accessible interpreter services or appropriate health educational materials also contribute to the problem. Provider education on cross-cultural issues occurs rarely if at all.

DISPARITIES OBJECTIVE 1

Develop internal structure to coordinate cross-cutting efforts to increase access to health care and reduce health disparities

Strategies

1. Support remediation of access and health disparities issues identified in the Plan (Table 4)
2. Identify relevant geographic disparities in access for age-gender subgroups, and identify solutions to alleviate disparities and gaps in access to cancer-related care including populations with special needs
3. Identify cross-cutting strategies to increase cancer service access and resources for all populations through public education
4. Identify disparities in financial barriers to care for cancer patients and advocate for change
5. Advocate to ensure access to health insurance coverage for cancer patients and survivors so that their treatment and continuing care needs are met

Table 4
Connecticut Comprehensive Cancer Control Plan
Strategies from Each Priority Area Regarding Health Disparities

Prevention

- ✓ Support access/disparities goals of Connecticut Tobacco Use, Prevention, and Control Plan
- ✓ Review existing data regarding barriers and motivating factors for healthy nutrition for all age and ethnic groups; identify best practices for implementation
- ✓ Review existing data regarding barriers and motivating factors for physical activity for all age, racial and ethnic groups; identify best practices for implementation

Early Detection

- ✓ Maintain and promote access/disparities goals in the current Breast and Cervical Cancer Early Detection Program (CBCCEDP) goals and objectives
- ✓ Develop and implement strategies to reduce economic barriers to access breast cancer screening
- ✓ Identify specific populations under-utilizing cervical cancer screening for targeted educational activities; develop/supplement Plan to reach targeted audiences

Treatment

- ✓ Increase access to treatment information and evidence-based quality standards of care by health care professionals and the public, taking into consideration cultural, literacy, and access needs
- ✓ Increase access to comprehensive clinical treatment trial information by cancer patients and cancer care providers
- ✓ Improve access to cancer treatment services, so that no cancer patient has financial or other barriers to treatment
- ✓ Ensure that all cancer patients have access to pain and symptom management during treatment

Survivorship

- ✓ Improve access to quality treatment and supportive care for underserved cancer survivor populations, including the elderly, children, minorities and the uninsured

(Table 4 continues)

Table 4 (Continued)
Connecticut Comprehensive Cancer Control Plan
Strategies from Each Priority Area Regarding Health Disparities

Palliative and Hospice Care

- ✓ Educate health care providers on cultural practices/preferences at end of life including what choices religious traditions permit
- ✓ Recruit more health care professionals into palliative and hospice care, targeting underserved areas
- ✓ Provide education on end of life care to CT prison staff and inmate hospice volunteers
- ✓ Address palliative and hospice care needs of veteran's in state Veteran's Hospital
- ✓ Target education on hospice and palliative care to clergy and parish nurses, elderly service providers, minority populations/immigrant groups, corporations, community health centers and schools
- ✓ Develop programs to overcome barriers to access for all residents, particularly minority/underserved populations
- ✓ Identify and establish priority partnerships to increase palliative and hospice care outreach to minority and underserved populations

COMMUNICATING ABOUT THE PLAN AND THE PARTNERSHIP

VISION

An active, coordinated communications program that will raise awareness about the Plan and the Partnership for a wide variety of audiences

A creative, well-organized communications program is essential to the success of the Connecticut Cancer Partnership and its Comprehensive Cancer Control Plan. If the strategies in the Plan are to be implemented successfully, many diverse audiences need to be reached with information. Audiences include patients, health professionals, present and new partners, policy makers, state leaders, public agencies and organizations, target populations, the public and the private sectors. A Communications Committee, made up of experts in the public relations and communications fields, is formulating a plan with goals and objectives for each of the audiences to be reached and messages that need to be communicated. The Committee will work collaboratively with other Partnership Committees to support their communications needs (Table 5) and will ensure that these needs are met in a structured, orderly manner.

Table 5
Connecticut Comprehensive Cancer Control Plan
Strategies from Each Priority Area Regarding Communications

Prevention

- ✓ Support creating statewide tobacco cessation program that meets Public Health Service and National Action Plan guidelines, including evidence-based counseling, pharmacotherapy, and a marketing campaign
- ✓ Help initiate a statewide tobacco education media campaign like those shown to be effective in other states such as Florida and California
- ✓ In conjunction with the National Partnership 5-A-Day Plan, develop a coordinated effort to increase consumption of fruits and vegetables
- ✓ Develop and implement campaigns targeted to community physicians for discussion with their patients to promote fruits and vegetables, guidelines related to calories, fats, carbohydrates, the need for physical activity and risks associated with alcohol use and cancer
- ✓ Develop and implement a campaign for pediatricians to inform parents about caring for the skin of babies and young children

Early Detection

- ✓ Increase awareness of breast cancer risk factors and the benefits of early detection
- ✓ Develop and implement plan to reach specific audiences with targeted education messages on cervical screening
- ✓ Conduct consumer education to increase appropriate colorectal screening
- ✓ Increase public awareness of risk factors and early signs of skin cancer, especially malignant melanoma
- ✓ Increase public awareness of ACS Sun Safe Communities
- ✓ Research and/or develop evidence-based, multicultural education and outreach materials to increase screening utilization among racial and ethnic minority groups
- ✓ Promote and conduct outreach education activities to increase consumer awareness of risk reduction factors for ovarian, prostate, skin and oral cancers

(Table 5 continues)

Table 5 (Continued)
Connecticut Comprehensive Cancer Control Plan
Strategies from Each Priority Area Regarding Communications

Treatment

- ✓ Develop and promote a Connecticut Cancer Partnership web site as a vehicle for information dissemination throughout the state
- ✓ Develop content on treatment information and guidelines for web site
- ✓ Develop and implement a marketing plan, including measurement tools
- ✓ Develop, implement and market patient education resources on treatment information and standards of care to diverse populations
- ✓ Review available patient education materials on clinical trials for cultural sensitivity and literacy appropriateness and if needed develop new materials. Develop marketing plan for promotion of patient education materials
- ✓ Develop cancer treatment resource guide to assist patients, families and clinicians in identifying financial, cultural and support services
- ✓ Determine databases that carry evidence-based complementary/alternative medicine information for cancer patients and families
- ✓ Develop and implement a professional education plan regarding all aspects of ACoS accreditation for professionals

Survivorship

- ✓ Develop and maintain centralized information clearinghouse of survivorship services and survivor organizations to be house on the Connecticut Cancer Partnership web site
- ✓ Create alternative communications vehicles to assist those unable to access web-based information
- ✓ Promote availability of services to survivors and health care providers
- ✓ Develop and implement a plan to improve access to information about services for underserved cancer survivor populations
- ✓ Identify current survivorship care guidelines and disseminate availability to survivors
- ✓ Educate health care professionals about existing research and survivorship studies/issues for cancer survivors

Palliative and Hospice Care

- ✓ Create a centralized database of information and resources for healthcare professionals
- ✓ Develop and implement a program to educate third-party payers regarding compassionate, cost-effective palliative and hospice care
- ✓ Disseminate information on programs designed to help hospitals and long-term care facilities integrate palliative care into clinical services
- ✓ Investigate and implement best practices to educate public on benefits and availability of palliative and hospice care
- ✓ Sponsor public forums in communities, churches, and businesses on death planning

COMMUNICATIONS OBJECTIVE 1

Develop a plan to communicate information about the Connecticut Comprehensive Cancer Control Plan and Connecticut Cancer Partnership

Strategies

1. Review communications work from other states
2. Develop communications goals and objectives
3. Determine primary and secondary audience(s) with priority, pertinent characteristics, and rationale
4. List activities for each defined audience/market
5. Propose channels to be used (mass media, exhibits, web site, newsletters, company publications, health professionals, community events, banners, etc.)
6. Identify materials to be developed or adapted
7. Develop messages; test on target audiences
8. Produce promotion/materials and distribution plan
9. Determine key tasks, time line and resources needed
10. Create evaluation plan (with Data, Surveillance and Evaluation Committee)

COMMUNICATIONS OBJECTIVE 2

Create plan for ongoing communications with members

Strategies

1. Develop PowerPoint presentation
2. Develop text for fact sheets on issues for use at regional meetings
3. Assist in developing format, stylebook and text for web site
4. Develop newsletter formats (e.g., e-news)

COMMUNICATIONS OBJECTIVE 3

Prepare campaign for release of Plan

Strategies

1. Create goals and objectives for campaign
2. Determine time and place of release
3. Develop plan for press conference
4. Determine speakers for press conference
5. Identify other persons to invite to press conference
6. Determine media invitees
7. Prepare materials for press kit – news releases, photos, fact sheets on plan, lists of committees, etc.
8. Arrange logistics for day of press conference

COMMUNICATIONS OBJECTIVE 4
Identify and train Partners for a Speakers Bureau

Strategies

1. Develop goals and objectives
2. Create criteria for recruiting speakers
3. Generate training program for speakers
4. Write text for PowerPoint presentation
5. Write text for video
6. Identify persons to appear in video
7. Work with advertising agency, supervise creation of presentation and video
8. Develop system for booking speakers, scheduling them
9. Produce evaluation plan for speakers' bureau

COMMUNICATIONS OBJECTIVE 5
Produce community guides on specific subjects for target group use.

Strategies

1. Develop goals and objectives for guide
2. Gather information
3. Develop text, graphics
4. Work with agency to supervise creation of layout, printing
5. Produce evaluation plan

COMMUNICATIONS OBJECTIVE 6
Develop and produce two portable exhibits.

Strategies

1. Develop goals and objectives for each exhibit
2. Develop basic design, messages, text, and graphics for each exhibit
3. Supervise creation of exhibits
4. Develop system for scheduling, setting up, and taking down exhibits
5. Produce ancillary material for exhibits (brochures, fact sheets, etc.)
6. Produce evaluation plan

STIMULATING AND TRANSLATING RESEARCH

VISION

To perform cutting-edge cancer research in Connecticut and translate it into practice

Research is the engine that is changing our understanding of cancer. In discussing the implications of cancer research, Dr. Andrew Van Eschenbach, Director of the National Cancer Institute, noted, "While we have much more to learn about this complex disease, our increased understanding of cancer at the genetic, molecular, and cellular levels is opening up enormous opportunity to interrupt the initiation and progression of the disease. Over the course of the 20th century, the primary strategy for treating cancer was 'seek and destroy.' Now, in an effort to preserve healthy cells and improve outcomes, we are increasing efforts to 'target and control' cancer by modulating and altering the behavior of the disease.... We will strive to prevent cancer before it starts, identify cancers that do develop at the earliest stage, eliminate cancers through innovative treatment interventions, and biologically control those cancers that we cannot eliminate, so they become manageable, chronic diseases."[15]

The following activities related to cancer research are key to the Connecticut Comprehensive Cancer Control Plan.

1. Translate research discoveries into better methods of prevention, early detection, and treatment
2. Deliver these methods to all who could benefit from them
3. Increase partnering and resources among Connecticut's researchers
4. Support research projects in the Plan
5. Develop methods of identifying and funding additional priority projects
6. Increase participation in clinical trials

CONNECTICUT'S MAJOR RESEARCH INSTITUTIONS

Connecticut has long been a leader in many fields of cancer research, from basic laboratory work to clinical, prevention, and intervention studies. Considerable cancer research on various subjects is being conducted in Connecticut, with the majority of studies being carried out at Yale University and the University of Connecticut (Table 6). Research in prevention, early detection, behavior modification, communications, and policy development is not as widespread as is research into the biology, causes, and treatment of cancer. Several clinical trials, mostly in the treatment area, are available in the state's medical centers and hospitals (Table 7). In 2004, Connecticut institutions--mainly Yale University, University of Connecticut, and Connecticut Department of Public Health--received grants totaling more than $28 million from the National Cancer Institute to support new and ongoing research projects. In addition, more than $6 million of research was funded in Connecticut by the American Cancer Society--approximately $1.5 million at the University of Connecticut and $4.8 million at Yale.

Table 6
NCI-Funded Research in Connecticut
(NCI Research Portfolio, 2003)

Type of Research	Number of Studies by Institution				Total Studies
	Yale	UConn	Wesleyan	Other[a]	
All Types	71	18	1	7	97[b]
Biology	32	13	1	1	47
Causes/Etiology	29	6	-	-	35
Early Detection and Diagnosis	7	1	-	2	10
Treatment	13	3	-	3	19
Cancer Control, Survivorship, Outcomes	6	-	-	1	7
Scientific Model Systems	4	-	-	-	4

a Other = Ikonisys, Inc., June Biotechnologies, Inc., Real-Time Analyzers, Sibtech, Inc. Ultrasound Detection Systems LLC, Vion Pharmaceuticals

b Research types total to more than 97 because NCI classified some research studies in multiple categories.

PREVENTION RESEARCH CENTERS.

The CDC is administrating a nationwide network of 28 Prevention Research Centers (PRCs) funded by the National Cancer Institute and associated with schools of public health, medicine, or osteopathy. The network comprises academic researchers, public health agencies, and community members that conduct applied research in disease prevention and control. These centers serve as a national resource for developing effective prevention strategies and applying those strategies at the community level. The Yale-Griffin Prevention Center in Derby, Connecticut is one of three PRCs in New England and is the only hospital-based PRC in the network. A member of the Center's staff serves on the Connecticut Cancer Partnership's Core Committee.

Table 7
Clinical Trials at Connecticut Medical Centers and Hospitals[16]

Research Entity	No. Programs
CALGB (Cancer and Leukemia Group B)	5
CDC prevention trials	1
Cancer communications trials	2
COG (Central Oncology Group)	1
ECOG (Eastern Cooperative Oncology Group)	8
EORTC (European)	1
GOG (Gynecologic Oncology Group)	
Industry and pharmaceutical companies	16
NASBP (National Surgical Adjuvant Breast and Bowel Project)	9
NSCLC Complementary	1
Institutional Nursing, Quality of Life	1
Nutrition	1
Pediatric and POG (Pediatric Oncology Group)	2
ROTG (Radiation Oncology Trials Group)	2
SELECT (Selenium and vitamin E Cancer Prevention Trial) (SWOG)	1
STAR Trial, co-STAR trial (Tamoxifen/Raloxifen) NSABP	16
SWOG (Southwest Oncology Group) treatment trials	4

Source: Connecticut Cancer Partnership Treatment Committee, 2003 Telephone Survey

GENETICS

Cancer is a genetic disease resulting from multiple molecular abnormalities that are inherited or acquired during life. Genetics research therefore can directly affect the prevention, prediction, diagnosis, and treatment of cancer. Genetics can provide insight into the biological basis of inheritance, and can be used to determine individual risk for certain types of cancer. Although the risk contributed by genetic factors in cancer is small when compared with lifestyle factors such as smoking and diet, lifetime risk for those with certain genetic mutations is high. In the areas of treatment and prevention, gene therapy--delivering therapeutic genetic material into a patient's cells to fight or help prevent cancer--is being studied in several clinical trials for major cancers.

Numerous ethical, legal, and social issues surround genetic testing, giving rise to a need for policy decisions concerning matters such as privacy of medical records, whether to take preventive measures to lessen risk, and the use of genetic information as a basis for discrimination in insurance and employment.

In recognition of the need to address the implications of genetics for public health, the Connecticut Department of Public Health, with funding from the U.S. Health Resources and Services Administration, collaboratively has drafted a long-range *Connecticut Genomics Action Plan*. Some objectives of the plan are to assess the adequacy of and identify areas of improvement to the current system of genetic screening, treatment, and services.

CANCER RESEARCH STRATEGIES

Each priority area of the Connecticut Comprehensive Cancer Control Plan contains objectives with implementation strategies involving research (Table 8). A framework is needed to achieve an integrated and collaborative program of cancer research in Connecticut, especially in the areas of intervention, policy, communications, and behavior change, and for coordinating the efforts needed to translate and disseminate the research findings.

Table 8
Connecticut Comprehensive Cancer Control Plan
Strategies from Each Priority Area Related to Research

Prevention

- ✓ Advocate for intervention research in increasing physical activity
- ✓ Advocate for research to find effective intervention strategies in reducing obesity

Early Detection

- ✓ Research and/or develop evidence-based, culturally sensitive materials and programs for increasing screening rates in targeted communities
- ✓ Investigate science-based strategies to promote education about and participation in clinical trials for cancer screening

Treatment

- ✓ Build statewide clinical trials network supporting investigator-initiated trials and removing barriers, to allow more clinicians to enroll patients easily into clinical trials
- ✓ Conduct, in collaboration with appropriate organizations and agencies, a study of current cancer treatment modalities being used and resulting treatment outcomes, based on data from the Connecticut Tumor Registry
- ✓ Determine database(s) that carry evidenced-based complementary/alternative medicine information for cancer patients and families
- ✓ Facilitate multidisciplinary research programs in specific cancer areas

Survivorship

- ✓ Advocate for increased funding that will expand survivorship research

RESEARCH OBJECTIVE 1
Develop internal structure to coordinate cross-cutting research efforts for the Connecticut Comprehensive Cancer Control Plan

Strategies

1. Support research issues identified in the Plan (see Table 8)
2. Research cross-cutting solutions to allow greater funding for intervention, policy, communications and behavioral research
3. Develop a statewide intervention research alliance; develop further relationships with the Yale-Griffin Prevention Research Center and with the other funded NCI PRCs
4. Support the *Connecticut Genomics Action Plan*

DATA, SURVEILLANCE, AND EVALUATION

VISION

A coordinated system for reviewing data collection activities and evaluating progress

Connecticut has a well-established system of cancer surveillance. The *Connecticut General Statutes* require that all new cancer cases, inpatient hospitalizations for cancer, and deaths due to cancer are reported to the Connecticut Tumor Registry, Connecticut Office of Health Care Access, or the Connecticut Department of Public Health. The Tumor Registry is the oldest registry of reported cancers in the United States, with records dating back to 1935. It is a part of the National Cancer Institute's Surveillance, Epidemiology and Ends Results (SEER) Program, and, together with other SEER registries, collects data used to set priorities for preventing and treating cancer in the United States. Data are contributed to the Registry's data base by Connecticut hospitals and private pathology laboratories, and through reciprocal agreements with all surrounding states and several other states.

Data on cancer hospitalizations are maintained in the Hospital Discharge and Billing Data Base, which includes data beginning with 1991. Death data have been maintained in the Connecticut Death Registry, part of the DPH Vital Records section, since 1848. Information on risk factors for cancer are collected through the Behavioral Risk Factor Surveillance System, Youth Risk Behavior Surveillance survey, and the Connecticut Youth Tobacco Survey. Other types of cancer-related data are collected through specialized studies and programs such as the Connecticut Breast and Cervical Cancer Early Detection Program at DPH.

The Data, Surveillance, and Evaluation Committee of the Connecticut Cancer Partnership has been instrumental in guiding the Plan's development, by reviewing all objectives to ensure that as many as possible are SMART (specific, measurable, attainable, realistic, and time-phased). Following the model of *Healthy People 2010*, those objectives in the plan without adequate baseline data have been labeled 'developmental,' and strategies include developing methods of obtaining suitable data. Strategies involving data, surveillance and evaluation from the major priority areas of the Plan are summarized in Table 9. The Committee's objectives and strategies are discussed below.

GOAL

To ensure the continued availability of high quality cancer-related data, and support the collection and synthesis of data described in the Connecticut Comprehensive Cancer Plan that are not currently available

DATA, SURVEILLANCE, & EVALUATION OBJECTIVE 1
Increase the use and timely dissemination of available information to increase knowledge about cancer incidence, prevalence, stage at diagnosis, treatment, hospitalizations, deaths, and related behavioral and environmental risk factors in Connecticut (Developmental)

Strategies

1. Promote the Connecticut Tumor Registry (CTR) and the use of CTR data to professionals by holding workshops or/and presentations about the CTR
2. Disseminate information about the CTR to the public, including information on reporting requirements for cancer
3. Explore use of the DPH and Partnership web sites to publicize cancer incidence, prevalence, stage at diagnosis, hospitalization, and death data
4. Continue support for the following existing data bases and collection mechanisms:
   - Connecticut Tumor Registry (CTR)
   - Connecticut Death Registry
   - Hospital Discharge and Billing Data Base
   - Behavioral Risk Factor Surveillance System (BRFSS)
   - Youth Risk Behavior Surveillance (YRBS)
   - Connecticut Youth Tobacco Survey (CYTS)
   - Breast and Cervical Cancer Early Detection Program
5. Support the publication of data on the incidence, prevalence, stage at diagnosis, treatment, hospitalizations, deaths, and trends for cancer and related risk factors in Connecticut

DATA, SURVEILLANCE, & EVALUATION OBJECTIVE 2
Create a mechanism for the Data, Surveillance, and Evaluation Committee to assist other committees in developing data collection tools, implementing data collection, and analyzing data required for setting baselines and targets and for measuring progress on objectives

Strategies

1. Meet routinely with members of all Partnership committees
2. Design methods of setting baselines and targets
3. Develop methods for measuring progress on objectives

DATA, SURVEILLANCE, & EVALUATION OBJECTIVE 3
Evaluate the implementation of the Connecticut Cancer Plan

Strategies

1. Enhance the mechanism for evaluating the implementation of the Connecticut Cancer Plan
2. Conduct annual evaluations
3. Disseminate evaluation results to the Partnership

TABLE 9
Connecticut Comprehensive Cancer Control Plan
Strategies from Each Priority Area Regarding Data, Surveillance, & Evaluation

Prevention
- ✓ Establish baseline for physical activity for high school students
- ✓ Establish baseline for cancer-related environmental exposures and protective measures

Early Detection
- ✓ Establish baseline for patients who do not receive timely and appropriate follow-up after receiving abnormal breast cancer screening results
- ✓ Establish baseline for patients who do not receive timely and appropriate follow-up after receiving abnormal Pap test results
- ✓ Establish baseline for patients who receive timely and appropriate follow-up after receiving abnormal colon screening results
- ✓ Establish baseline for public awareness of risk factors and early signs of skin cancer
- ✓ Establish baseline for screening utilization among racial and ethnic communities

Treatment
- ✓ Complete surveys of available non-web-based resources for public (e.g., telephone lines, written information), taking into account needs of diverse populations
- ✓ List all open Connecticut clinical trials in Connecticut hospitals, cancer centers, and oncology offices and provide link to NCI's PDQ information
- ✓ Create inventory of private practice oncologists and clinicians with an oncology subspecialty who presently participate in clinical trials; assess number and location of non-participating physicians interested in forming a linkage to data collection and analysis resources
- ✓ Conduct survey to determine number of private practice oncologists presently participating in clinical trials; assess number and location of non-participating physicians interested in forming a linkage to data collection and analysis resources
- ✓ Conduct literature search on barriers and gaps to treatment; conduct focus groups to determine if Connecticut barriers and gaps differ
- ✓ Conduct literature search, focus groups and surveys of patients, families and health professionals regarding barriers that hinder patients in accessing pain and symptom management during treatment
- ✓ Develop mechanisms to identify barriers and benefits to Connecticut hospitals for ACoS accreditation

Survivorship
- ✓ Establish baseline for number of survivors and providers who access and utilize survivor support services
- ✓ Identify criteria for deciding how to assess the quality of the service organization before including it in the centralized information database
- ✓ Survey survivors to determine the baseline number of survivors aware of guidelines for survivorship care
- ✓ Conduct a survey of health care providers to determine the baseline number of providers aware of available guidelines for survivorship care.

Palliative and Hospice Care
- ✓ Assess geographic distribution of CT physicians and nurses certified in palliative and hospice care
- ✓ Identify organizations that offer palliative or hospice care education programs and facilitate collaboration to increase end-of-life-educational opportunities in Connecticut.
- ✓ Assess current coverage for pain and palliative/hospice services offered by Medicare, Medicaid and private insurance companies; establish baseline
- ✓ Assess current status of palliative care services in long-term care facilities; establish baseline
- ✓ Assess current status of hospital and long term care contracts with Medicare-certified hospice programs; establish baseline
- ✓ Obtain statewide and local annual survey data from NHPCO to determine baseline; develop strategies to increase survey participation by Medicare-certified hospice programs in Connecticut
- ✓ Assess end-of-life needs, in partnership with Veteran's Home administrators and staff
- ✓ Monitor patient/family satisfaction with pain and symptom management through yearly surveys by CT Council for Hospice and Palliative Care
- ✓ Survey cancer survivors' pain experience through ACS Navigation program
- ✓ Review and disseminate data on compliance with JCAHO pain standards in CT health care institutions
- ✓ Obtain baseline data on annual number of referrals to hospice, including analysis by demographic criteria
- ✓ Conduct needs assessment to identify barriers to access to hospice and palliative care for all Connecticut residents, particularly minority/underserved populations

REFERENCES

[1] Jemal, A., Clegg, L.X., E. Ward, et al. 2004. Annual report to the nation on the status of cancer, 1975-2001, with a special feature regarding survival. *Cancer* 101: 3-27.

[2] National Cancer Institute, Surveillance, Epidemiology, and End Results. *SEER Cancer Statistics Review, 1975-2002*. Bethesda, MD: National Cancer Institute. http://seer.cancer.gov/csr/1975_2002

[3] *Ibid.*

[4] *Ibid.*

[5] *Ibid.*

[6] Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Prevalence Data, Nationwide, 2003. http://apps.nccd.cdc.gov/brfss/page.asp?cat=XX&yr=2003&state=US#XX

[7] Kaiser Family Foundation. 2005. Overweight and Obesity Rate by Race/Ethnicity, 2002. http://www.statehealthfacts.kff.org

[8] Connecticut Office of Health Care Access. 2005. *Snapshot: Connecticut's Health Insurance Coverage. Results of the Office of Health Care Access 2004 Household Survey.* Hartford, CT: Office of Health Care Access. 25 pp.

[9] *Ibid.*

[10] Mandelblatt, J. and K.R. Yabroff. 1999. *Access to Quality Cancer Care: Evaluating and Ensuring Equitable Services, Quality of Life, and Survival*. Institute of Medicine, National Cancer Policy Board Background Paper. http://www.iom.edu/Object.File/Master/12/812/0.pdf

[11] Kaiser Family Foundation. 2005. Connecticut: Poverty Rate by Race/Ethnicity, State Data 2002-2003, U.S. 2003. Kaiser State Health Facts. http://www.statehealthfacts.kff.org

[12] U.S Census Bureau, 2000 Census Data. http://www.census.gov

[13] Mandleblatt and Yabroff, *op. cit.*

[14] Mandelblatt and Yabroff, *op cit.*

[15] Von Eschenbach A. 2005. *The Director's Corner: Welcome to the National Cancer Institute.* http://www.nci.nih.gov/directorscorner/welcome/print?page=&keyword

[16] Connecticut Cancer Partnership, Treatment Committee. 2003 Telephone Survey. (Unpublished.)

DATA, SURVEILLANCE, AND EVALUATION TIMETABLE

Goal	Objective	Strategy	2005	2006	2007	2008	On-going
Ensure the continued availability of high quality cancer-related data and support the collection and synthesis of data described in the Connecticut Comprehensive Cancer Plan that are not currently available	1. Increase use and timely dissemination of information about cancer and its risk factors	1. Promote the Connecticut Tumor Registry (CTR), hold workshops and presentations					
		2. Disseminate information about the CTR					
		3. Explore use of DPH and partnership web site for publicizing cancer information					
		4. Continue support for existing data bases and collection mechanisms					
		5. Support publication of data on cancer and its risk factors					
	2. Create a mechanism for the Data, Surveillance, and Evaluation Committee to assist other committees	1. Meet routinely with members of other Partnership committees					
		2. Design methods of setting baselines and targets					
		3. Develop methods for measuring progress					
	3. Evaluate the implementation of the Connecticut Comprehensive Cancer Plan	1. Enhance the mechanism for evaluating the Plan					
		2. Conduct annual evaluation					
		3. Disseminate evaluation results to the Partnership					

Appendices

Appendix 1
ACRONYMS USED IN THE PLAN

ACS	American Cancer Society
ACDD	Association of Chronic Disease Directors
ACoS	American College of Surgeons
AHRQ	Agency for Healthcare Research and Quality
BRFSS	Behavioral Risk Factor Surveillance System
CBCCEDP	Connecticut Breast and Cervical Cancer Early Detection Program
CDC	Centers for Disease Control and Prevention
CIS	Cancer Information Service (Yale University)
CMMS	Centers for Medicare and Medicaid Services
CSMS	Connecticut State Medical Society
CTR	Connecticut Tumor Registry
CYTS	Connecticut Youth Tobacco Survey
DPH	Connecticut Department of Public Health
FOBT	Fecal Occult Blood Test
HPV	Human Papillomavirus
ICC	International Cancer Council
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
LMRP	Local Medical Review Policy
LTC	Long Term Care
MADD	Mothers Against Drunk Driving
NACCR	North American Association of Central Cancer Registries
NCI	National Cancer Institute
NCCN	National Comprehensive Cancer Network
NDC	National Dialogue on Cancer (now called C-Change)
NECON	New England Coalition for Health Promotion and Disease Prevention
NHPCO	National Hospice and Palliative Care Organization
NPHA	National Prison Hospice Association
PPSG	Pain and Policy Studies Group
PRC	Prevention Research Center
PSA	Prostate Specific Antigen
UCHC	University of Connecticut Health Center
YCC	Yale Cancer Center
YRBS	Youth Risk Behavior Survey
WISEWOMAN	Well-Integrated Screening and Evaluation for Women Across the Nation

Appendix 2
SUMMARY LIST OF GOALS AND OBJECTIVES

PREVENTING CANCER BEFORE IT STARTS

Goal

Reduce cancer risk through promoting healthy lifestyles and risk reduction behaviors among children and adults

Objectives

1 Decrease the proportion of adults (≥18 years) and youths (high school and middle school students) who currently use tobacco, paying special attention to populations experiencing tobacco-related disparities

2 Increase the proportion of adults (≥18 years) and youths (<18 years) who make healthy food choices, including increasing consumption of fruits and vegetables to meet current HHS and USDA Dietary Guidelines for Americans

3 Decrease the proportion of adults (≥18 years) and high school students who engage in no leisure time physical activity or exercise

4 Reduce the percentage of overweight and obese adults (≥18 years) and children

5 Increase the public's awareness of cancer-related environmental exposures and protective measures

6 Increase the practice of sun protection behaviors, especially among youths
Increase awareness of risk of overexposure to ultraviolet light in tanning booths

7 Reduce the percentage of adults and adolescents who engage in excessive drinking, which is defined as greater than 2 drinks per day for males and 1 drink per day for females

8 Increase to 50% the proportion of adults 18-64 years of age who always use condoms if sexually active with more than one sex partner

9 Increase to 95% the proportion of high school students who abstain from sexual intercourse or use condoms if sexually active

INCREASING EARLY DETECTION

Goal 1

Promote, improve, and optimize the appropriate use of high-quality breast, colorectal, and cervical cancer screening and follow-up services

Objectives

1-1 Increase the percentage of women aged 40 and over who have had a mammogram in the past two years to 85%

1-2 Increase the proportion of patients who receive timely and appropriate follow-up after receiving abnormal breast cancer screening results

1-3 Increase the percentage of women who have had a Pap test within the past year to 90% by 2008

1-4 Increase the proportion of patients who receive timely and appropriate follow-up on receiving abnormal Pap test screening results

1-5 Increase the percentage of adults 50 and over who have had a sigmoidoscopy or colonoscopy within the past five years to 65%

1-6 Increase the proportion of adults 50 and over who have had a fecal occult blood test within the past year to 63%

1-7 Increase the proportion of patients who receive timely and appropriate follow-up on receiving abnormal colon screening results

Goal 2

Eliminate or decrease racial, ethnic, and socioeconomic disparities in access to and utilization of cancer screening

Objectives

2-1 Increase screening utilization among underserved minority groups (Developmental)

2-2 Increase enrollment of underserved populations in cancer screening trials (Developmental)

Goal 3

Identify and promote evidence-based strategies for education and early detection of cancers without proven early detection tests

Objectives

3-1 Seek and develop strategies to reduce morbidity and mortality for cancers with high incidence or mortality rates for which effective screening tests are not yet available, including lung, ovarian, and prostate cancers

3-2 Increase awareness of lung, ovarian, prostate, skin, and oral cancers, for which there are no widely accepted, evidence-based, screening modalities, through education about risk factors and symptoms

3-3 Increase public awareness of risk factors and early signs of skin cancer, with emphasis on malignant melanoma

ASSURING QUALITY TREATMENT FOR ALL PATIENTS

Goal

Ensure that Connecticut residents will have equal access to high quality, evidence-based cancer care

Objectives

1 Increase the proportion of cancer care providers and cancer patients with access to treatment information and evidence-based quality standards of care, taking into consideration cultural, literacy, and access needs (Developmental)

2 Increase the proportion of cancer care providers and cancer patients with access to comprehensive information on clinical treatment trials (Developmental)

3 Build a statewide clinical trials network supporting investigator-initiated trials and removing barriers, to allow more clinicians to enroll patients easily into clinical trials

4 Reduce the proportion of cancer patients who experience difficulty or delays in accessing treatment or who do not receive needed treatment (Developmental)

5 Increase the proportion of cancer patients and their families who have access to support systems, including psychosocial support and evidence-based complementary medicine (Developmental)

6 Increase the proportion of cancer patients who have access to pain and symptom management during treatment (Developmental)

7 Increase to 28 the number of Connecticut acute care hospitals that are accredited by the American College of Surgeons (ACoS)

EMPOWERING SURVIVORS AND THEIR FAMILIES

Goal

To ensure a high quality of life and care for all Connecticut residents living with cancer and for their families

Objectives

1 Increase the proportion of cancer survivors and cancer care providers who access and utilize survivor support services (Developmental)

2 Increase the proportion of cancer survivors who are knowledgeable about published guidelines for survivorship care (Developmental)

3 Increase the proportion of health care providers who are knowledgeable about evidence-based survivorship care (Developmental)

HELP AT THE END OF LIFE

Goal 1

To ensure that high quality palliative and hospice care services are available and accessible to all Connecticut residents

Objectives

1-1 Increase the number of health care professionals (physicians, nurses, social workers, and spiritual counselors) who are knowledgeable about palliative and hospice care (Developmental)

1-2 Increase the number of health professionals who are board certified in palliative and hospice care

1-3 Increase the number of health insurance programs that provide coverage for pain and palliative/hospice services (Developmental)

1-4 Increase the proportion of facilities that self-report palliative care programs

1-5 Increase the number of hospitals and long term care facilities that have contractual agreements with Medicare-certified hospice programs (Developmental)

1-6 Improve end-of-life care in Connecticut State correctional facilities

1-7 Assess patient and family satisfaction with palliative and hospice services (Developmental)

1-8 Improve end-of-life care services in State Veterans Home (Developmental)

Goal 2

Ensure that Connecticut residents have improved quality of life through effective management of pain and other symptoms

Objectives

2-1 Increase legislation and public policy supporting pain, palliative, and hospice care services to achieve Grade C in strength of pain policies in Connecticut

2-2 Decrease the prevalence of pain among Connecticut nursing home residents

2-3 Demonstrate an increase in patient and family satisfaction with management of pain and symptoms (Developmental)

Goal 3

Ensure that Connecticut residents are more aware of, better prepared for, and more willing to seek palliative and hospice care

Objectives

3-1 Increase the utilization of palliative and hospice care

3-2 Increase the number of referrals to hospice and palliative care, especially among persons from minority and medically underserved populations (Developmental)

CROSS-CUTTING ISSUES

ADVOCATING FOR QUALITY PROGRAMS AND ACCESS

Objective

1 Develop internal structure and tracking instruments to coordinate advocacy efforts for the Connecticut Comprehensive Cancer Control Plan

ADDRESSING HEALTH DISPARITIES

Objective

1 Develop internal structure to coordinate cross-cutting efforts to increase access to health care and reduce health disparities

COMMUNICATING ABOUT THE PLAN AND THE PARTNERSHIP

Objectives

1 Develop a plan to communicate information about the Connecticut Comprehensive Cancer Control Plan and Connecticut Cancer Partnership

2 Create plan for ongoing communications with members

3 Prepare campaign for release of Plan

4 Identify and train Partners for a Speakers Bureau

5 Produce community guides on specific subjects for target group use

6 Develop and produce two portable exhibits

STIMULATING AND TRANSLATING RESEARCH

Objective

1 Develop internal structure to coordinate cross-cutting research efforts for the Connecticut Comprehensive Cancer Control Plan

DATA, SURVEILLANCE, AND EVALUATION

Goal

To ensure the continued availability of high quality cancer-related data, and support the collection and synthesis of data described in the Connecticut Comprehensive Cancer Plan that are not currently available

Objectives

1 Increase the use and timely dissemination of available information to increase knowledge about cancer incidence, prevalence, stage at diagnosis, treatment, hospitalizations, deaths, and related behavioral and environmental risk factors in Connecticut (Developmental)

2 Create a mechanism for the Data, Surveillance, and Evaluation Committee to assist other committees in developing data collection tools, implementing data collection, and analyzing data required for setting baselines and targets and for measuring progress on objectives

3 Evaluate the implementation of the Connecticut Cancer Plan

Appendix 3
COMMITTEE MEMBERS

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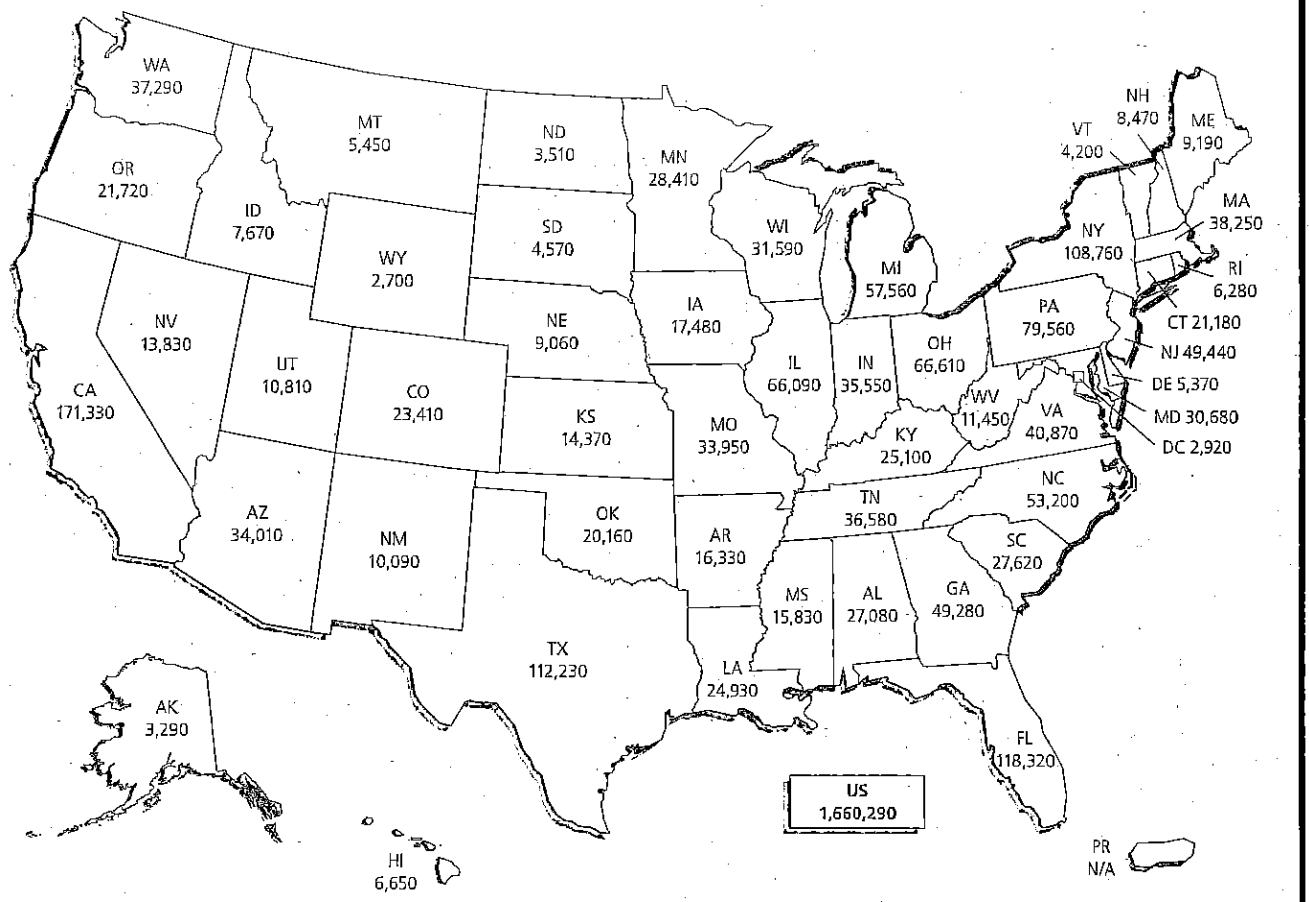
Cancer Facts & Figures 2013



Estimated numbers of new cancer cases for 2013, excluding basal cell and squamous cell skin cancers and in situ carcinomas except urinary bladder.
Note: State estimates are offered as a rough guide and should be interpreted with caution. State estimates may not add to US total due to rounding.

Special Section:
Pancreatic Cancer
see page 25

Contents

**Indicates a figure or table*

Corporate Center: American Cancer Society Inc.
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This publication attempts to summarize current scientific information about cancer. Except when specified, it does not represent the official policy of the American Cancer Society.

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Basic Cancer Facts

What Is Cancer?

Cancer is a group of diseases characterized by uncontrolled growth and spread of abnormal cells. If the spread is not controlled, it can result in death. Cancer is caused by both external factors (tobacco, infectious organisms, chemicals, and radiation) and internal factors (inherited mutations, hormones, immune conditions, and mutations that occur from metabolism). These causal factors may act together or in sequence to initiate or promote the development of cancer. Ten or more years often pass between exposure to external factors and detectable cancer. Cancer is treated with surgery, radiation, chemotherapy, hormone therapy, biological therapy, and targeted therapy.

Can Cancer Be Prevented?

A substantial proportion of cancers could be prevented. All cancers caused by cigarette smoking and heavy use of alcohol could be prevented completely. The American Cancer Society estimates that in 2013 about 174,100 cancer deaths will be caused by tobacco use. The World Cancer Research Fund estimates that about one-quarter to one-third of the new cancer cases expected to occur in the US in 2013 will be related to overweight or obesity, physical inactivity, and poor nutrition, and thus could also be prevented. Certain cancers are related to infectious agents, such as human papillomavirus (HPV), hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and *Helicobacter pylori (H. pylori)*; many of these cancers could be prevented through behavioral changes, vaccines, or antibiotics. Many of the more than 2 million skin cancers that are diagnosed annually could be prevented by protecting skin from excessive sun exposure and avoiding indoor tanning.

In addition to preventing cancer through the avoidance of risk factors, regular screening tests that allow the detection and removal of precancerous growths can prevent cancers of the cervix, colon, and rectum.

Early detection of cancer, which usually results in less extensive treatment and better outcomes, can also be achieved through screening for some cancers. Screening is known to reduce mortality for cancers of the breast, colon, rectum, and cervix. A heightened awareness of changes in the breast or skin may also result in detection of these tumors at earlier stages. For complete cancer screening guidelines, please see page 60.

Who Is at Risk of Developing Cancer?

Anyone can develop cancer. Since the risk of being diagnosed with cancer increases with age, most cases occur in adults who are middle aged or older. About 77% of all cancers are diagnosed in persons 55 years of age and older. Cancer researchers use the word "risk" in different ways, most commonly expressing risk as lifetime risk or relative risk.

Lifetime risk refers to the probability that an individual will develop or die from cancer over the course of a lifetime. In the US, men have slightly less than a 1 in 2 lifetime risk of developing cancer; for women, the risk is a little more than 1 in 3. However, it is important to note that these estimates are based on the average experience of the general population and may over- or underestimate individual risk because of differences in exposure (e.g. smoking), and/or genetic susceptibility.

Relative risk is a measure of the strength of the relationship between a risk factor and cancer. It compares the risk of developing cancer in persons with a certain exposure or trait to the risk in persons who do not have this characteristic. For example, male smokers are about 23 times more likely to develop lung cancer than nonsmokers, so their relative risk is 23. Most relative risks are not this large. For example, women who have a first-degree relative (mother, sister, or daughter) with a history of breast cancer are about two times more likely to develop breast cancer than women who do not have this family history.

All cancers involve the malfunction of genes that control cell growth and division. About 5% of all cancers are strongly hereditary, in that an inherited genetic alteration confers a very high risk of developing one or more specific types of cancer. However, most cancers do not result from inherited genes but from damage to genes occurring during one's lifetime. Genetic damage may result from internal factors, such as hormones or the metabolism of nutrients within cells, or external factors, such as tobacco, or excessive exposure to chemicals, sunlight, or ionizing radiation.

How Many People Alive Today Have Ever Had Cancer?

The National Cancer Institute estimates that approximately 13.7 million Americans with a history of cancer were alive on January 1, 2012. Some of these individuals were cancer free, while others still had evidence of cancer and may have been undergoing treatment.

How Many New Cases Are Expected to Occur This Year?

About 1,660,290 new cancer cases are expected to be diagnosed in 2013. This estimate does not include carcinoma in situ (noninvasive cancer) of any site except urinary bladder, and does not include basal cell and squamous cell skin cancers, which are not required to be reported to cancer registries.

How Many People Are Expected to Die of Cancer This Year?

In 2013, about 580,350 Americans are expected to die of cancer, almost 1,600 people per day. Cancer is the second most common cause of death in the US, exceeded only by heart disease, accounting for nearly 1 of every 4 deaths.

What Percentage of People Survive Cancer?

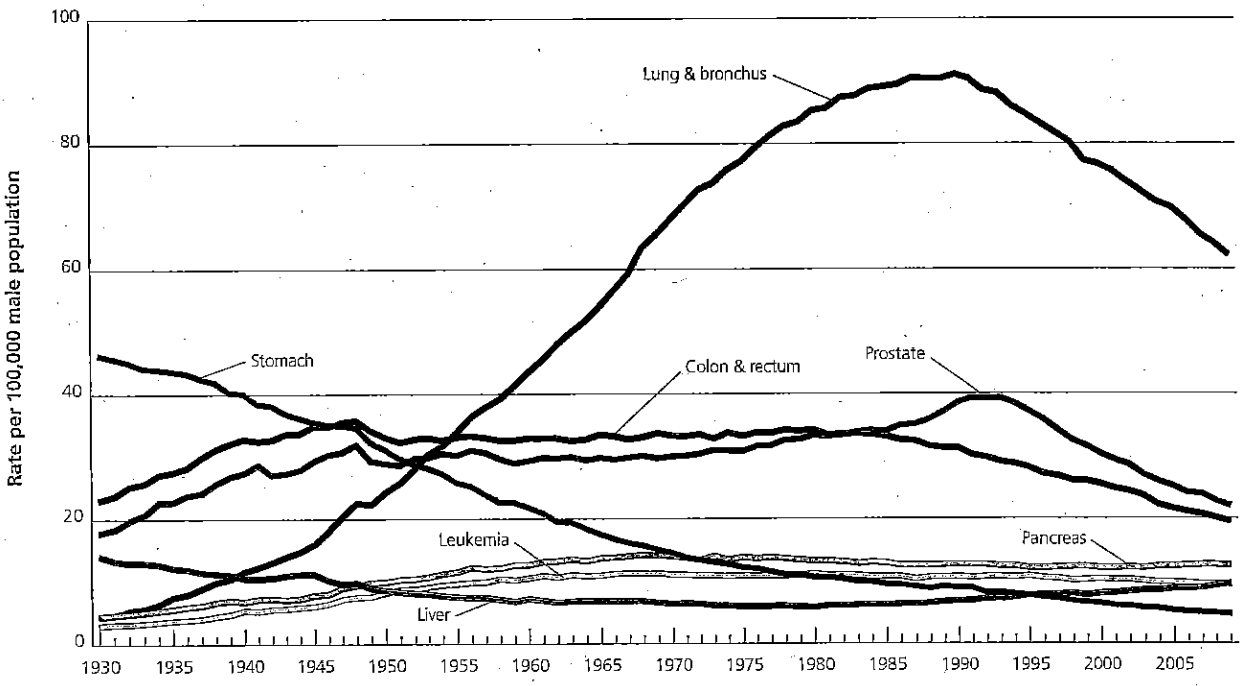
The 5-year relative survival rate for all cancers diagnosed between 2002 and 2008 is 68%, up from 49% in 1975-1977 (see page 18). The improvement in survival reflects both progress in diagnosing certain cancers at an earlier stage and improvements in treatment. Survival statistics vary greatly by cancer type and stage at diagnosis. Relative survival compares survival among cancer patients to that of people not diagnosed with cancer who are of the same age, race, and sex. It represents the percentage of cancer patients who are alive after some designated time period (usually 5 years) relative to persons without cancer. It does not distinguish between patients who have been cured and those who have relapsed or are still in treatment. While 5-year relative survival is useful in monitoring progress in the early detection and treatment of cancer, it does not represent the proportion of people who are cured permanently, since cancer deaths can occur beyond 5 years after diagnosis.

Although relative survival for specific cancer types provides some indication about the average survival experience of cancer patients in a given population, it may or may not predict individual prognosis and should be interpreted with caution. First, 5-year relative survival rates for the most recent time period are based on patients who were diagnosed from 2002 to 2008 and thus, do not reflect the most recent advances in detection and treatment. Second, factors that influence survival, such as treatment protocols, other illnesses, and biological and behavioral differences of individual cancers or people, cannot be taken into account in the estimation of relative survival rates. For more information about survival rates, see Sources of Statistics on page 58.

How Is Cancer Staged?

Staging describes the extent or spread of cancer at the time of diagnosis. Proper staging is essential in determining the choice of therapy and in assessing prognosis. A cancer's stage is based on the size or extent of the primary (main) tumor and whether it has spread to other areas of the body. A number of different staging systems are used to classify tumors. A system of summary staging (in situ, local, regional, and distant) is used for descriptive and statistical analysis of tumor registry data. If cancer cells are present only in the layer of cells where they developed and have not spread, the stage is in situ. If cancer cells have penetrated beyond the original layer of tissue, the cancer is invasive and categorized as local, regional, or distant stage based on the

Age-adjusted Cancer Death Rates*, Males by Site, US, 1930-2009



*Per 100,000, age adjusted to the 2000 US standard population.

Note: Due to changes in ICD coding, numerator information has changed over time. Rates for cancer of the liver, lung and bronchus, and colon and rectum are affected by these coding changes.

Source: US Mortality Volumes 1930 to 1959, US Mortality Data 1960 to 2009, National Center for Health Statistics, Centers for Disease Control and Prevention.

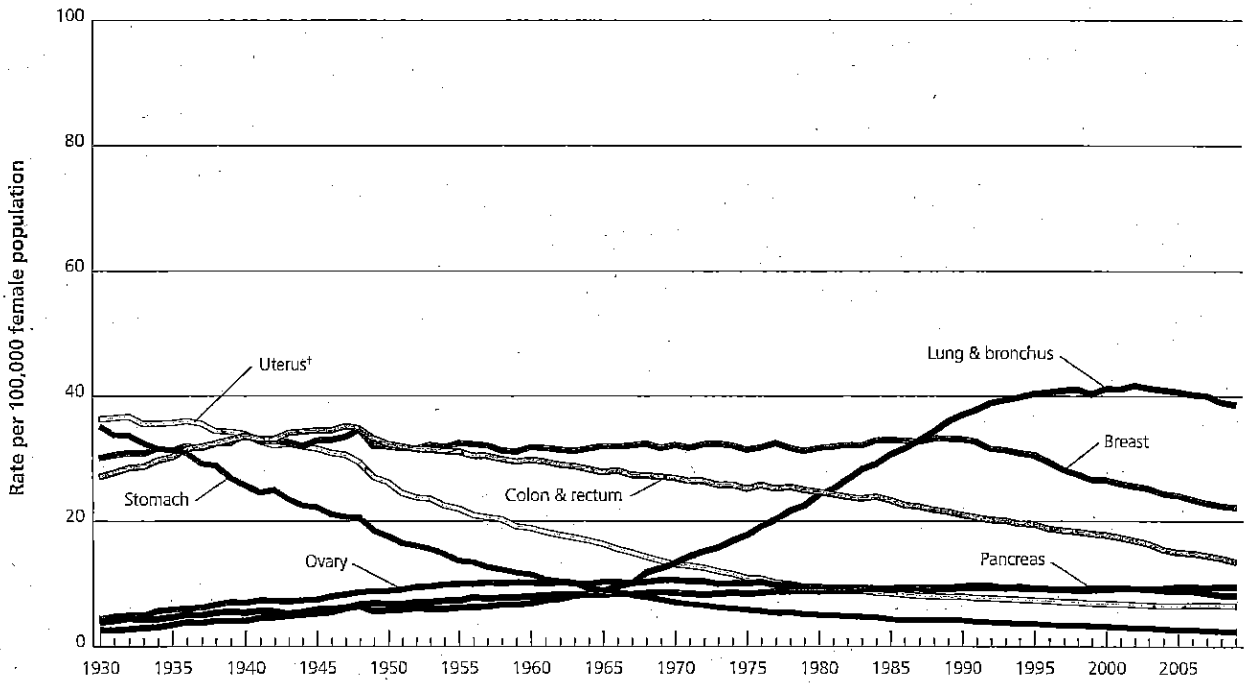
extent of spread. (For a description of the summary stage categories, see the footnotes in the table on page 17, Five-year Relative Survival Rates (%) by Stage at Diagnosis, 2002-2008.) Clinicians typically use the TNM cancer staging system, which assesses tumors in three ways: extent of the primary tumor (T), absence or presence of regional lymph node involvement (N), and absence or presence of distant metastases (M). Once the T, N, and M categories are determined, a stage of 0, I, II, III, or IV is assigned, with stage 0 being in situ, stage I being early, and stage IV being the most advanced disease. Some cancers have alternative staging systems (e.g., leukemia). As the molecular properties of cancer have become better understood, tumor biological markers and genetic features have been incorporated into prognostic models, treatment plans, and/or stage for some cancer sites.

What Are the Costs of Cancer?

The National Institutes of Health (NIH) estimates that the overall costs of cancer in 2008 were $201.5 billion: $77.4 billion for direct medical costs (total of all health expenditures) and $124.0 billion for indirect mortality costs (cost of lost productivity due to premature death). PLEASE NOTE: These numbers are not comparable to those published in previous years because as of 2011, the NIH is calculating the estimates using a different data source: the Medical Expenditure Panel Survey (MEPS) of the Agency for Healthcare Research and Quality. The MEPS estimates are based on more current, nationally representative data and are used extensively in scientific publications. As a result, direct and indirect costs will no longer be projected to the current year, and estimates of indirect morbidity costs have been discontinued. For more information, please visit nhlbi.nih.gov/about/factpdf.htm.

Lack of health insurance and other barriers prevents many Americans from receiving optimal health care. According to the US Census Bureau, approximately 50 million Americans were uninsured in 2010; almost one-third of Hispanics (31%) and one in 10 children (17 years of age and younger) had no health insurance coverage. Uninsured patients and those from ethnic minorities are substantially more likely to be diagnosed with cancer at a later stage, when treatment can be more extensive and more costly. For more information on the relationship between health insurance and cancer, see *Cancer Facts & Figures 2008*, Special Section, available online at cancer.org/statistics.

Age-adjusted Cancer Death Rates*, Females by Site, US, 1930-2009



*Per 100,000, age adjusted to the 2000 US standard population. †Uterus refers to uterine cervix and uterine corpus combined.

Note: Due to changes in ICD coding, numerator information has changed over time. Rates for cancer of the lung and bronchus, colon and rectum, and ovary are affected by these coding changes.

Source: US Mortality Volumes 1930 to 1959, US Mortality Data 1960 to 2009, National Center for Health Statistics, Centers for Disease Control and Prevention.

Estimated Number* of New Cancer Cases and Deaths by Sex, US, 2013

	Estimated New Cases			Estimated Deaths		
	Both Sexes	Male	Female	Both Sexes	Male	Female
All Sites	1,660,290	854,790	805,500	580,350	306,920	273,430
Oral cavity & pharynx	41,380	29,620	11,760	7,890	5,500	2,390
Tongue	13,590	9,900	3,690	2,070	1,380	690
Mouth	11,400	6,730	4,670	1,800	1,080	720
Pharynx	13,930	11,200	2,730	2,400	1,790	610
Other oral cavity	2,460	1,790	670	1,640	1,260	380
Digestive system	290,200	160,750	129,450	144,570	82,700	61,870
Esophagus	17,990	14,440	3,550	15,210	12,220	2,990
Stomach	21,600	13,230	8,370	10,990	6,740	4,250
Small intestine	8,810	4,670	4,140	1,170	610	560
Colon†	102,480	50,090	52,390	50,830	26,300	24,530
Rectum	40,340	23,590	16,750			
Anus, anal canal, & anorectum	7,060	2,630	4,430	880	330	550
Liver & intrahepatic bile duct	30,640	22,720	7,920	21,670	14,890	6,780
Gallbladder & other biliary	10,310	4,740	5,570	3,230	1,260	1,970
Pancreas	45,220	22,740	22,480	38,460	19,480	18,980
Other digestive organs	5,750	1,900	3,850	2,130	870	1,260
Respiratory system	246,210	131,760	114,450	163,890	90,600	73,290
Larynx	12,260	9,680	2,580	3,630	2,860	770
Lung & bronchus	228,190	118,080	110,110	159,480	87,260	72,220
Other respiratory organs	5,760	4,000	1,760	780	480	300
Bones & joints	3,010	1,680	1,330	1,440	810	630
Soft tissue (including heart)	11,410	6,290	5,120	4,390	2,500	1,890
Skin (excluding basal & squamous)	82,770	48,660	34,110	12,650	8,560	4,090
Melanoma-skin	76,690	45,060	31,630	9,480	6,280	3,200
Other nonepithelial skin	6,080	3,600	2,480	3,170	2,280	890
Breast	234,580	2,240	232,340	40,030	410	39,620
Genital system	339,810	248,080	91,730	58,480	30,400	28,080
Uterine cervix	12,340		12,340	4,030		4,030
Uterine corpus	49,560		49,560	8,190		8,190
Ovary	22,240		22,240	14,030		14,030
Vulva	4,700		4,700	990		990
Vagina & other genital, female	2,890		2,890	840		840
Prostate	238,590	238,590		29,720	29,720	
Testis	7,920	7,920		370	370	
Penis & other genital, male	1,570	1,570		310	310	
Urinary system	140,430	96,800	43,630	29,790	20,120	9,670
Urinary bladder	72,570	54,610	17,960	15,210	10,820	4,390
Kidney & renal pelvis	65,150	40,430	24,720	13,680	8,780	4,900
Ureter & other urinary organs	2,710	1,760	950	900	520	380
Eye & orbit	2,800	1,490	1,310	320	120	200
Brain & other nervous system	23,130	12,770	10,360	14,080	7,930	6,150
Endocrine system	62,710	16,210	46,500	2,770	1,270	1,500
Thyroid	60,220	14,910	45,310	1,850	810	1,040
Other endocrine	2,490	1,300	1,190	920	460	460
Lymphoma	79,030	42,670	36,360	20,200	11,250	8,950
Hodgkin lymphoma	9,290	5,070	4,220	1,180	660	520
Non-Hodgkin lymphoma	69,740	37,600	32,140	19,020	10,590	8,430
Myeloma	22,350	12,440	9,910	10,710	6,070	4,640
Leukemia	48,610	27,880	20,730	23,720	13,660	10,060
Acute lymphocytic leukemia	6,070	3,350	2,720	1,430	820	610
Chronic lymphocytic leukemia	15,680	9,720	5,960	4,580	2,750	1,830
Acute myeloid leukemia	14,590	7,820	6,770	10,370	5,930	4,440
Chronic myeloid leukemia	5,920	3,420	2,500	610	340	270
Other leukemia‡	6,350	3,570	2,780	6,730	3,820	2,910
Other & unspecified primary sites‡	31,860	15,450	16,410	45,420	25,020	20,400

*Rounded to the nearest 10; estimated new cases exclude basal cell and squamous cell skin cancers and in situ carcinomas except urinary bladder. About 64,640 carcinoma in situ of the female breast and 61,300 melanoma in situ will be newly diagnosed in 2013. †Estimated deaths for colon and rectal cancers are combined. ‡More deaths than cases may reflect lack of specificity in recording underlying cause of death on death certificates and/or an undercount in the case estimate.

Source: Estimated new cases are based on cancer incidence rates from 49 states and the District of Columbia during 1995-2009 as reported by the North American Association of Central Cancer Registries (NAACCR), represesnting about 98% of the US population. Estimated deaths are based on US mortality data during 1995-2009, National Center for Health Statistics, Centers for Disease Control and Prevention.

Estimated Number* of New Cases for Selected Cancers by State, US, 2013

State	All Sites	Female Breast	Uterine Cervix	Colon & Rectum	Uterine Corpus	Leukemia	Lung & Bronchus	Melanoma of the Skin	Non-Hodgkin Lymphoma	Prostate	Urinary Bladder
Alabama	27,080	3,720	200	2,390	610	640	4,550	1,300	990	3,940	960
Alaska	3,290	510	†	310	90	100	470	90	140	440	140
Arizona	34,010	4,660	220	2,630	860	920	4,250	1,400	1,360	4,340	1,400
Arkansas	16,330	2,280	150	1,540	370	450	2,700	530	680	2,370	610
California	171,330	25,360	1,480	14,690	5,160	5,210	18,720	8,530	7,280	23,740	6,920
Colorado	23,410	3,300	160	1,880	690	840	2,550	1,310	1,050	3,870	990
Connecticut	21,180	3,050	110	1,670	740	570	2,780	1,080	890	2,940	1,090
Delaware	5,370	770	†	430	170	140	760	300	220	860	250
Dist. of Columbia	2,920	450	†	240	90	70	320	90	100	500	90
Florida	118,320	15,710	940	10,290	3,110	3,490	17,960	5,330	5,060	17,330	5,720
Georgia	49,280	7,310	420	3,970	1,230	1,290	6,690	2,360	1,810	7,930	1,610
Hawaii	6,650	960	50	730	240	180	900	380	240	800	200
Idaho	7,670	1,010	50	670	220	270	930	420	360	1,330	380
Illinois	66,090	9,350	500	6,140	2,150	2,020	9,270	2,480	2,840	9,230	2,990
Indiana	35,550	4,540	260	3,250	1,040	1,000	5,500	1,470	1,460	4,310	1,560
Iowa	17,480	2,310	90	1,640	580	590	2,350	980	790	2,270	810
Kansas	14,370	2,160	90	1,250	440	450	1,930	800	650	2,020	600
Kentucky	25,100	3,300	190	2,300	700	720	4,560	1,540	1,100	3,130	1,060
Louisiana	24,930	3,630	220	2,400	550	660	3,740	770	950	4,040	930
Maine	9,190	1,150	50	730	310	280	1,380	440	390	1,290	530
Maryland	30,680	4,760	220	2,410	950	780	4,040	1,530	1,180	4,880	1,220
Massachusetts	38,250	5,820	210	2,910	1,280	990	4,880	1,840	1,590	5,700	2,060
Michigan	57,560	8,140	330	4,730	1,920	1,750	8,250	2,900	2,530	9,490	2,860
Minnesota	28,410	4,260	120	2,220	890	950	3,860	1,020	1,210	4,090	1,190
Mississippi	15,830	2,080	130	1,580	340	390	2,630	550	560	2,490	540
Missouri	33,950	4,680	250	3,110	1,040	980	5,410	1,500	1,480	4,170	1,480
Montana	5,450	740	†	510	160	180	700	250	260	870	280
Nebraska	9,060	1,230	50	910	290	310	1,220	460	430	1,290	420
Nevada	13,830	1,760	120	1,350	330	400	1,970	440	520	1,900	660
New Hampshire	8,470	1,180	50	640	290	240	1,150	410	350	1,180	460
New Jersey	49,440	6,960	460	4,640	1,740	1,430	5,960	2,520	2,190	7,190	2,450
New Mexico	10,090	1,360	80	860	270	330	1,050	460	400	1,610	380
New York	108,760	14,950	850	9,210	3,850	3,270	13,480	4,200	4,740	16,720	5,510
North Carolina	53,200	7,430	360	4,260	1,430	1,470	8,040	2,620	2,080	8,150	2,070
North Dakota	3,510	450	†	370	100	120	460	150	150	550	170
Ohio	66,610	9,060	440	5,890	2,230	1,770	10,230	2,960	2,840	8,530	3,020
Oklahoma	20,160	2,690	170	1,780	500	610	3,370	770	840	2,500	790
Oregon	21,720	3,310	120	1,610	670	620	2,860	1,410	950	3,380	1,030
Pennsylvania	79,560	10,490	480	7,390	2,720	2,240	10,980	3,890	3,440	9,450	3,980
Rhode Island	6,280	900	†	530	210	180	870	270	250	820	340
South Carolina	27,620	3,580	220	2,340	710	760	4,390	1,320	1,040	4,160	1,070
South Dakota	4,570	600	†	430	140	150	620	200	200	730	220
Tennessee	36,580	5,070	280	3,180	900	990	6,200	1,900	1,450	4,990	1,440
Texas	112,230	14,980	1,110	9,750	2,870	3,740	15,000	3,930	4,830	15,730	4,030
Utah	10,810	1,550	70	740	320	380	800	720	490	1,960	420
Vermont	4,200	550	†	320	130	110	590	220	170	560	210
Virginia	40,870	6,280	300	3,270	1,240	990	5,380	2,380	1,590	6,840	1,590
Washington	37,290	5,610	230	2,730	1,140	1,160	4,700	2,350	1,650	5,690	1,690
West Virginia	11,450	1,460	80	1,180	350	330	2,100	540	470	1,470	530
Wisconsin	31,590	4,490	190	2,610	1,080	1,050	4,310	1,250	1,400	4,370	1,530
Wyoming	2,700	380	†	240	80	80	320	130	120	430	130
United States	1,660,290	232,340	12,340	142,820	49,560	48,610	228,190	76,690	69,740	238,590	72,570

*Rounded to the nearest 10. Excludes basal cell and squamous cell skin cancers and in situ carcinomas except urinary bladder. †Estimate is fewer than 50 cases.

Note: These estimates are offered as a rough guide and should be interpreted with caution. State estimates may not sum to US total due to rounding and exclusion of state estimates fewer than 50 cases.

Estimated Number* of Deaths for Selected Cancers by State, US, 2013

State	All Sites	Brain/ Nervous System	Female Breast	Colon & Rectum	Leukemia	Liver	Lung & Bronchus	Non-Hodgkin Lymphoma	Ovary	Pancreas	Prostate
Alabama	10,430	250	690	970	400	330	3,290	320	270	630	550
Alaska	980	†	70	80	†	†	270	†	†	60	50
Arizona	11,210	310	790	990	480	460	2,850	400	310	740	630
Arkansas	6,650	150	420	610	270	200	2,170	200	150	390	320
California	57,290	1,590	4,220	5,150	2,460	2,980	12,700	2,000	1,540	4,010	3,390
Colorado	7,350	230	510	680	320	290	1,710	250	230	500	440
Connecticut	6,890	170	460	470	290	230	1,740	230	170	530	400
Delaware	1,940	50	120	170	70	80	580	60	50	120	100
Dist. of Columbia	1,030	†	80	100	†	50	240	†	†	80	80
Florida	42,370	880	2,660	3,640	1,770	1,550	12,070	1,400	930	2,770	2,200
Georgia	16,010	360	1,200	1,450	600	530	4,670	460	410	1,010	790
Hawaii	2,400	†	140	230	80	120	580	80	50	210	110
Idaho	2,660	90	180	220	120	80	670	100	60	200	180
Illinois	24,000	530	1,610	2,230	1,010	750	6,560	780	550	1,620	1,230
Indiana	13,250	320	850	1,120	550	370	4,110	440	300	820	590
Iowa	6,420	190	400	580	280	200	1,780	230	170	390	350
Kansas	5,430	150	360	490	250	170	1,590	210	140	350	240
Kentucky	9,970	200	590	880	340	270	3,510	300	200	540	390
Louisiana	9,040	210	650	860	330	380	2,670	260	190	580	420
Maine	3,240	90	190	250	130	90	950	110	60	200	160
Maryland	10,480	230	800	930	410	380	2,810	310	250	730	560
Massachusetts	12,840	310	810	1,020	500	500	3,530	400	340	910	650
Michigan	20,570	540	1,360	1,700	910	670	5,940	730	490	1,460	890
Minnesota	9,610	250	610	770	440	330	2,500	340	240	630	520
Mississippi	6,300	140	420	630	250	210	2,010	170	110	380	330
Missouri	12,730	310	890	1,100	540	420	3,940	380	240	820	560
Montana	2,000	50	120	180	90	50	550	70	50	130	140
Nebraska	3,440	100	210	340	140	90	900	130	80	230	210
Nevada	4,760	140	360	450	180	210	1,480	140	100	350	290
New Hampshire	2,680	70	170	200	100	80	750	80	60	200	140
New Jersey	16,410	340	1,330	1,560	630	570	4,060	530	440	1,180	750
New Mexico	3,540	90	240	350	140	170	770	110	90	240	230
New York	34,240	780	2,390	3,020	1,450	1,410	8,790	1,090	900	2,500	1,770
North Carolina	18,620	390	1,260	1,510	710	620	5,660	550	420	1,150	910
North Dakota	1,280	†	90	130	60	†	310	†	†	90	80
Ohio	25,130	590	1,720	2,170	980	750	7,350	800	560	1,620	1,240
Oklahoma	7,850	190	490	720	300	270	2,440	260	170	440	380
Oregon	7,820	230	490	660	320	310	2,110	280	220	520	460
Pennsylvania	28,680	600	1,950	2,540	1,190	930	7,640	1,020	730	1,950	1,430
Rhode Island	2,140	50	130	170	100	80	600	60	50	130	100
South Carolina	9,800	220	660	820	360	340	2,990	280	210	600	500
South Dakota	1,590	50	110	150	60	†	440	50	†	110	90
Tennessee	14,080	360	910	1,220	520	460	4,600	440	280	800	630
Texas	37,180	940	2,650	3,390	1,490	1,950	9,670	1,210	850	2,340	1,650
Utah	2,790	110	260	240	150	90	450	120	80	220	210
Vermont	1,300	†	80	100	50	50	380	†	†	90	60
Virginia	14,720	320	1,110	1,270	580	480	4,130	460	370	1,020	740
Washington	12,390	350	800	980	520	530	3,260	440	360	850	730
West Virginia	4,660	100	280	440	170	120	1,480	160	100	230	190
Wisconsin	11,220	310	700	880	520	370	2,980	400	300	770	630
Wyoming	950	†	60	80	†	†	240	†	†	70	50
United States	580,350	14,080	39,620	50,830	23,720	21,670	159,480	19,020	14,030	38,460	29,720

*Rounded to nearest 10. †Estimate is fewer than 50 deaths.
Note: These estimates are offered as a rough guide and should be interpreted with caution. State estimates may not sum to US total due to rounding and exclusion of state estimates fewer than 50 deaths.

Incidence Rates* for Selected Cancers by State, US, 2005-2009

	All Sites		Breast	Colon & Rectum		Lung & Bronchus		Non-Hodgkin Lymphoma		Prostate	Urinary Bladder	
State	Male	Female	Female	Male	Female	Male	Female	Male	Female	Male	Male	Female
Alabama†	582.4	395.4	119.4	59.7	41.3	104.8	54.6	19.5	13.4	162.1	33.2	7.4
Alaska	523.7	435.7	130.0	55.4	44.2	83.8	63.0	22.0	18.3	139.9	38.2	9.5
Arizona	439.6	361.0	106.7	41.9	31.8	62.5	48.2	17.6	13.3	118.1	31.5	8.3
Arkansas‡	551.6	381.6	109.2	54.7	39.8	107.4	59.6	21.9	15.0	153.4	32.5	7.9
California	510.5	398.9	123.3	50.7	38.1	62.4	45.2	23.0	15.6	143.0	33.9	8.0
Colorado	493.9	396.4	125.4	46.0	35.1	57.2	44.6	22.2	15.8	152.3	31.8	8.3
Connecticut	594.1	462.5	137.3	55.3	41.1	78.5	61.0	25.9	17.9	165.2	47.9	12.5
Delaware	613.1	448.2	127.9	56.4	41.4	90.6	68.8	24.0	17.1	182.8	44.2	11.3
Dist. of Columbia‡	562.6	399.0	128.3	53.0	42.2	77.2	45.9	21.3	13.5	185.1	24.6	8.0
Florida	528.3	403.1	114.9	49.6	37.9	82.8	58.1	21.7	15.2	137.7	35.6	8.8
Georgia	569.8	397.2	119.7	53.4	38.8	95.6	54.7	21.6	14.2	167.8	33.0	7.8
Hawaii	504.3	401.6	125.1	59.6	38.7	68.7	40.4	20.9	13.0	128.4	26.2	6.4
Idaho	528.7	411.6	119.1	45.8	36.5	64.6	48.1	22.1	17.3	160.1	36.7	8.9
Illinois	573.5	437.8	125.4	61.3	44.8	88.9	60.6	23.8	16.3	157.9	40.2	10.3
Indiana	539.3	421.5	116.9	57.5	43.3	99.5	64.0	23.1	17.0	129.2	36.3	8.9
Iowa	568.2	436.5	123.5	59.6	45.9	87.6	56.3	26.5	18.5	142.2	43.0	8.7
Kansas	563.8	422.2	124.6	57.6	40.4	85.0	55.0	23.6	17.2	157.3	38.2	9.3
Kentucky	615.4	459.7	121.2	65.7	46.9	128.2	80.1	25.1	17.3	139.0	40.3	9.9
Louisiana†	614.5	410.9	118.9	64.6	43.7	101.9	58.2	24.2	16.8	173.7	34.4	8.2
Maine	600.1	467.3	128.5	55.8	43.9	95.5	67.6	25.6	18.4	153.6	48.1	13.5
Maryland	532.8	411.8	124.8	49.9	37.9	77.3	56.6	21.1	14.2	158.4	33.5	9.3
Massachusetts	581.1	459.2	132.8	53.3	40.3	81.0	64.0	25.1	16.3	157.5	45.0	12.3
Michigan	578.0	433.3	120.3	52.9	40.9	87.3	61.3	24.8	17.8	166.5	42.5	10.9
Minnesota	566.5	424.4	128.5	51.2	40.1	66.7	49.8	26.9	18.1	179.0	40.0	9.6
Mississippi†	612.1	395.5	114.3	62.7	44.7	116.4	56.3	21.8	14.4	174.2	31.4	7.2
Missouri	548.3	423.4	121.9	58.3	42.0	100.0	64.7	22.3	15.9	132.9	36.3	8.4
Montana	531.6	417.9	123.0	52.7	38.5	73.0	58.5	23.0	15.3	164.1	37.6	9.7
Nebraska	547.1	426.6	124.7	62.8	46.2	78.2	51.7	24.2	17.7	150.9	35.8	8.9
Nevada	514.4	405.1	114.3	52.1	39.3	76.8	65.5	20.9	15.4	138.4	38.4	11.0
New Hampshire	584.8	452.4	132.5	51.9	39.5	81.4	62.2	23.9	17.4	155.1	48.1	13.3
New Jersey	593.0	454.1	130.0	58.2	43.0	76.1	56.8	25.5	17.6	172.4	45.1	11.8
New Mexico	480.8	370.5	111.4	46.4	34.6	55.7	39.3	19.1	14.5	141.6	26.9	6.4
New York	583.3	442.7	125.8	54.6	41.5	77.1	55.1	25.9	17.8	167.2	42.5	10.9
North Carolina	579.2	418.1	125.0	54.5	38.7	100.1	58.2	23.0	15.6	158.3	37.5	9.1
North Dakota	555.6	421.0	126.4	62.9	44.1	71.5	46.2	22.0	17.8	169.4	40.9	10.1
Ohio	546.5	421.5	119.6	56.3	42.3	93.2	60.0	23.0	16.0	144.1	39.0	9.7
Oklahoma	567.8	426.7	123.9	56.1	42.1	101.9	64.7	22.6	17.6	153.2	35.5	8.7
Oregon	521.7	432.3	130.7	47.9	38.3	74.2	59.2	23.3	16.1	145.1	37.6	10.0
Pennsylvania	583.8	453.7	125.8	59.4	44.5	87.5	58.2	25.4	17.8	154.1	44.5	11.0
Rhode Island	590.8	466.7	133.2	55.2	43.0	88.2	64.7	23.9	17.6	152.6	52.4	13.8
South Carolina	559.9	397.7	121.4	52.2	38.7	96.7	53.7	20.6	13.6	159.0	30.4	8.0
South Dakota	494.3	389.8	118.4	54.2	41.0	72.2	47.1	20.5	16.0	149.1	34.2	8.0
Tennessee	565.6	413.7	119.6	56.2	41.3	106.1	61.5	23.0	16.2	145.6	34.9	8.4
Texas†	533.7	394.6	116.1	53.0	37.0	81.8	49.9	22.6	15.9	142.7	30.1	6.9
Utah	469.7	345.2	108.0	39.3	31.3	33.8	22.8	23.0	15.5	169.8	28.8	5.6
Vermont	554.3	455.5	129.4	45.8	40.4	82.0	64.6	24.0	17.7	150.9	43.6	12.6
Virginia‡	537.0	396.9	124.0	49.8	37.9	85.2	54.5	21.4	14.3	157.7	33.8	8.1
Washington	552.6	438.4	131.8	48.6	37.2	73.3	57.7	26.6	17.5	155.3	39.5	9.5
West Virginia	576.5	441.6	112.2	61.8	45.4	112.7	73.6	24.0	16.8	138.4	39.3	11.4
Wisconsin‡	513.8	404.6	118.8	48.2	37.4	70.6	51.2	22.5	16.5	144.4	36.4	9.3
Wyoming	513.8	388.8	113.2	49.5	38.7	59.7	47.9	20.9	15.5	162.6	42.6	10.4
United States	550.7	419.3	122.3	54.0	40.3	82.7	55.9	23.3	16.2	151.4	37.5	9.3

*Per 100,000, age adjusted to the 2000 US standard population. †Data for 2005 are limited to cases diagnosed from January-June due to the effect of large migrations of populations on this state as a result of Hurricane Katrina in September 2005. ‡This state's data are not included in the US rates because cancer registry data submitted for 2009 did not meet high-quality standards according to the North American Association of Central Cancer Registries (NAACCR).

Source: NAACCR, 2012. Data are collected by cancer registries participating in the National Cancer Institute's SEER program and the Centers for Disease Control and Prevention's National Program of Cancer Registries.

American Cancer Society, Surveillance Research, 2013

Death Rates* for Selected Cancers by State, US, 2005-2009

	All Sites		Breast	Colon & Rectum		Lung & Bronchus		Non-Hodgkin Lymphoma		Pancreas		Prostate
State	Male	Female	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Alabama	259.0	157.4	24.0	22.9	15.1	89.4	41.1	8.3	5.3	13.3	9.5	28.7
Alaska	209.5	159.6	23.5	20.0	14.1	62.9	45.5	7.9	5.8	12.3	10.0	22.1
Arizona	182.1	130.0	20.5	16.8	11.6	50.2	33.2	7.5	4.8	10.9	7.9	19.7
Arkansas	253.7	161.2	23.6	22.5	15.2	92.5	46.3	8.8	5.2	13.6	9.4	25.3
California	194.9	141.7	22.3	18.1	12.9	49.2	33.1	8.1	5.0	11.8	9.4	23.2
Colorado	185.0	134.4	19.9	17.4	13.0	45.1	31.9	8.0	4.4	10.9	8.9	23.8
Connecticut	212.0	149.6	22.5	17.3	13.0	55.9	38.8	8.1	5.2	14.7	10.2	24.8
Delaware	229.6	162.8	23.0	20.3	14.3	69.2	48.5	8.4	5.0	12.3	9.7	24.9
Dist. of Columbia	256.3	160.4	28.0	23.1	17.7	64.7	34.8	9.4	3.5	16.3	10.7	41.3
Florida	206.0	141.9	21.5	18.3	13.0	63.5	39.3	7.8	4.9	12.0	8.7	19.6
Georgia	230.8	146.8	23.0	20.2	13.8	75.8	38.7	7.7	4.6	12.4	8.9	27.5
Hawaii	184.6	119.6	17.8	18.7	10.8	51.2	27.0	7.5	4.2	12.9	9.4	16.2
Idaho	195.9	143.5	21.3	15.9	13.4	51.3	35.6	8.1	5.4	11.5	9.8	26.7
Illinois	229.4	160.1	24.2	22.5	15.6	67.8	41.9	8.8	5.5	13.1	10.1	25.5
Indiana	244.9	163.2	23.9	22.5	15.0	82.0	47.2	9.7	5.6	13.1	9.4	23.8
Iowa	220.1	151.0	21.8	20.6	15.2	67.5	39.4	9.2	5.5	12.0	8.8	23.9
Kansas	221.5	149.9	22.9	21.2	14.0	70.6	41.0	9.6	5.2	12.5	9.4	21.4
Kentucky	267.2	173.6	23.4	24.3	16.6	99.7	55.5	9.2	5.9	12.5	9.4	24.6
Louisiana	260.8	165.8	26.3	25.1	15.7	84.4	44.1	9.0	5.2	13.8	11.0	27.1
Maine	240.0	161.6	21.4	20.5	14.4	73.1	46.4	9.2	5.5	12.2	9.8	24.4
Maryland	226.5	157.3	24.9	22.0	14.6	65.6	41.8	7.9	4.9	12.9	10.4	26.7
Massachusetts	222.6	154.0	21.9	19.6	13.8	62.6	42.5	8.3	5.1	13.1	10.3	23.4
Michigan	228.1	160.9	24.0	20.2	14.7	70.3	43.9	9.2	6.1	13.9	10.1	22.6
Minnesota	206.8	146.0	21.3	18.0	12.6	55.2	37.2	9.6	5.2	11.8	9.5	24.3
Mississippi	274.2	158.8	24.9	24.9	16.2	97.3	42.3	8.3	4.8	13.8	9.9	31.0
Missouri	237.6	160.4	24.9	21.6	14.6	79.8	46.0	8.4	5.3	13.1	9.7	22.7
Montana	203.4	150.5	20.5	17.8	14.7	57.1	41.3	8.1	5.4	12.4	8.7	27.2
Nebraska	215.2	145.7	21.2	22.5	15.1	62.4	36.0	9.0	5.7	12.2	9.4	24.7
Nevada	213.3	158.4	23.3	20.7	15.3	62.5	48.8	6.7	4.8	12.3	9.8	23.4
New Hampshire	218.2	154.7	21.4	19.3	13.2	62.0	43.0	7.7	5.0	13.4	10.6	23.2
New Jersey	213.8	157.7	26.1	22.0	15.5	57.9	38.3	8.1	5.5	13.3	10.0	22.4
New Mexico	190.1	134.3	21.1	18.7	13.5	44.4	29.1	6.7	4.4	11.6	8.9	24.3
New York	201.3	145.2	22.5	19.4	14.0	55.2	35.8	8.0	4.9	12.6	9.7	22.2
North Carolina	236.9	152.7	23.5	19.8	13.6	79.3	41.6	7.6	5.0	12.1	9.7	25.9
North Dakota	210.2	144.1	22.0	21.6	14.8	56.5	34.3	7.4	5.5	12.8	8.7	25.2
Ohio	243.4	163.4	25.2	22.5	15.5	77.4	44.5	9.4	5.6	13.1	9.9	25.4
Oklahoma	243.0	161.2	23.8	22.9	14.8	82.7	46.9	8.9	5.9	12.0	8.7	23.6
Oregon	214.4	155.5	21.5	18.5	13.9	61.2	43.6	8.6	5.7	12.2	10.0	25.7
Pennsylvania	232.4	158.5	24.1	22.3	15.2	68.5	40.0	9.2	5.6	13.4	10.0	23.7
Rhode Island	228.8	151.3	21.9	19.6	13.3	66.3	43.0	8.8	4.6	12.4	8.4	22.5
South Carolina	241.3	151.0	24.0	20.5	14.1	79.6	40.0	8.0	4.8	12.5	9.7	26.9
South Dakota	206.0	141.5	20.9	20.1	14.2	62.2	35.5	7.8	5.1	11.1	9.1	22.9
Tennessee	257.9	162.0	24.0	22.4	15.1	91.5	47.2	9.3	5.5	13.0	9.3	25.3
Texas	212.5	142.8	22.2	20.2	13.1	63.4	35.9	8.1	5.0	11.7	8.7	21.4
Utah	154.1	109.6	21.5	14.3	10.4	28.1	16.1	7.5	4.6	9.5	8.0	24.5
Vermont	211.9	152.8	20.7	18.8	14.2	61.6	44.3	8.1	5.0	12.5	9.6	22.0
Virginia	228.5	153.9	24.8	19.9	14.2	70.6	40.7	8.3	5.0	13.0	9.9	26.0
Washington	209.6	153.9	21.9	17.7	12.7	58.1	42.8	8.8	5.5	12.4	9.8	24.9
West Virginia	254.8	173.2	23.6	24.2	16.8	87.5	51.9	9.1	6.4	11.2	7.7	21.7
Wisconsin	218.8	152.0	21.6	18.7	13.1	59.9	38.7	9.4	5.7	12.9	9.8	25.6
Wyoming	199.5	148.3	21.4	18.9	14.2	52.8	38.5	8.1	5.9	13.2	9.7	20.9
United States	219.4	151.1	23.0	20.2	14.1	65.7	39.6	8.4	5.2	12.5	9.5	23.6

*Per 100,000, age adjusted to the 2000 US standard population.

Source: US Mortality Data, National Center for Health Statistics, Centers for Disease Control and Prevention.

American Cancer Society, Surveillance Research, 2013

Selected Cancers

Breast

New cases: An estimated 232,340 new cases of invasive breast cancer are expected to be diagnosed among women in the US during 2013; about 2,240 new cases are expected in men. Excluding cancers of the skin, breast cancer is the most frequently diagnosed cancer in women. The dramatic decrease in the breast cancer incidence rate of almost 7% from 2002 to 2003 has been attributed to reductions in the use of menopausal hormone therapy (MHT), previously known as hormone replacement therapy, following the publication of results from the Women's Health Initiative in 2002; this study found that the use of combined estrogen plus progestin MHT was associated with an increased risk of breast cancer, as well as coronary heart disease. From 2005 to 2009, the most recent five years for which data are available, breast cancer incidence rates were stable.

In addition to invasive breast cancer, 64,640 new cases of in situ breast cancer are expected to occur among women in 2013. Of these, approximately 85% will be ductal carcinoma in situ (DCIS). In situ breast cancer incidence rates increased 2.8% per year from 2005 to 2009.

Deaths: An estimated 40,030 breast cancer deaths (39,620 women, 410 men) are expected in 2013. Breast cancer ranks second as a cause of cancer death in women (after lung cancer). Death rates for breast cancer have steadily decreased in women since 1989, with larger decreases in younger women; from 2005 to 2009, rates decreased 3.0% per year in women younger than 50 and 2.0% per year in women 50 and older. The decrease in breast cancer death rates represents progress in earlier detection, improved treatment, and possibly decreased incidence as a result of declining use of MHT.

Signs and symptoms: Breast cancer typically produces no symptoms when the tumor is small and most treatable. Therefore, it is important for women to follow recommended screening guidelines to detect breast cancer at an early stage. Larger tumors may become evident as a breast mass, which is often painless. Less common symptoms include persistent changes to the breast, such as thickening, swelling, distortion, tenderness; skin irritation, redness, scaliness, or nipple abnormalities, such as ulceration, retraction, or spontaneous discharge. Breast pain is more likely to be caused by benign conditions and is not a common early symptom of breast cancer.

Risk factors: Besides being female, increasing age is the most important risk factor for breast cancer. Potentially modifiable risk factors include weight gain after age 18, being overweight or obese (for postmenopausal breast cancer), use of menopausal hormone therapy (combined estrogen and progestin), physical inactivity, and alcohol consumption. Medical findings that predict higher risk include high breast tissue density (a mammographic measure of the amount of glandular tissue relative to fatty tissue), high bone mineral density (women with low density are at increased risk for osteoporosis), and biopsy-confirmed hyperplasia (overgrowth of cells), especially atypical hyperplasia (overgrowth of abnormal cells). High-dose radiation to the chest for cancer treatment also increases risk. Reproductive factors that increase risk include a long menstrual history (menstrual periods that start early and/or end later in life), recent use of oral contraceptives, never having children, and having one's first child after age 30.

Risk is also increased by a family history of breast cancer, particularly having one or more first-degree relatives with breast cancer (though most women with breast cancer do not have a family history of the disease). Inherited mutations (alterations) in breast cancer susceptibility genes account for approximately 5%-10% of all female breast cancers and an estimated 4%-40% of all male breast cancers, but are very rare in the general population (much less than 1%). Most of these mutations are located in *BRCA1* and *BRCA2* genes, although mutations in other known genes have also been identified. Individuals with a strong family history of breast and certain other cancers, such as ovarian and colon cancer, should consider counseling to determine if genetic testing is appropriate. Prevention measures may be possible for individuals with breast cancer susceptibility mutations. In *BRCA1* and *BRCA2* mutation carriers, studies suggest that prophylactic removal of the ovaries and/or breasts decreases the risk of breast cancer considerably, though not all women who choose this surgery would have developed breast cancer. Women who consider prophylactic surgery should undergo counseling before reaching a decision.

There is limited, but accumulating evidence that long-term, heavy smoking increases the risk of breast cancer, particularly among women who began smoking at an early age. The International Agency for Research on Cancer has concluded that there is limited evidence that shift work, particularly at night, is also associated with an increased risk of breast cancer.

Modifiable factors that are associated with a lower risk of breast cancer include breastfeeding, moderate or vigorous physical activity, and maintaining a healthy body weight. Two medications, tamoxifen and raloxifene, have been approved to reduce breast cancer risk in women at high risk. Raloxifene appears to have a lower risk of certain side effects, such as uterine cancer and blood clots; however, it is only approved for use in postmenopausal women.

Early detection: Breast cancer screening for women at average risk includes clinical breast exam and mammography. Mammography can often detect breast cancer at an early stage, when treatment is more effective and a cure is more likely. Numerous studies have shown that early detection with mammography

Leading New Cancer Cases and Deaths – 2013 Estimates

Estimated New Cases*		Estimated Deaths	
Male	Female	Male	Female
Prostate 238,590 (28%)	Breast 232,340 (29%)	Lung & bronchus 87,260 (28%)	Lung & bronchus 72,220 (26%)
Lung & bronchus 118,080 (14%)	Lung & bronchus 110,110 (14%)	Prostate 29,720 (10%)	Breast 39,620 (14%)
Colon & rectum 73,680 (9%)	Colon & rectum 69,140 (9%)	Colon & rectum 26,300 (9%)	Colon & rectum 24,530 (9%)
Urinary bladder 54,610 (6%)	Uterine corpus 49,560 (6%)	Pancreas 19,480 (6%)	Pancreas 18,980 (7%)
Melanoma of the skin 45,060 (5%)	Thyroid 45,310 (6%)	Liver & intrahepatic bile duct 14,890 (5%)	Ovary 14,030 (5%)
Kidney & renal pelvis 40,430 (5%)	Non-Hodgkin lymphoma 32,140 (4%)	Leukemia 13,660 (4%)	Leukemia 10,060 (4%)
Non-Hodgkin lymphoma 37,600 (4%)	Melanoma of the skin 31,630 (4%)	Esophagus 12,220 (4%)	Non-Hodgkin lymphoma 8,430 (3%)
Oral cavity & pharynx 29,620 (3%)	Kidney & renal pelvis 24,720 (3%)	Urinary bladder 10,820 (4%)	Uterine corpus 8,190 (3%)
Leukemia 27,880 (3%)	Pancreas 22,480 (3%)	Non-Hodgkin lymphoma 10,590 (3%)	Liver & intrahepatic bile duct 6,780 (2%)
Pancreas 22,740 (3%)	Ovary 22,240 (3%)	Kidney & renal pelvis 8,780 (3%)	Brain & other nervous system 6,150 (2%)
All sites 854,790 (100%)	All sites 805,500 (100%)	All sites 306,920 (100%)	All sites 273,430 (100%)

*Excludes basal and squamous cell skin cancers and in situ carcinoma except urinary bladder.

saves lives and increases treatment options. Steady declines in breast cancer mortality among women since 1989 have been attributed to a combination of early detection and improvements in treatment. Mammography is a very accurate screening tool for women at both average and increased risk; however, like any medical test, it is not perfect. Mammography will detect most, but not all, breast cancers in women without symptoms, and the sensitivity of the test is lower for women with dense breasts. However, newer technologies have shown promising developments for women with dense breast tissue. Digital mammography has improved sensitivity for women with dense breasts. In addition, the Food and Drug Administration recently approved the use of several ultrasound technologies that could be used in addition to standard mammography for women with dense breast tissue. Although the majority of women with an abnormal mammogram do not have cancer, all suspicious lesions that cannot be resolved with additional imaging should be biopsied for a definitive diagnosis. Annual screening using magnetic resonance imaging (MRI) in addition to mammography is recommended for women at high lifetime risk of breast cancer starting at age 30. (For more information, see *Breast Cancer Facts & Figures* at cancer.org/statistics.) Concerted efforts should be made to improve access to health care and to encourage all women 40 and older to receive regular mammograms. For more information on the American Cancer Society's recommendations for breast cancer screening, see page 60.

Treatment: Taking into account tumor size, extent of spread, and other characteristics, as well as patient preference, treatment usually involves breast-conserving surgery (surgical removal of the tumor and surrounding tissue) or mastectomy (surgical removal of the breast). Numerous studies have shown that for early breast cancer (cancer that has not spread to the skin, chest wall, or distant organs), long-term survival for women treated with breast-conserving surgery plus radiation therapy is similar to that for those treated with mastectomy. For women undergoing mastectomy, significant advances in reconstruction techniques provide several options for breast reconstruction, including the timing of the procedure.

Removal and evaluation of some of the underarm lymph nodes during surgery is usually recommended to determine whether the tumor has spread beyond the breast. In women with early stage disease, sentinel lymph node biopsy, a procedure in which only the first lymph nodes to which cancer is likely to spread are removed, has a lower chance of long-term side effects and is as effective as a full axillary node dissection, in which many nodes are removed.

Treatment may also involve radiation therapy, chemotherapy (before or after surgery), hormone therapy (e.g., selective estrogen response modifiers, aromatase inhibitors, ovarian ablation), or/or targeted therapy. Postmenopausal women with early stage breast cancer that tests positive for hormone receptors benefit

from treatment with an aromatase inhibitor (e.g., letrozole, anastrozole, or exemestane) in addition to, or instead of, tamoxifen. For women whose cancer tests positive for HER2/neu, approved targeted therapies include trastuzumab (Herceptin) and, for advanced disease, lapatinib (Tykerb) and pertuzumab (Perjetal). The US Food and Drug Administration (FDA) revoked approval of bevacizumab (Avastin) for the treatment of metastatic breast cancer in 2011 because of evidence showing minimal benefit and some potentially dangerous side effects.

It is recommended that all patients with ductal carcinoma in situ (DCIS) be treated to avoid potential progression to invasive cancer. Treatment options for DCIS include breast-conserving surgery with radiation therapy or mastectomy; either of these options may be followed by treatment with tamoxifen if the tumor is hormone receptor-positive. Removal of axillary lymph nodes is not generally needed, but a sentinel lymph node procedure may be performed. A report by a panel of experts convened by the National Institutes of Health concluded that in light of the noninvasive nature and favorable prognosis of DCIS, the primary goal for future research is to accurately define patient risk categories in order to administer the minimum treatment required for a successful outcome.

Survival: The 5-year relative survival rate for female invasive breast cancer patients has improved from 75% in the mid-1970s to 90% today. The 5-year relative survival for women diagnosed with localized breast cancer (cancer that has not spread to lymph nodes or other locations outside the breast) is 98%; if the cancer has spread to nearby lymph nodes (regional stage) or distant lymph nodes or organs (distant stage), the survival rate falls to 84% or 24%, respectively. For all stages combined, relative survival rates at 10 and 15 years after diagnosis are 83% and 77%, respectively. Caution should be used when interpreting long-term survival rates because they represent patients who were diagnosed many years ago and do not reflect recent advances in detection and treatment. For example, 15-year relative survival is based on patients diagnosed as early as 1991.

Many studies have shown that being overweight adversely affects survival for postmenopausal women with breast cancer. In addition, women who are more physically active are less likely to die from the disease than those who are inactive.

For more information about breast cancer, see the American Cancer Society's *Breast Cancer Facts & Figures*, available online at cancer.org/statistics.

Childhood Cancer (Ages 0-14 years)

New cases: An estimated 11,630 new cases are expected to occur among children 0 to 14 years of age in 2013. Childhood cancers are rare, representing less than 1% of all new cancer diagnoses. Overall, childhood cancer incidence rates increased slightly by 0.6% per year from 2005 to 2009, the most recent 5 years of available data.

Deaths: An estimated 1,310 cancer deaths are expected to occur among children 0 to 14 years of age in 2013, about one-third of these from leukemia. Although uncommon, cancer is the second leading cause of death in children, exceeded only by accidents. Mortality rates for childhood cancer have declined by 68% over the past four decades, from 6.5 (per 100,000) in 1969 to 2.1 in 2009. The substantial progress in reducing childhood cancer mortality is largely attributable to improvements in treatment and high rates of participation in clinical trials.

Signs and symptoms: Early symptoms are usually nonspecific. Parents should ensure that children have regular medical checkups and be alert to any unusual, persistent symptoms. Signs of childhood cancer include an unusual mass or swelling; unexplained paleness or loss of energy; a sudden increase in the tendency to bruise or bleed; a persistent, localized pain; a prolonged, unexplained fever or illness; frequent headaches, often with vomiting; sudden eye or vision changes; and excessive, rapid weight loss. Major categories of pediatric cancer and more specific symptoms include:

- Leukemia (31% of all childhood cancers, including benign brain tumors), which may be recognized by bone and joint pain, weakness, pale skin, bleeding or bruising, and fever or infection
- Brain and other central nervous system tumors (25%), which may cause headaches, nausea, vomiting, blurred or double vision, dizziness, and difficulty walking or handling objects
- Neuroblastoma (6%), a cancer of the nervous system that is most common in children younger than 5 years of age and usually appears as a swelling in the abdomen
- Wilms tumor (5%), a kidney cancer that may be recognized by a swelling or lump in the abdomen
- Non-Hodgkin lymphoma (4%) and Hodgkin lymphoma (4%), which affect lymph nodes but may involve the bone marrow and other organs, and may cause swelling of lymph nodes in the neck, armpit, or groin, as well as weakness and fever
- Rhabdomyosarcoma (3%), a soft tissue sarcoma that can occur in the head and neck, genitourinary area, trunk, and extremities, and may cause pain and/or a mass or swelling
- Osteosarcoma (3%), a bone cancer that most often occurs in adolescents and commonly appears as sporadic pain in the affected bone that may worsen at night or with activity, with eventual progression to local swelling
- Retinoblastoma (2%), an eye cancer that usually occurs in children younger than 5 years of age and is typically recognized because of discoloration behind the pupil
- Ewing sarcoma (1%), another type of cancer that usually arises in bone, is most common in adolescents, and typically appears as pain at the tumor site.

(Proportions are based on International Classification of Childhood Cancer groupings, including benign brain/central nervous system tumors, and are for all races combined and may vary according to race/ethnicity.)

Treatment: Childhood cancers can be treated by a combination of therapies (surgery, radiation, and chemotherapy) chosen based on the type and stage of cancer. Treatment is coordinated by a team of experts, including pediatric oncologists and nurses, social workers, psychologists, and others who assist children and their families. Because these cancers are uncommon, outcomes are more successful when treatment is managed by specialists at a children's cancer center. If the child is eligible, placement in a clinical trial, which compares a new treatment to the best current treatment, should also be considered.

Survival: Survival for all invasive childhood cancers combined has improved markedly over the past 30 years due to new and improved treatments. The 5-year relative survival rate increased from 58% for diagnoses in the mid-1970s to 83% in the most recent time period (2002-2008). However, rates vary considerably depending on cancer type, patient age, and other characteristics. For the most recent time period (2002-2008), the 5-year survival among children 0-14 years of age with retinoblastoma is 98%; Hodgkin lymphoma, 96%; Wilms tumor, 89%; non-Hodgkin lymphoma, 86%; leukemia, 84%; neuroblastoma, 75%; Ewing tumors, 75%; brain and other central nervous system tumors, 71%; osteosarcoma, 71%; and rhabdomyosarcoma, 68%.

Pediatric cancer patients may experience treatment-related side effects long after active treatment. Late treatment effects include impairment in the function of specific organs, secondary cancers, and cognitive deficits. The Children's Oncology Group (COG) has developed long-term follow-up guidelines for screening and management of late effects in survivors of childhood cancer. For more information on childhood cancer management, see the COG Web site at survivorshipguidelines.org. The Childhood Cancer Survivor Study, which has followed more than 14,000 long-term childhood cancer survivors, has also provided important and valuable information about the late effects of cancer treatment; for more information, visit ccss.stjude.org.

Colon and Rectum

New cases: An estimated 102,480 cases of colon and 40,340 cases of rectal cancer are expected to occur in 2013. Colorectal cancer is the third most common cancer in both men and women. Colorectal cancer incidence rates have been decreasing for most of the past two decades, which has largely been attributed to increases in the use of colorectal cancer screening tests that allow for the detection and removal of colorectal polyps before they progress to cancer. From 2005 to 2009, incidence rates declined by 4.1% per year among adults 50 years of age and older, for whom screening is recommended, and increased by 1.1% per year among those younger than age 50.

Deaths: An estimated 50,830 deaths from colorectal cancer are expected to occur in 2013, accounting for 9% of all cancer deaths. Mortality rates for colorectal cancer have declined in both men and women over the past two decades; from 2005 to 2009, the rate declined by 2.4% per year in men and by 3.1% per year in women. These decreases reflect declining incidence rates and improvements in early detection and treatment.

Signs and symptoms: Early stage colorectal cancer does not typically have symptoms; therefore, screening is usually necessary to detect this cancer in its early stages. Symptoms of advanced disease may include rectal bleeding, blood in the stool, a change in bowel habits, cramping pain in the lower abdomen, decreased appetite, or weight loss. In some cases, blood loss from the cancer leads to anemia (low red blood cells), causing symptoms such as weakness and excessive fatigue. Timely evaluation of symptoms consistent with colorectal cancer in adults younger than age 50 is especially important due to the increase in colorectal cancer incidence in this age group in recent years.

Risk factors: The risk of colorectal cancer increases with age; 90% of cases are diagnosed in individuals 50 years of age and older. Modifiable factors associated with increased risk include obesity, physical inactivity, a diet high in red or processed meat, alcohol consumption, long-term smoking, and possibly very low intake of fruits and vegetables. Hereditary and medical factors that increase risk include a personal or family history of colorectal cancer and/or polyps, a personal history of chronic inflammatory bowel disease, and certain inherited genetic conditions (e.g., Lynch syndrome, also known as hereditary nonpolyposis colorectal cancer, and familial adenomatous polyposis [FAP]). Studies have also found that individuals with type 2 diabetes are at higher risk of colorectal cancer.

Consumption of milk and calcium and higher blood levels of vitamin D appear to decrease colorectal cancer risk. Regular use of nonsteroidal anti-inflammatory drugs, such as aspirin, also reduces risk. However, these drugs are not recommended for the prevention of colorectal cancer among individuals at average risk because they can have serious adverse health effects. Study results are mixed about the association between menopausal hormone therapy and colorectal cancer.

Early detection: Beginning at age 50, men and women who are at average risk for developing colorectal cancer should begin screening. Screening can detect and allow for the removal of colorectal polyps that might have become cancerous, as well as detect cancer at an early stage, when treatment may be less extensive and more successful. In 2008, the American Cancer Society collaborated with several other organizations to release updated colorectal cancer screening guidelines. These joint guidelines emphasize cancer prevention and draw a distinction between colorectal screening tests that primarily detect cancer and those that can detect both cancer and precancerous polyps. There are a number of recommended screening options that

vary by the extent of bowel preparation, as well as test performance, limitations, time interval, and cost. For detailed information on colorectal cancer screening options, see *Colorectal Cancer Facts & Figures* at cancer.org/statistics, and for the American Cancer Society's screening guidelines for colorectal cancer, see page 60.

Treatment: Surgery is the most common treatment for colorectal cancer. For cancers that have not spread, surgical removal may be curative. A permanent colostomy (creation of an abdominal opening for elimination of body waste) is rarely needed for colon cancer and is infrequently required for rectal cancer. Chemotherapy alone, or in combination with radiation, is given before or after surgery to most patients whose cancer has penetrated the bowel wall deeply or spread to lymph nodes. Adjuvant chemotherapy (anticancer drugs in addition to surgery or radiation) for colon cancer in otherwise healthy patients 70 years of age and older is equally effective as in younger patients; toxicity in older patients can be limited if certain drugs (e.g., oxaliplatin) are avoided. Several targeted therapies are approved by the FDA to treat metastatic colorectal cancer: bevacizumab (Avastin) and ziv-aflibercept (Zaltrap) block the growth of blood vessels to the tumor, and cetuximab (Erbitux) and panitumumab (Vectibix) block the effects of hormone-like factors that promote cancer growth.

Survival: The 1- and 5-year relative survival rates for persons with colorectal cancer are 84% and 64%, respectively. Survival continues to decline to 58% at 10 years after diagnosis. When colorectal cancers are detected at an early, localized stage, the 5-year survival is 90%; however, only 39% of colorectal cancers are diagnosed at this stage, in part due to the underuse of screening. If the cancer has spread regionally to involve nearby organs or lymph nodes at the time of diagnosis, the 5-year survival drops to 70%. If the disease has spread to distant organs, the 5-year survival is 12%.

Kidney

New cases: An estimated 65,150 new cases of kidney (renal) cancer are expected to be diagnosed in 2013. This estimate includes cancers of the renal pelvis (6%) and Wilms tumor (1%), a childhood cancer that usually develops before age 5 (see Childhood Cancer, page 11). From 2005 to 2009, kidney cancer incidence rates increased by 3.1% per year, primarily due to an increase in early stage disease. Some of the increase in kidney cancer rates, paticularly for early stage disease, may be due to incidental diagnosis during abdominal imaging performed for unrelated issues. Based on the most recent years of data, it appears as though the rate may be reaching a plateau after several decades of increase.

Deaths: An estimated 13,680 deaths from kidney cancer are expected to occur in 2013. Death rates for kidney cancer decreased by 0.5% per year from 2005 to 2009.

Signs and symptoms: Early stage kidney cancer usually has no symptoms. Symptoms that may develop as the tumor progresses include a pain or lump in the lower back or abdomen, fatigue, weight loss, fever, or swelling in the legs and ankles.

Risk factors: Tobacco use is a strong risk factor for kidney cancer, with the largest increased risk for cancer of the renal pelvis, particularly among heavy smokers. Additional risk factors for renal cell carcinoma include obesity, to which an estimated 30% of cases can be attributed; hypertension (high blood pressure); chronic renal failure; and occupational exposure to certain chemicals, such as trichloroethylene, an industrial agent used as a metal degreaser and chemical additive. Radiation exposure (e.g., in medical procedures) slightly increases risk. A small proportion of renal cell cancers are the result of rare hereditary conditions (e.g., von Hippel-Lindau disease and hereditary papillary renal cell carcinoma).

Early detection: There are no recommended screening tests for people at average risk.

Treatment: Active surveillance (observation) may be offered to some patients with small tumors. Surgery (traditional or laparoscopic, i.e., minimally invasive, performed through very small incisions) is the primary treatment for most kidney cancers. Patients who are not surgical candidates may be offered ablation therapy, a procedure that uses heat or cold to destroy the tumor. Kidney cancer tends to be resistant to both traditional chemotherapy and radiation therapy. Improved understanding of the biology of kidney cancer has led to the development of several targeted therapies that control cancer growth by blocking the tumor's blood supply or through other mechanisms and are used to treat metastatic disease.

Survival: The 1- and 5-year relative survival rates for cancers of the kidney are 85% and 71%, respectively. More than half (62%) of cases are diagnosed at the local stage, for which the 5-year relative survival rate is 91%. Five-year survival is lower for renal pelvis (50%) than for renal cell (72%) carcinoma.

Leukemia

New cases: An estimated 48,610 new cases of leukemia are expected in 2013. Leukemia is a cancer of the bone marrow and blood and is classified into four main groups according to cell type and rate of growth: acute lymphocytic (ALL), chronic lymphocytic (CLL), acute myeloid (AML), and chronic myeloid (CML). Almost 90% of leukemia cases are diagnosed in adults 20 years of age and older, among whom the most common types are CLL (38%) and AML (30%). Among children and teens, ALL is most common, accounting for 75% of leukemia cases (see Childhood Cancer, page 11). From 2005 to 2009, overall leukemia incidence rates increased slightly by 0.4% per year.

Probability (%) of Developing Invasive Cancers during Selected Age Intervals by Sex, US, 2007-2009*

		Birth to 39	40 to 59	60 to 69	70 and Older	Birth to Death
All sites†	Male	1.46 (1 in 69)	8.79 (1 in 11)	16.03 (1 in 6)	38.07 (1 in 3)	44.81 (1 in 2)
	Female	2.20 (1 in 46)	9.19 (1 in 11)	10.39 (1 in 10)	26.69 (1 in 4)	38.17 (1 in 3)
Urinary bladder‡	Male	0.02 (1 in 4,924)	0.37 (1 in 272)	0.92 (1 in 109)	3.69 (1 in 27)	3.81 (1 in 26)
	Female	0.01 (1 in 12,663)	0.12 (1 in 864)	0.24 (1 in 410)	0.98 (1 in 106)	1.15 (1 in 87)
Breast	Female	0.50 (1 in 202)	3.78 (1 in 26)	3.56 (1 in 28)	6.65 (1 in 15)	12.38 (1 in 8)
Colon & rectum	Male	0.08 (1 in 1,212)	0.94 (1 in 106)	1.40 (1 in 71)	4.19 (1 in 24)	5.17 (1 in 19)
	Female	0.08 (1 in 1,236)	0.75 (1 in 134)	0.98 (1 in 102)	3.80 (1 in 26)	4.78 (1 in 21)
Leukemia	Male	0.16 (1 in 612)	0.23 (1 in 440)	0.35 (1 in 288)	1.26 (1 in 80)	1.59 (1 in 63)
	Female	0.13 (1 in 746)	0.15 (1 in 655)	0.21 (1 in 481)	0.81 (1 in 123)	1.14 (1 in 88)
Lung & bronchus	Male	0.03 (1 in 3,552)	0.92 (1 in 109)	2.27 (1 in 44)	6.82 (1 in 15)	7.77 (1 in 13)
	Female	0.03 (1 in 3,287)	0.76 (1 in 131)	1.72 (1 in 58)	4.93 (1 in 20)	6.35 (1 in 16)
Melanoma of the skin§	Male	0.15 (1 in 691)	0.63 (1 in 160)	0.77 (1 in 130)	2.02 (1 in 50)	2.87 (1 in 35)
	Female	0.26 (1 in 391)	0.55 (1 in 181)	0.40 (1 in 248)	0.84 (1 in 120)	1.85 (1 in 54)
Non-Hodgkin lymphoma	Male	0.13 (1 in 753)	0.44 (1 in 225)	0.60 (1 in 167)	1.77 (1 in 57)	2.34 (1 in 43)
	Female	0.09 (1 in 1,147)	0.31 (1 in 322)	0.44 (1 in 229)	1.40 (1 in 72)	1.93 (1 in 52)
Prostate	Male	0.01 (1 in 7,964)	2.68 (1 in 37)	6.78 (1 in 15)	12.06 (1 in 8)	16.15 (1 in 6)
Uterine cervix	Female	0.16 (1 in 641)	0.27 (1 in 374)	0.13 (1 in 795)	0.18 (1 in 551)	0.68 (1 in 147)
Uterine corpus	Female	0.07 (1 in 1,348)	0.77 (1 in 129)	0.89 (1 in 112)	1.25 (1 in 80)	2.64 (1 in 38)

*For those who are cancer-free at the beginning of each age interval. †All sites excludes basal cell and squamous cell skin cancers and in situ cancers except urinary bladder. ‡Includes invasive and in situ cancers. §Statistic is for whites only.

Source: DevCan: Probability of Developing or Dying of Cancer Software, Version 6.6.1. Statistical Research and Applications Branch, National Cancer Institute, 2012. www.srab.cancer.gov/devcan.

American Cancer Society, Surveillance Research, 2013

Deaths: An estimated 23,720 deaths are expected to occur in 2013. Death rates for leukemia have been declining for the past several decades; from 2005 to 2009, rates decreased by 0.8% per year among males and by 1.4% per year among females.

Signs and symptoms: Symptoms may include fatigue, paleness, weight loss, repeated infections, fever, bruising easily, and nosebleeds or other hemorrhages. In acute leukemia, these signs can appear suddenly. Chronic leukemia typically progresses slowly with few symptoms and is often diagnosed during routine blood tests. Patients with CLL may experience swollen lymph nodes or pain in the upper left abdomen due to an enlarged spleen.

Risk factors: Exposure to ionizing radiation increases risk of several types of leukemia (excluding CLL). Medical radiation, such as that used in cancer treatment, is a substantial source of radiation exposure. Leukemia may also occur as a side effect of chemotherapy. Children with Down syndrome and certain other genetic abnormalities are at increased risk of leukemia. Workers in the rubber-manufacturing industry also have an increased risk. Recent studies suggest that obesity increases risk of leukemia.

Some factors are most closely associated with specific types of leukemia. Family history is one of the strongest risk factors for CLL. Cigarette smoking is a risk factor for AML, and there is limited evidence that parental smoking and maternal exposure to paint increases the risk of childhood leukemia. Exposure to certain chemicals, such as formaldehyde and benzene (a component in cigarette smoke and gasoline that has become more regulated due to its carcinogenicity), also increases risk of AML. Infection with human T-cell leukemia virus type I (HTLV-I) can cause a rare type of leukemia called adult T-cell leukemia/lymphoma. The prevalence of HTLV-I infection is geographically localized and is most common in southern Japan and the Caribbean; infected individuals in the US tend to be descendants or immigrants from endemic regions.

Early detection: Leukemia can be difficult to diagnose early because symptoms often resemble those of other, less serious conditions. When a physician does suspect leukemia, diagnosis can be made using blood tests and a bone marrow biopsy.

Treatment: Chemotherapy is the most effective method of treating leukemia. Various anticancer drugs are used, either in combination or as single agents. Imatinib (Gleevec), nilotinib (Tasigna), and dasatinib (Sprycel) are very effective drugs that are targeted at the genetic abnormality that is the hallmark of CML. Imatinib and dasatinib are also FDA-approved to treat a type of ALL with the same genetic defect. People diagnosed with CLL that is not progressing or causing symptoms may not require treatment. Recent clinical trials have shown that adults with AML who are treated with twice the conventional dose of daunorubicin experience higher and more rapid rates of remission. Antibiotics and transfusions of blood components are used as supportive treatments. Under appropriate conditions, stem cell transplantation may be useful in treating certain types of leukemia.

Survival: Survival rates vary substantially by leukemia type, ranging from a 5-year relative survival of 25% for patients diagnosed with AML to 82% for those with CLL. Advances in treatment have resulted in a dramatic improvement in survival over the past three decades for most types of leukemia. For example, from 1975-1977 to 2002-2008, the 5-year relative survival rate for ALL increased from 41% to 68% overall, and from 58% to 91% among children. In large part due to the discovery of targeted cancer drugs like imatinib, the 5-year survival rate for CML increased from 31% for cases diagnosed during 1990-1992 to 56% for those diagnosed during 2002-2008.

Liver

New Cases: An estimated 30,640 new cases of liver cancer (including intrahepatic bile duct cancers) are expected to occur in the US during 2013. More than 80% of these cases are hepatocellular carcinoma (HCC), originating from hepatocytes, the predominant liver cell type. Liver cancer incidence rates are three times higher in men than in women. From 2005 to 2009, rates increased by 3.7% per year in men and by 3.0% per year in women.

Deaths: An estimated 21,670 liver cancer deaths (6,780 women, 14,890 men) are expected in 2013. From 2005 to 2009, death rates for liver cancer increased by 2.3% per year in men and 1.3% per year in women.

Signs and symptoms: Common symptoms include abdominal pain and/or swelling, weight loss, weakness, loss of appetite, jaundice (a yellowish discoloration of the skin and eyes), and fever. Enlargement of the liver is the most common physical sign.

Risk factors: In the US and other western countries, alcohol-related cirrhosis, and possibly nonalcoholic fatty liver disease associated with obesity, account for the majority of liver cancer cases. Chronic infections with hepatitis B virus (HBV) and hepatitis C virus (HCV) are associated with less than half of liver cancer cases in the US, although they are the major risk factors for the disease worldwide. In the US, rates of HCC are higher in immigrants from areas where HBV is endemic, such as China, Southeast Asia, and sub-Saharan Africa. A vaccine that protects against HBV has been available since 1982. The HBV vaccination is recommended for all infants at birth; for all children under 18 years of age who were not vaccinated at birth; for adults in high-risk groups (e.g., health care workers and those younger than 60 years who have been diagnosed with diabetes). It is also recommended that all pregnant women be tested for HBV.

There is no vaccine available against HCV, but there are treatments that can clear infection and halt liver disease progression. It is estimated that persons who were born between 1945 and 1965 account for about three-fourths of HCV-infected individuals and HCV-related deaths in the US. Therefore, the Centers for Disease Control and Prevention (CDC) now recommends one-time HCV testing for all persons born from 1945 to 1965 in addition to routine testing for individuals at high risk (e.g., injection drug users). Infected individuals can receive treatment that may reduce their risk of liver cancer and counseling to reduce the risk of HCV transmission to others. Other preventive measures for HCV infection include screening of donated blood, organs, and tissues; adherence to infection control practices during medical, surgical, and dental procedures; and needle-exchange programs for injecting drug users. For more information on hepatitis infections, including who is at risk, visit the CDC Web site at cdc.gov/hepatitis/.

Other risk factors for liver cancer, particularly in economically developing countries, include parasitic infections (schistosomiasis and liver flukes) and consumption of food contaminated with aflatoxin, a toxin produced by mold during the storage of agricultural products in a warm, humid environment.

Early detection: Screening for liver cancer has not been proven to improve survival. Nonetheless, many doctors in the US screen high-risk persons (e.g., HCV-infected persons with cirrhosis) with ultrasound or blood tests.

Treatment: Early stage liver cancer can sometimes be successfully treated with surgery in patients with sufficient healthy liver tissue; liver transplantation may also be an option. Surgical treatment of early stage liver cancer is often limited by pre-existing liver disease that has damaged the portion of the liver not affected by cancer. Patients whose tumors cannot be surgically removed may choose ablation (tumor destruction) or embolization, a procedure that cuts off blood flow to the tumor. Fewer treatment options exist for patients diagnosed at an advanced stage of the disease. Sorafenib (Nexavar) is a targeted drug approved for the treatment of HCC in patients who are not candidates for surgery.

Survival: The overall 5-year relative survival rate for patients with liver cancer is 15%. Forty percent of patients are diagnosed at an early stage, for which 5-year survival is 28%. Survival decreases to 10% and 3% for patients who are diagnosed at regional and distant stages of disease, respectively.

Lung and Bronchus

New cases: An estimated 228,190 new cases of lung cancer are expected in 2013, accounting for about 14% of cancer diagnoses. The incidence rate has been declining in men over the past two decades, but has just recently begun to decrease in women. From 2005 to 2009, lung cancer incidence rates decreased by 1.9% per year in men and by 0.3% per year in women.

Deaths: Lung cancer accounts for more deaths than any other cancer in both men and women. An estimated 159,480 deaths, accounting for about 27% of all cancer deaths, are expected to occur in 2013. Death rates began declining in men in 1991; from 2005 to 2009, rates decreased 2.8% per year. Lung cancer death rates did not begin declining in women until 2003; from 2005 to

2009, rates decreased by 1.0% per year. Gender differences in lung cancer mortality patterns reflect historical differences in the uptake and reduction of cigarette smoking over the past 50 years.

Signs and symptoms: Symptoms may include persistent cough, sputum streaked with blood, chest pain, voice change, and recurrent pneumonia or bronchitis.

Risk factors: Cigarette smoking is by far the most important risk factor for lung cancer; risk increases with both quantity and duration of smoking. Cigar and pipe smoking also increase risk. Exposure to radon gas released from soil and building materials is estimated to be the second leading cause of lung cancer in Europe and North America. Other risk factors include occupational or environmental exposure to secondhand smoke, asbestos (particularly among smokers), certain metals (chromium, cadmium, arsenic), some organic chemicals, radiation, air pollution, diesel exhaust, and paint. Additional occupational exposures that increase lung cancer risk include rubber manufacturing, paving, roofing, and chimney sweeping. Risk is also probably increased among people with a medical history of tuberculosis. Genetic susceptibility plays a contributing role in the development of lung cancer, especially in those who develop the disease at a young age.

Early detection: Annual screening with chest x-ray has not been shown to reduce lung cancer mortality. Results from the National Lung Screening Trial (NLST), a clinical trial designed to determine the effectiveness of lung cancer screening in high-risk individuals, showed 20% fewer lung cancer deaths among current and former heavy smokers who were screened with spiral CT compared to standard chest x-ray. However, these study participants had a history of smoking that was the equivalent of at least a pack of cigarettes per day for 30 years, so it is unknown whether these results are relevant for individuals who have smoked less. In addition, the potential risks associated with screening, including the high rate of false positive results, cumulative radiation exposure from multiple CT scans, and unnecessary lung biopsy and surgery, are important considerations. The American Cancer Society (ACS), the National Comprehensive Cancer Network (NCCN), the American College of Chest Physicians (ACCP), and the American Society of Clinical Oncology (ASCO) have all issued initial lung cancer screening guidelines. The ACS, ACCP, and ASCO have endorsed shared decision making with a clinician for adults who meet the eligibility criteria for participation in the NLST, i.e., current and former smokers (quit within previous 15 years) ages 55-74 in good health with at least a 30-year pack history of smoking. The NCCN expands eligibility for adults with additional risk factors for lung cancer. For more information, visit cancer.org/healthy/findcancerearly.

Treatment: Lung cancer is classified as small cell (15%) or non-small cell (84%) for the purposes of treatment. Based on type and stage of cancer, treatments include surgery, radiation therapy, chemotherapy, and targeted therapies such as bevacizumab (Avastin), erlotinib (Tarceva), and crizotinib (Xalkori). For localized non-small cell lung cancers, surgery is usually the treatment of choice; for most of these patients, survival is improved when chemotherapy is given after surgery. Because the disease has usually spread by the time it is discovered, radiation therapy and chemotherapy are often used, sometimes in combination with surgery. Advanced-stage non-small cell lung cancer patients are usually treated with chemotherapy, targeted drugs, or some combination of the two. Chemotherapy alone or combined with radiation is the usual treatment of choice for small cell lung cancer; on this regimen, a large percentage of patients experience remission, though the cancer often returns.

Survival: The 1-year relative survival for lung cancer increased from 37% in 1975-1979 to 44% in 2005-2008, largely due to improvements in surgical techniques and combined therapies. However, the 5-year survival rate for all stages combined is only 16%. Only 15% of lung cancers are diagnosed at a localized stage, for which the 5-year survival rate is 52%. The 5-year survival for small cell lung cancer (6%) is lower than that for non-small cell (18%).

Lymphoma

New cases: An estimated 79,030 new cases of lymphoma will occur in 2013. Lymphoma is cancer of the lymphocytes, a type of white blood cell, and is classified as Hodgkin (9,290 cases in 2013) or non-Hodgkin (69,740 cases in 2013). From 2005 to 2009, incidence rates were stable among men and women for both Hodgkin and non-Hodgkin lymphoma (NHL). (NHL encompasses a wide variety of disease subtypes for which incidence patterns may vary.)

Deaths: An estimated 20,200 deaths from lymphoma will occur in 2013 (Hodgkin lymphoma, 1,180; NHL, 19,020). Death rates for Hodgkin lymphoma have been decreasing for the past four decades; from 2005 to 2009, rates decreased by 2.7% per year. Death rates for NHL began decreasing in the late 1990s; from 2005 to 2009, rates decreased 3.0% per year. Declines in lymphoma death rates reflect improvements in treatment over time.

Signs and symptoms: Symptoms may include swollen lymph nodes, itching, night sweats, fatigue, unexplained weight loss, and intermittent fever.

Risk factors: Like most cancers, the risk of developing NHL increases with age. In contrast, the risk of Hodgkin lymphoma is highest during adolescence and early adulthood. For most cases of lymphoma, the cause is unknown, though various risk factors associated with altered immune function have been identified. Non-Hodgkin lymphoma risk is elevated in persons who receive immune suppressants to prevent organ transplant rejection, in people with severe autoimmune conditions, and in people infected with human immunodeficiency virus (HIV) and human T-cell leukemia virus type I. Epstein Barr virus causes Burkitt lymphoma (an aggressive type of NHL that occurs most often in

Five-year Relative Survival Rates* (%) by Stage at Diagnosis, 2002-2008

	All Stages	Local	Regional	Distant		All Stages	Local	Regional	Distant
Breast (female)	89	98	84	24	Ovary	44	92	72	27
Colon & rectum	64	90	70	12	Pancreas	6	23	9	2
Esophagus	17	38	20	3	Prostate	99	100	100	28
Kidney†	71	91	64	12	Stomach	27	62	28	4
Larynx	61	76	42	35	Testis	95	99	96	73
Liver‡	15	28	10	3	Thyroid	98	100	97	54
Lung & bronchus	16	52	25	4	Urinary bladder§	78	70	33	6
Melanoma of the skin	91	98	62	15	Uterine cervix	68	91	57	16
Oral cavity & pharynx	62	82	57	35	Uterine corpus	82	95	67	16

*Rates are adjusted for normal life expectancy and are based on cases diagnosed in the SEER 18 areas from 2002-2008, followed through 2009.
†Includes renal pelvis. ‡Includes intrahepatic bile duct. §Rate for in situ cases is 96%.

Local: an invasive malignant cancer confined entirely to the organ of origin. **Regional:** a malignant cancer that 1) has extended beyond the limits of the organ of origin directly into surrounding organs or tissues; 2) involves regional lymph nodes by way of lymphatic system; or 3) has both regional extension and involvement of regional lymph nodes. **Distant:** a malignant cancer that has spread to parts of the body remote from the primary tumor either by direct extension or by discontinuous metastasis to distant organs, tissues, or via the lymphatic system to distant lymph nodes.

Source: Howlader N, Noone AM, Krapcho M, et al. (eds). *SEER Cancer Statistics Review, 1975-2009*, National Cancer Institute, Bethesda, MD, www.seer.cancer.gov/csr/1975_2009/, 2012.

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children and young adults) and is associated with a number of autoimmune-related NHLs and some types of Hodgkin lymphoma. *H. pylori* infection increases the risk of gastric lymphoma. A family history of lymphoma and a growing number of common genetic variations are associated with modestly increased risk. Workers in the rubber manufacturing industry are at increased risk of lymphoma, and occupational and environmental exposures to certain chemicals (e.g., solvents such as dichloromethane) may also increase risk.

Treatment: Non-Hodgkin lymphoma patients are usually treated with chemotherapy; radiation, alone or in combination with chemotherapy, is used less often. Highly specific monoclonal antibodies directed at lymphoma cells, such as rituximab (Rituxan) and alemtuzumab (Campath), are used for initial treatment and the recurrence of some types of NHL, as are antibodies linked to a radioactive atom, such as ibritumomab tiuxetan (Zevalin) and tositumomab (Bexxar). If NHL persists or recurs after standard treatment, stem cell transplantation (with high-dose or nonmyeloablative chemotherapy) may be an option.

Hodgkin lymphoma is usually treated with chemotherapy, radiation therapy, or a combination of the two, depending on disease stage and cell type. Stem cell transplantation may be an option if these are not effective. The targeted drug brentuximab vedotin (Adcetris) is used to treat Hodgkin lymphoma (as well as a rare form of NHL) in patients whose disease has failed to respond to other treatment.

Survival: Survival varies widely by cell type and stage of disease. For NHL, the overall 1- and 5-year relative survival is 81% and 68%, respectively; survival declines to 57% at 10 years after diagnosis. For Hodgkin lymphoma, the 1-, 5-, and 10-year relative survival rates are 92%, 85%, and 80%, respectively.

Oral Cavity and Pharynx

New cases: An estimated 41,380 new cases of cancer of the oral cavity and pharynx (throat) are expected in 2013. Incidence rates are more than twice as high in men as in women. From 2005 to 2009, incidence rates were stable in men and decreasing by 0.9% annually in women. However, recent studies have shown that incidence is increasing for cancers of the oropharynx that are associated with human papillomavirus (HPV) infection among white men and women.

Deaths: An estimated 7,890 deaths from oral cavity and pharynx cancer are expected in 2013. Death rates have been decreasing over the past three decades; from 2005 to 2009, rates decreased by 1.3% per year in men and by 2.2% per year in women.

Signs and symptoms: Symptoms may include a sore in the throat or mouth that bleeds easily and does not heal, a persistent red or white patch or a lump or thickening in the throat or mouth, ear pain, a neck mass, or coughing up blood. Difficulties in chewing, swallowing, or moving the tongue or jaws are often late symptoms.

Risk factors: Known risk factors include all forms of smoked and smokeless tobacco products and excessive consumption of alcohol. Many studies have reported a synergism between smoking and alcohol use, resulting in a more than 30-fold increased risk for individuals who both smoke and drink heavily. HPV infection is associated with cancers of the tonsil, base of tongue, and some other sites within the oropharynx and is believed to be transmitted through sexual contact.

Early detection: Cancer can affect any part of the oral cavity, including the lip, tongue, mouth, and throat. Through visual inspection, dentists and primary care physicians can often

Trends in 5-year Relative Survival Rates* (%) by Race, US, 1975-2008

	All races			White			African American		
	1975-77	1987-89	2002-2008	1975-77	1987-89	2002-2008	1975-77	1987-89	2002-2008
All sites	49	56	68†	50	57	69†	39	43	60†
Brain & other nervous system	22	29	35†	22	28	34†	25	32	41†
Breast (female)	75	84	90†	76	85	92†	62	71	78†
Colon	51	61	65†	51	61	66†	45	53	55†
Esophagus	5	10	19†	6	11	21†	3	7	14†
Hodgkin lymphoma	72	79	87†	72	80	88†	70	72	83†
Kidney & renal pelvis	50	57	72†	50	57	72†	49	55	70†
Larynx	66	66	63†	67	67	65	59	56	51
Leukemia	34	43	58†	35	44	59†	33	35	51†
Liver & intrahepatic bile duct	3	5	16†	3	6	16†	2	3	11†
Lung & bronchus	12	13	17†	12	13	17†	11	11	14†
Melanoma of the skin	82	88	93†	82	88	93†	57‡	79‡	70‡
Myeloma	25	28	43†	25	27	43†	30	30	43†
Non-Hodgkin lymphoma	47	51	71†	47	52	72†	48	46	63†
Oral cavity & pharynx	53	54	65†	54	56	67†	36	34	45†
Ovary	36	38	43†	35	38	43†	42	34	36
Pancreas	2	4	6‡	3	3	6†	2	6	5†
Prostate	68	83	100†	69	85	100†	61	72	98†
Rectum	48	58	68†	48	59	69†	45	52	61†
Stomach	15	20	28†	14	19	27†	16	19	28†
Testis	83	95	96†	83	96	97†	73‡#	88‡	89
Thyroid	92	95	98†	92	94	98†	90	92	96†
Urinary bladder	73	79	80†	74	80	81†	50	63	62†
Uterine cervix	69	70	69	70	73	70	65	57	61
Uterine corpus	87	83	83†	88	84	85†	60	57	63

*Survival rates are adjusted for normal life expectancy and are based on cases diagnosed in the SEER 9 areas from 1975-77, 1987-89, and 2002 to 2008, all followed through 2009. †The difference in rates between 1975-1977 and 2002-2008 is statistically significant ($p < 0.05$). ‡The standard error is between 5 and 10 percentage points. #Survival rate is for cases diagnosed in 1978-1980.

Source: Howlader N, Noone AM, Krapcho M, et al. (eds). *SEER Cancer Statistics Review, 1975-2009*, National Cancer Institute, Bethesda, MD. seer.cancer.gov/csr/1975_2009/, 2012.

American Cancer Society, Surveillance Research, 2013

detect premalignant abnormalities and cancer at an early stage, when treatment is both less extensive and more successful.

Treatment: Radiation therapy and surgery, separately or in combination, are standard treatments; chemotherapy is added for advanced disease. Targeted therapy with cetuximab (Erbitux) may be combined with radiation in initial treatment or used to treat recurrent cancer.

Survival: For all stages combined, about 84% of persons with oral cavity and pharynx cancer survive 1 year after diagnosis. The 5-year and 10-year relative survival rates are 62% and 51%, respectively.

Ovary

New cases: An estimated 22,240 new cases of ovarian cancer are expected in the US in 2013. Ovarian cancer accounts for about 3% of all cancers among women. From 2005 to 2009, incidence rates decreased by 0.9% per year.

Deaths: An estimated 14,030 deaths are expected in 2013. Ovarian cancer accounts for 5% of cancer deaths among women and causes more deaths than any other cancer of the female reproductive system. The death rate for ovarian cancer decreased by 2.0% per year from 2005 to 2009.

Signs and symptoms: Early ovarian cancer usually has no obvious symptoms. However, studies have indicated that some women may experience persistent, nonspecific symptoms, such as bloating, pelvic or abdominal pain, difficulty eating or feeling full quickly, or urinary urgency or frequency. Women who experience such symptoms daily for more than a few weeks should seek prompt medical evaluation. The most common sign of ovarian cancer is swelling of the abdomen, which is caused by the accumulation of fluid. Abnormal vaginal bleeding is rarely a symptom of ovarian cancer, though it is a symptom of cervical and uterine cancers.

Risk factors: The most important risk factor is a strong family history of breast or ovarian cancer. Women who have had breast cancer or who have tested positive for inherited mutations in

BRCA1 or *BRCA2* genes are at increased risk. Studies indicate that preventive surgery to remove the ovaries and fallopian tubes in these women can decrease the risk of ovarian cancer. Other medical conditions associated with increased risk include pelvic inflammatory disease and a genetic condition called hereditary nonpolyposis colorectal cancer (also called Lynch syndrome). The use of estrogen alone as menopausal hormone therapy has been shown to increase risk in several large studies. Tobacco smoking increases risk of mucinous ovarian cancer. Heavier body weight may be associated with increased risk of ovarian cancer. Pregnancy, long-term use of oral contraceptives, and tubal ligation reduce the risk of developing ovarian cancer; hysterectomy (with retention of the ovaries) also appears to decrease risk.

Early detection: There is currently no sufficiently accurate screening test for the early detection of ovarian cancer. Pelvic examination only occasionally detects ovarian cancer, generally when the disease is advanced. However, for women who are at high risk of ovarian cancer, the combination of a thorough pelvic exam, transvaginal ultrasound, and a blood test for the tumor marker CA125 may be offered, though this strategy has not yet proven effective in screening even high-risk groups of women. A pelvic exam, sometimes in combination with a transvaginal ultrasound, may be used to evaluate women with symptoms. Although a clinical trial in the US showed that these tests had no effect on ovarian cancer mortality when used as a screening tool in average risk women, results are expected in 2015 from another large screening trial under way in the United Kingdom.

Treatment: Treatment includes surgery and usually chemotherapy. Surgery usually involves removal of one or both ovaries and fallopian tubes (salpingo-oophorectomy), the uterus (hysterectomy), and the omentum (fatty tissue attached to some of the organs in the belly), along with biopsies of the peritoneum (lining of the abdominal cavity). In younger women with very early stage tumors who wish to have children, only the involved ovary and fallopian tube may be removed. Among patients with early ovarian cancer, complete surgical staging has been associated with better outcomes. For women with advanced disease, surgically removing all abdominal metastases larger than one centimeter (debulking) enhances the effect of chemotherapy and helps improve survival. For women with stage III ovarian cancer that has been optimally debulked, studies have shown that chemotherapy administered both intravenously and directly into the abdomen (intraperitoneally) improves survival. Studies have also found that ovarian cancer patients whose surgery is performed by a gynecologic oncologist have more successful outcomes. Clinical trials are currently under way to test targeted drugs such as bevacizumab and cediranib in the treatment of ovarian cancer.

Survival: Relative survival varies by age; women younger than 65 are twice as likely to survive 5 years (56%) following diagnosis as women 65 and older (27%). Overall, the 1-, 5-, and 10-year relative survival of ovarian cancer patients is 75%, 44%, and 34%, respectively. If diagnosed at the localized stage, the 5-year survival rate is 92%; however, only 15% of all cases are detected at this stage, usually incidentally during another medical procedure. The majority of cases (61%) are diagnosed at distant stage. For women with regional and distant disease, 5-year survival rates are 72% and 27%, respectively.

Pancreas

Please see page 25 for the special section on pancreatic cancer.

Prostate

New cases: An estimated 238,590 new cases of prostate cancer will occur in the US during 2013. Prostate cancer is the most frequently diagnosed cancer in men aside from skin cancer. For reasons that remain unclear, incidence rates are 70% higher in African Americans than in whites. Incidence rates for prostate cancer changed substantially between the mid-1980s and mid-1990s and have since fluctuated widely from year to year, in large part reflecting changes in prostate cancer screening with the prostate-specific antigen (PSA) blood test. From 2005 to 2009, incidence rates decreased by 1.9% per year.

Deaths: With an estimated 29,720 deaths in 2013, prostate cancer is the second-leading cause of cancer death in men. Prostate cancer death rates have been decreasing since the early 1990s in both African Americans and whites, though they remain more than twice as high in African Americans as in whites. The higher death rate among African Americans is mostly due to higher incidence rates, but also because African American men are more likely to die from prostate cancer than are white men. Prostate cancer death rates decreased 3.4% per year in white men and 3.5% per year in African American men from 2005 to 2009.

Signs and symptoms: Early prostate cancer usually has no symptoms. With more advanced disease, men may experience weak or interrupted urine flow; the inability to urinate or difficulty starting or stopping the urine flow; the need to urinate frequently, especially at night; blood in the urine; or pain or burning with urination. Advanced prostate cancer commonly spreads to the bones, which can cause pain in the hips, spine, ribs, or other areas.

Risk factors: The only well-established risk factors for prostate cancer are increasing age, African ancestry, and a family history of the disease. About 60% of all prostate cancer cases are diagnosed in men 65 years of age and older, and 97% occur in men 50 and older. African American men and Jamaican men of African descent have the highest documented prostate cancer incidence

rates in the world. The disease is common in North America and northwestern Europe, but less common in Asia and South America. Genetic studies suggest that strong familial predisposition may be responsible for 5%-10% of prostate cancers. Recent studies suggest that a diet high in processed meat or dairy foods may be a risk factor, and obesity appears to increase risk of aggressive prostate cancer. There is some evidence that occupational exposures of firefighters (e.g., toxic combustion products) moderately increase risk.

Prevention: The chemoprevention of prostate cancer is an active area of research. Two drugs of interest, finasteride and dutasteride, reduce the amount of certain male hormones in the body and are already used to treat the symptoms of benign prostate enlargement. Both drugs have been found to lower the risk of prostate cancer by about 25% in large clinical trials with similar potential side effects, including reduced libido and risk of erectile dysfunction. However, it is not entirely clear which men are most likely to gain benefit from prophylactic treatment with these agents and an advisory committee to the FDA has recommended against approval for both finasteride and dutasteride for the prevention of prostate cancer based on risk-benefit analyses.

Early detection: At this time, there are insufficient data to recommend for or against routine testing for early prostate cancer detection with the PSA test. The American Cancer Society recommends that beginning at age 50, men who are at average risk of prostate cancer and have a life expectancy of at least 10 years receive information about the potential benefits and known limitations associated with testing for early prostate cancer detection and have an opportunity to make an informed decision about testing. Men at high risk of developing prostate cancer (African Americans or men with a close relative diagnosed with prostate cancer before age 65) should have this discussion with their health care provider beginning at age 45. Men at even higher risk (because they have several close relatives diagnosed with prostate cancer at an early age) should have this discussion with their provider at age 40. All men should be given sufficient information about the benefits and limitations of testing and early detection to allow them to make a decision based on their personal values and preferences.

Results from clinical trials designed to determine the efficacy of PSA testing for reducing prostate cancer deaths have been mixed; two European studies found a lower risk of death from prostate cancer among men receiving PSA screening while a study in the US found no reduction. Current research is exploring new biologic markers for prostate cancer, as well as alternative ages of screening initiation and timing of testing, with the goal of identifying and treating men at highest risk for aggressive disease while minimizing unnecessary testing and treatment of men at low risk for prostate cancer death. See page 62 for the American Cancer Society's screening guidelines for the early detection of prostate cancer.

Treatment: Treatment options vary depending on age, stage, and grade of cancer, as well as other medical conditions. The grade assigned to the tumor, typically called the Gleason score, indicates the likely aggressiveness of the cancer. Although scores as low as 2 are theoretically possible, in practice most cancers are assigned scores ranging from 6 (low grade, less aggressive) to 10 (high grade, very aggressive). Surgery (open, laparoscopic, or robotic-assisted), external beam radiation, or radioactive seed implants (brachytherapy) may be used to treat early stage disease. Data show similar survival rates for patients with early stage disease treated with any of these methods, and there is no current evidence supporting a "best" treatment for prostate cancer. Hormonal therapy before or after surgery may be indicated in some cases. All of these treatments may impact a man's quality of life through side effects or complications that include urinary and erectile difficulties. Accumulating evidence indicates that careful observation ("active surveillance"), rather than immediate treatment, can be an appropriate option for men with less aggressive tumors and for older men.

Hormonal therapy, chemotherapy, radiation, or a combination of these treatments is used to treat more advanced disease. Hormone treatment may control advanced prostate cancer for long periods by shrinking the size or limiting the growth of the cancer, thus helping to relieve pain and other symptoms. An option for some men with advanced prostate cancer that is no longer responding to hormones is a cancer vaccine known as sipuleucel-T (Provenge). For this treatment, special immune cells are removed from a man's body, exposed to prostate proteins in a lab, and then re-infused back into the body, where they attack prostate cancer cells. Newer, more effective forms of hormone therapy, such as abiraterone (Zytiga) and enzalutamide (Xtandi), have been shown to be beneficial for the treatment of metastatic disease that is resistant to initial hormone therapy and chemotherapy.

Survival: The majority (93%) of prostate cancers are discovered in the local or regional stages, for which the 5-year relative survival rate approaches 100%. Over the past 25 years, the 5-year relative survival rate for all stages combined has increased from 68% to almost 100%. According to the most recent data, 10- and 15-year relative survival rates are 98% and 93%, respectively. Obesity and smoking are associated with an increased risk of dying from prostate cancer.

Skin

New cases: The number of basal cell and squamous cell skin cancers (i.e., nonmelanoma skin cancers, or NMSC) is difficult to estimate because these cases are not required to be reported to cancer registries. One report on NMSC occurrence in the US estimated that 3.5 million cases were diagnosed and 2.2 million people were treated for the disease in 2006, with some patients having multiple diagnoses. Most cases of these forms of skin cancer are highly curable. Melanoma is expected to be diagnosed in

about 76,690 persons in 2013, accounting for less than 5% of all skin cancer cases but the vast majority of skin cancer deaths. Melanoma is rare among African Americans; the lifetime risk of developing melanoma is 23 times higher among whites than among African Americans. Although before age 40, the incidence rate in women is twice that in men, after 40, the rate is higher in men; among those 80 and older, the rate in men is three times that in women. Melanoma incidence rates have been increasing for at least 30 years. From 2005 to 2009, incidence rates among whites increased by 2.8% per year.

Deaths: An estimated 12,650 deaths (9,480 from melanoma and 3,170 from other nonepithelial skin cancers) will occur in 2013. The death rate for melanoma has been declining rapidly in whites younger than 50 years of age; from 2005 to 2009, rates decreased by 2.8% per year in men and by 2.0% per year in women. In contrast, among whites 50 years of age and older, death rates increased by 1.1% per year in men and were stable in women during this same time period.

Signs and symptoms: Important warning signs of melanoma include changes in size, shape, or color of a mole or other skin lesion or the appearance of a new growth on the skin. Changes that progress over a month or more should be evaluated by a doctor. Basal cell carcinomas may appear as growths that are flat, or as small, raised, pink or red, translucent, shiny areas that may bleed following minor injury. Squamous cell carcinoma may appear as growing lumps, often with a rough surface, or as flat, reddish patches that grow slowly. Another sign of skin cancers is a sore that doesn't heal.

Risk factors: Risk factors vary for different types of skin cancer. For melanoma, major risk factors include a personal or family history of melanoma and the presence of atypical or numerous moles (more than 50). Other risk factors for all types of skin cancer include sun sensitivity (sunburning easily, difficulty tanning, natural blond or red hair color); a history of excessive sun exposure, including sunburns; use of tanning booths; diseases that suppress the immune system; and a past history of skin cancer.

Prevention: Skin should be protected from intense sun exposure by covering with tightly woven clothing and a wide-brimmed hat, applying sunscreen that has a sun protection factor (SPF) of 30 or higher to unprotected skin, seeking shade (especially at midday, when the sun's rays are strongest), and avoiding sunbathing and indoor tanning. Sunglasses should be worn to protect the skin around the eyes. Children in particular should be protected from the sun because severe sunburns in childhood may greatly increase risk of melanoma in later life. Tanning beds and sun lamps, which provide an additional source of UV radiation, are associated with cancer risk and should be avoided. In 2009, the International Agency for Research on Cancer upgraded their classification of indoor tanning devices from "probably carcinogenic" to "carcinogenic to humans" after a reassessment of the scientific evidence.

Early detection: At this time, the best way to detect skin cancer early is to recognize changes in skin growths, including the appearance of new growths. Adults should periodically examine their skin and be aware of any changes. New or unusual lesions or a progressive change in a lesion's appearance (size, shape, or color, etc.) should be evaluated promptly by a physician. Melanomas often start as small, mole-like growths that increase in size and may change color. A simple ABCD rule outlines the warning signals of the most common type of melanoma: A is for asymmetry (one half of the mole does not match the other half); B is for border irregularity (the edges are ragged, notched, or blurred); C is for color (the pigmentation is not uniform, with variable degrees of tan, brown, or black); D is for diameter greater than 6 millimeters (about the size of a pencil eraser). Other types of melanoma may not have these signs, so be alert for any new or changing skin growths.

Treatment: Removal and microscopic examination of all suspicious skin lesions are essential. Early stage basal cell and squamous cell cancers can be removed in most cases by one of several methods: surgical excision, electrodesiccation and curettage (tissue destruction by electric current and removal by scraping with a curette), or cryosurgery (tissue destruction by freezing). Radiation therapy and certain topical medications may be used in some cases. For malignant melanoma, the primary growth and surrounding normal tissue are removed and sometimes a sentinel lymph node is biopsied to determine stage. More extensive lymph node surgery may be needed if the sentinel lymph nodes contain cancer. Melanomas with deep invasion or that have spread to lymph nodes may be treated with surgery, immunotherapy, chemotherapy, and/or radiation therapy. Advanced cases of melanoma are treated with palliative surgery, immunotherapy, and/or chemotherapy, and sometimes radiation therapy. The targeted drug vemurafenib (Zelboraf) and the immunotherapy drug ipilimumab (Yervoy) have recently been approved by the FDA based on improved survival in people with advanced melanoma.

Survival: Most basal cell and squamous cell cancers can be cured, especially if the cancer is detected and treated early. Melanoma is also highly curable if detected in its earliest stages and treated properly. However, melanoma is more likely than other skin tumors to spread to other parts of the body. The 5- and 10-year relative survival rates for persons with melanoma are 91% and 89%, respectively. For localized melanoma (84% of cases), the 5-year survival rate is 98%; survival declines to 62% and 15% for regional and distant stage disease, respectively.

Thyroid

New cases: An estimated 60,220 new cases of thyroid cancer are expected to be diagnosed in 2013 in the US, with 3 in 4 cases occurring in women. The incidence rate of thyroid cancer has been increasing sharply since the mid-1990s, and it is the fastest-

increasing cancer in both men and women. From 2005 to 2009, incidence rates increased by 5.6% per year in men and 7.0% per year in women.

Deaths: An estimated 1,850 deaths from thyroid cancer are expected in 2013 in the US. From 2005 to 2009, the death rate for thyroid cancer was stable at 0.5 per 100,000 in both men and women.

Signs and symptoms: The most common symptom of thyroid cancer is a lump in the neck that is noticed by a patient or felt by a health care provider during a clinical exam. Other symptoms include a tight or full feeling in the neck, difficulty breathing or swallowing, hoarseness or swollen lymph nodes, and pain in the throat or neck that does not go away. Although most lumps in the thyroid gland are not cancerous, individuals who notice an abnormality should seek timely medical attention.

Risk factors: Risk factors for thyroid cancer include being female, having a history of goiter (enlarged thyroid) or thyroid nodules, a family history of thyroid cancer, and radiation exposure related to medical treatment during childhood. Radiation exposure as a result of radioactive fallout from atomic weapons testing and nuclear power plant accidents, such as Chernobyl, has also been linked to increased risk of thyroid cancer, especially in children. Certain rare genetic syndromes also increase risk. People who test positive for an abnormal gene that causes a hereditary form of thyroid cancer can decrease the risk of developing the disease with surgical removal of the thyroid gland. Unlike most other adult cancers, for which older age increases risk, 80% of newly diagnosed thyroid cancer patients are under 65 years of age.

Early detection: At present, there is no screening test recommended for the early detection of thyroid cancer in people without symptoms. However, because symptoms usually develop early, most thyroid cancers (68%) are diagnosed at an early stage. Tests used in the evaluation of thyroid nodules include: blood tests to determine levels of hormones related to normal functions of the thyroid gland; medical imaging techniques to determine the size and characteristics of the nodule and nearby lymph nodes; and biopsy to determine if the cells in the nodule are benign or malignant.

Treatment: Most thyroid cancers are highly curable, though about 5% of cases (medullary and anaplastic) are more aggressive and more likely to spread to other organs. Treatment depends on the cell type, tumor size, and extent of the disease. The first choice of treatment is surgery in nearly all cases. Total or partial removal of the thyroid gland (thyroidectomy), with or without lymph node removal, is recommended for most patients. Treatment with radioactive iodine (I-131) after surgery to destroy any remaining thyroid tissue may be recommended for more advanced disease. Hormone therapy is given after thyroidectomy to replace hormones normally produced by the thyroid gland and to prevent the body from making thyroid-stimulating hormone, decreasing the likelihood of recurrence.

Survival: The 5-year relative survival rate for all thyroid cancer patients is 98%. However, survival varies by stage, age at diagnosis, and disease subtype. The 5-year survival rate approaches 100% for localized disease, is 97% for regional stage disease, and 54% for distant stage disease. For all stages combined, survival is highest for patients younger than 45 years of age (almost 100%), and progressively decreases to 83% for those 75 or older.

Urinary Bladder

New cases: An estimated 72,570 new cases of bladder cancer are expected to occur in 2013. From 2005 to 2009, bladder cancer incidence rates were stable in men and decreased by 1.3% per year in women. Bladder cancer incidence is about four times higher in men than in women and almost two times higher in white men than in African American men.

Deaths: An estimated 15,210 deaths will occur in 2013. From 2005 to 2009, death rates were stable in men and decreasing by 0.6% per year in women.

Signs and symptoms: The most common symptom is blood in the urine. Other symptoms may include increased frequency or urgency of urination and irritation during urination.

Risk factors: Smoking is the most well-established risk factor for bladder cancer. Smokers' risk of bladder cancer is approximately four-fold that of nonsmokers', and smoking is estimated to cause about half of all bladder cancer cases in both men and women. Workers in the dye, rubber, leather, and aluminum industries, painters, and people who live in communities with high levels of arsenic in the drinking water also have an increased risk.

Early detection: There is currently no screening method recommended for people at average risk. Bladder cancer is diagnosed by microscopic examination of cells from urine or bladder tissue and examination of the bladder wall with a cystoscope, a slender tube fitted with a lens and light that can be inserted through the urethra. These and other tests may be used to screen people at increased risk, due to occupational exposure or certain bladder birth defects, and during follow up after bladder cancer treatment to detect recurrent or new tumors.

Treatment: Surgery, alone or in combination with other treatments, is used in more than 90% of cases. Early stage cancers may be treated by administering immunotherapy or chemotherapy drugs directly into the bladder after surgery. More advanced cancers may require removal of the entire bladder (cystectomy). Patient outcomes are improved with the use of chemotherapy, alone or with radiation, before cystectomy. Timely follow-up care is extremely important because of the high rate of bladder cancer recurrence.

Survival: For all stages combined, the 5-year relative survival rate is 78%. Survival declines to 71% at 10 years and 65% at 15 years after diagnosis. Half of all bladder cancer patients are diagnosed while the tumor is in situ (noninvasive, present only in the layer of cells in which the cancer developed), for which the 5-year survival is 96%. Patients with invasive tumors diagnosed at a localized stage have a 5-year survival rate of 70%; 35% of cancers are detected at this early stage. For patients diagnosed with regional and distant staged disease, 5-year survival is 33% and 6%, respectively.

Uterine Cervix

New cases: An estimated 12,340 cases of invasive cervical cancer are expected to be diagnosed in 2013. Large declines in incidence rates over most of the past several decades have begun to taper off, particularly among younger women; from 2005 to 2009, rates were stable in women younger than 50 years and decreased by 3.0% per year in women 50 and older.

Deaths: An estimated 4,030 deaths from cervical cancer are expected in 2013. Mortality rates declined rapidly in past decades due to prevention and early detection as a result of screening with the Pap test, but have begun to level off in recent years. From 2005 to 2009, rates were stable among both women younger than 50, and among those 50 years and older.

Signs and symptoms: Symptoms usually do not appear until abnormal cervical cells become cancerous and invade nearby tissue. When this happens, the most common symptom is abnormal vaginal bleeding. Bleeding may start and stop between regular menstrual periods, or it may occur after sexual intercourse, douching, or a pelvic exam. Menstrual bleeding may last longer and be heavier than usual. Bleeding after menopause or increased vaginal discharge may also be symptoms.

Risk factors: The cause of cervical cancer is persistent infection with certain types of human papillomavirus (HPV). While women who begin having sex at an early age or who have had many sexual partners are at increased risk for HPV infection and cervical cancer, a woman may be infected with HPV even if she has had only one sexual partner. In fact, HPV infections are common in healthy women and are typically cleared successfully by the immune system; only rarely does the infection persist and result in cervical cancer. Persistence of HPV infection and progression to cancer may be influenced by many factors, including a suppressed immune system, high parity (number of childbirths), and cigarette smoking. Long-term use of oral contraceptives (birth control pills) is also associated with increased risk of cervical cancer.

Prevention: There are two vaccines (Gardasil and Cervarix) approved for use in females 9 to 26 years of age for the prevention of the most common types of HPV infection that cause cervical cancer. Gardasil is also approved for the prevention of anal, vaginal, and vulvar cancers (and precancers) in women and for the prevention of anal and penile cancers in males 9 to 26 years of age; approximately 90% of anal cancers have been linked to HPV infection. These vaccines may also protect against HPV-related head and neck cancers, which have been increasing in recent years. HPV vaccines cannot protect against established infections, nor do they protect against all types of HPV.

Screening can prevent cervical cancer by detecting precancerous lesions. As screening has become more common, precancerous lesions of the cervix are detected far more frequently than invasive cancer. The Pap test is the most widely used cervical cancer screening method. It is a simple procedure in which a small sample of cells is collected from the cervix and examined under a microscope. Pap tests are effective, but not perfect. Sometimes results are reported as normal when abnormal cells are present (false negative), and likewise, sometimes test results are positive when no abnormal cells are present (false positive). HPV tests, which detect types of HPV associated with cervical cancer, can forecast cervical cancer risk many years in the future and are used in conjunction with the Pap test, either as an additional screening test or when Pap test results are uncertain. Fortunately, most cervical precancers develop slowly, so most cancers can be prevented if a woman is screened regularly. It is important for all women, even those who have received the HPV vaccine, to follow cervical cancer screening guidelines.

Early detection: In addition to preventing cancer, cervical cancer screening can detect cancer early, when treatment is most successful. It is important that all eligible women be screened according to guidelines; most cervical cancers are detected in women who have never or not recently been screened. The American Cancer Society, in collaboration with the American Society for Colposcopy and Cervical Pathology and the American Society for Clinical Pathology, issued new screening guidelines for the prevention and early detection of cervical cancer in 2012. The most important changes to the guidelines are the age range for which screening is appropriate and the emphasis on the incorporation of HPV testing in addition to the Pap test. Among women at average risk, screening is now recommended for ages 21 years through 65 years and the preferred screening method for women 30 to 65 years is now HPV and Pap "co-testing" every five years. For more detailed information on the American Cancer Society's screening guidelines for the early detection of cervical cancer, see page 60.

Treatment: Preinvasive lesions may be treated by electrocoagulation (the destruction of tissue through intense heat by electric current), cryotherapy (the destruction of cells by extreme cold), laser ablation, or local surgery. Invasive cervical cancers are generally treated with surgery, radiation, or both, and with chemotherapy in selected cases.

Survival: One- and 5-year relative survival rates for cervical cancer patients are 87% and 68%, respectively. The 5-year survival rate for patients diagnosed with localized disease is 91%. Cervical cancer is diagnosed at an early stage more often in whites (49%) than in African Americans (40%) and more often in women younger than 50 years of age (59%) than in women 50 and older (33%).

Uterine Corpus (Endometrium)

New cases: An estimated 49,560 cases of cancer of the uterine corpus (body of the uterus) are expected to be diagnosed in 2013. These usually occur in the endometrium (lining of the uterus). From 2005 to 2009, incidence rates of endometrial cancer were stable in white women, but increasing in African American women by 2.2% per year.

Deaths: An estimated 8,190 deaths are expected in 2013. Death rates for cancer of the uterine corpus were stable in white women, but increasing slightly (by 0.4% per year) in African American women from 2005 to 2009.

Signs and symptoms: Abnormal uterine bleeding or spotting (especially in postmenopausal women) is a frequent early sign. Pain during urination, intercourse, or in the pelvic area is also a symptom.

Risk factors: Obesity and greater abdominal fatness increase the risk of endometrial cancer, most likely by increasing the amount of estrogen in the body. Estrogen exposure is a strong risk factor for endometrial cancer. Other factors that increase estrogen exposure include menopausal estrogen therapy (without use of progestin), late menopause, never having children, and a history of polycystic ovary syndrome. (Estrogen plus progestin menopausal hormone therapy does not appear to increase risk.) Tamoxifen, a drug used to reduce breast cancer risk, increases risk slightly because it has estrogen-like effects on the uterus. Medical conditions that increase risk include Lynch syndrome, also known as hereditary nonpolyposis colorectal cancer (HNPCC), and diabetes. Pregnancy, use of oral contraceptives or intrauterine devices, and physical activity provide protection against endometrial cancer.

Early detection: There is no standard or routine screening test for endometrial cancer. Most endometrial cancer (68%) is diagnosed at an early stage because of postmenopausal bleeding. Women are encouraged to report any unexpected bleeding or spotting to their physicians. The American Cancer Society recommends that women with known or suspected Lynch syndrome be offered annual screening with endometrial biopsy and/or transvaginal ultrasound beginning at 35 years of age.

Treatment: Uterine corpus cancers are usually treated with surgery, radiation, hormones, and/or chemotherapy, depending on the stage of disease.

Survival: The 1- and 5-year relative survival rates for uterine corpus cancer are 92% and 82%, respectively. The 5-year survival rate is 95%, 67%, or 16%, if the cancer is diagnosed at a local, regional, or distant stage, respectively. Relative survival in whites exceeds that for African Americans by more than 8 percentage points at every stage of diagnosis.

Special Section: Pancreatic Cancer

Cancer of the pancreas is one of the deadliest cancer types. Most pancreatic cancer patients will die within the first year of diagnosis, and just 6% will survive five years. Over the past decade, pancreatic cancer death rates have been slowly increasing among US men and women, in contrast to the downward trend in rates for most other major cancer sites, such as lung, colorectum, female breast, and prostate. The lack of progress in primary prevention, early diagnosis, and treatment underscores the need for additional efforts in pancreatic cancer research and has motivated us to address this disease in the current edition of *Cancer Facts & Figures*. Specifically, this special section provides updated information on occurrence, prevention, early detection, diagnosis, and treatment of pancreatic cancer. This information is intended to inform anyone interested in learning more about pancreatic cancer, including policy makers, researchers, clinicians, cancer control advocates, patients, and caregivers.

The pancreas contains two types of glands that each perform very different functions. The exocrine glands produce enzymes that help digest food; the endocrine glands produce important hormones such as insulin, which regulates blood sugar levels. Exocrine and endocrine cells form completely different types of tumors with distinct risk factors, symptoms, diagnostic tests, treatment, and survival rates. Exocrine tumors are the focus of this special section because they are by far the most common type of pancreatic cancer, representing about 95% of cases.

How Many Cases and Deaths Are Estimated to Occur in 2013?

Pancreatic cancer is the 10th most common cancer diagnosis among men and the 9th most common among women in the US. In 2013, an estimated 45,220 new cases of pancreatic cancer will be diagnosed nationwide.

Pancreatic cancer accounts for about 7% of all cancer deaths and ranks fourth as a cause of cancer death among both men and women in the US. In 2013, approximately 38,460 people are expected to die from pancreatic cancer nationwide.

Who Gets Pancreatic Cancer?

Sex

- Pancreatic cancer is about 30% more common in men than in women. During 2005-2009, the age-adjusted incidence rate (per 100,000 persons) of pancreatic cancer was 13.6 for men and 10.5 for women.
- The lifetime risk of developing pancreatic cancer is about 1.5% for both men and women (Table 1).
- Men are more likely than women to develop pancreatic cancer at every age after 35 years (Figure 1a, page 26).
- During 2005-2009, the age-adjusted death rate (per 100,000 persons) for pancreatic cancer was 12.5 for men and 9.5 for women.

Age

- Pancreatic cancer incidence and death rates increase with advancing age, with a steep increase after about age 50.
- During 2005-2009, the incidence rate (per 100,000) in men was 1.2 among those 35 to 39 years of age compared to 100.5 among those 85 years and older; in women the rate was 1.0 among those 35 to 39 years of age compared to 87.7 among those 85 years and older (Figure 1a, page 26).
- During 2005-2009, the median age at diagnosis of pancreatic cancer was 71 years of age. This means that about half of all patients developed this disease when they were older than age 71.
- The likelihood of developing pancreatic cancer in the next 10 years is about four times higher at age 70 than at age 50 (Table 1).

Race/Ethnicity

- Pancreatic cancer incidence and mortality rates vary across different racial/ethnic groups, with the highest rates in African Americans and the lowest rates in Asian Americans/Pacific Islanders (Figure 2, page 27).
- Incidence rates are higher in African Americans than in whites at every age (Figure 1b, page 26).
- During 2005-2009, the incidence rate (per 100,000 persons) was 15.3 for African Americans, 11.6 for whites, and 8.8 for Asian Americans/Pacific Islanders.

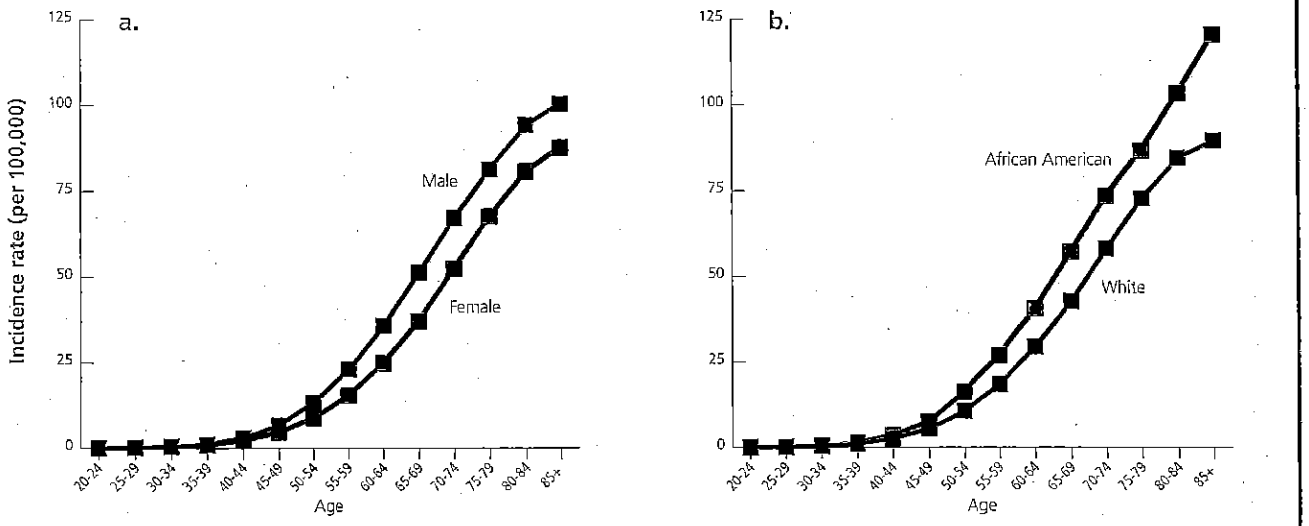
Table 1. Probability (%) of Developing Pancreatic Cancer over Selected Age Intervals by Sex, US, 2007-2009*

Age	Male	Female
0 to 39	0.01 (1 in 9,746)	0.01 (1 in 9,479)
40-49	0.05 (1 in 2,063)	0.04 (1 in 2,674)
50-59	0.18 (1 in 563)	0.12 (1 in 843)
60-69	0.41 (1 in 241)	0.30 (1 in 335)
70-79	0.65 (1 in 155)	0.56 (1 in 179)
Lifetime risk	1.48 (1 in 67)	1.45 (1 in 69)

*For people free of cancer at beginning of age interval. Percentages and "1 in" numbers may not be equivalent due to rounding.

Source: DevCan: Probability of Developing or Dying of Cancer Software, Version 6.6.1. Statistical Research and Applications Branch, National Cancer Institute, 2012.srab.cancer.gov/devcan.

Figure 1. Pancreatic Cancer Incidence Rates* by Age and Sex (a) and Age and Race (b), US, 2005-2009.



*Age adjusted to the 2000 US standard population.
Source: North American Association of Central Cancer Registries (NAACCR). Data are collected by cancer registries participating in NCI's SEER program and CDC's National Program of Cancer Registries.

American Cancer Society, Surveillance Research, 2013

- Mortality rates (per 100,000 persons) during the corresponding time interval were 13.8, 10.7, and 7.5 for African Americans, whites, and Asian American/Pacific Islanders, respectively.
- Racial differences in pancreatic cancer rates are largely explained by established risk factors, such as cigarette smoking, obesity, and diabetes.[1]

Socioeconomic status

Number of years of education is one measure of socioeconomic status used by researchers to study health disparities.

- Pancreatic cancer death rates are higher among those with fewer years of education.
- One study found that in 2007, the pancreatic cancer death rate among non-Hispanic white men 25 to 64 years of age was about 80% higher for those with 12 or fewer years of education than for those with 16 or more years of education; among non-Hispanic white women, the death rate for the less-educated group was double that of the most educated.[2]
- This study also found that from 1993 to 2007, pancreatic cancer death rates among non-Hispanic white men and women 25 to 64 years of age increased among those with the least education, but remained stable among those with the most education.[2]
- Another study found that low income was associated with an 80% increased risk of pancreatic cancer in white men and a 170% increased risk in African American men after accounting for differences in smoking, dietary factors, and heavy alcohol drinking.[1]

Are There Geographic Differences in Pancreatic Cancer in the US?

- Despite substantial international variation, within the US, pancreatic cancer incidence and mortality rates vary only slightly between states.
- Among whites, pancreatic cancer death rates are highest in the Northeast, and range from 8.4 (per 100,000) in the District of Columbia to 12.1 in Connecticut (Figure 3, page 28).
- Among African Americans, death rates are highest in the Midwest, and range from 7.8 (per 100,000) in West Virginia to 18.9 in Iowa (Figure 3, page 28).

How Has the Occurrence of Pancreatic Cancer Changed over Time?

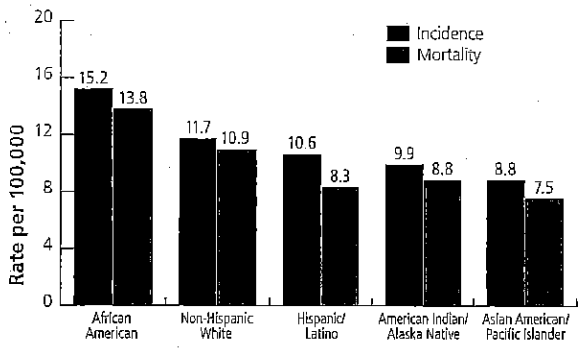
Incidence trends

During the past 10 years of data (2000-2009), for which we have coverage for almost the entire US, pancreatic cancer incidence rates increased by 0.9% per year among white men, white women, and African American men, while rates remained stable for African American women and men and women of all other major racial and ethnic groups.[3]

Mortality trends

Although the pancreatic cancer death rate increased for the overall US over the past 10 years of data (2000-2009), this increase was confined to white men and women (by 0.5% per year) and Asian American and Pacific Islander men (by 1.0% per year).[3]

Figure 2. Pancreatic Cancer Incidence and Mortality Rates* by Race and Ethnicity†, US, 2005-2009.



*Per 100,000, age adjusted to the 2000 US standard population. †Persons of Hispanic/Latino origin may be of any race.
Sources: Incidence: North American Association of Central Cancer Registries (NAACCR) data; Mortality: US mortality data, National Center for Health Statistics, Centers for Disease Control and Prevention. Data for American Indians/Alaska Natives are based on Contract Health Service Delivery Area (CHSDA) counties.

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Can Pancreatic Cancer Be Prevented?

The causes of pancreatic cancer are not well understood, though there are several factors known to increase risk. Known modifiable risk factors include obesity, cigarette smoking, and other forms of tobacco use. Risk factors that are not modifiable include a family history of pancreatic cancer and certain inherited syndromes. Strategies for preventing pancreatic cancer include not smoking and maintaining normal body weight. Consuming adequate quantities of fruits and vegetables may also have a preventive effect, although strong evidence for this association is lacking.

Modifiable Risk Factors

Tobacco use

Tobacco use is the most important known risk factor for pancreatic cancer; approximately 20% of pancreatic cancers are attributable to cigarette smoking.[4] The risk of developing pancreatic cancer is about twice as high among smokers as among never smokers;[5] risk increases with greater tobacco use and longer duration of smoking.[6,7] Cigar and pipe smoking also increase risk.[8,9] Quitting smoking rapidly reduces the risk of pancreatic cancer; after 5-10 years of cessation, the risk among former smokers returns to that of never smokers.[4,10] Use of smokeless tobacco products also increases the risk of pancreatic cancer.[11] Evidence on secondhand smoke exposure and pancreatic cancer is inconsistent.[12]

Obesity and physical activity

Obesity has also been fairly consistently linked to increased risk of pancreatic cancer. Obese individuals have a 20% higher risk of developing pancreatic cancer than those who are normal weight.[13-15] Being obese during early adulthood may be associated with an even greater risk of pancreatic cancer and a younger age of disease onset.[16] Abdominal obesity may increase risk independent of general obesity, especially in women.[15,17]

Results regarding the association between physical activity and pancreatic cancer risk are mixed.[14,18-21] A slightly decreased risk of pancreatic cancer was linked to total and occupational physical activity in a recent literature review[22] but not in a previous one.[23] There is currently limited evidence to support a protective effect of recreational physical activity on risk of pancreatic cancer.[22]

Alcohol use

Whether alcohol use causes pancreatic cancer remains to be determined. A positive association between alcohol use and pancreatic cancer was found in several but not all studies.[24] Accumulating evidence suggests that a moderate increased risk is limited to heavy alcohol users.[25] A recent meta-analysis showed that consumption of three or more drinks of alcohol per day is associated with a 20% to 30% increased risk of pancreatic cancer.[25] However, due to the strong relationship between alcohol consumption and tobacco use, it is difficult to eliminate the effect of smoking when studying the association between alcohol drinking and pancreatic cancer risk.

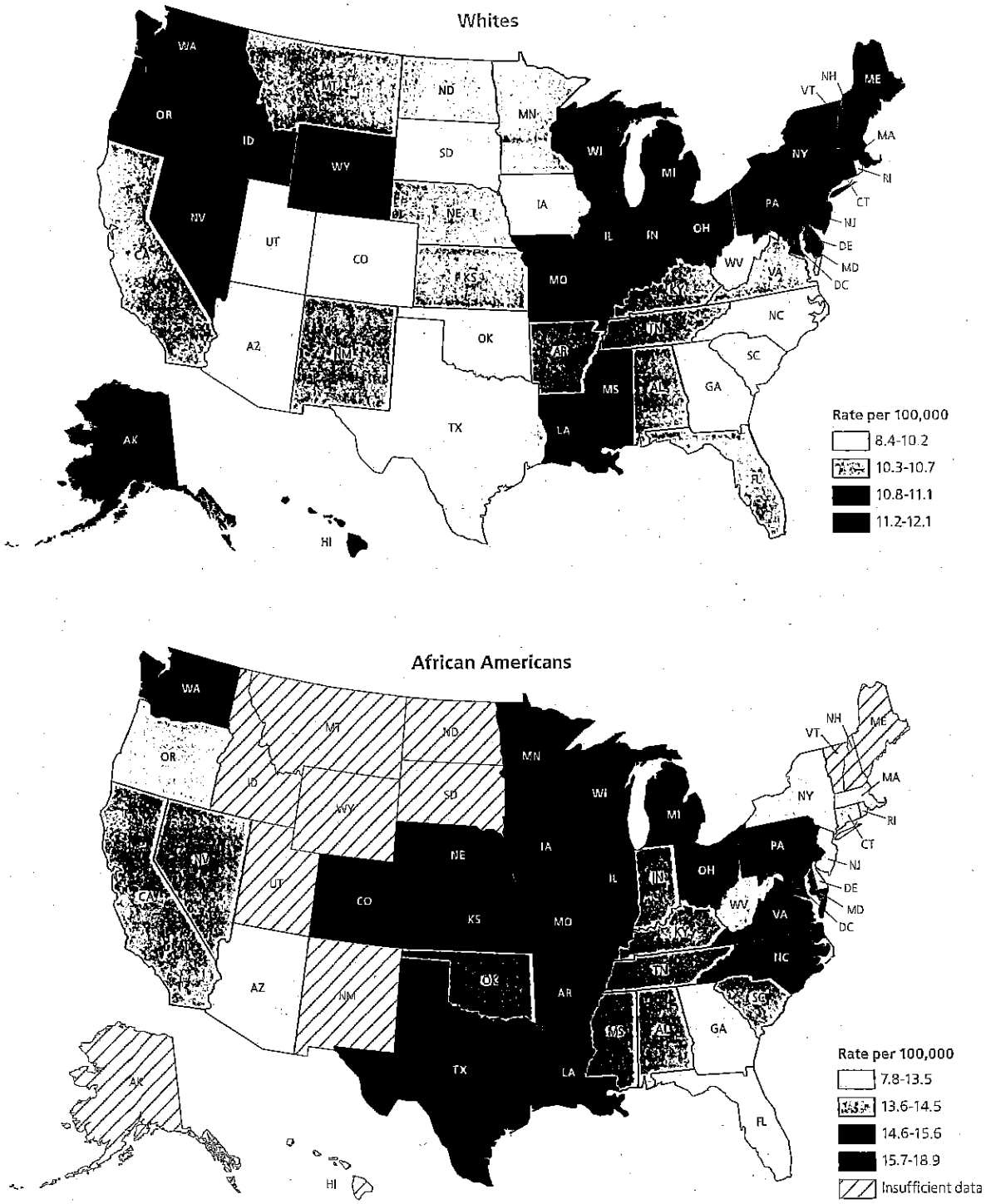
Dietary factors

A number of dietary factors have been assessed regarding their association with pancreatic cancer risk. There is some evidence that the consumption of red and processed meat may slightly increase risk.[26] Investigators have also found some evidence for increased risk among those who consume meat that has been cooked at very high temperatures.[27] A protective effect of folate intake on pancreatic cancer risk has been reported in several studies;[28] however, a recent large analysis found no association.[29] At present, there is limited evidence supporting a protective effect of fruit and vegetable consumption on the risk of pancreatic cancer.[30-33] No association between coffee consumption and pancreatic cancer was found in a recent analysis that combined many studies.[34]

Sunlight and vitamin D

Studies are conflicting about the relationship between sunlight, vitamin D, and pancreatic cancer. Several studies have found that sun exposure is associated with lower pancreatic cancer death rates, suggesting that vitamin D, acquired primarily through sun exposure to the skin, may be protective against pancreatic cancer.[35-37] However, results from epidemiological studies that assessed individual-level vitamin D intake and pancreatic cancer risk have been inconsistent. Two large studies found that both dietary vitamin D and vitamin D derived from both diet and sunlight exposure are protective.[38,39] Conversely, a recently published analysis found that while there was no association between low levels of vitamin D and pancreatic cancer, high vitamin D levels were associated with an increased risk of pancreatic cancer.[40]

Figure 3. Geographic Patterns in Pancreatic Cancer Death Rates* by State and Race, US, 2005-2009.



*Age adjusted to the 2000 US standard population. Insufficient data indicates states with fewer than 20 deaths.
Source: US mortality data, National Center for Health Statistics, Centers for Disease Control and Prevention.

American Cancer Society, Surveillance Research, 2013

Non-modifiable Factors and Medical Conditions

Family history

A number of studies have linked family history to an increased risk of pancreatic cancer. Generally, individuals with a family history of pancreatic cancer have a nearly 2-fold increased risk for developing pancreatic cancer, compared to those without such a history.[41] The risk increases to 7- to 9-fold for individuals with at least 1 first-degree relative (a parent or sibling) with pancreatic cancer and 17- to 32-fold for individuals with 3 or more first-degree relatives with pancreatic cancer.[42,43] Risk is also increased if a first-degree relative was diagnosed with pancreatic cancer before age 50.[43]

Genetic factors

Genetic factors (factors related to gene variations or alterations) account for approximately 5% to 10% of all pancreatic cancer cases.[44,45] There are several gene mutations that are associated with an increased risk of pancreatic cancer, though these are extremely rare in the general population.[46,47] Mutations in the *BRCA2* gene are associated with a 3- to 10-fold increased risk of pancreatic cancer and account for the highest proportion (5% to 17%) of known causes of inherited pancreatic cancer.[48-50] Mutations in the CDKN2A gene, which are linked to the familial atypical multiple mole-melanoma (FAMMM) syndrome, are associated with an approximately 13- to 22-fold increased risk of pancreatic cancer.[51] Patients with Peutz-Jeghers Syndrome (PJS), which is usually caused by STK11 mutations, have an 11% to 36% chance of developing pancreatic cancer during their lifetime.[52,53] The risk among people with hereditary pancreatitis (inflammation of the pancreas) linked to PRSS1 mutations is approximately 70 times greater than that expected in the normal population, with lifetime risk of developing pancreatic cancer approximately 40% to 55%.[54] Patients with hereditary non-polyposis colorectal cancer (HNPCC or Lynch syndrome), which is most often caused by MLH1 or MSH2 mutations, have about a 9-fold increased risk of developing pancreatic cancer.[45,55] Recent studies have found that people with non-O blood groups (i.e., blood groups A, AB, and B) have a slightly increased risk of pancreatic cancer, though the mechanisms of this association are still unclear.[56-58]

Chronic pancreatitis (inflammation of the pancreas)

Accumulating evidence suggests that long-standing chronic pancreatitis is a strong risk factor for pancreatic cancer, though pancreatitis may also be an early indicator of pancreatic cancer.[54,59,60] After excluding the pancreatic cancer cases diagnosed within 2 years from chronic pancreatitis diagnosis, a review study reported a 6-fold increased risk of pancreatic cancer among patients with chronic pancreatitis.[54] The risk is especially strong in patients with rare types of pancreatitis, such as hereditary pancreatitis and tropical pancreatitis. The lag period between pancreatitis diagnosis and pancreatic cancer onset is usually about 10 to 20 years. Despite the strong association between chronic pancreatitis and pancreatic cancer, chronic pancreatitis is uncommon; moreover, only about 4% of these patients will develop pancreatic cancer within 20 years of diagnosis.[59]

Diabetes

About 25% of patients with pancreatic cancer have diabetes mellitus at diagnosis, and roughly another 40% have pre-diabetes (higher than normal blood glucose levels).[61,62] Compared with non-diabetic individuals, patients with long-term (≥ 5 years) type-II diabetes have a 50% increased risk of pancreatic cancer.[63] Pancreatic cancer can cause diabetes, and sometimes diabetes is an early sign of the tumor.[62] Elevated pancreatic cancer risk has also been reported among individuals with type-I diabetes.[64] Recent reports also suggest that hyperglycemia (high blood glucose), abnormal glucose metabolism, and insulin resistance are associated with increased risk of pancreatic cancer.[65-69]

Infection and other medical conditions

Several studies have detected an increased risk of pancreatic cancer among people with chronic infections with hepatitis B virus, hepatitis C virus,[70,71] and *Helicobacter pylori*.[72] Individuals with a history of cholecystectomy (surgical removal of the gallbladder)[73] or partial gastrectomy (partial surgical removal of the stomach)[74] have also been found to be at increased risk of developing pancreatic cancer. Other medical conditions that may increase risk include cystic fibrosis[75] and periodontal disease.[76]

Can Pancreatic Cancer Be Detected Early?

Early stage pancreatic cancer usually has no symptoms. When symptoms do occur, the tumor has usually spread to surrounding tissues or distant organs. Common symptoms of pancreatic cancer include mild abdominal discomfort, mid-back pain, jaundice (yellowing of the skin or whites of the eyes), and weight loss. Nausea and vomiting may occur among patients with more advanced disease. In the US, only about 15% to 20% of pancreatic cancer cases are diagnosed early enough to be eligible for surgery.

To date, there is no single, reliable test for the early detection of pancreatic cancer; therefore, screening the general population is not recommended by any health agency.[77] Existing screening programs have been limited to research settings with a focus on detecting precancerous lesions among high-risk individuals.[78]

The most frequently tested techniques for pancreatic cancer screening include endoscopic ultrasound (EUS), helical computed tomography (CT), magnetic resonance imaging (MRI), and endoscopic retrograde cholangiopancreatography (ERCP). Single use of EUS or various combinations of these imaging techniques are capable of detecting early pancreatic cancer or precancer in high-risk patients, such as those with chronic, hereditary, or tropical pancreatitis; Peutz-Jeghers syndrome; cystic fibrosis; or familial atypical multiple mole-melanoma.[79-81] However, it remains unclear whether screening high-risk populations is effective in

Table 2. Median Pancreatic Cancer Survival by Stage at Diagnosis

Stage	Median Survival*
IA	24.1 Months
IB	20.6 Months
IIA	15.4 Months
IIB	12.7 Months
III	10.6 Months
IV	4.5 Months

*Data from Bilimoria et al.[84]

reducing pancreatic cancer mortality. Therefore, pancreatic cancer screening should currently be limited to high-risk populations within a research setting.[78] Recent advances in understanding the molecular basis of cancer offer promise for the discovery of new methods for detecting pancreatic cancer early.

How Is Pancreatic Cancer Diagnosed?

When pancreatic cancer is suspected, patients will be asked to provide a full medical history and be given a physical exam mainly focused on the abdomen, but also of the skin and eyes for indications of jaundice (yellow coloring). Pancreatic cancer is typically diagnosed with the use of an imaging test, usually a CT scan, often with a contrast dye, given by mouth or through injection, to better outline abnormal areas.[46,82] This procedure is also often used to stage the tumor, with 70% to 85% accuracy for predicting whether or not the tumor can be surgically removed. If pancreatic cancer is highly suspected but a CT scan appears normal, additional diagnostic tests, such as endoscopic ultrasound or ERCP, may be performed. The ERCP technique is especially useful in patients with bile duct tumors[83] and endoscopic ultrasound can often detect small tumors missed by CT scan. A cancer diagnosis is typically confirmed with a biopsy – a procedure in which a small sample of the tumor is removed and viewed under a microscope. The most common type of biopsy to confirm pancreatic cancer is called a fine needle aspiration biopsy. The needle is inserted into the pancreas guided by an endoscopic ultrasound or CT scan images to obtain tissues for evaluation. However, a tissue diagnosis is not needed for patients who are scheduled for surgery. Due to the deep location of the pancreas and the medical complications of biopsy, pancreatic cancer is the least likely of all major cancers to be microscopically confirmed.

What Factors Influence Pancreatic Cancer Survival?

The prognosis (disease course and expected outcome) of pancreatic cancer is largely determined by the stage of disease at diagnosis, which is based on the tumor's size, whether there is lymph node involvement, and the extent of spread locally and to distant organs. Table 2 presents the characteristics and median survival time for each stage of invasive pancreatic cancer. The median survival ranges from 4.5 months for the most advanced stage to 24.1 months for the earliest stage.[84]

At present, surgery provides the only chance of prolonged survival for pancreatic cancer patients. Even for patients with a tumor that has been surgically removed (generally Stages I or II), the 5-year survival is only about 20% to 25%. Indications of a poor survival outcome include positive resection margins (cancer cells at the outer edge of the removed tissue), poor tumor differentiation (the tumor does not resemble pancreatic tissue), a large tumor size, lymph node involvement, high levels of preoperative carbohydrate (or cancer) antigen 19-9 (CA19-9), and persistently elevated levels of postoperative CA 19-9.[46,85-89] In addition, several molecular markers have been associated with poor outcome after surgery.[90,91] As these molecular markers were mainly evaluated in small studies, their value requires further validation in larger studies, and thus none have been routinely used in clinical practice.

How Is Pancreatic Cancer Treated?

Treatment

Patients with pancreatic cancer are best managed by a multidisciplinary team, including surgeons, medical and radiation oncologists, radiologists, gastroenterologists, pain management experts, nutritionists, social workers, and others. The treatment choice is largely determined by whether the tumor can be surgically removed. Surgery remains the only treatment that offers a chance of cure for pancreatic cancer patients.[92]

For those patients who are candidates for surgery (approximately 20% of all pancreatic cancer patients), the operative approaches include cephalic pancreatoduodenectomy (the Whipple procedure), distal pancreatectomy, or total pancreatectomy, depending on the location of the tumor (see sidebar on page 31). Postoperative (adjuvant) chemotherapy either alone or in combination with radiation has been proven to improve progression-free and overall survival in both randomized controlled trials and observational studies.[93,94] The role of radiation therapy by itself in the adjuvant setting remains unclear.[95] Treatment with chemotherapy or chemoradiotherapy prior to surgery (neoadjuvant) is an emerging strategy. The goal of neoadjuvant treatment is to increase the ability to successfully remove all of the tumor.[96] However, there is no evidence that neoadjuvant therapy is superior to adjuvant therapy, especially among those patients who clearly have resectable disease.[97] For this reason,

Pancreatic Cancer Treatment Options

Surgery

- Cephalic pancreatoduodenectomy (Whipple procedure) is the removal of the head of the pancreas, the gallbladder, part of the stomach, part of the small intestine, and the bile duct, retaining enough of the pancreas to produce digestive juices and insulin.
- Distal pancreatectomy is the removal of the body and the tail of the pancreas as well as the spleen.
- Total pancreatectomy is the removal of the whole pancreas, part of the stomach, part of the small intestine, the common bile duct, the gallbladder, the spleen, and nearby lymph nodes.

Chemotherapy is the use of drugs to kill cancer cells by preventing them from growing and dividing. Gemcitabine is usually the recommended first-line drug for pancreatic cancer patients. It can be given alone or in combination with other drugs.

Radiation therapy is the use of high-energy radiation to control or kill cancer cells. Radiation can be delivered by a machine outside the body (external beam radiation) or can come from a radioactive substance implanted in or near the cancer (internal radiation or brachytherapy). Brachytherapy is rarely used in treating pancreatic cancer.

Chemoradiation therapy combines chemotherapy and radiation therapy to increase the effects of both. The side effects of this combination therapy are more severe than either therapy alone.

Targeted therapy is the use of drugs or other substances to inhibit the growth of cancer cells by interfering with specific molecules involved in tumor progression. Erlotinib, which targets the epidermal growth factor receptor (EGER), may be used with gemcitabine among pancreatic cancer patients with advanced disease.

neoadjuvant treatment is considered more relevant for patients with locally advanced or borderline resectable disease.[97-99]

The treatment for patients with advanced disease focuses on managing symptoms and relieving pain and suffering (palliative care). Treatment options include chemotherapy alone or in combination with radiation. The combination of 5-FU, leucovorin, irinotecan, and oxaliplatin (FOLFIRINOX) can help prolong life in patients with advanced disease, though many patients are too ill to tolerate this regimen. Other treatment options include gemcitabine alone or in combination with a platinum agent, erlotinib (Tarceva), or fluoropyrimidine.[82]

Supportive care

Given the poor survival and persistent symptoms experienced by many pancreatic cancer patients who do not respond to treatment, care focusing on relieving and preventing suffering represents an important aspect of managing this disease. Palliative care should be offered at the initiation of any treatment regimen in order to relieve symptoms and side effects, which include pain, bile duct or gastric outlet obstruction, and loss of appetite. Palliative efforts may also include psychological support to relieve patients' stresses associated with pancreatic cancer diagnosis and treatment.

Opioid analgesics (morphine and similar drugs) are often needed to help reduce pain. Radiation may be given to help relieve pain from locally advanced disease. Another pain management approach is nerve block, whereby a pain specialist injects either an anesthetic or a medication to block or destroy the nerves. For example, abdominal pain can sometimes be treated effectively by endoscopic ultrasound or CT guided celiac plexus block.

If the tumor is blocking the bile duct, a stent (a thin tube) can be placed to relieve the blockage using nonsurgical approaches, such as ERCP and percutaneous transhepatic cholangiogram (PTC). If a patient develops gastric-outlet obstruction, treatment may include duodenal wall stents or PEG (percutaneous endoscopic gastrostomy) placement for decompression. Sometimes, a patient may need surgery to create a bypass (biliary bypass or gastric bypass) to manage obstructive jaundice and gastric outlet obstruction.

If the pancreas is not working well or has been partially or entirely removed, a special diet and specially prescribed enzymes may help the patient's digestion. Meeting with a nutritionist is also often very helpful for patients who are losing weight and have a poor appetite because of their disease.

What Is the American Cancer Society Doing about Pancreatic Cancer?

Research

The American Cancer Society, through its Extramural Grants program, funds individual investigators in medical schools, universities, research institutes, and hospitals throughout the United States. Currently, this program is funding $8,077,500 in pancreatic cancer research through 32 research grants. Ongoing research includes:

- Identifying new avenues of early detection and treatment through better understanding of the biological mechanisms of pancreatic cancer development, progression, and metastasis
- Determining the optimal sequencing strategy for pancreatic cancer treatment through mathematical decision analysis

- Examining new biomarkers for drug response to optimize the effectiveness of common chemotherapeutic agents, such as gemcitabine
- Testing new therapeutic agents for targeted therapy, such as PARP inhibitors and glutaminase inhibitors
- Exploring targeted delivery of pro-apoptotic therapeutics into pancreatic cancer cells
- Integrating immunotherapy into pancreatic cancer treatment regimens

The Society's intramural research program also conducts a wide range of research on pancreatic cancer. For example, researchers from the surveillance research program monitor trends in pancreatic cancer incidence and mortality, and recently published a study showing that socioeconomic disparities in pancreatic cancer death rates widened among working-age US populations during 1993-2007. Using data collected in the Society's Cancer Prevention Study II (CPS-II), Society epidemiologists have also examined the relationship between pancreatic cancer death and various factors, including alcohol consumption, carbohydrate intake, aspirin use, and reproductive patterns. In addition, the CPS-II Nutrition Cohort is part of a large international Pancreatic Cancer Cohort Consortium (PanScan), which aims to identify genetic factors, environmental exposures, and gene-environment interactions that contribute to the development of pancreatic cancer. To date, PanScan researchers have discovered four novel regions in the genome associated with risk for pancreatic cancer. In addition, many other epidemiological studies on environmental risk factors (including lifestyle factors) have been published.

Advocacy

The American Cancer Society Cancer Action Network℠ (ACS CAN), the nonprofit nonpartisan advocacy affiliate of the American Cancer Society, recognizes that cancer research is the engine behind our ongoing progress in the fight against cancer. Research offers hope to the millions of people who face cancer – for better treatments, for more opportunities to prevent and detect the disease early, and for improved quality of life for those already diagnosed. The National Cancer Institute (NCI) – one of the 27 institutes and centers that comprise the National Institutes of Health (NIH) – is the foundation of the nation's cancer research efforts. As a federal agency, NCI-funded research has played a role in every major advance in the fight against cancer over the past 70 years. That's why it is so important that the NCI continues to receive the government investment that it needs to support lifesaving research projects. Funding for pancreatic cancer research at NCI has increased from $73 million in 2007 to $100 million in 2011. Billions of dollars exist in the federal budget for medical research purposes, and ACS CAN is leading the effort to lobby our government for the crucial funds necessary for the clinical research that could lead to the prevention, early detection, and effective treatment of pancreatic cancer.

Resources outside the American Cancer Society

- **National Cancer Institute:** cancer.gov/cancertopics/types/pancreatic/
- **Pancreatic Cancer Action Network:** pancan.org/
- **The Lustgarten Foundation:** lustgarten.org/
- **Hirshberg Foundation for Pancreatic Cancer Research:** pancreatic.org/
- **National Pancreas Foundation:** pancreasfoundation.org/
- **Pancreatica Initiative:** pancreatica.org/

References

1. Silverman DT, Hoover RN, Brown LM, et al. Why do Black Americans have a higher risk of pancreatic cancer than White Americans? *Epidemiology* 2003;14(1): 45-54.

2. Jemal A, Simard EP, Xu J, Ma J, Anderson RN. Selected cancers with increasing mortality rates by educational attainment in 26 states in the United States, 1993-2007. *Cancer Causes Control* 2012.

3. Jemal A, Simard EP, Dorell C, et al. Annual Report to the Nation on the Status of Cancer, 1975-2009, Featuring the Burden and Trends in HPV-Associated Cancers and HPV Vaccination Coverage Levels. *JNCI* (in press).

4. Iodice S, Gandini S, Maisonneuve P, Lowenfels AB. Tobacco and the risk of pancreatic cancer: a review and meta-analysis. *Langenbecks Arch Surg* 2008;393(4): 535-45.

5. Anderson K, Potter JD, Mack TM. Pancreatic cancer. In: Schottenfeld D, Fraumeni JF, editors. *Cancer Epidemiology and Prevention.* New York: Oxford University Press, 2006:721-62.

6. Lynch SM, Vrieling A, Lubin JH, et al. Cigarette smoking and pancreatic cancer: a pooled analysis from the pancreatic cancer cohort consortium. *Am J Epidemiol* 2009;170(4): 403-13.

7. Bosetti C, Lucenteforte E, Silverman DT, et al. Cigarette smoking and pancreatic cancer: an analysis from the International Pancreatic Cancer Case-Control Consortium (Panc4). *Ann Oncol* 2012;23(7):1880-8.

8. Henley SJ, Thun MJ, Chao A, Calle EE. Association between exclusive pipe smoking and mortality from cancer and other diseases. *J Natl Cancer Inst* 2004;96(11): 853-61.

9. Bertuccio P, La Vecchia C, Silverman DT, et al. Cigar and pipe smoking, smokeless tobacco use and pancreatic cancer: an analysis from the International Pancreatic Cancer Case-Control Consortium (PanC4). *Ann Oncol* 2011;22(6): 1420-6.

10. Vrieling A, Bueno-de-Mesquita HB, Boshuizen HC, et al. Cigarette smoking, environmental tobacco smoke exposure and pancreatic cancer risk in the European Prospective Investigation into Cancer and Nutrition. *Int J Cancer* 2010;126(10): 2394-403.

11. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. *Smokeless Tobacco and some Tobacco-specific N-Nitrosamines.* Lyon, France: IARC, 2007.

12. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. *A review of human carcinogens. Part E: Personal habits and indoor combustions.* Lyon, France: IARC, 2009.

13. Berrington de Gonzalez A, Sweetland S, Spencer E. A meta-analysis of obesity and the risk of pancreatic cancer. *Br J Cancer* 2003;89(3): 519-23.

14. Michaud DS, Giovannucci E, Willett WC, Colditz GA, Stampfer MJ, Fuchs CS. Physical activity, obesity, height, and the risk of pancreatic cancer. *JAMA* 2001;286(8): 921-9.

15. Arslan AA, Helzlsouer KJ, Kooperberg C, et al. Anthropometric measures, body mass index, and pancreatic cancer: a pooled analysis from the Pancreatic Cancer Cohort Consortium (PanScan). *Arch Intern Med* 2010;170(9): 791-802.

16. Li D, Morris JS, Liu J, et al. Body mass index and risk, age of onset, and survival in patients with pancreatic cancer. *JAMA* 2009;301(24): 2553-62.

17. Larsson SC, Permert J, Hakansson N, Naslund I, Bergkvist L, Wolk A. Overall obesity, abdominal adiposity, diabetes and cigarette smoking in relation to the risk of pancreatic cancer in two Swedish population-based cohorts. *Br J Cancer* 2005;93(11): 1310-5.

18. Heinen MM, Verhage BA, Goldbohm RA, Lumey LH, van den Brandt PA. Physical activity, energy restriction, and the risk of pancreatic cancer: a prospective study in the Netherlands. *Am J Clin Nutr* 2011;94(5): 1314-23.

19. Nothlings U, Wilkens LR, Murphy SP, Hankin JH, Henderson BE, Kolonel LN. Body mass index and physical activity as risk factors for pancreatic cancer: the Multiethnic Cohort Study. *Cancer Causes Control* 2007;18(2): 165-75.

20. Patel AV, Rodriguez C, Bernstein L, Chao A, Thun MJ, Calle EE. Obesity, recreational physical activity, and risk of pancreatic cancer in a large U.S. Cohort. *Cancer Epidemiol Biomarkers Prev* 2005;14(2): 459-66.

21. Hanley AJ, Johnson KC, Villeneuve PJ, Mao Y. Physical activity, anthropometric factors and risk of pancreatic cancer: results from the Canadian enhanced cancer surveillance system. *Int J Cancer* 2001;94(1): 140-7.

22. O'Rorke MA, Cantwell MM, Cardwell CR, Mulholland HG, Murray LJ. Can physical activity modulate pancreatic cancer risk? a systematic review and meta-analysis. *Int J Cancer* 2010;126(12): 2957-68.

23. Bao Y, Michaud DS. Physical activity and pancreatic cancer risk: a systematic review. *Cancer Epidemiol Biomarkers Prev* 2008;17(10): 2671-82.

24. Genkinger JM, Spiegelman D, Anderson KE, et al. Alcohol intake and pancreatic cancer risk: a pooled analysis of fourteen cohort studies. *Cancer Epidemiol Biomarkers Prev* 2009;18(3): 765-76.

25. Tramacere I, Scotti L, Jenab M, et al. Alcohol drinking and pancreatic cancer risk: a meta-analysis of the dose-risk relation. *Int J Cancer* 2010;126(6): 1474-86.

26. Larsson SC, Wolk A. Red and processed meat consumption and risk of pancreatic cancer: meta-analysis of prospective studies. *Br J Cancer* 2012;106(3): 603-7.

27. Anderson KE, Mongin SJ, Sinha R, et al. Pancreatic cancer risk: associations with meat-derived carcinogen intake in the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial (PLCO) cohort. *Mol Carcinog* 2012;51(1):128-37.

28. Larsson SC, Giovannucci E, Wolk A. Folate intake, MTHFR polymorphisms, and risk of esophageal, gastric, and pancreatic cancer: a meta-analysis. *Gastroenterology* 2006;131(4): 1271-83.

29. Bao Y, Michaud DS, Spiegelman D, et al. Folate intake and risk of pancreatic cancer: pooled analysis of prospective cohort studies. *J Natl Cancer Inst* 2011;103(24): 1840-50.

30. Jansen RJ, Robinson DP, Stolzenberg-Solomon RZ, et al. Fruit and vegetable consumption is inversely associated with having pancreatic cancer. *Cancer Causes Control* 2011;22(12): 1613-25.

31. Vrieling A, Verhage BA, van Duijnhoven FJ, et al. Fruit and vegetable consumption and pancreatic cancer risk in the European Prospective Investigation into Cancer and Nutrition. *Int J Cancer* 2009;124(8): 1926-34.

32. Larsson SC, Hakansson N, Naslund I, Bergkvist L, Wolk A. Fruit and vegetable consumption in relation to pancreatic cancer risk: a prospective study. *Cancer Epidemiol Biomarkers Prev* 2006;15(2): 301-5.

33. Chan JM, Wang F, Holly EA. Vegetable and fruit intake and pancreatic cancer in a population-based case-control study in the San Francisco bay area. *Cancer Epidemiol Biomarkers Prev* 2005;14(9): 2093-7.

34. Turati F, Galeone C, Edefonti V, et al. A meta-analysis of coffee consumption and pancreatic cancer. *Ann Oncol* 2012;23(2): 311-8.

35. Grant WB. An ecologic study of cancer mortality rates in Spain with respect to indices of solar UVB irradiance and smoking. *Int J Cancer* 2007;120(5): 1123-8.

36. Mohr SB, Garland CF, Gorham ED, Grant WB, Garland FC. Ultraviolet B irradiance and vitamin D status are inversely associated with incidence rates of pancreatic cancer worldwide. *Pancreas* 2010;39(5): 669-74.

37. Boscoe FP, Schymura MJ. Solar ultraviolet-B exposure and cancer incidence and mortality in the United States, 1993-2002. *BMC Cancer* 2006;6: 264.

38. Bao Y, Ng K, Wolpin BM, Michaud DS, Giovannucci E, Fuchs CS. Predicted vitamin D status and pancreatic cancer risk in two prospective cohort studies. *Br J Cancer* 2010;102(9): 1422-7.

39. Giovannucci E. Vitamin D and cancer incidence in the Harvard cohorts. *Ann Epidemiol* 2009;19(2): 84-8.

40. Stolzenberg-Solomon RZ, Jacobs EJ, Arslan AA, et al. Circulating 25-hydroxyvitamin D and risk of pancreatic cancer: Cohort Consortium Vitamin D Pooling Project of Rarer Cancers. *Am J Epidemiol* 2010;172(1): 81-93.

41. Permuth-Wey J, Egan KM. Family history is a significant risk factor for pancreatic cancer: results from a systematic review and meta-analysis. *Fam Cancer* 2009;8(2): 109-17.

42. Klein AP, Brune KA, Petersen GM, et al. Prospective risk of pancreatic cancer in familial pancreatic cancer kindreds. *Cancer Res* 2004;64(7): 2634-8.

43. Brune KA, Lau B, Palmisano E, et al. Importance of age of onset in pancreatic cancer kindreds. *J Natl Cancer Inst* 2010;102(2): 119-26.

44. Petersen GM, de Andrade M, Goggins M, et al. Pancreatic cancer genetic epidemiology consortium. *Cancer Epidemiol Biomarkers Prev* 2006;15(4): 704-10.

45. Shi C, Hruban RH, Klein AP. Familial pancreatic cancer. *Arch Pathol Lab Med* 2009;133(3): 365-74.

46. Vincent A, Herman J, Schulick R, Hruban RH, Goggins M. Pancreatic cancer. *Lancet* 2011;378(9791): 607-20.

47. Landi S. Genetic predisposition and environmental risk factors to pancreatic cancer: A review of the literature. *Mutat Res* 2009;681(2-3): 299-307.

48. Couch FJ, Johnson MR, Rabe KG, et al. The prevalence of BRCA2 mutations in familial pancreatic cancer. *Cancer Epidemiol Biomarkers Prev* 2007;16(2): 342-6.

49. Hahn SA, Greenhalf B, Ellis I, et al. BRCA2 germline mutations in familial pancreatic carcinoma. *J Natl Cancer Inst* 2003;95(3): 214-21.

50. Murphy KM, Brune KA, Griffin C, et al. Evaluation of candidate genes MAP2K4, MADH4, ACVR1B, and BRCA2 in familial pancreatic cancer: deleterious BRCA2 mutations in 17%. *Cancer Res* 2002;62(13): 3789-93.

51. Lynch HT, Fusaro RM, Lynch JF, Brand R. Pancreatic cancer and the FAMMM syndrome. *Fam Cancer* 2008;7(1): 103-12.

52. Giardiello FM, Brensinger JD, Tersmette AC, et al. Very high risk of cancer in familial Peutz-Jeghers syndrome. *Gastroenterology* 2000;119(6): 1447-53.

53. van Lier MG, Wagner A, Mathus-Vliegen EM, Kuipers EJ, Steyerberg EW, van Leerdam ME. High cancer risk in Peutz-Jeghers syndrome: a systematic review and surveillance recommendations. *Am J Gastroenterol* 2010;105(6): 1258-64; author reply 65.

54. Raimondi S, Lowenfels AB, Morselli-Labate AM, Maisonneuve P, Pezzilli R. Pancreatic cancer in chronic pancreatitis; aetiology, incidence, and early detection. *Best Pract Res Clin Gastroenterol* 2010;24(3): 349-58.

55. Kastrinos F, Mukherjee B, Tayob N, et al. Risk of pancreatic cancer in families with Lynch syndrome. *JAMA* 2009;302(16): 1790-5.

56. Amundadottir L, Kraft P, Stolzenberg-Solomon RZ, et al. Genome-wide association study identifies variants in the ABO locus associated with susceptibility to pancreatic cancer. *Nat Genet* 2009;41(9): 986-90.

57. Wolpin BM, Chan AT, Hartge P, et al. ABO blood group and the risk of pancreatic cancer. *J Natl Cancer Inst* 2009;101(6): 424-31.

58. Wolpin BM, Kraft P, Gross M, et al. Pancreatic cancer risk and ABO blood group alleles: results from the pancreatic cancer cohort consortium. *Cancer Res* 2010;70(3): 1015-23.

59. Lowenfels AB, Maisonneuve P, Cavallini G, et al. Pancreatitis and the risk of pancreatic cancer. International Pancreatitis Study Group. *N Engl J Med* 1993;328(20): 1433-7.

60. Malka D, Hammel P, Maire F, et al. Risk of pancreatic adenocarcinoma in chronic pancreatitis. *Gut* 2002;51(6): 849-52.

61. Pannala R, Leirness JB, Bamlet WR, Basu A, Petersen GM, Chari ST. Prevalence and clinical profile of pancreatic cancer-associated diabetes mellitus. *Gastroenterology* 2008;134(4): 981-7.

62. Chari ST, Leibson CL, Rabe KG, et al. Pancreatic cancer-associated diabetes mellitus: prevalence and temporal association with diagnosis of cancer. *Gastroenterology* 2008;134(1): 95-101.

63. Huxley R, Ansary-Moghaddam A, Berrington de Gonzalez A, Barzi F, Woodward M. Type-II diabetes and pancreatic cancer: a meta-analysis of 36 studies. *Br J Cancer* 2005;92(11): 2076-83.

64. Stevens RJ, Roddam AW, Beral V. Pancreatic cancer in type 1 and young-onset diabetes: systematic review and meta-analysis. *Br J Cancer* 2007;96(3): 507-9.

65. Gapstur SM, Gann PH, Lowe W, Liu K, Colangelo L, Dyer A. Abnormal glucose metabolism and pancreatic cancer mortality. *JAMA* 2000;283(19): 2552-8.

66. Jee SH, Ohrr H, Sull JW, Yun JE, Ji M, Samet JM. Fasting serum glucose level and cancer risk in Korean men and women. *JAMA* 2005;293(2): 194-202.

67. Stolzenberg-Solomon RZ, Graubard BI, Chari S, et al. Insulin, glucose, insulin resistance, and pancreatic cancer in male smokers. *JAMA* 2005;294(22): 2872-8.

68. Stattin P, Bjor O, Ferrari P, et al. Prospective study of hyperglycemia and cancer risk. *Diabetes Care* 2007;30(3): 561-7.

69. Stocks T, Rapp K, Bjorge T, et al. Blood glucose and risk of incident and fatal cancer in the metabolic syndrome and cancer project (me-can): analysis of six prospective cohorts. *PLoS Med* 2009;6(12): e1000201.

70. El-Serag HB, Engels EA, Landgren O, et al. Risk of hepatobiliary and pancreatic cancers after hepatitis C virus infection: A population-based study of U.S. veterans. *Hepatology* 2009;49(1): 116-23.

71. Hassan MM, Li D, El-Deeb AS, et al. Association between hepatitis B virus and pancreatic cancer. *J Clin Oncol* 2008;26(28): 4557-62.

72. Risch HA, Yu H, Lu L, Kidd MS. ABO blood group, Helicobacter pylori seropositivity, and risk of pancreatic cancer: a case-control study. *J Natl Cancer Inst* 2010;102(7): 502-5.

73. Lin G, Zeng Z, Wang X, et al. Cholecystectomy and risk of pancreatic cancer: a meta-analysis of observational studies. *Cancer Causes Control* 2012;23(1): 59-67.

74. Gong Y, Zhou Q, Zhou Y, et al. Gastrectomy and risk of pancreatic cancer: systematic review and meta-analysis of observational studies. *Cancer Causes Control* 2012;23(8): 1279-88.

75. Maisonneuve P, Marshall BC, Lowenfels AB. Risk of pancreatic cancer in patients with cystic fibrosis. *Gut* 2007;56(9): 1327-8.

76. Fitzpatrick SG, Katz J. The association between periodontal disease and cancer: a review of the literature. *J Dent* 2010;38(2): 83-95.

77. Greenhalf W, Grocock C, Harcus M, Neoptolemos J. Screening of high-risk families for pancreatic cancer. *Pancreatology* 2009;9(3): 215-22.

78. Shin EJ, Canto MI. Pancreatic cancer screening. *Gastroenterol Clin North Am* 2012;41(1): 143-57.

79. Canto MI, Goggins M, Yeo CJ, et al. Screening for pancreatic neoplasia in high-risk individuals: an EUS-based approach. *Clin Gastroenterol Hepatol* 2004;2(7): 606-21.

80. Canto MI, Goggins M, Hruban RH, et al. Screening for early pancreatic neoplasia in high-risk individuals: a prospective controlled study. *Clin Gastroenterol Hepatol* 2006;4(6): 766-81; quiz 665.

81. Gemmel C, Eickhoff A, Helmstadter L, Riemann JF. Pancreatic cancer screening: state of the art. *Expert Rev Gastroenterol Hepatol* 2009;3(1): 89-96.

82. Hidalgo M. Pancreatic cancer. *N Engl J Med* 2010;362(17): 1605-17.

83. Dumonceau JM, Vonlaufen A. Pancreatic endoscopic retrograde cholangiopancreatography (ERCP). *Endoscopy* 2007;39(2): 124-30.

84. Bilimoria KY, Bentrem DJ, Ko CY, et al. Validation of the 6th edition AJCC Pancreatic Cancer Staging System: report from the National Cancer Database. *Cancer* 2007;110(4): 738-44.

85. Berger AC, Garcia M, Jr., Hoffman JP, et al. Postresection CA 19-9 predicts overall survival in patients with pancreatic cancer treated with adjuvant chemoradiation: a prospective validation by RTOG 9704. *J Clin Oncol* 2008;26(36): 5918-22.

86. Ferrone CR, Finkelstein DM, Thayer SP, Muzikansky A, Fernandez-delCastillo C, Warshaw AL. Perioperative CA19-9 levels can predict stage and survival in patients with resectable pancreatic adenocarcinoma. *J Clin Oncol* 2006;24(18): 2897-902.

87. Hernandez JM, Cowgill SM, Al-Saadi S, et al. CA 19-9 velocity predicts disease-free survival and overall survival after pancreatectomy of curative intent. *J Gastrointest Surg* 2009;13(2): 349-53.

88. Slidell MB, Chang DC, Cameron JL, et al. Impact of total lymph node count and lymph node ratio on staging and survival after pancreatectomy for pancreatic adenocarcinoma: a large, population-based analysis. *Ann Surg Oncol* 2008;15(1): 165-74.

89. Maithel SK, Maloney S, Winston C, et al. Preoperative CA 19-9 and the yield of staging laparoscopy in patients with radiographically resectable pancreatic adenocarcinoma. *Ann Surg Oncol* 2008;15(12): 3512-20.

90. Blackford A, Serrano OK, Wolfgang CL, et al. SMAD4 gene mutations are associated with poor prognosis in pancreatic cancer. *Clin Cancer Res* 2009;15(14): 4674-9.

91. Infante JR, Matsubayashi H, Sato N, et al. Peritumoral fibroblast SPARC expression and patient outcome with resectable pancreatic adenocarcinoma. *J Clin Oncol* 2007;25(3): 319-25.

92. Shaib Y, Davila J, Naumann C, El-Serag H. The impact of curative intent surgery on the survival of pancreatic cancer patients: a U.S. Population-based study. *Am J Gastroenterol* 2007;102(7): 1377-82.

93. O'Reilly EM. Refinement of adjuvant therapy for pancreatic cancer. *JAMA* 2010;304(10): 1124-5.

94. Neoptolemos JP. Adjuvant treatment of pancreatic cancer. *Eur J Cancer* 2011;47 Suppl 3: S378-80.

95. Abrams RA. Radiotherapy in the adjuvant management of pancreatic adenocarcinoma: is it helpful? Expert *Rev Gastroenterol Hepatol* 2012;6(2): 149-61.

96. Evans DB, Varadhachary GR, Crane CH, et al. Preoperative gemcitabine-based chemoradiation for patients with resectable adenocarcinoma of the pancreatic head. *J Clin Oncol* 2008;26(21): 3496-502.

97. Gillen S, Schuster T, Meyer Zum Buschenfelde C, Friess H, Kleeff J. Preoperative/neoadjuvant therapy in pancreatic cancer: a systematic review and meta-analysis of response and resection percentages. *PLoS Med* 2010;7(4): e1000267.

98. Katz MH, Pisters PW, Evans DB, et al. Borderline resectable pancreatic cancer: the importance of this emerging stage of disease. *J Am Coll Surg* 2008;206(5): 833-46; discussion 46-8.

99. Callery MP, Chang KJ, Fishman EK, Talamonti MS, William Traverso L, Linehan DC. Pretreatment assessment of resectable and borderline resectable pancreatic cancer: expert consensus statement. *Ann Surg Oncol* 2009;16(7): 1727-33.

Tobacco Use

Smoking-related diseases remain the world's most preventable cause of death. Since the first US Surgeon General's report on smoking and health in 1964, there have been more than 15 million premature deaths attributable to smoking in the US.[1,2] The World Health Organization estimates that there are 6 million smoking-related premature deaths worldwide each year.[3]

Health Consequences of Smoking

Half of all those who continue to smoke will die from smoking-related diseases.[4] In the US, tobacco use is responsible for nearly 1 in 5 deaths; this equaled an estimated 443,000 premature deaths each year between 2000 and 2004.[5,6] In addition, an estimated 8.6 million people suffer from chronic conditions related to smoking, such as chronic bronchitis, emphysema, and cardiovascular diseases.[7]

- Smoking accounts for at least 30% of all cancer deaths and 87% of lung cancer deaths.[1,8]
- The risk of developing lung cancer is about 23 times higher in male smokers and 13 times higher in female smokers, compared to lifelong nonsmokers.[1]
- Smoking increases the risk of the following types of cancer: nasopharynx, nasal cavity and paranasal sinuses, lip, oral cavity, pharynx, larynx, lung, esophagus, pancreas, uterine cervix, ovary (mucinous), kidney, bladder, stomach, colorectum, and acute myeloid leukemia.[1,9]
- The International Agency for Research on Cancer (IARC) recently concluded that there is limited evidence that tobacco smoking causes female breast cancer.[9]
- Smoking is a major cause of heart disease, cerebrovascular disease, chronic bronchitis, and emphysema, and is associated with gastric ulcers.[1,10]
- The risk of lung cancer is just as high in smokers of "light" or "low-tar" yield cigarettes as in those who smoke "regular" or "full-flavored" products.[11]

Reducing Tobacco Use and Exposure

The US Surgeon General in 2000 outlined the goals and components of comprehensive statewide tobacco control programs.[12] These programs seek to prevent the initiation of tobacco use among youth; promote quitting at all ages; eliminate nonsmokers' exposure to secondhand smoke; and identify and eliminate the disparities related to tobacco use and its effects among different population groups.[13]

The Centers for Disease Control and Prevention (CDC) recommends funding levels for comprehensive tobacco use prevention and cessation programs for all 50 states and the District of Columbia. In fiscal year 2012, 6 states allocated 50% or more of CDC-recommended funding levels for tobacco control programs.[14] States that have invested in comprehensive tobacco control programs, such as California, Massachusetts, and Florida, have reduced smoking rates and saved millions of dollars in tobacco-related health care costs.[12,15] Recent federal initiatives in tobacco control, including national legislation ensuring coverage of clinical cessation services, regulation of tobacco products, tax increases, and increased tobacco control funding hold promise for reducing tobacco use. Provisions in the Affordable Care Act signed into law on March 23, 2010, ensure at least minimum coverage of evidence-based cessation treatments, including pharmacotherapy and cessation counseling to previously uninsured tobacco users, pregnant Medicaid recipients, and eligible Medicare recipients. The Centers for Medicare and Medicaid subsequently issued a decision memo changing the eligibility requirement for Medicare recipients, so that they no longer have to be diagnosed with a smoking-related disease in order to access cessation treatments. Starting in 2014, state Medicaid programs can no longer exempt cessation pharmacotherapy from prescription drug coverage. Several provisions of the Family Smoking Prevention and Tobacco Control Act, which for the first time grants the US Food and Drug Administration the authority to regulate the manufacturing, selling, and marketing of tobacco products, have already gone into effect. For more information about tobacco control, see *Cancer Prevention & Early Detection Facts & Figures*, available online at cancer.org/statistics.

Trends in Smoking

- Between 1965 and 2004, cigarette smoking among adults 18 years of age and older declined by half from 42% to 21%.[16] Between 2005 and 2011, there was a modest, but statistically significant, decline in smoking prevalence from 21% to 19%.[17,18] However, declines were not consistent from year-to-year and were not observed in all population subgroups.
- In 2011, approximately 43.8 million adults were current smokers, about 2 million fewer than in 2005.
- The proportion of daily smokers reporting light or intermittent smoking (less than 10 cigarettes/day) increased significantly between 2005 (16%) and 2011 (22%), whereas heavy smoking declined from 13% to 9%.[17,18]
- Although cigarette smoking became prevalent among men before women, the gender gap narrowed in the mid-1980s and has since remained constant.[19] As of 2011, there was a 4% absolute difference in smoking prevalence between white men (23%) and women (19%), an 8% difference between African American men (24%) and women (16%), an 8% difference between Hispanic men (17%) and women (9%) and a 9% difference between Asian men (15%) and women (6%).[18]
- Smoking is most common among the least educated. While the percentage of smokers has decreased at every level of educational attainment since 1983, college graduates had the greatest decline, from 21% to 9%, in 2011.[18,20] By contrast, among those with a high school diploma, prevalence decreased modestly from 34% to 24% during the same time period. Adults with a GED certificate (high school equivalency diploma) had the highest smoking rate (45%) in 2011.[18] Groups with a high school degree or less quit smoking at lower rates than higher educated groups between 1998 and 2008.[21]
- The decrease in smoking prevalence among high school students between the late 1970s and early 1990s was more rapid among African Americans than whites; consequently, lung cancer rates among adults younger than 40 years of age, which historically were substantially higher in African Americans, have converged in these two groups.[22]
- Although cigarette smoking among US high school students increased significantly from 28% in 1991 to 36% in 1997, the rate declined to 21% (male: 22%, female: 22%) by 2003.[23,24] Between 2003 and 2011, there has been no significant change in the smoking rate among high school males (20%) and females (16%).[25]

Smokeless Tobacco Products

Smokeless tobacco products include moist snuff, chewing tobacco, snus (a "spitless," moist powder tobacco pouch), dissolvable nicotine products (Orbs, Strips and Sticks), and a variety of other tobacco-containing products that are not smoked. Recently, the smokeless market in high-income countries, including the US, has been consolidated from smaller tobacco companies into the control of the tobacco multinationals.[26] In the US, the sales of smokeless tobacco products are growing at a more rapid pace than cigarettes. As part of their marketing strategy, the industry is actively promoting these products both for use in settings where smoking is prohibited and as a way to quit smoking; however, there is no evidence to date that these products are as effective as proven cessation therapies. When smokeless tobacco was aggressively marketed in the US in the 1970s and 1980s, use of these products increased among adolescent males, but not among older smokers trying to quit.[27,28] Use of any smokeless tobacco product is not considered a safe substitute for quitting. These products cause oral, esophageal, and pancreatic cancers, precancerous lesions of the mouth, gum recession, bone loss around the teeth, and tooth staining; they can also lead to nicotine addiction.[29,30]

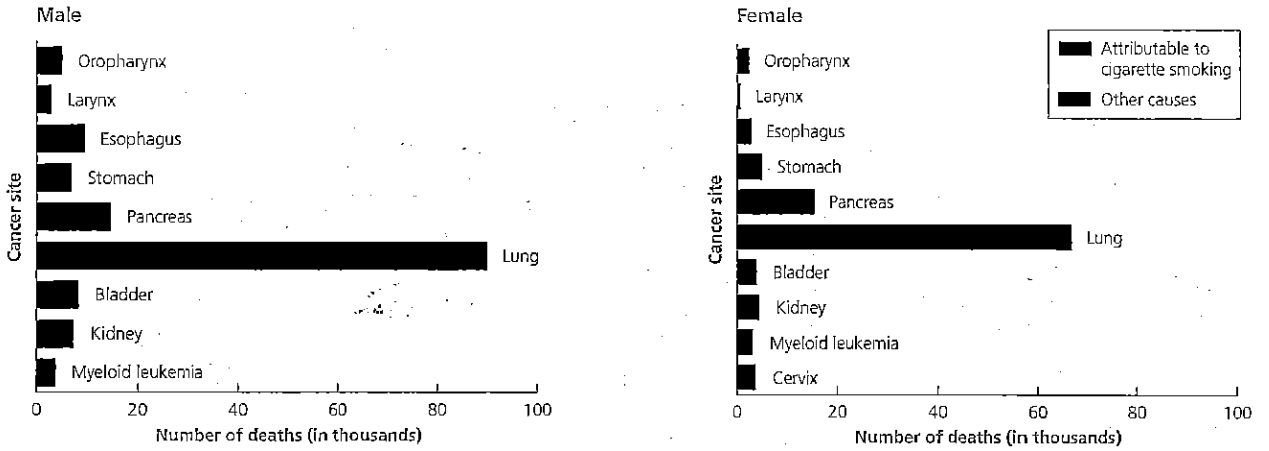
- Smokers who use smokeless products as a supplemental source of nicotine to postpone or avoid quitting will increase rather than decrease their risk of lung cancer.[31]
- Long-term use of snuff substantially increases the risk of cancers of the oral cavity, particularly cancers of the cheek and gum.[30]
- According to the US Department of Agriculture, manufactured output of moist snuff has increased more than 80% in less than two decades, from 48 million pounds in 1991 to an estimated 88 million pounds in 2007.[32,33]
- According to the 2010 National Health Interview Survey, 3% of adults 18 years of age and older (5% of men and 0.2% of women) were current users of smokeless products.[34]
- According to the 2010 National Survey on Drug Use and Health (NSDUH), whites were more likely to use smokeless tobacco than African Americans, Hispanics/Latinos, or Asians.[35]
- Adult smokeless tobacco use (including snus use) varied from 1% to 10% across states in 2011, with higher rates observed in the South and North-Central states.[36]
- Among high school students nationwide, the prevalence of current smokeless tobacco use (chewing tobacco, snuff, or dip) decreased from 1995 to 2003 (from 11% to 7%), but remained stable from 2003 to 2011 (7% to 8%). Current (2011) use was higher in males (13%) than females (2%) and higher in whites (9%) than African Americans (3%) and Hispanics (6%).[25]

Cigars

Cigar smoking has health consequences similar to those of cigarette smoking and smokeless tobacco.[37]

- Regular cigar smoking is associated with an increased risk of cancers of the lung, oral cavity, larynx, esophagus, and probably pancreas. Cigar smokers have 4 to 10 times the risk of dying from laryngeal, oral, or esophageal cancer compared to nonsmokers.[37]

Annual Number of Cancer Deaths Attributable to Smoking by Sex and Site, US, 2000-2004



Source: Centers for Disease Control and Prevention. Smoking-attributable mortality, years of potential life lost, and productivity losses – United States, 2000-2004. *MMWR Morb Mortal Wkly Rep.* 2008;57(45):1226-1228.

American Cancer Society, Surveillance Research, 2013

- In 2010, 3% of adults 18 years of age and older (5% of men and 0.5% of women) were current users of cigars (smoked at least 50 cigars in their lifetime and now smoked some days or every day).[34]
- According to the 2010 NSDUH, African Americans and American Indians/Alaska Natives had the highest prevalence of past month cigar use, followed by, whites, Hispanics, and Asians.[35]
- Among states, cigar smoking prevalence among adults ranges from 2% to 5%.[38]
- In 2011, 13% of US high school students had smoked cigars, cigarillos, or little cigars at least once in the past 30 days.[25]
- Between 1997 and 2007, while sales of little cigars had increased by 240%, large cigar sales decreased by 6%.[39] Small cigars are similar in shape and size to cigarettes, but are not regulated or taxed like cigarettes, making them more affordable to youth.

Smoking Cessation

A US Surgeon General's Report outlined the benefits of smoking cessation:[40]

- People who quit, regardless of age, live longer and are healthier than people who continue to smoke.
- Smokers who quit before age 50 cut their risk of dying in the next 15 years in half.
- Quitting smoking substantially decreases the risk of lung, laryngeal, esophageal, oral, pancreatic, bladder, and cervical cancers.
- Quitting lowers the risk for other major diseases, including heart disease, chronic lung disease, and stroke.

While the majority of ever-smokers in the US have quit smoking, rates of adult smoking cessation remained stable between 1998 and 2008.[41]

- In 2011, an estimated 49.5 million adults were former smokers, representing 53% of living persons who ever smoked.[34]
- Smokers with an undergraduate or graduate degree are more likely to quit than less educated smokers.[41] Among those who smoked in 2010, an estimated 20.6 million (or 47%) had stopped smoking at least one day during the preceding 12 months because they were trying to quit.[34]
- In 47 states and the District of Columbia, the majority of adults (50% or more) who ever smoked have quit smoking.[42]
- In 2011, among high school students who were current cigarette smokers, national data showed that one-half (50%) had tried to quit smoking cigarettes during the 12 months preceding the survey; female students (54%) were more likely to have made a quit attempt than male students (47%).[25]

Tobacco dependence is a chronic disease; effective cessation treatments can double or triple smokers' chances of long-term abstinence.[43] Certain racial and ethnic groups (Hispanics and non-Hispanic African Americans) and those with low socioeconomic status are significantly less likely to receive cessation services.[39] Improving access by promoting available coverage for these treatments through government health programs, including Medicaid and Medicare, and private health insurance mandates can help reduce these disparities.

Secondhand Smoke

In 2006, the US Surgeon General published a comprehensive report titled *The Health Consequences of Involuntary Exposure to Tobacco Smoke.*[44] This report determined that secondhand smoke (SHS), or environmental tobacco smoke, contains numerous human carcinogens for which there is no safe level of exposure. It is estimated that more than 88 million nonsmoking Americans 3 years of age and older were exposed to SHS in 2007-2008.[45] Numerous other scientific consensus groups have also reviewed data on the health effects of SHS.[44-50] Public policies to protect people from SHS are based on the following detrimental effects:

- SHS contains more than 7,000 chemicals, at least 69 of which cause cancer.[2]
- Each year, about 3,400 nonsmoking adults die of lung cancer as a result of breathing SHS.[6]
- SHS causes an estimated 46,000 deaths annually from heart disease in people who are not current smokers.[6]
- SHS may cause coughing, wheezing, chest tightness, and reduced lung function in adult nonsmokers.[45]
- Some studies have reported an association between SHS exposure and breast cancer. The US Surgeon General has designated this evidence suggestive rather than conclusive.[45] In any case, women should be aware that there are many health reasons to avoid exposure to tobacco smoke.

Laws that prohibit smoking in public places and create smoke-free environments are an extremely effective approach to prevent exposure to and harm from SHS.[51] In addition, there is strong evidence that smoke-free policies decrease the prevalence of both adult and youth smoking.[52] Momentum to regulate public smoking began to increase in 1990, and smoke-free laws have become increasingly common and comprehensive over time.[53]

- In the past decade, the largest decline in SHS exposure among nonsmokers occurred from 1999-2000 (53%) to 2001-2002 (42%), with estimates since remaining relatively unchanged (2007-2008: 40%).[44]
- In the US, as of July 2012, 3,501 municipalities have passed smoke-free legislation and 36 states, the District of Columbia, the Northern Mariana islands, Puerto Rico, American Samoa and the US Virgin Islands have either implemented or enacted statewide smoking bans that prohibit smoking in workplaces and/or restaurants and/or bars.[54]
- In the US, as of July 2012, there were 774 100% smoke-free college campuses; of these, 562 are 100% tobacco-free (i.e., no forms of tobacco allowed).[55]
- Currently, 48% of the US population is covered by a 100% smoke-free policy in workplaces, restaurants and bars.[54]

Workplace smoking restrictions vary by geographic area; 72% of Southern residents reported working under a smoke-free policy, compared to 81% of workers in the Northeast.[56]

Costs of Tobacco

The number of people who die prematurely or suffer illness from tobacco use impose substantial health-related economic costs on society. It is estimated that in the US, between 2000 and 2004, smoking accounted for 3.1 million years of potential life lost in men and 2.0 million years of potential life lost in women. Smoking, on average, reduces life expectancy by approximately 14 years.[6]

In addition:

- Between 2000 and 2004, smoking resulted in more than $193 billion in average annual health-related costs, including $96 billion in smoking-attributable medical costs and $96.8 billion in productivity losses.[6]
- Annual smoking-attributable health care expenditures were estimated to increase $24 billion annually between 1997-2001 and 2000-2004.[6] Over the same time period, smoking-attributable productivity losses were estimated to increase $4.3 billion annually.[6,57]

Conclusion

Substantial progress has been made in reducing the disease burden from tobacco over the nearly 50 years since the 1964 Surgeon General's Report; smoking prevalence rates have been reduced by more than half and millions of premature deaths have been averted. Nevertheless, more needs to be done to further reduce the health and economic burden of tobacco on our society. Numerous studies confirm that a comprehensive approach to tobacco control, including higher taxes, 100% smoke-free environments, coverage for tobacco dependence treatment, full implementation of the FDA Family Smoking Prevention and Tobacco Control Act, and vigorous tobacco counter-advertising, can be successful in reducing the death, disease, and economic disruption from tobacco use.

References

1. US Department of Health and Human Services. *The Health Consequences of Smoking – A Report of the Surgeon General.* Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2004.

2. US Department of Health and Human Services. *How Tobacco Smoke Causes Disease – The Biology and Behavioral Basis for Smoking-Attributable Disease.* Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2010.

3. World Health Organization. *WHO Report on the Global Tobacco Epidemic, 2011: Warning about the Dangers of Tobacco.* Geneva, Switzerland 2011.

4. Peto R, Lopez A, Boreham J, Thun M, Heath CJ. *Mortality from Smoking in Developed Countries, 1950-2000:* Oxford University Press, New York, NY; 1994.

5. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. *JAMA.* 2004;291(10):1238-1245.

6. Centers for Disease Control and Prevention. Smoking-attributable mortality, years of potential life lost, and productivity losses – United States, 2000-2004. *MMWR Morb Mortal Wkly Rep.* Nov 14 2008;57(45):1226-1228.

7. Centers for Disease Control and Prevention. Cigarette Smoking-Attributable Morbidity – United States, 2000. *MMWR Morb Mortal Wkly Rep.* 2003;52(35):842-844.

8. Doll R, Peto R. *The Causes of Cancer.* New York, NY: Oxford Press; 1981.

9. Secretan B, Straif K, Baan R, et al. A review of human carcinogens – Part E: tobacco, areca nut, alcohol, coal smoke, and salted fish. *Lancet Oncol.* Nov 2009;10(11):1033-1034.

10. US Department of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General.* Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 1989.

11. Harris JE, Thun MJ, Mondul AM, Calle EE. Cigarette tar yields in relation to mortality from lung cancer in the Cancer Prevention Study II prospective cohort, 1982-8. *BMJ.* 2004;328(7431):72-76.

12. US Department of Health and Human Services. *Reducing Tobacco Use: A Report of the Surgeon General.* Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2000.

13. Centers for Disease Control and Prevention. *Best Practices for Comprehensive Tobacco Control Programs.* Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health; 2007.

14. Campaign for Tobacco-Free Kids, et al. *A Broken Promise to Our Children: The 1998 State Tobacco Settlement Thirteen Years Later.* Washington, DC: National Center for Tobacco-Free Kids; 2011.

15. American Cancer Society. Cancer Prevention & Early Detection Facts & Figures, 2008. 2008; http://www.cancer.org/downloads/STT/CPED_2008.pdf. Accessed August 7, 2008.

16. National Center for Health Statistics. *Health, United States, 2011 with Chartbook on Trends in the Health of Americans.* Hyattsville, MD: Public Health Service; 2011.

17. Centers for Disease Control and Prevention. Current Cigarette Smoking Among Adults Aged ≥18 Years – United States, 2005-2010. *MMWR Morb Mortal Wkly Rep.* 2011;60(35):1207-1212.

18. Centers for Disease Control and Prevention. Current Cigarette Smoking Among Adults Aged ≥18 Years – United States, 2011. *MMWR Morb Mortal Wkly Rep.* 2012;61(44):889-894.

19. US Department of Health and Human Services. *Women and Smoking: A Report of the Surgeon General.* Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2001.

20. National Center for Health Statistics. *Health, United States, 2007 with Chartbook on Trends in the Health of Americans.* Hyattsville, MD: Public Health Service; 2008.

21. Centers for Disease Control and Prevention. Quitting Smoking Among Adults – United States, 2001-2010. *MMWR Morb Mortal Wkly Rep.* 2011 60(44):1513-1519.

22. Jemal A, Center MM, Ward E. The convergence of lung cancer rates between blacks and whites under the age of 40, United States. *Cancer Epidemiol Biomarkers Prev.* Dec 2009;18(12):3349-3352.

23. Centers for Disease Control and Prevention. Youth Risk Behavior Surveillance – United States, 2007 *MMWR Morb Mortal Wkly Rep.* 2008;57(SS-4):1-131.

24. Centers for Disease Control and Prevention. Cigarette Use Among High School Students-United States, 1991-2005. *MMWR Morb Mortal Wkly Rep.* July 7 2006;55(26):724-726.

25. Centers for Disease Control and Prevention. Youth risk behavior surveillance – United States, 2011. *MMWR Morb Mortal Wkly Rep.* June 8 2012;61(4):1-168.

26. Eriksen M, Ross H, Mackay J. *The Tobacco Atlas, Fourth Edition:* American Cancer Society & World Lung Foundation; 2012.

27. Connolly GN. The marketing of nicotine addiction by one oral snuff manufacturer. *Tobacco control.* 1995;4:73-79.

28. US Department of Health and Human Services. *Preventing Tobacco Use Among Young People: A Report of the Surgeon General.* Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 1994.

29. Boffetta P, Hecht S, Gray N, Gupta P, Straif K. Smokeless tobacco and cancer. *Lancet Oncol.* 2008;9(7):667-675.

30. US Department of Health and Human Services. *The Health Consequences of Using Smokeless Tobacco: A Report of the Advisory Committee to the Surgeon General.* Atlanta, GA: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute;1986.

31. Henley SJ, Thun MJ, Connell C, Calle EE. Two large prospective studies of mortality among men who use snuff or chewing tobacco (United States). *Cancer Causes Control.* 2005;16(4):347-358.

32. US Department of Agriculture. *Tobacco Situation and Outlook Report. Pub. No. TBS-256.* Washington, DC: US Department of Agriculture, Market and Trade Economics Division, Economics Research Service; April 2004.

33. US Department of Agriculture. *Tobacco Outlook, TBS-263.* Washington, DC: US Department of Agriculture, Market and Trade Economics Division, Economics Research Service;2007.

34. National Center for Health Statistics. *National Health Interview Survey Public Use Data File 2010:* Centers for Disease Control and Prevention; 2011.

35. Substance Abuse and Mental Health Services Administration, Office of Applied Studies, National Survey on Drug Use and Health. Results from the 2010 National Survey on Drug Use and Health. Tobacco and Alchohol Use Tables. 2011; http://oas.samhsa.gov/NSDUH/2k10NSDUH/tabs/LOTSect2pe.htm#TopOfPage. Accessed September 22, 2011.

36. American Cancer Society. *Cancer Prevention & Early Detection Facts & Figures, 2013* (In Press). Atlanta, GA: American Cancer Society; 2013.

37. National Cancer Institute. Disease consequences of cigar smoking. *Smoking and Tobacco Control, Monograph 9: Cigars – Health Effects and Trends.* Vol NIH Publication No. 98-4302,. Washington, DC: National Institutes of Health; 1998:105-160.

38. American Cancer Society. *Cancer Prevention & Early Detection Facts & Figures, 2012.* Atlanta, GA: American Cancer Society; 2012.

39. American Legacy Foundation. Cigars, Cigarillos & Little Cigars Fact Sheet. 2009. Available at: http://www.legacyforhealth.org/PDF/Cigars-Cigarillos-and-Little-Cigars_FactSheet.pdf. Accessed December 21, 2010.

40. US Department of Health and Human Services. *The Health Benefits of Smoking Cessation: A Report of the Surgeon General.* Rockville, MD: U.S. Department of Health and Human Services, Public Health Service,

Centers for Disease Control and Prevention, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 1990.

41. Centers for Disease Control and Prevention. Cigarette Smoking Among Adults and Trends in Smoking Cessation – United States, 2008. *MMWR Morb Mortal Wkly Rep.* 2009;58(44):1227-1232.

42. Centers for Disease Control and Prevention. *Behavioral Risk Factor Surveillance System Survey Data.* Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention;2011.

43. Clinical Practice Guideline Treating Tobacco Use and Dependence 2008 Update Panel L, and Staff. A clinical practice guideline for treating tobacco use and dependence: 2008 update. A U.S. Public Health Service report. *Am J Prev Med.* 2008;35(2):158-176. Review.

44. US Department of Health and Human Services. *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General.* Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2006.

45. Centers for Disease Control and Prevention. Vital Signs: Nonsmokers' Exposure to Secondhand Smoke – United States, 1999-2008. *MMWR Morb Mortal Wkly Rep.* 2010;59(35):1141-1146.

46. IARC Tobacco Smoke and Involuntary Smoking. *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Volume 83.* Lyon: International Agency for Research on Cancer; 2004.

47. US Environmental Protection Agency. *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders.* Washington, DC: U.S. Environmental Protection Agency;1992. EPA/600/6-90/006F.

48. California Environmental Protection Agency. *Health Effects of Exposure to Environmental Tobacco Smoke: Final Report.* Sacramento, CA: California Environmental Protection Agency, Office of Environmental Health Hazard Assesment; 1997.

49. California Environmental Protection Agency, Air Resource Board, Office of Environmental Health Hazard Assessment. Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant, SRP Version. 2005; http://www.arb.ca.gov/toxics/ets/dreport/dreport.htm. Accessed August 8, 2005.

50. National Institute of Environmental Sciences. *11th Report on Carcinogens.* Research Triangle Institute, NC: National Institute of Environmental Sciences, National Toxicology Program; 2005.

51. International Agency for Research on Cancer. *IARC Handbooks of Cancer Prevention. Volume 13: Evaluating the Effectiveness of Smoke-Free Policies.* Lyon, France: IARC Press; 2009.

52. International Agency for Research on Cancer. *IARC Handbooks of Cancer Prevention. Volume 13: Evaluating the Effectiveness of Smoke-free Policies.* Lyon, France: IARC Press; 2009.

53. National Cancer Institute. *State and Local Legislative Action to Reduce Tobacco Use. Smoking and Tobacco Control Monograph No. 11.* Bethesda, Maryland: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute NIH Pub. No. 00-4804; 2000.

54. American Nonsmokers' Rights Foundation. Overview List - How Many Smokefree Laws? 2012; http://www.no-smoke.org/pdf/mediaordlist.pdf. Accessed September 7, 2012.

55. American Nonsmokers' Rights Foundation. U.S. Colleges and Universities with Smokefree and Tobacco-Free Policies. 2012; http://www.no-smoke.org/pdf/smokefreecollegesuniversities.pdf. Accessed September 8, 2012.

56. US Department of Commerce, Census Bureau. National Cancer Institute and Centers for Disease Control and Prevention Co-sponsored Tobacco Use Supplement to the Current Population Survey (2006-07). Home and Work Environments in Which Smoking is Not Allowed - Percentage Estimates. 2008; http://riskfactor.cancer.gov/studies/tus-cps/results/data0607/table2.html. Accessed September 9, 2011.

57. Centers for Disease Control and Prevention. Annual Smoking – Attributable Mortality, Years of Potential Life Lost, and Productivity Losses – United States, 1997-2001. *MMWR Morb Mortal Wkly Rep.* 2005;54(25):625-628.

Cancer Disparities

An overarching objective of the American Cancer Society's 2015 challenge goals is to eliminate disparities in the cancer burden among different segments of the US population, defined in terms of socioeconomic status (income, education, insurance status, etc.), race/ethnicity, residence, sex, and sexual orientation. The causes of health disparities within each of these groups are complex and include interrelated social, economic, cultural, and health system factors. However, disparities predominantly arise from inequities in work, wealth, income, education, housing, and overall standard of living, as well as social barriers to high-quality cancer prevention, early detection, and treatment services.

Socioeconomic Status

Persons with lower socioeconomic status (SES) have disproportionately higher cancer death rates than those with higher SES, regardless of demographic factors such as race/ethnicity. For example, cancer mortality rates among both African American and non-Hispanic white men with 12 or fewer years of education are almost 3 times higher than those of college graduates for all cancers combined, and are 4-5 times higher for lung cancer. Furthermore, progress in reducing cancer death rates has been slower in persons with lower SES. These disparities occur largely because persons with lower SES are at higher risk for cancer and have less favorable outcomes after diagnosis. People with lower SES are more likely to engage in behaviors that increase cancer risk, such as tobacco use, physical inactivity, and poor diet. This is in part because of marketing strategies that target these populations, but also because of environmental or community factors that provide fewer opportunities for physical activity and less access to fresh fruits and vegetables. Lower SES is also associated with financial, structural, and personal barriers to health care, including inadequate health insurance, reduced access to recommended preventive care and treatment services, and lower literacy rates. Individuals with no health insurance

are more likely to be diagnosed with advanced cancer and less likely to receive standard treatment and survive their disease. For more information about the relationship between SES and cancer, see *Cancer Facts & Figures 2011*, Special Section, and *Cancer Facts & Figures 2008*, Special Section, available online at cancer.org.

Racial and Ethnic Minorities

Disparities in the cancer burden among racial and ethnic minorities largely reflect obstacles to receiving health care services related to cancer prevention, early detection, and high-quality treatment, with poverty (low SES) as the overriding factor. According to the US Census Bureau, in 2010, more than 1 in 4 African Americans and Hispanics/Latinos lived below the poverty line, compared to 1 in 10 non-Hispanic whites. Moreover, 1 in 5 African Americans and 1 in 3 Hispanics/Latinos were uninsured, while only 1 in 10 non-Hispanic whites lacked health insurance.

Discrimination is another factor that contributes to racial/ethnic disparities in cancer mortality. Racial and ethnic minorities tend to receive lower-quality health care than whites even when insurance status, age, severity of disease, and health status are comparable. Social inequalities, including communication barriers and provider assumptions, can affect interactions between patient and physician and contribute to miscommunication or delivery of substandard care.

In addition to poverty and social discrimination, cancer occurrence in a population may also be influenced by cultural and/or inherited factors that decrease or increase risk. For example, Hispanic women have a lower risk of breast cancer in part because they tend to begin having children at a younger age, which decreases breast cancer risk. Individuals who maintain a primarily plant-based diet or do not use tobacco because of cultural or religious beliefs have a lower risk of many cancers. Populations that include large numbers of recent immigrants, such as Hispanics and Asians, have higher rates of cancers related to infectious agents (e.g., stomach, liver, uterine cervix), reflecting a higher prevalence of infection in immigrant countries of origin. Genetic factors may also explain some differences in cancer incidence. For example, women from population groups with an increased frequency of mutations in the breast cancer susceptibility genes (*BRCA1* and *BRCA2*), such as women of Ashkenazi Jewish descent, have an increased risk of breast and ovarian cancer. Genetic factors may also play a role in the elevated risk of prostate cancer among African American men and the incidence of more aggressive forms of breast cancer in African American women. However, genetic differences associated with race or ethnicity make a minor contribution to the disparate cancer burden between populations. Following is a brief overview of the cancer burden for each of the four major nonwhite racial/ethnic groups.

African Americans: African Americans are more likely to develop and die from cancer than any other racial or ethnic group. The death rate for cancer among African American males is 33% higher than among white males; for African American females, it is 16% higher than among white females. African American men have higher incidence and mortality rates than whites for each of the cancer sites listed in the table on page 43. For more information on cancer in African Americans, see *Cancer Facts & Figures for African Americans*, available online at cancer.org/statistics.

Hispanics: Hispanics have lower incidence rates for all cancers combined and for most common types of cancer compared to whites, but have higher rates of cancers associated with infection, such as liver, stomach, and uterine cervix. For example, Hispanic women have the highest incidence rate for cervical cancer, and rates of liver cancer are about twice as high in Hispanics as in whites. For more information on cancer in Hispanics, see *Cancer Facts & Figures for Hispanics/Latinos*, available online at cancer.org/statistics.

Asian Americans and Pacific Islanders: Compared to other racial/ethnic groups, Asian Americans and Pacific Islanders have the lowest overall cancer incidence rates, as well as the lowest rates for most common cancer types. However, similar to Hispanics, this population has higher rates for many of the cancers related to infection. As shown in the table on page 43, they have the highest liver cancer incidence and death rates of all racial and ethnic groups in both men and women. Liver cancer incidence and death rates among Asian American and Pacific Islander men and women are about 2.5-fold higher than those among whites and 20% higher than those among Hispanics, who have the second-highest rates. (For more information on cancers related to infection, see *Cancer Facts & Figures 2005*, Special Section, available online at cancer.org.)

American Indians and Alaska Natives: Kidney cancer incidence and mortality rates are higher in American Indian and Alaska Native men and women than in any other racial or ethnic population – three times higher than those among Asian Americans/Pacific Islanders, who have the lowest rates. High prevalence of smoking and obesity likely contribute to this disparity.

Cancer information for American Indians and Alaska Natives is known to be incomplete because the racial/ethnic status of many of these individuals is not correctly identified in medical and death records. Although efforts have been made to collect more accurate information through linkage with the Indian Health Service records, available statistics probably do not represent the true cancer burden in this population.

Note: It is important to recognize that although cancer data in the US are primarily reported for broad racial and ethnic minority groups, these populations are not homogenous. There are significant variations in the cancer burden within each racial/

ethnic group. For example, among Asian Americans, incidence rates for cervical cancer are almost three times higher in Vietnamese women than in Chinese and Japanese women, partly because the Vietnamese, in general, immigrated more recently, are poorer, and have less access to cervical cancer screening.

Geographic Variability

Cancer rates in the US vary by geographic area, with larger differences for some cancer sites than others. Lung cancer, for example, shows the most striking variation by state (figure, page 44). Among both men and women, lung cancer death rates are more than 3-fold higher in Kentucky (100 and 56 per 100,000 in men and women, respectively) – the state with the highest rates – than in Utah (28 and 16 per 100,000 in men and women, respectively), which has the lowest rates. These differences reflect the substantial historic and continuing variation in smoking prevalence among states, which is influenced to some extent by state tobacco control policies. Geographic variations also reflect differences in environmental exposures, socioeconomic factors in population demographics, and screening behaviors. For more information about cancer disparities, see *Cancer Facts & Figures 2011*, Special Section, available online at cancer.org.

Public Policy

The American Cancer Society and the American Cancer Society Cancer Action Network℠ (ACS CAN), the Society's nonprofit, nonpartisan advocacy affiliate, are dedicated to reducing cancer incidence and mortality rates among minority and medically underserved populations. This goal can be achieved by instituting effective policies and public health programs that promote overall wellness and help save lives. Listed below are some of the efforts at both the state and federal levels that the Society and ACS CAN have been involved with in the past few years:

- **Patient Protection and Affordable Care Act.** The Society and ACS CAN are working to ensure that key provisions of the Affordable Care Act (ACA) that benefit cancer patients and survivors are implemented as strongly as possible and are adequately funded. Some of the law's provisions that will directly help address disparities include:
  - Improving the affordability of coverage by increasing insurance subsidies and eliminating arbitrary annual and lifetime caps on coverage for all insurance plans so that families affected by cancer will face fewer financial barriers to care
  - Focusing on prevention and early detection by requiring all new insurance plans to provide coverage for essential, evidence-based preventive measures with no additional copays
  - Eliminating discrimination based on health status and preexisting conditions, which has been so detrimental to cancer patients over the years
  - Requiring qualified health plans to provide materials in appropriate languages

  ACS CAN will continue to look for ways to strengthen the legislation throughout the implementation process both at the federal and state level.
- **National Breast and Cervical Cancer Early Detection Program.** A high priority for the Society and ACS CAN at both the state and federal level is fighting to increase funding for the National Breast and Cervical Cancer Early Detection Program (NBCCEDP). This successful program, which began in 1991, provides community-based breast and cervical cancer screening to low-income, uninsured, and underinsured women, more than 50% of whom are from racial/ethnic minority groups. Due to a large cut in funding, screening rates within the program greatly declined in 2007; rates have been increasing slowly since, but still have not fully recovered. ACS CAN is asking Congress to increase funding to $275 million for fiscal year 2013 to support continued growth and to give women access to lifesaving screening services. While the Affordable Care Act will greatly improve access to screening, the NBCCEDP will remain an essential program for improving breast and cervical cancer screening and treatment in our nation's most vulnerable populations. It will be critical to use the program's infrastructure and community-outreach specialists to help women receive the lifesaving services they need.
- **Colorectal Cancer Prevention, Early Detection, and Treatment Act.** The Society and ACS CAN are advocating for the Colorectal Cancer Prevention, Early Detection, and Treatment Act, a national screening, treatment, and outreach program focused on increasing colorectal cancer screening rates in low-income, medically underserved populations.
- **Patient Navigation.** Patient navigation demonstration programs have shown navigation to be an important aspect of improving satisfaction and care among cancer patients, especially those in medically underserved and minority populations. In order to increase patient navigation services, ACS CAN is looking to expand the reach of patient navigators through federal funding support.

The Society and ACS CAN also are leading efforts to increase federal investment in cutting-edge biomedical and cancer research and treatments, as well as ways to expand access to them. To learn more, to get involved, and to make a difference in the fight against cancer, visit cancer.org/involved/advocate.

Cancer Incidence and Death Rates* by Site, Race, and Ethnicity†, US, 2005-2009

Incidence	White	African American	Asian American or Pacific Islander	American Indian or Alaska Native‡	Hispanic/ Latino
All sites					
Male	543.1	619.7	327.5	423.2	418.7
Female	424.0	396.8	286.2	360.3	333.2
Breast (female)	123.3	118.0	85.9	89.1	93.0
Colon & rectum					
Male	52.8	65.1	41.4	50.7	46.9
Female	39.2	48.0	32.1	41.1	33.3
Kidney & renal pelvis					
Male	21.2	23.3	10.1	29.0	19.8
Female	11.2	12.1	5.1	16.6	11.4
Liver & intrahepatic bile duct					
Male	9.1	15.0	21.6	16.4	17.5
Female	3.1	4.2	8.1	7.6	6.6
Lung & bronchus					
Male	82.3	99.3	49.4	67.4	45.4
Female	57.5	51.3	28.1	49.5	26.6
Prostate	141.0	228.7	77.2	98.8	124.9
Stomach					
Male	8.4	16.3	16.1	13.0	13.5
Female	4.0	8.2	9.3	6.4	8.1
Uterine cervix	7.8	10.4	7.2	10.1	11.8
Mortality					
All sites					
Male	216.7	288.3	132.6	184.9	146.4
Female	150.8	174.6	93.2	135.9	100.6
Breast (female)	22.4	31.6	11.9	16.6	14.9
Colon & rectum					
Male	19.5	29.8	13.1	18.8	15.3
Female	13.6	19.8	9.6	14.6	10.2
Kidney & renal pelvis					
Male	5.9	6.0	2.9	8.8	5.0
Female	2.7	2.6	1.3	4.1	2.3
Liver & intrahepatic bile duct					
Male	7.4	11.9	14.5	11.9	11.8
Female	3.1	4.0	6.1	5.9	5.3
Lung & bronchus					
Male	65.3	82.6	35.9	48.3	30.8
Female	40.8	38.0	18.5	33.2	14.1
Prostate	21.7	53.1	10.0	19.7	17.8
Stomach					
Male	4.3	10.3	9.0	8.3	7.4
Female	2.2	4.8	5.3	3.8	4.3
Uterine cervix	2.2	4.3	2.0	3.5	3.0

*Per 100,000, age adjusted to the 2000 US standard population.

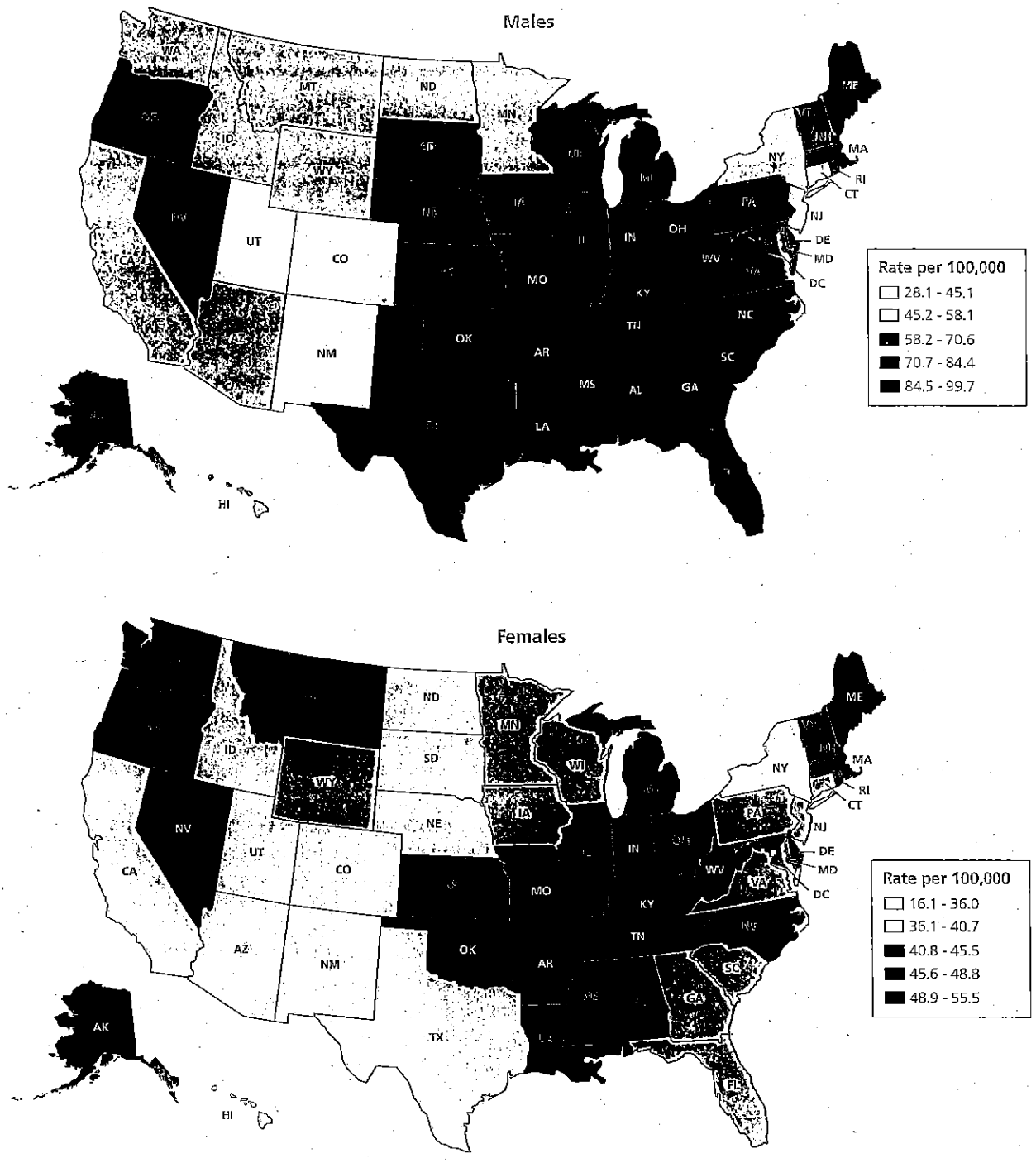
†Race and ethnicity categories are not mutually exclusive; persons of Hispanic/Latino origin may be of any race.

‡Data based on Contract Health Service Delivery Area counties.

Source: Jemal A, et al. Annual report to the nation on the status of cancer, 1975-2009, featuring the burden and trends in human papillomavirus (HPV)-associated cancers and HPV vaccination levels. *J Natl Cancer Inst*.2012. In press.

American Cancer Society, Surveillance Research, 2013

Geographic Patterns in Lung Cancer Death Rates* by State, US, 2005-2009



*Age adjusted to the 2000 US standard population.
Source: US Mortality Data, National Center for Health Statistics, Centers for Disease Control and Prevention.

American Cancer Society, Surveillance Research, 2013

Nutrition and Physical Activity

It has been estimated by the World Cancer Research Fund that one-quarter to one-third of the cancers that occur in high-income countries like the US are due to poor nutrition, physical inactivity, and excess weight, and thus could be prevented. Maintaining a healthy body weight, being physically active on a regular basis, and eating a healthy diet are as important as not using tobacco products in reducing cancer risk. The American Cancer Society's nutrition and physical activity guidelines emphasize the importance of weight control, physical activity, dietary patterns, and limited, if any, alcohol consumption in reducing cancer risk and helping people stay well; unfortunately, the majority of Americans are not meeting these recommendations. Increasing trends in unhealthy eating and physical inactivity – and resultant increases in overweight and obesity – have largely been influenced by the environments in which people live, learn, work, and play. As a result, the guidelines include explicit Recommendations for Community Action to facilitate the availability of healthy, affordable food choices and opportunities for physical activity in communities, schools, and workplaces.

The following recommendations reflect the best nutrition and physical activity evidence available to help Americans reduce their risk of cancer, as well as lower their risk of heart disease and diabetes.

Recommendations for Individual Choices

1. Achieve and maintain a healthy weight throughout life.

- Be as lean as possible throughout life without being underweight.
- Avoid excess weight gain at all ages. For those who are currently overweight or obese, losing even a small amount of weight has health benefits and is a good place to start.
- Engage in regular physical activity and limit consumption of high-calorie foods and beverages as key strategies for maintaining a healthy weight.

In the United States, it has been estimated that overweight and obesity contribute to 14% to 20% of all cancer-related mortality. Overweight and obesity are clearly associated with increased risk for developing many cancers, including cancers of the breast in postmenopausal women, colon and rectum, endometrium, adenocarcinoma of the esophagus, kidney, and pancreas. Overweight and obesity may also be associated with increased risk of cancers of the liver, non-Hodgkin lymphoma, multiple myeloma, cervix, ovary, and aggressive prostate cancer, and obesity also likely increases the risk of cancer of the gallbladder. In addition, abdominal fatness is convincingly associated with colorectal cancer, and probably related to higher risk of pancreatic, endometrial, and postmenopausal breast cancers.

Increasing evidence also suggests that being overweight increases the risk for cancer recurrence and decreases the likelihood of survival for several cancers. Some studies have shown that surgery to treat morbid obesity reduces mortality from major chronic diseases, including cancer. Although knowledge about the relationship between weight loss and cancer risk is incomplete, individuals who are overweight should be encouraged and supported in their efforts to reduce weight.

At the same time that evidence connecting excess weight to increased cancer risk has been accumulating, trends in overweight and obesity have been increasing dramatically. The prevalence of obesity in the US more than doubled between 1976-1980 and 2003-2006. Although overall prevalence has stabilized in recent years, more than one-third of adults – 36% of both men and women – are currently obese. More than likely, these trends are already impacting cancer trends: in the midpoint assessment of its 2015 Challenge Goals, American Cancer Society researchers reported that while the incidence of both colorectal cancer and postmenopausal breast cancer had been declining, it is likely that the declines in both would have started earlier and would have been steeper had it not been for the increasing prevalence of obesity. Indeed, some researchers have speculated that the longstanding, historic increases in life expectancy in the US may level off or even decline within the first half of this century as a result of the obesity epidemic.

Similar to adults, obesity among children and adolescents has tripled over the past several decades across race, ethnicity, and gender. In 2009-2010, 17% of American children ages 2 to 19 years were obese; obesity prevalence was 24% in African Americans, 21% in Hispanics, and 14% in non-Hispanic whites. Because overweight in youth tends to continue throughout life, efforts to establish healthy body weight patterns should begin in childhood. The high prevalence of overweight and obesity in children and adolescents may increase incidence of cancer in the future.

2. Adopt a physically active lifestyle.

- Adults should engage in at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity activity each week, or an equivalent combination, preferably spread throughout the week.
- Children and adolescents should engage in at least 1 hour of moderate- or vigorous-intensity activity each day, with vigorous-intensity activity at least three days each week.
- Limit sedentary behavior such as sitting, lying down, and watching television and other forms of screen-based entertainment.

- Doing any intentional physical activity above usual activities, even if currently inactive, can have many health benefits.

Living a physically active lifestyle is important to reduce the risk of a variety of types of cancer, as well as heart disease and diabetes. Scientific evidence indicates that physical activity may reduce the risk of several types of cancer, including cancers of the breast, colon, and endometrium, as well as advanced prostate cancer. Physical activity also indirectly reduces the risk of developing the many types of obesity-related cancers because of its role in helping to maintain a healthy weight. Being active is thought to reduce cancer risk largely by improving energy metabolism and reducing circulating concentrations of estrogen, insulin, and insulin-like growth factors. Physical activity also improves the quality of life of cancer patients and is associated with a reduction in the risk of cancer recurrences and improved overall mortality in multiple cancer survivor groups, including breast, colorectal, prostate, and ovarian cancer.

Despite the wide variety of health benefits from being active, 25% of adults report no leisure-time activity, and only 49% meet minimum recommendations for moderate activity. Similarly, only 37% of youth meet recommendations. However, recent data released by the Centers for Disease Control and Prevention (CDC) indicate that trends may be improving. Walking prevalence (defined as walking for transportation or leisure in at least one bout of 10 minutes or more in the preceding 7 days) among adults increased significantly from 56% in 2005 to 62% in 2010.

3. Consume a healthy diet, with an emphasis on plant foods.

- Choose foods and beverages in amounts that help achieve and maintain a healthy weight.
- Limit consumption of processed meat and red meat.
- Eat at least 2½ cups of vegetables and fruits each day.
- Choose whole grains instead of refined-grain products.

There is strong scientific evidence that healthy dietary patterns, in combination with regular physical activity, are needed to maintain a healthy body weight and to reduce cancer risk. Studies have shown that individuals who eat more processed and red meat, potatoes, refined grains, and sugar-sweetened beverages and foods are at a higher risk of developing or dying from a variety of cancers. Alternatively, adhering to a diet that contains a variety of fruits and vegetables, whole grains, and fish or poultry and fewer red and processed meats is associated with lower risk. A recent study found that dietary and lifestyle behaviors consistent with the American Cancer Society nutrition and physical activity guidelines are associated with lower mortality rates for all causes of death combined, and for cancer and cardiovascular diseases, specifically. Despite the known benefits of a healthy diet, Americans are not following recommendations; according to the US Department of Agriculture, the majority of Americans would need to substantially lower their intake of added sugars, added fats, refined grains, and sodium, and increase their consumption of fruits, vegetables, whole grains, and low-fat dairy products in order to meet the 2010 Dietary Guidelines for Americans.

Currrently, the overall evidence related to dietary supplements does not support their use in cancer prevention. The results of recently completed randomized clinical trials of antioxidant supplements and selenium showed no reduction in risk for cancer, at least in generally well-nourished populations.

The scientific study of nutrition and cancer is highly complex, and many important questions remain unanswered. It is not presently clear how single nutrients, combinations of nutrients, over-nutrition, and energy imbalance, or the amount and distribution of body fat at particular stages of life affect a person's risk of specific cancers. Until more is known about the specific components of diet that influence cancer risk, the best advice is to consume a mostly plant-based diet that limits red and processed meats and emphasizes a variety of vegetables, fruits, and whole grains. A special emphasis should be placed on controlling total caloric intake to help achieve and maintain a healthy weight.

4. If you drink alcoholic beverages, limit consumption.

People who drink alcohol should limit their intake to no more than two drinks per day for men and one drink per day for women. Alcohol consumption is a risk factor for cancers of the mouth, pharynx, larynx, esophagus, liver, colorectum, and breast. For each of these cancers, risk increases substantially with the intake of more than two drinks per day. Even a few drinks per week may be associated with a slightly increased risk of breast cancer in women. The mechanism for how alcohol can affect breast cancer is not known with certainty, but it may be due to alcohol-induced increases in circulating estrogen or other hormones in the blood, reduction of folic acid levels, or a direct effect of alcohol or its metabolites on breast tissue. Alcohol consumption combined with tobacco use increases the risk of cancers of the mouth, larynx, and esophagus far more than either drinking or smoking alone.

The American Cancer Society Recommendations for Community Action

While many Americans would like to adopt a healthy lifestyle, many encounter substantial barriers to consuming healthy food and engaging in physical activity. Increased portion sizes, especially of restaurant meals; marketing and advertising of foods and beverages high in calories, fat, and added sugar, particularly to kids; schools and worksites that are not conducive to good health; community design that hinders physical activity; economic and time constraints, as well as other influences, have collectively contributed to increasing trends in obesity.

The Society's nutrition and physical activity guidelines include Recommendations for Community Action because of the tremendous influence that the surrounding environment has on individual food and activity choices. Acknowledging that turning obesity trends around will require extensive policy and environmental changes, the Society calls for public, private, and community organizations to create social and physical environments that support the adoption and maintenance of healthy nutrition and physical activity behaviors to help people stay well.

Achieving these Recommendations for Community Action will require multiple strategies and bold action, ranging from the implementation of community and workplace health promotion programs to policies that affect community planning, transportation, school-based physical education, and food services. The Centers for Disease Control and Prevention (CDC), the Institute of Medicine, the World Health Organization (WHO), and others have outlined a variety of evidenced-based approaches in communities, worksites, and schools to halt and ultimately turn around the obesity trends. Following are some specific approaches that are currently under way:

- Limit the availability, advertising, and marketing of foods and beverages of low nutritional value, particularly in schools.
- Strengthen nutrition standards in schools for foods and beverages served as part of school meal programs and for competitive foods and beverages served outside of the programs.
- Increase the quality and quantity of physical education and the amount of time students are physically active in K-12 schools.
- Ensure that worksites have healthy food and beverage options and that physical environments are designed or adapted and maintained to facilitate physical activity and weight control.
- Provide calorie information on chain restaurant menus.
- Invest in community design that supports development of sidewalks, bike lanes, and access to parks and green space.

The tobacco control experience has shown that policy and environmental changes at the national, state, and local levels are critical to achieving changes in individual behavior. Measures such as clean indoor air laws and increases in cigarette excise taxes are highly effective in deterring tobacco use. To avert an epidemic of obesity-related disease, similar purposeful changes in public policy and in the community environment will be required to help individuals maintain a healthy body weight and remain physically active.

Environmental Cancer Risks

Two major classes of factors influence the incidence of cancer: hereditary factors and acquired (environmental) factors. Hereditary factors come from our parents and cannot be modified. Environmental factors, which include behavioral choices, are potentially modifiable. These include tobacco use, poor nutrition, physical inactivity, obesity, certain infectious agents, certain medical treatments, excessive sun exposure, and exposures to carcinogens (cancer-causing agents) that exist as pollutants in our air, food, water, and soil. Some carcinogens occur naturally, and some are created or concentrated by human activity. For example, radon is a naturally occurring carcinogen present in soil and rock; however, occupational radon exposure occurs in underground mines, and substantial exposures also occur in poorly ventilated basements in regions where radon soil emissions are high.

Environmental factors (as opposed to hereditary factors) account for an estimated 75%-80% of cancer cases and deaths in the US. Exposure to carcinogenic agents in occupational, community, and other settings is thought to account for a relatively small percentage of cancer deaths – about 4% from occupational exposures and 2% from environmental pollutants (man-made and naturally occurring). Although the estimated percentage of cancers related to occupational and environmental carcinogens is small compared to the cancer burden from tobacco smoking (30%) and the combination of poor nutrition, physical inactivity, and obesity (35%), the relationship between such agents and cancer is important for several reasons. First, even a small percentage of cancers can represent many deaths: 6% of cancer deaths in the US in 2011 correspond to approximately 34,320 deaths. Second, the burden of exposure to occupational and environmental carcinogens is borne disproportionately by lower-income workers and communities, contributing to disparities in the cancer burden across the US population. Third, although much is known about the relationship between occupational and environmental exposure and cancer, some important research questions remain. These include the role of exposures to certain classes of chemicals (such as hormonally active agents) during critical periods of human development and the potential for pollutants to interact with each other, as well as with genetic and acquired factors.

How Environmental Carcinogens Are Identified

The term carcinogen refers to exposures that can increase the incidence of malignant tumors (cancer). The term can apply to a single chemical such as benzene; fibrous minerals such as asbestos; metals and physical agents such as x-rays or ultraviolet light; or exposures linked to specific occupations or industries (e.g.,

nickel refining). Carcinogens are usually identified on the basis of epidemiological studies or by testing in animals. Studies of occupational groups (cohorts) have played an important role in understanding many chemical carcinogens – as well as radiation – because exposures are often higher among workers, who can be followed for long periods of time. Some information has also come from studies of persons exposed to carcinogens during medical treatments (such as radiation and estrogen), as well as from studies conducted among individuals who experienced high levels of short-term exposure to a chemical or physical agent due to an accidental or intentional release (such as survivors of the atomic bomb explosions of Hiroshima and Nagasaki). It is more difficult to study the relationship between exposure to potentially carcinogenic substances and cancer risk in the general population because of uncertainties about exposure and the challenge of long-term follow up. Moreover, relying upon epidemiological information to determine cancer risk does not fulfill the public health goal of prevention since by the time the increased risk is detected, a large number of people may have been exposed.

Thus, for the past 40 years, the US and many other countries have developed methods for identifying carcinogens through animal testing using the "gold standard" of a 2-year or lifetime bioassay in rodents. This test is expensive and time-consuming, but it can provide information about potential carcinogens so that human exposure can be reduced or eliminated. Many substances that are carcinogenic in rodent bioassays have not been adequately studied in humans, usually because an acceptable study population has not been identified. Among the substances that have proven carcinogenic in humans, all have shown positive results in animals when tested in well-conducted 2-year bioassays.[1] Between 25%-30% of established human carcinogens were first identified through animal bioassays. Since animal tests necessarily use high-dose exposures, human risk assessment usually requires extrapolation of the exposure-response relationship observed in rodent bioassays to predict effects in humans at lower doses. Typically, regulatory agencies in the US and abroad have adopted the default assumption that no threshold level (level below which there is no increase in risk) of exposure exists for carcinogenesis.

Evaluation of Carcinogens

The National Toxicology Program (NTP) plays an important role in the identification and evaluation of carcinogens in the US, and the International Agency for Research on Cancer (IARC) plays a similar role internationally. The NTP was established in 1978 to coordinate toxicology testing programs within the federal government, including tests for carcinogenicity. The NTP is also responsible for producing the *Report on Carcinogens*, an informational scientific and public health document that identifies agents, substances, mixtures, or exposure circumstances that may increase the risk of developing cancer.[2] There are currently 107 agents classified by IARC as Group 1 (i.e., carcinogenic to humans). For a list of substances included in the *11th Report on Carcinogens* that are known or reasonably anticipated to be human carcinogens, see ntp.niehs.nih.gov/ntp/roc/toc11.html. The IARC is a branch of the World Health Organization that regularly convenes scientific consensus groups to evaluate potential carcinogens. After reviewing published data from laboratory, animal, and human research, these committees reach consensus about whether the evidence should be designated "sufficient," "limited," or "inadequate" to conclude that the substance is a carcinogen. For a list of substances that have been reviewed by the IARC monograph program, visit monographs.iarc.fr/ENG/Classification/index.pdf. The American Cancer Society does not have a formal program to systematically review and evaluate carcinogens. However, information on selected topics can be found at cancer.org.

Although the relatively small risks associated with low-level exposure to carcinogens in air, food, or water are difficult to detect in epidemiological studies, scientific and regulatory bodies worldwide have accepted the principle that it is reasonable and prudent to reduce human exposure to substances shown to be carcinogenic at higher levels of exposure. Although much public concern about the influence of manmade pesticides and industrial chemicals has focused on cancer, pollution may adversely affect the health of humans and ecosystems in many other ways. Research to understand the short- and long-term impact of environmental pollutants on a broad range of outcomes, as well as regulatory actions to reduce exposure to recognized hazards, has contributed to the protection of the public and the preservation of the environment for future generations. It is important that this progress be recognized and sustained. For more information on environmental cancer risks, see the article published by Fontham et al. in *CA: A Cancer Journal for Clinicians*.[3]

References

1. Tomatis L, Melnick RL, Haseman J, et al. Alleged "misconceptions" distort perceptions of environmental cancer risks. *FASEBJ*. 2001; 15:195203.

2. National Toxicology Program *11th Report on Carcinogens*. Research Triangle Park; 2005.

3. Fontham ET, Thun MJ, Ward E, et al. American Cancer Society perspectives on environmental factors and cancer. *CA Cancer J Clin*. 2009; 59:343351.

The Global Fight against Cancer

The ultimate mission of the American Cancer Society is to eliminate cancer as a major health problem. Because cancer knows no boundaries, this mission extends around the world. Cancer is an enormous global health burden, touching every region and socioeconomic level. Today, cancer accounts for one in every eight deaths worldwide – more than HIV/AIDS, tuberculosis, and malaria combined. In 2008, there were an estimated 12.7 million cases of cancer diagnosed and 7.6 million deaths from cancer around the world. More than 60 percent of all cancer deaths occur in low- and middle-income countries, many of which lack the medical resources and health systems to support the disease burden. Moreover, the global cancer burden is growing at an alarming pace; in 2030 alone, about 21.3 million new cancer cases and 13.1 million cancer deaths are expected to occur, simply due to the growth and aging of the population. The future burden may be further increased by the adoption of behaviors and lifestyles associated with economic development and urbanization (e.g., smoking, poor diet, physical inactivity, and reproductive patterns) in low- and middle-income countries. Tobacco use is a major cause of the increasing global burden of cancer as the number of smokers worldwide continues to grow.

Worldwide Tobacco Use

Tobacco use is the most preventable cause of death worldwide, and is responsible for the deaths of approximately half of long-term users. Tobacco use killed 100 million people in the 20th century and will kill 1 billion people in the 21st century if current trends continue. Each year, tobacco use is responsible for almost 6 million premature deaths, and by 2030 this number is expected to increase to 8 million, 80% of whom will reside in low- and middle-income countries.

- Between 2002 and 2030, tobacco-attributable deaths are projected to decline by 9% in high-income countries, but are expected to double from 3.4 million to 6.8 million in low- and middle-income countries. For example, tobacco use is currently the number one killer in China, responsible for 1.2 million deaths annually. This number is expected to rise to 3.5 million deaths annually by the year 2030.
- Approximately 18% of the world's population – more than 1 billion men and 250 million women – smoke. In 32 countries, male smoking prevalence is greater than or equal to 45%: all but 5 of these are low- and middle-income countries.
- Data from the Global Youth Tobacco Survey conducted during 1999-2008 found that among youth 13 to 15 years of age, 12% of boys and 7% of girls reported smoking cigarettes, and 12% of boys and 8% of girls reported using other tobacco products. Data from 1999-2005 showed that in every region of the world, the ratio of male-to-female smoking among youth was smaller than the ratio reported among adults, reflecting a global trend of increased smoking among female youth.
- It has been estimated that in 2004, more than 600,000 nonsmokers worldwide died as a result of exposure to secondhand smoke and 40% of children were exposed to secondhand smoke.
- The use of smokeless tobacco accounts for a significant and growing portion of tobacco use throughout the world. The majority of smokeless tobacco is consumed in South Asia. However, consistent with trends in the US, the sales of smokeless tobacco products are growing at a rapid pace in high-income countries, even as smoking rates decline.
- As emerging and developing economies come to prominence and their health systems develop further, the medical costs of tobacco-related disease will continue to grow. In China, for example, the direct costs of smoking were $6.2 billion in 2008 (an increase of 154% compared to 2000), while the indirect costs of smoking were $22.7 billion in 2008 (an increase of 376% compared to 2000).
- Spending on tobacco products diverts resources from essential goods and services. For example, in India tobacco consumption impoverishes roughly 15 million people, and in Cambodia, the amount of money spent on one pack of premium cigarettes can buy as much as 3,500 food calories comprising a typical daily diet in that country.
- About 55% of the world's population was covered by one or more evidence-based tobacco control measures in 2010, up from less than 10% in 2008. The WHO estimates that 11% of the world's population lives in smoke-free environments.

The first global public health treaty, the Framework Convention on Tobacco Control (FCTC), was unanimously adopted by the World Health Assembly on May 21, 2003, and subsequently entered into force as a legally binding accord for all ratifying states on February 27, 2005.[65] The FCTC features specific provisions to control both the global supply and demand for tobacco, including regulation of tobacco product contents, packaging, labeling, advertising, promotion, sponsorship, taxation, illicit trade, youth access, exposure to secondhand tobacco smoke, and environmental and agricultural impacts. Parties to the treaty are expected to strengthen national legislation, enact effective tobacco control policies, and cooperate internationally to reduce global tobacco consumption. As of August 2012, out of 195 eligible countries, 176 have ratified or acceded to the treaty representing approximately 88% of the world's population. A number of major tobacco-producing nations, including Argentina, Indonesia, Malawi, the US, and Zimbabwe, have either not signed or have signed but not ratified the treaty.

The Role of the American Cancer Society

With a century of experience in cancer control, the American Cancer Society is uniquely positioned to help in leading the global fight against cancer and tobacco by assisting and empowering the world's cancer societies and anti-tobacco advocates. The Society's Global Health and Intramural Research departments are raising awareness about the growing global cancer burden and promoting evidence-based cancer and tobacco control programs.

The American Cancer Society has established three integrated goals to reduce the global burden of cancer:

- **Make cancer control a political and public health priority.** According to the World Health Organization, noncommunicable diseases (NCDs) – such as cancer, heart disease and diabetes – claim more lives each year and account for about 60% of the world's deaths. About 28 million (80%) of these deaths occur in low- and middle-income countries, yet less than 3% of private and public funding for health is allocated to prevent and control cancer and other NCDs in these areas. The Society has become actively involved in working with global partners, including the Union for International Cancer Control (UICC), the International Diabetes Federation, the World Heart Federation, Lance Armstrong Foundation, and others to prioritize cancer and NCDs on the global health agenda.
- **Reduce tobacco use, with a particular focus on sub-Saharan Africa.** Through an $8 million (US) grant received from the Bill & Melinda Gates Foundation in 2010, the Society and its partners, including the Africa Tobacco Control Regional Initiative, the Africa Tobacco Control Alliance, the Framework Convention Alliance, the Campaign for Tobacco-Free Kids, and the International Union Against Tuberculosis and Lung Disease, support and assist national governments and civil societies in Africa to implement tobacco control policies such as advertising bans, tobacco tax increases, graphic warning labels, and the promotion of smoke-free environments. The partners on this project actively advocate for further tobacco control resources in sub-Saharan Africa and help establish mechanisms to protect existing laws from tobacco industry efforts to overturn them. In addition, the Society supports the development of research and technical capacity for tobacco control through partnerships with the University of Cape Town and the University of Pretoria. These projects focus on the advancement of taxation as a tobacco control tool, the economics of tobacco control, and the training of future public health practitioners.
- **Increase awareness about the burden of cancer and its leading risk factor, tobacco use.** The Society continues to work with global partners to increase awareness about the growing global cancer and tobacco burdens and their impact on low- and middle-income countries. In addition to print publications, the American Cancer Society provides cancer information to millions of individuals throughout the world on its Web site, cancer.org. More than 20% of the visitors to the Web site come from outside the US. Information is currently available in English, Spanish, Mandarin, and several other Asian languages, with plans to include more languages in the near future. For more information on the global cancer burden, visit the Society's Global Health program Web site at cancer.org/international and see the following intramural research program publications available on cancer.org and tobaccoatlas.org:
  - *Global Cancer Facts & Figures 2nd Edition*
  - *The Tobacco Atlas, Fourth Edition*
  - *The Cancer Atlas*

The American Cancer Society

In 1913, 10 physicians and five laypeople founded the American Society for the Control of Cancer. Its purpose was to raise awareness about cancer symptoms, treatment, and prevention; to investigate what causes cancer; and to compile cancer statistics. Later renamed the American Cancer Society, Inc., the organization now works with its more than 3 million volunteers to save lives and create a world with less cancer and more birthdays by helping people stay well, helping people get well, by working to find cures, and by fighting back against the disease. By working relentlessly to bring cancer under control, the Society is making remarkable progress in cancer prevention, early detection, treatment, and patient quality of life. The overall cancer death rate has steadily declined since the early 1990s, and the 5-year survival rate is now 68%, up from 49% in the 1970s. Thanks to this progress, nearly 14 million cancer survivors in the US will celebrate another birthday this year.

How the American Cancer Society Is Organized

The American Cancer Society, Inc., is a 501(c)(3) nonprofit corporation governed by a Board of Directors that sets policy, develops and approves an enterprise-wide strategic plan and related resource allocation, and is responsible for the performance of the organization as a whole, with the advice and support of regionally based volunteer boards.

The Society's structure includes a central corporate office in Atlanta, Georgia, regional offices supporting 12 geographic

Divisions, and more than 900 local offices in those regions. The corporate office is responsible for overall strategic planning; corporate support services such as human resources, financial management, IT, etc.; development and implementation of global and nationwide endeavors such as our groundbreaking research program, our international program, and 24-hour call center; and provides technical support and materials to regional and local offices for local delivery.

With a presence in more than 5,100 communities, the American Cancer Society fights for every life threatened by every cancer in every community. Our regional and local offices are organized to engage communities in the cancer fight, delivering lifesaving programs and services and raising money at the local level. Offices are strategically placed around the country in an effort to maximize the impact of our efforts, and to be as efficient as possible with the money donated to the Society to fight cancer and save lives.

Volunteers

As a global grassroots force, the Society relies on the strength of more than three million dedicated volunteers. From leadership volunteers who set strategy and policy to members of the community who organize special events, patient support, and education programs, Society volunteers, supported by professional staff, drive every part of our mission. The Society's vast array of volunteer opportunities empowers people from every community to play a role in saving lives, while they fulfill their own.

How the American Cancer Society Saves Lives

The American Cancer Society is working relentlessly to saves lives from cancer by helping people stay well and get well, by finding cures, and by fighting back against the disease.

Helping People Stay Well

The American Cancer Society provides information that empowers people to take steps that help them prevent cancer or find it early, when it is most treatable.

Prevention

The Society helps people quit using tobacco through the American Cancer Society Quit For Life® Program, managed and operated by Alere Wellbeing. These two organizations have more than 35 years of combined experience in tobacco cessation coaching and have helped more than 1 million tobacco users quit. Together, they will help millions more make a plan to quit, realizing the American Cancer Society's mission to save lives and create a world with less cancer and more birthdays.

The Society offers many programs to companies to help their employees stay well and reduce their cancer risk, too. These include:

- **FreshStart®**, a group-based tobacco cessation counseling program designed to help employees plan a successful quit attempt by providing essential information, skills for coping with cravings, and group support
- **Content subscription service,** a free electronic tool kit subscription offered by the Society to employers that support the health and wellness needs of employees with information about cancer prevention and early detection, and support services and resources for those facing cancer
- ***HealthyLiving***, a monthly electronic newsletter produced by the American Cancer Society that teaches the importance of making healthy lifestyle choices
- **American Cancer Society Workplace Solutions Assessment,** which surveys a company's health and wellness policies and practices and recommends evidence-based strategies that help improve employee health behaviors, control health care costs, and increase productivity
- **Active For Life℠**, a 10-week online program that uses individual and group strategies to help employees become more physically active

Across the nation, the Society's nonprofit, nonpartisan advocacy affiliate, the American Cancer Society Cancer Action Network℠ (ACS CAN), works to create healthier communities by protecting people from the dangers of secondhand smoke. As of July 1, 2012, 48% of the US population was covered by comprehensive smoke-free workplace, restaurant, and bar laws. In 2009, the Family Smoking Prevention and Tobacco Control Act was signed into law. A decade in the making, the law, grants the US Food and Drug Administration the authority to regulate the manufacturing, selling, and marketing of tobacco products. Strong implementation of the law is vital to reducing death and disease from tobacco products.

For the majority of Americans who do not smoke, the most important ways to reduce cancer risk are to maintain a healthy weight, be physically active on a regular basis, and eat a mostly plant-based diet, consisting of a variety of vegetables and fruit, whole grains, and limited amounts of red and processed meats. The Society publishes guidelines on nutrition and physical activity for cancer prevention in order to review the accumulating scientific evidence on diet and cancer; to synthesize this evidence into clear, informative recommendations for the general public; to promote healthy individual behaviors, as well as environments that support healthy eating and physical activity habits; and, ultimately, to reduce cancer risk. These guidelines form the foundation for the Society's communication, worksite, school, and community strategies designed to encourage and support people in making healthy lifestyle behavior changes.

Early Detection

Finding cancer at its earliest, most treatable stage gives patients the greatest chance of survival. To help the public and health care providers make informed decisions about cancer screening, the American Cancer Society publishes a variety of early detection guidelines. These guidelines are assessed regularly to ensure that recommendations are based on the most current scientific evidence.

The Society currently provides screening guidelines for cancers of the breast, cervix, colorectum, prostate, and endometrium, and general recommendations for a cancer-related component of a periodic checkup to examine the thyroid, mouth, skin, lymph nodes, testicles, and ovaries.

Throughout its history, the American Cancer Society has implemented a number of aggressive awareness campaigns targeting the public and health care professionals. Campaigns to increase usage of Pap testing and mammography have contributed to a 70% decrease in cervical cancer incidence rates since the introduction of the Pap test in the 1950s and a 33% decline in breast cancer mortality rates since 1989. More recently, the Society launched ambitious multimedia campaigns to encourage adults 50 years of age and older to get tested for colorectal cancer. The Society also continues to encourage the early detection of breast cancer through public awareness and other efforts targeting poor and underserved communities.

Helping People Get Well

For the nearly 1.7 million cancer patients diagnosed this year and appoximately 14 million US cancer survivors, the American Cancer Society is available anytime, day and night, to offer free information, programs, services, and community referrals to patients, survivors, and caregivers to help them make decisions through every step of a cancer experience. These resources are designed to help people facing cancer on their journey to getting well.

Information, 24 Hours a Day, Seven Days a Week

The American Cancer Society is available 24 hours a day, seven days a week online at cancer.org and by calling 1-800-227-2345. Callers are connected with a Cancer Information Specialist who can help them locate a hospital, understand cancer and treatment options, learn what to expect and how to plan, help address insurance concerns, find financial resources, find a local support group, and more. The Society can also help people who speak languages other than English or Spanish find the assistance they need, offering services in 170 languages in total.

Information on every aspect of the cancer experience, from prevention to survivorship, is also available through the Society's Web site, cancer.org. The site includes an interactive cancer resource center containing in-depth information on every major cancer type.

The Society also publishes a wide variety of pamphlets and books that cover a multitude of topics, from patient education, quality of life, and caregiving issues to healthy living. A complete list of Society books is available for order at cancer.org/bookstore.

The Society publishes a variety of information sources for health care providers, including three clinical journals: *Cancer*, *Cancer Cytopathology*, and *CA: A Cancer Journal for Clinicians*. More information about free subscriptions and online access to *CA* and *Cancer Cytopathology* articles is available at cancer.org/journals. The American Cancer Society also collaborates with numerous community groups, nationwide health organizations, and large employers to deliver health information and encourage Americans to adopt healthy lifestyle habits through the Society's science-based worksite programs.

Day-to-day Help and Emotional Support

The American Cancer Society can help cancer patients and their families find the resources they need to make decisions about the day-to-day challenges that can come from a cancer diagnosis, such as transportation to and from treatment, financial and insurance needs, and lodging when having to travel away from home for treatment. The Society also connects people with others who have been through similar experiences to offer emotional support.

Help navigating the health care system: Learning how to navigate the cancer journey and the health care system can be overwhelming for anyone, but it is particularly difficult for those who are medically underserved, those who experience language or health literacy barriers, or those with limited resources. The American Cancer Society Patient Navigator Program was designed to reach those most in need. The largest oncology-focused patient navigator program in the country, it has specially trained patient navigators at 119 cancer treatment facilities across the nation. Patient navigators work in cooperation with patients, family members, caregivers, and facility staff to connect patients with information, resources, and support to decrease barriers and ultimately to improve health outcomes. In 2011, approximately 89,000 people relied on the Patient Navigator Program to help them through their diagnosis and treatment. The Society collaborates with a variety of organizations, including the National Cancer Institute's Center to Reduce Cancer Health Disparities, the Center for Medicare and Medicaid Services, numerous cancer treatment centers, and others to implement and evaluate this program.

Transportation to treatment: Cancer patients cite transportation to and from treatment as a critical need, second only to direct financial assistance. The American Cancer Society Road To Recovery® program matches these patients with specially trained volunteer drivers. This program offers patients an additional key benefit of companionship and moral support during the drive to medical appointments. In some areas, primarily

where transportation assistance programs are difficult to sustain, the Society helps patients or their drivers via prepaid gas cards to help defray costs associated with transportation to treatment. In 2011, the American Cancer Society provided more than 1.4 million transportation services to more than 77,000 constituents. Our service requests for transportation assistance increased by 15% in 2011 over the previous year, and the number of rides that we provided in 2011 was up by 18%.

Lodging during treatment: When someone diagnosed with cancer must travel away from home for the best treatment, where to stay and how to afford accommodations are immediate concerns and can sometimes affect treatment decisions. American Cancer Society Hope Lodge® facilities provide free, homelike, temporary lodging for patients and their caregivers close to treatment centers, thereby easing the emotional and financial burden of finding affordable lodging. In 2011, the 31 Hope Lodge locations provided approximately 250,000 nights of free lodging to nearly 38,000 patients and caregivers – saving them $23 million in lodging expenses.

Breast cancer support: Through the American Cancer Society Reach To Recovery® program, trained breast cancer survivor volunteers provide one-on-one support, information, and resource referrals to people facing breast cancer. Patients are matched with a volunteer who has had a similar breast cancer experience as well as other similar characteristics. These volunteers will meet one-on-one, either in person, by telephone, or via email, with women anytime throughout their breast cancer experience.

Prostate cancer support: Men facing prostate cancer can find one-on-one or group support through the American Cancer Society Man To Man® program. The program also offers men the opportunity to educate their communities about prostate cancer and to advocate with lawmakers for stronger research and treatment policies.

Cancer education classes: People with cancer and their caregivers need help coping with the challenges of living with the disease. Doctors, nurses, social workers, and other health care professionals provide them with that help by conducting the American Cancer Society I Can Cope® educational classes to guide patients and their families through their cancer journey.

Hair-loss and mastectomy products: Some women wear wigs, hats, breast forms, and bras to help cope with the effects of mastectomy and hair loss. The American Cancer Society's *"tlc" Tender Loving Care®* is a magazine and catalog in one that offers informative articles and a line of products to help women who are battling cancer restore their appearance and self-esteem. All proceeds from product sales go back into the Society's programs and services for patients and survivors.

Help with appearance-related side effects of treatment: **Look Good Feel Better®** is a collaboration of the American Cancer Society, the Personal Care Products Council Foundation, and the Professional Beauty Association that helps women learn beauty techniques to restore their self-image and cope with appearance-related side effects of cancer treatment. This free program engages certified, licensed beauty professionals trained as Look Good Feel Better volunteers to provide tips on makeup, skin care, nail care, and head coverings. Information and materials are also available for men and teens.

Finding hope and inspiration: People with cancer and their loved ones do not have to face their cancer experience alone. They can connect with others who have "been there" through the American Cancer Society Cancer Survivors Network®. The online community is a welcoming and safe place that was created by and for cancer survivors and their families.

WhatNext™ is another free online support network developed in part by the American Cancer Society that helps cancer patients, survivors, and caregivers gain firsthand insight into living with cancer and connect with others facing a similar diagnosis.

Finding Cures

Research is at the heart of the American Cancer Society's mission. For more than 65 years, the Society has been finding answers that save lives – from changes in lifestyle to new approaches in therapies to improving cancer patients' quality of life. No single nongovernmental, not-for-profit organization in the US has invested more to find the causes and cures of cancer than the American Cancer Society. We relentlessly pursue the answers that help us understand how to prevent, detect, and treat all cancer types. We combine the world's best and brightest researchers with the world's largest, oldest, and most effective community-based anti-cancer organization to put answers into action.

The Society's comprehensive research program consists of extramural grants, as well as intramural programs in epidemiology, surveillance and health policy research, behavioral research, international tobacco control research, and statistics and evaluation. Intramural research programs are led by the Society's own staff scientists.

Extramural Grants

The American Cancer Society's extramural grants program supports research in a wide range of cancer-related disciplines at more than 230 institutions. The Society is currently funding 937 research and training grants totaling more than $468 million as of August 28, 2012. Grant applications are solicited through a nationwide competition and are subjected to a rigorous external peer-review process, ensuring that only the most promising research is funded. The Society primarily funds investigators early in their research careers at, a time when they are less likely to receive funding from the federal government, thus giving the best and the brightest a chance to explore cutting-edge ideas at a time when they might not find funding elsewhere. In addition to funding across the continuum of cancer research, from basic

science to clinical and quality-of-life research, the Society also focuses on needs that are unmet by other funding organizations. For instance, for 10 years, the Society supported a targeted research program to address the causes of higher cancer mortality in the poor and medically underserved; this has recently become a priority area for funding.

To date, 46 Nobel Prize winners have received grant support from the Society early in their careers, a number unmatched in the nonprofit sector, and proof that the organization's approach to funding young researchers truly helps launch high-quality scientific careers.

Intramural Research

For more than 65 years, the Society's intramural research program has conducted and published high-quality epidemiologic research to advance understanding of the causes and prevention of cancer and monitored and disseminated surveillance information on cancer occurrence, risk factors, and screening.

Epidemiology

As a leader in cancer research, the Society's Epidemiology Research program has been conducting studies to identify factors that cause or prevent cancer since 1951. The first of these, the Hammond-Horn Study, helped to establish cigarette smoking as a cause of death from lung cancer and coronary heart disease, and also demonstrated the Society's ability to conduct very large prospective cohort studies. The Cancer Prevention Study I (CPS-I) was launched in 1959 and included more than 1 million men and women recruited by 68,000 volunteers. Results from CPS-I clearly demonstrated that the sharp increase in lung cancer death rates among US men and women between 1959-1972 occurred only in smokers. Epidemiologic study of this cohort was also among the first to show a relationship between obesity and all-cause and cancer mortality.

In 1982, Cancer Prevention Study II (CPS-II) was established through the recruitment of 1.2 million men and women by 77,000 volunteers. The more than 480,000 lifelong nonsmokers in CPS-II provide the most stable estimates of lung cancer risk in the absence of active smoking. CPS-II data are used extensively by the Centers for Disease Control and Prevention (CDC) to estimate deaths attributable to smoking. The CPS-II study also made important contributions in establishing the link between obesity and cancer. A subgroup of CPS-II participants, the CPS-II Nutrition Cohort has been particularly valuable for clarifying associations of obesity, physical activity, diet, aspirin use, and hormone use with cancer risk. Blood samples from this group allow Society investigators and their collaborators at other institutions to study how genetic, hormonal, nutritional, and other blood markers are related to cancer risk and/or progression.

The Cancer Prevention Studies have resulted in more than 500 scientific publications and have provided unique contributions both within the Society and the global scientific community. In addition to key contributions to the effects of the tobacco epidemic over the past half-century, other important findings from these studies include:

- The association of obesity with increased death rates for at least 10 cancer sites, including colon and postmenopausal breast cancer
- The link between aspirin use and lower risk of colon cancer, opening the door to research on chronic inflammation and cancer
- The relationship between cancer and certain potentially modifiable factors, such as physical inactivity, prolonged hormone use, and certain dietary factors
- The association between air pollution, especially small particulates and ozone, with increased death rates from heart and lung conditions, which helped to motivate the Environmental Protection Agency to propose more stringent limits on air pollution

While landmark findings from the CPS-II Nutrition Cohort have informed multiple areas of public health policy and clinical practice, the cohort is aging. A new cohort is needed to explore the effects of changing exposures and to provide greater opportunity to integrate biological measurements into studies of genetic and environmental risk factors. In 2006, Society epidemiologists began the enrollment of a new cohort, CPS-3, with the goal of recruiting and following approximately 300,000 men and women. All participants are providing blood samples at the time of enrollment. Following on the long history of partnering with Society volunteers and supporters for establishing a cohort, the Society's community-based Relay For Life® events are one of the primary venues for recruiting and enrolling participants. Although similar large cohorts are being established in Canada and some European and Asian countries, there are currently no nationwide studies of this magnitude; therefore, the data collected from CPS-3 participants will provide unique opportunities for research in the US.

Surveillance & Health Services Research

Through the Surveillance Research program, the Society disseminates the most current cancer statistics in *CA: A Cancer Journal for Clinicians* (caonline.amcancersoc.org), as well as eight *Cancer Facts & Figures* publications. These publications are the most widely cited sources for cancer statistics and are available in hard copy from Society Division offices and online through the Society's Web site at cancer.org/statistics. Society scientists also monitor trends in cancer risk factors and screening and publish these results annually – along with Society recommendations, policy initiatives, and evidence-based programs – in *Cancer Prevention & Early Detection Facts & Figures*. Surveillance Research also collaborates with the International Agency for Research on

Cancer (IARC) to publish *Global Cancer Facts & Figures*, an international companion to *Cancer Facts & Figures*.

Since 1998, the Society has collaborated with the National Cancer Institute, the Centers for Disease Control and Prevention, the National Center for Health Statistics, and the North American Association of Central Cancer Registries to produce the Annual Report to the Nation on the Status of Cancer, a peer-reviewed journal article that reports current information related to cancer rates and trends in the US.

Epidemiologists in Surveillance Research also conduct and publish high-quality epidemiologic research in order to advance the understanding of cancer. Research topics include exploring differences in the burden of cancer by socioeconomic status in the US, describing global cancer trends, and demonstrating the association between public health interventions, such as tobacco control, and cancer incidence and mortality. Recent studies have focused on state differences in colorectal cancer mortality, temporal trends in breast cancer incidence rates, and use of sunless tanning products by adolescents in the US.

Interest in developing a Health Services Research (HSR) program within the American Cancer Society's intramural research program began in the late 1990s, motivated by increasing disparities in the quality and outcomes of cancer care. The primary objective of the HSR program is to perform high-quality, high-impact research to evaluate disparities in cancer treatment and outcomes and support the Society's mission and program initiatives. Additional, related objectives include identifying critical gaps in quality patient care and taking leadership in policy and technical initiatives to address these gaps. The HSR program is uniquely positioned to respond rapidly to critical information needs by Society personnel, as well as national and international policy makers.

To accomplish its objectives, the HSR program's work has primarily involved the use of secondary data sources. The National Cancer Data Base (NCDB), jointly sponsored by the American Cancer Society and the American College of Surgeons, has been key to the HSR program's research on the impact of insurance on cancer status, treatments, and outcomes, as well as for broader surveillance of cancer incidence/prevalence and treatment patterns. Other databases used to support the HSR program's objectives include linked SEER-Medicare data, linked state registry and Medicaid enrollment data, and Medical Expenditure Panel Survey Data linked with National Health Interview Survey Data.

International Tobacco Control Research

The predecessor of the International Tobacco Control Research Program (ITCRP), the International Tobacco Surveillance unit, was created in 1998 to support collaborative international tobacco surveillance efforts involving the Society, the WHO Tobacco Free Initiative, the World Bank, and the Centers for Disease Control and Prevention's (CDC) Office of Smoking and Health. Its special publications, the *Tobacco Control Country Profiles*, 1st and 2nd editions, were distributed during the 11th and 12th World Conference on Tobacco or Health in 2000 and in 2003, respectively.

Since 2006, the ITCRP has begun to focus on economic research in tobacco control, taking advantage of established partnerships with numerous academic and nonprofit organizations. In addition to original research, the program helps build capacity for the collection and analysis of economic data to provide the evidence base for tobacco control in low- and middle- income countries. To that end, the ITCRP received funding from the Bloomberg Global Initiative to Reduce Tobacco Use, the Bill & Melinda Gates Foundation, and grants from the National Institutes of Health Fogarty International Center.

The most important service publication of the ITCRP is The *Tobacco Atlas*, which is produced in collaboration with the Society's Global Health department, Georgia State University, and the World Lung Foundation. *The Tobacco Atlas, Fourth Edition* (tobaccoatlas.org) was released at the 15th World Conference on Tobacco or Health in 2012 in Singapore.

Behavioral Research Center

The American Cancer Society was one of the first organizations to recognize the importance of behavioral and psychosocial factors in the prevention and control of cancer and to fund extramural research in this area. In 1995, the Society established the Behavioral Research Center (BRC) as an intramural department. The BRC's work currently focuses on cancer survivorship, quality of life, and tobacco research. It also addresses the issues of special populations, including minorities, the poor, rural populations, and other underserved groups. The BRC's ongoing projects include:

- Studies of the quality of life of cancer survivors, which include a nationwide longitudinal study and a cross-sectional study, that explore the physical and psychosocial adjustment to cancer and identify factors affecting quality of life
- Studies to identify and prioritize gaps in information and resources for cancer survivors as they transition from active treatment back to the community care setting
- Contributions to the development of a National Cancer Survivorship Resource Center meant to advance survivorship as a distinct phase of cancer care, promote healthy behaviors to reduce late and long-term effects of cancer and its treatment, and improve surveillance and screening practices to detect the return of cancer
- Studies of family caregivers that explore the impact of the family's involvement in cancer care on the quality of life of the cancer survivor and the caregiver

- Efforts to establish and implement a process to measure the effective control of pain, other symptoms, and side effects for those who have been affected by cancer
- Studies of racial disparities and the role of sociocultural and neighborhood factors in cancer-related behaviors (smoking, poor diet, lack of exercise, and cancer screening) among a statewide sample of more than 1,000 African Americans in Georgia
- Studies investigating how social, psychological, and other factors impact smokers' motivation and ability to quit for the purposes of improving existing Society programs for smoking cessation (e.g., FreshStart, the Great American Smokeout®) and to develop new technology-based cessation interventions.

Statistics and Evaluation Center

The Statistics & Evaluation Center (SEC) provides expert statistical, survey, study design, evaluation, sampling and research consultation services to the American Cancer Society. Their mission is to improve Society programs, processes, and services based on good science. They strive to capture, analyze, and report data that are objective, valid, reliable, accurate, and timely – to provide a solid evidence base for decision making. High-quality evaluation produces the greatest benefit to cancer patients, their caregivers, and their families.

The SEC has two areas of focus – Statistics and Survey Research – that work independently or in tandem, depending on the nature of the project. SEC staff regularly interact with multiple stakeholders in addition to Society staff, including patients, caregivers, volunteers, and staff from partnering health care systems. The SEC is engaged in evaluations of many of the priority mission outcomes around survivorship, quality-of-life, prevention, early detection, and tobacco control, collaborating regularly with the Society's Health Promotions, Extramural Grants, Cancer Control Sciences, and Global Health departments. The SEC uses multiple methods, including a variety of quantitative and qualitative approaches, all of which help produce robust and effective findings.

The SEC, working within the Integrated Evaluation Team, developed a Strategic Leader Discussion Series which has fostered communication, integration, and collaboration, facilitating the systematic inclusion of evaluation into the planning cycle of many of the Society's transformation efforts (see below). The Center continues to provide leadership on evaluation efforts related to cancer prevention projects that utilize community health advisors on a large program funded by Walmart. They are also leading evaluations of the Dietitian-on-Call and the Patient Navigation Center of Excellence programs, as well as some focused studies around Hope Lodge facilities – including an innovative return-on-investment project. Finally, the SEC completed the third year of its pilot project around geo-mapping to support program decision making.

In the past year, a large fraction of SEC staff time has been engaged in support of the strategic and operational planning needed to transform the Society into an outcomes-focused organization. SEC staff actively participated on multiple national transformation workgroups, as well as provided many of these teams with data analysis and geo-maps.

Fighting Back

Conquering cancer is as much a matter of public policy as scientific discovery. Whether it's advocating for quality, affordable health care for all Americans, increasing funding for cancer research and programs, or enacting laws and policies that help decrease tobacco use, lawmakers play a critical role in determining how much progress we make as a country to defeat cancer. The American Cancer Society Cancer Action Network (ACS CAN), the Society's nonprofit nonpartisan advocacy affiliate, uses applied policy analysis, direct lobbying, grassroots action, and media advocacy to ensure elected officials nationwide pass laws that help save lives from cancer.

Created in 2001, ACS CAN is the force behind a powerful grassroots movement uniting and empowering cancer patients, survivors, caregivers, and their families to fight back against cancer. The nation's leading voice advocating for public policies that are helping to defeat cancer, ACS CAN works to encourage elected officials and candidates to make cancer a top national priority. In recent years, ACS CAN has worked to pass a number of laws at the federal, state, and local levels focused on preventing cancer and detecting it early, increasing research on ways to prevent and treat cancer, improving access to lifesaving screenings and treatment, and improving quality of life for cancer patients. Some recent advocacy accomplishments impacting cancer patients include:

- Passage and implementation of the Affordable Care Act (ACA) of 2010, comprehensive legislation that:
  - Prohibits insurance companies from denying insurance coverage based on a preexisting conditions (children starting in 2010, adults in 2014)
  - Prohibits insurance coverage from being rescinded when a patient gets sick
  - Removes lifetime limits from all insurance plans
  - Allows children and young adults to be covered under their parents' insurance plans until they turn 26
  - Makes coverage for routine care costs available to patients who take part in clinical trials
  - Establishes a National Institutes of Health Interagency Pain Research Advisory Committee to coordinate pain management research initiatives and an Institute of Medicine Pain Conference series that will be important to relieving cancer-related pain and other chronic pain conditions

- Establishes a National Prevention and Health Promotion Strategy; a National Prevention, Health Promotion and Public Health Council; and a Prevention and Public Health Fund with mandatory funding to prioritize, coordinate, oversee, and fund prevention-related activities nationwide
- Requires all new health insurance plans and Medicare to cover preventive services rated "A" or "B" by the US Preventive Services Task Force (USPTF) at no cost to patients (including breast, cervical, and colorectal cancer screening and smoking cessation treatment)
- Requires state Medicaid programs to provide pregnant women with tobacco cessation treatment at no cost
- Protects children and families against states rules that limit program eligibility or increase premiums or enrollment fees in Medicaid
- Provides funding to states to expand Medicaid coverage to low-income adults (below 133% of the federal poverty level)
- Saves states money in uncompensated care by replacing local dollars with new federal subsidies
- Prioritizes health disparities at the National Institutes of Health, establishes a network of federal offices of minority health, and creates an Office of Women's Health
- Enhances data collection and reporting to ensure racial and ethnic minorities are receiving appropriate, timely, and quality health care
- Authorizes grants to help states and local jurisdictions address health workforce needs
- Secures coverage for a new annual wellness visit with a personalized prevention plan and gradually reduces out-of-pocket costs for prescription drugs for Medicare beneficiaries
- Creates incentives for health care providers to deliver more coordinated and integrated care to beneficiaries enrolled in Medicare and Medicaid
- Requires chain restaurants to provide calorie information on menus and have other nutrition information available to consumers upon request; requires chain vending machine owners or operators to display calorie information for all products available for sale

Please refer to *The Affordable Care Act: How It Helps People with Cancer and their Families* for more information (http://action.acscan.org/site/DocServer/Affordable_Care_Act_Through_the_Cancer_Lens_Final.pdf?docID=18421).

- Supporting legislation that focuses on preventing cancer by reducing tobacco use, obesity prevalence, and sun exposure; improving nutrition; and increasing physical activity. By successfully working with partners, ACS CAN has:
  - Helped empower the FDA with authority over tobacco products
  - Helped pass comprehensive smoke-free laws in 23 states and the District of Columbia, Puerto Rico, and the US Virgin Islands that require all workplaces, restaurants, and bars to be smoke-free, covering nearly half of the US population, and defended these laws in court
  - Helped increase taxes on tobacco products to an average state cigarette tax of $1.49 per pack and defended against tax rollbacks
  - Continued its role as intervener in the US government's lawsuit against the tobacco industry, in which manufacturers have been convicted as racketeers for decades of fraud associated with marketing of tobacco products
  - Begun implementing the Healthy, Hunger-Free Kids Act of 2010, strong legislation to reauthorize the federal child nutrition programs and strengthen school nutrition. The law improves nutrition standards and increases funding for school meals, establishes nutrition standards for foods sold in schools outside of meal programs, and strengthens local wellness policies by providing resources and technical assistance for their implementation and requiring them to be publicly available and periodically reviewed.
  - Advocated for state requirements for increased, quality physical education in all schools
  - Supported the federal government's development of voluntary nutrition standards for foods marketed to children
  - Worked with state governments to implement laws prohibiting tanning bed use for everyone under the age of 18
- Worked to improve access to essential cancer screening services, especially among low-income, uninsured, and underinsured populations
- Advocated for full funding for the National Breast and Cervical Cancer Early Detection Program (NBCCEDP), which provides free breast and cervical cancer screenings and treatment to low-income, uninsured, and medically underserved women
- Advocated for legislation to create a new nationwide colorectal screening and treatment program modeled after NBCCEDP
- Improved quality of life for cancer patients by advocating for patients and survivors to receive the best cancer care that matches treatments to patient and family goals across their life course. ACS CAN has:
  - Advocated for balanced pain policies in multiple states and at the federal level to ensure patients and survivors have continued access to the treatments that promote better pain management and improved quality of life

- Advanced a new quality-of-life legislative platform that addresses the need for better patient access to palliative care services that address patient symptoms such as pain and fatigue that begins at point of diagnosis and is provided alongside curative treatment, as well as expand research funding in this area and build the health professions work force needed to provide patients with serious illnesses better patient-centered, coordinated care. Increased public awareness of the increasingly urgent cancer drug shortage problem and advocated for solutions to the complex, multiple causes of cancer drug shortages

Some efforts in the fight against cancer are more visible than others, but each successful battle is an important contribution to what will ultimately be victory over the disease. ACS CAN is making sure the voice of the cancer community is heard in the halls of government and is empowering communities everywhere to fight back.

The Society is also rallying people to fight back against the disease through our Relay For Life and Making Strides Against Breast Cancer® programs. The American Cancer Society Relay For Life is a life-changing event that gives everyone in communities across the globe a chance to celebrate the lives of people who have battled cancer, remember loved ones lost, and fight back against the disease, making it the world's largest movement to end cancer. At Relay events, teams of people camp out at a local high school, park, or fairground and take turns walking or running around track or path for up to 24 hours. Making Strides Against Breast Cancer events unite communities to walk together, one million strong, as the most powerful force to end breast cancer. Dollars raised fund groundbreaking research, provide free resources and support to help people throughout their cancer journey, and ensures access to mammograms for women who need them.

Sources of Statistics

Estimated new cancer cases in 2013. The numbers of new US cancer cases in 2013 are projected using a two-step process. First, the total number of cases in each state is estimated using a spatiotemporal model based on incidence data from 49 states and the District of Columbia for the years 1995-2009 that met the North American Association of Central Cancer Registries' (NAACCR) high-quality data standard for incidence, which covers about 98% of the US population. This method considers geographic variations in sociodemographic and lifestyle factors, medical settings, and cancer screening behaviors as predictors of incidence, as well as accounting for expected delays in case reporting. Then, the number of new cases nationally and in each state is projected four years ahead using a temporal projection method. (For more information on the estimation of new cases, see "A" in Additional information on page 59.)

Incidence rates. Incidence rates are defined as the number of people per 100,000 who are diagnosed with cancer during a given time period. Incidence rates in this publication are age adjusted to the 2000 US standard population to allow comparisons across populations with different age distributions. State incidence rates were published in NAACCR's publication *Cancer Incidence in North America, 2005-2009.* (See "B" in Additional information, page 59, for full reference.) Trends in cancer incidence provided for selected cancer sites are based on incidence rates that have been adjusted for delays in reporting and were originally published in the *Surveillance, Epidemiology, and End Results (SEER) Cancer Statistics Review (CSR) 1975-2009.* (See "C" in Additional information, page 59, for full reference). Incidence rates that are not adjusted for delays in reporting may underestimate the number of cancer cases in the most recent time period. Cancer rates most affected by reporting delays are melanoma of the skin, leukemia, and prostate because these cancers are frequently diagnosed in nonhospital settings. Cancer incidence rates by race/ethnicity were obtained from NAACCR.

Estimated cancer deaths in 2013. The estimated numbers of US cancer deaths are calculated by fitting the numbers of cancer deaths for 1995-2009 to a statistical model that forecasts the numbers of deaths expected to occur in 2013. The estimated numbers of cancer deaths for each state are calculated similarly, using state-level data. For both US and state estimates, data on the numbers of deaths are obtained from the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention. (For more information on this method, see "D" in Additional information on page 59.)

Mortality rates. Mortality rates, or death rates, are defined as the number of people per 100,000 dying of a disease during a given year. In this publication, mortality rates are based on counts of cancer deaths compiled by NCHS and population data from the US Census Bureau. Death rates in this publication are age adjusted to the 2000 US standard population to allow comparisons across populations with different age distributions. These rates should be compared only to other statistics that are age adjusted to the US 2000 standard population. Trends in cancer mortality rates provided for selected cancer sites are based on mortality data from 1992 to 2009 and were first published in the *CSR 1975-2009.* (See "C" in Additional information, page 59, for full reference.)

Important note about estimated cancer cases and deaths for the current year. The estimated numbers of new cancer cases and deaths in the current year are model-based and may produce numbers that vary considerably from year to year for reasons other than changes in cancer occurrence. For this reason, the use of our estimates to track year-to-year changes in cancer occurrence or deaths is strongly discouraged. Age-adjusted incidence and mortality rates reported by the SEER program and NCHS, respectively, are the suggested statistics to use when tracking cancer trends for the US. Rates from state cancer registries are useful for tracking local trends.

Survival. This report presents relative survival rates to describe cancer survival. Relative survival adjusts for normal life expectancy by comparing survival among cancer patients to that of people not diagnosed with cancer who are of the same age, race, and sex. Five-year survival statistics presented in this publication were originally published in *CSR 1975-2009* and are for diagnosis years 2002 to 2008, with all patients followed through 2009. In addition to 5-year relative survival rates, 1-, 10-, and 15-year survival rates are presented for selected cancer sites. These survival statistics are generated using the National Cancer Institute's SEER 18 database and SEER*Stat software version 7.1.0. (See "E" in Additional information, for full references.) One-year survival rates are based on cancer patients diagnosed from 2005 and 2008, 10-year survival rates are based on diagnoses from 1996 and 2008, and 15-year survival rates are based on diagnoses from 1991 and 2008; all patients were followed through 2009.

Probability of developing cancer. Probabilities of developing cancer are calculated using DevCan (Probability of Developing Cancer) software version 6.6.1, developed by the National Cancer Institute. (See "F" in Additional information, for full reference.) These probabilities reflect the average experience of people in the US and do not take into account individual behaviors and risk factors. For example, the estimate of 1 man in 13 developing lung cancer in a lifetime underestimates the risk for smokers and overestimates the risk for nonsmokers.

Additional information. More information on the methods used to generate the statistics for this report can be found in the following publications:

A. Zhu L, Pickle LW, Naishadham D, et al. Predicting US and state-level cancer counts for the current calendar year: part II – evaluation of spatio-temporal projection methods for incidence. *Cancer* 2012;118(4): 1100-9.

B. Copeland G, Lake A, Firth R, et al. (eds). *Cancer in North America: 2005-2009. Volume Two: Registry-specific Cancer Incidence in the United States and Canada.* Springfield, IL: North American Association of Central Cancer Registries, Inc. May 2012. Available at naaccr.org/DataandPublications/CINAPubs.aspx.

C. Howlader N, Krapcho M, Neyman N, et al. (eds). *SEER Cancer Statistics Review, 1975-2009.* National Cancer Institute. Bethesda, MD, 2012. Available at seer.cancer.gov.

D. Chen HS, Portier K, Ghosh K, et al. Predicting US and State-level counts for the current calendar year: part I – evaluation of temporal projection methods for mortality. *Cancer* 2012;118(4):1091-9.

E. SEER 18 database: Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER 18 Regs Research Data + Hurricane Katrina Impacted Louisiana Cases, Nov 2011 Sub (1973-2009 varying) - Linked To County Attributes - Total U.S., 1969-2009 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released April 2012, based on the November 2011 submission. SEER*Stat software: Surveillance Research Program, National Cancer Institute SEER*Stat software (www.seer.cancer.gov/seerstat) version 7.1.0.

F. DevCan: Probability of Developing or Dying of Cancer Software, Version 6.6.1; Statistical Research and Applications Branch, National Cancer Institute, April 2012. http://srab.cancer.gov/devcan

Screening Guidelines for the Early Detection of Cancer in Average-risk Asymptomatic People

Cancer Site	Population	Test or Procedure	Frequency
Breast	Women, age 20+	Breast self-examination (BSE)	It is acceptable for women to choose not to do BSE or to do BSE regularly (monthly) or irregularly. Beginning in their early 20s, women should be told about the benefits and limitations of BSE. Whether or not a woman ever performs BSE, the importance of prompt reporting of any new breast symptoms to a health professional should be emphasized. Women who choose to do BSE should receive instruction and have their technique reviewed on the occasion of a periodic health examination.
		Clinical breast examination (CBE)	For women in their 20s and 30s, it is recommended that CBE be part of a periodic health examination, preferably at least every three years. Asymptomatic women aged 40 and over should continue to receive a CBE as part of a periodic health examination, preferably annually.
		Mammography	Begin annual mammography at age 40.*
Cervix†	Women, ages 21-65	Pap test & HPV DNA test	Cervical cancer screening should begin at age 21. For women ages 21-29, screening should be done every 3 years with conventional or liquid-based Pap tests. For women ages 30-65, screening should be done every 5 years with both the HPV test and the Pap test (preferred), or every 3 years with the Pap test alone (acceptable). Women aged 65+ who have had ≥3 consecutive negative Pap tests or ≥2 consecutive negative HPV and Pap tests within the last 10 years, with the most recent test occurring within 5 years, and women who have had a total hysterectomy should stop cervical cancer screening. Women should not be screened annually by any method at any age.
Colorectal	Men and women, ages 50+	Fecal occult blood test (FOBT) with at least 50% test sensitivity for cancer, or fecal immunochemical test (FIT) with at least 50% test sensitivity for cancer, **or**	Annual, starting at age 50. Testing at home with adherence to manufacturer's recommendation for collection techniques and number of samples is recommended. FOBT with the single stool sample collected on the clinician's fingertip during a digital rectal examination is not recommended. Guaiac based toilet bowl FOBT tests also are not recommended. In comparison with guaiac-based tests for the detection of occult blood, immunochemical tests are more patient-friendly, and are likely to be equal or better in sensitivity and specificity. There is no justification for repeating FOBT in response to an initial positive finding.
		Stool DNA test**, **or**	Interval uncertain, starting at age 50
		Flexible sigmoidoscopy (FSIG), **or**	Every 5 years, starting at age 50. FSIG can be performed alone, or consideration can be given to combining FSIG performed every 5 years with a highly sensitive gFOBT or FIT performed annually.
		Double contrast barium enema (DCBE), **or**	Every 5 years, starting at age 50
		Colonoscopy	Every 10 years, starting at age 50
		CT Colonography	Every 5 years, starting at age 50
Endometrial	Women, at menopause	At the time of menopause, women at average risk should be informed about risks and symptoms of endometrial cancer and strongly encouraged to report any unexpected bleeding or spotting to their physicians.	
Lung	Current or former smokers ages 55-74 in good health with at least a 30 pack-year history	Low dose helical CT (LDCT)	Clinicians with access to high-volume, high quality lung cancer screening and treatment centers should initiate a discussion about lung cancer screening with apparently healthy patients ages 55-74 who have at least a 30 pack-year smoking history, and who currently smoke or have quit within the past 15 years. A process of informed and shared decision making with a clinician related to the potential benefits, limitations, and harms associated with screening for lung cancer with LDCT should occur before any decision is made to initiate lung cancer screening. Smoking cessation counseling remains a high priority for clinical attention in discussions with current smokers, who should be informed of their continuing risk of lung cancer. Screening should not be viewed as an alternative to smoking cessation
Prostate	Men, ages 50+	Digital rectal examination (DRE) and prostate-specific antigen test (PSA)	Men who have at least a ten-year life expectancy should have an opportunity to make an informed decision with their health care provider about whether to be screened for prostate cancer, after receiving information about the potential benefits, risks, and uncertainties associated with prostate cancer screening. Prostate cancer screening should not occur without an informed decision making process.
Cancer-related checkup	Men and women, ages 20+	On the occasion of a periodic health examination, the cancer-related checkup should include examination for cancers of the thyroid, testicles, ovaries, lymph nodes, oral cavity, and skin, as well as health counseling about tobacco, sun exposure, diet and nutrition, risk factors, sexual practices, and environmental and occupational exposures.	

*Beginning at age 40, annual clinical breast examination should be performed prior to mammography. **The stool DNA test approved for colorectal cancer screening in 2008 is no longer commercially available. New stool DNA tests are presently undergoing evaluation and may become available at some future time.

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ARTICLES, STUDIES, REPORTS IN SUPPORT OF SPECT/CT

JOINT POSITION STATEMENT

On the basis of current information, the American Society of Nuclear Cardiology and the Society of Nuclear Medicine recommend that, when available and technically feasible, attenuation correction should be used in addition to electrocardiography gating with single photon emission computed tomographic (SPECT) myocardial perfusion imaging to maximize its diagnostic accuracy and clinical usefulness.

American Society of Nuclear Cardiology and Society of Nuclear Medicine joint position statement: Attenuation correction of myocardial perfusion SPECT scintigraphy

Gary V. Heller, MD, PhD, Jonathan Links, PhD, Timothy M. Bateman, MD, Jack A. Ziffer, MD, PhD, Edward Ficaro, PhD, Mylan C. Cohen, MD, MPH, and Robert C. Hendel, MD

INTRODUCTION

The Society of Nuclear Medicine (SNM), founded in 1953, and the American Society of Nuclear Cardiology (ASNC), founded in 1993, are professional medical societies whose missions are 3-fold: (1) to facilitate optimal delivery of nuclear medicine/nuclear cardiology services through professional education, (2) to support research, and (3) to establish standards and guidelines for training and practice. Recently, both societies recognized attenuation correction of myocardial perfusion single photon emission computed tomography (SPECT) studies as a potentially important means of distinguishing attenuation artifact from coronary artery disease, and they issued a statement to this effect.[1] Since that publication, additional scientific studies have been published. Manufacturers have substantially improved commercially available and validated attenuation correction approaches, and there is now a growing acceptance of the technology by clinicians. As a result, the boards of ASNC and the SNM have determined that, in the interest of the highest-quality patient care, a new statement should be made regarding attenuation correction.

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JUSTIFICATION

Following its initial description and demonstration,[2] multiple investigators have shown that attenuation correction adds to the diagnostic accuracy of stress myocardial perfusion SPECT.[3-7] Single-institution trials were followed by independent multicenter trials by use of different hardware/software approaches that clearly demonstrated the utility of attenuation correction.[8-13] In a prior joint statement, the SNM and ASNC concluded that "the objective technique of attenuation correction has become a method for which the weight of evidence and opinion is in favor of its usefulness."[1] At that time, however, concerns regarding the level of validation and quality-control aspects of the existing commercial systems limited the emphasis that could be included in the statement.

The ability to accurately perform attenuation correction with validated commercial hardware/software solutions by use of strict quality-control measures enhances the interpretive confidence and accuracy of SPECT myocardial perfusion imaging. With recent publications further validating attenuation correction by using a variety of methods including electrocardiography (ECG)-gated SPECT imaging,[10-16] there has been growing clinical acceptance of attenuation correction by practitioners. Recent investigations have also demonstrated the possibility for stress-only imaging in selected patients, therefore improving laboratory efficiency.[17-19]

As a result of these developments, several manufacturers now have commercial hardware/software approaches that have been clinically validated and have

implemented quality-control schemes in association with attenuation correction. ASNC and the SNM thus believe a more supportive statement of the utility of attenuation correction is justified.

PREREQUISITES

There are important prerequisites for the incorporation of attenuation correction into routine clinical practice; these prerequisites cover acquisition, processing, and interpretation.[1]

1. High-quality transmission scans and sufficient transmission counts with low cross-talk from the emission radionuclide are essential to reduce the propagation of noise and error into the corrected emission images.
2. Quality-control procedures for image registration should be used for projection data acquired by use of sequential transmission-emission imaging protocols (eg, computed tomography–SPECT systems).
3. Motion correction, scatter correction, and resolution recovery should be used with attenuation correction.
4. Attenuation correction should be employed concurrently with ECG-gated SPECT imaging.
5. Technologists must have adequate training in the acquisition and processing of attenuation-corrected studies. Physicians must have adequate training in the interpretation of attenuation-corrected images.
6. Physicians should view and interpret both uncorrected and corrected images.

CLINICAL SIGNIFICANCE

It is the position of ASNC and the SNM that incorporation of attenuation correction in addition to ECG gating with SPECT myocardial perfusion images will improve image quality, interpretive certainty, and diagnostic accuracy. These combined results are anticipated to have a substantial impact on improving the effectiveness of care and lowering health care costs.

References

1. Hendel RC, Corbett JR, Cullom SJ, et al. The value and practice of attenuation correction for myocardial perfusion SPECT imaging: a joint position statement from the American Society of Nuclear Cardiology and the Society of Nuclear Medicine. J Nucl Cardiol 2002;9:135-43.
2. Ficaro EP, Fessler JA, Shreve PD, et al. Simultaneous transmission/emission myocardial perfusion tomography. Circulation 1996; 93:463-73.
3. Prvulovich EM, Lonn AHR, Bomanji JB, Jarritt PH, Ell PJ. Effect of attenuation correction on myocardial thallium-201 distribution in patients with a low likelihood of coronary artery disease. Eur J Nucl Med 1997;24:266-75.
4. Kluge R, Sattler B, Seese A, Knapp WH. Attenuation correction by simultaneous emission-transmission myocardial single-photon emission tomography using a technetium-99m labelled radiotracer: impact on diagnostic accuracy. Eur J Nucl Med 1997;24:1107-14.
5. Chouraqui P, Livschitz S, Sharir T, et al. Evaluation of an attenuation correction method for thallium-201 myocardial perfusion tomographic imaging of patients with low likelihood of coronary artery disease. J Nucl Cardiol 1998;5:369-77.
6. Gallowitsch HJ, Sykora J, Mikosch P, et al. Attenuation-corrected thallium-201 single-photon emission tomography using a gadolinium-153 moving line source: clinical value and the impact of attenuation correction on the extent and severity of perfusion abnormalities. Eur J Nucl Med 1998;25:220-8.
7. Gallowitsch HJ, Unterweger O, Mikosch P, et al. Attenuation correction improves the detection of viable myocardium by thallium-201 cardiac tomography in patients with previous myocardial infarction and left ventricular dysfunction. Eur J Nucl Med 1999;26:459-66.
8. Hendel RC, Berman DS, Cullom SJ, et al. Multicenter clinical trial to evaluate the efficacy of correction for photon attenuation and scatter in SPECT myocardial perfusion imaging. Circulation 1999; 99:2742-9.
9. Links JM, Becker LC, Rigo P, et al. Combined corrections for attenuation, depth-dependent blur, and motion in cardiac SPECT: a multicenter trial. J Nucl Cardiol 2000;7:414-25.
10. Shotwell M, Singh BM, Fortman C, et al. Improved coronary disease detection with quantitative attenuation-corrected Tl-201 images. J Nucl Cardiol 2002;9:52-61.
11. Links JM, DePuey G, Taillefer R, Becker LB. Attenuation correction and gating synergistically improve the diagnostic accuracy of myocardial perfusion SPECT. J Nucl Cardiol 2002;9:183-7.
12. Bateman TM, Heller GV, Johnson LL, et al. Does attenuation correction add value to non-attenuation corrected ECG-gated technetium-99m sestamibi SPECT [abstract]?. J Nucl Cardiol 2003;10:S91.
13. Lui Y, Wackers FJ, Natale D, et al. Validation of a hybrid SPECT/CT system with attenuation correction: a phantom study and multicenter trial [abstract]. J Nucl Med 2003;44:290p.
14. Case JA, Cullom SJ, Galt JR, Garcia FV, Bateman TM. Impact of transmission scan reconstruction using an iterative algorithm (BITGA) versus FBP: clinical appearance of attenuation-corrected myocardial perfusion SPECT images [abstract]. J Nucl Med 2001;42:51P.
15. Cullom SJ, Case JA, Bateman TM, O'Keefe JHO, McGhie A. Reconstruction of attenuation maps from low-count Gd-153 transmission studies using an iterative Bayesian algorithm: clinical evaluation with simultaneous Tc-99m sestamibi SPECT [abstract]. J Nucl Med 2000;41:134P.
16. Simon E, Narayanan MV, Dahlberg ST, et al. Observer ROC evaluation of attenuation scatter and resolution compensation strategies for Tc-99m myocardial perfusion imaging [abstract]. J Nucl Cardiol 2003;10:S61.
17. Heller GV, Bateman TM, Botvinick EH, et al. Value of attenuation correction in interpretation of stress only exercise Tc-99m sestamibi SPECT imaging: results of a multicenter trial [abstract]. J Am Coll Cardiol 2002;39:343A.
18. Gibson PB, Demus D, Noto R, Hudson W, Johnson LL. Low event rate for stress-only perfusion imaging in patients evaluated for chest pain. J Am Coll Cardiol 2002;39:999-1004.
19. Vallejo EE, Acevedo C, Varela S, Alburez JC, Bialostozky D. Cost-efficiency and safety for stress-only myocardial perfusion SPECT imaging in patients evaluated for coronary artery disease [abstract]. J Nucl Cardiol 2003;10:S75.

SPECT attenuation correction: An essential tool to realize nuclear cardiology's manifest destiny

Ernest V. Garcia, PhD

Single photon emission computed tomography (SPECT) myocardial perfusion imaging has attained widespread clinical acceptance as a standard of care for cardiac patients. Yet, physical phenomena degrade the accuracy of how our cardiac images are visually interpreted or quantitatively analyzed. This degradation results in cardiac images in which brightness or counts are not necessarily linear with tracer uptake or myocardial perfusion. Attenuation correction (AC) is a methodology that has evolved over the last 30 years to compensate for this degradation. Numerous AC clinical trials over the last 10 years have shown increased diagnostic accuracy over non-AC SPECT for detecting and localizing coronary artery disease, particularly for significantly increasing specificity and normalcy rate. This overwhelming evidence has prompted our professional societies to issue a joint position statement in 2004 recommending the use of AC to maximize SPECT diagnostic accuracy and clinical usefulness. Phantom and animal studies have convincingly shown how SPECT AC recovers the true regional myocardial activity concentration, while non-AC SPECT does not. Thus, AC is also an essential tool for extracting quantitative parameters from all types of cardiac radionuclide distributions, and plays an important role in establishing cardiac SPECT for flow, metabolic, innervation, and molecular imaging, our manifest destiny. (J Nucl Cardiol 2007;14:16-24.)

Key Words: SPECT • attenuation correction • absolute quantification • myocardial perfusion imaging

Single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) has attained widespread clinical acceptance as a standard of care for patients with known or suspected coronary artery disease (CAD). The rapid technologic advancements in computed tomography (CT) angiography and the continuing improvements in cardiac magnetic resonance (MR) have prompted many persons to ask about the future of nuclear cardiology or, more specifically, cardiac SPECT imaging. The trend has been that manufacturers continue to invest in more technologically advanced (and expensive) CT, MR, and positron emission tomography (PET) scanners. At the same time, they continue to build simpler, less sophisticated SPECT systems using the same Anger technology of 50 years ago, often leaving SPECT technologic advancements such as attenuation correction (AC) behind. Yet, the number of cardiac patients imaged with SPECT overshadows the other 3 modalities combined. This is an opportune time to argue how AC is an essential tool to ensure optimal diagnostic accuracy but also how AC will allow nuclear cardiology to capitalize on its quantitative strength to ensure continued growth and success to realize our manifest destiny.

Manifest destiny expresses the concept that an entity that believes in its mission has a responsibility to realize its potential, spreading its belief of what is fundamentally important. The phrase implies that this dissemination is not only good but that it is obvious ("manifest") and certain ("destiny"). The fundamentally important concepts of nuclear cardiology are that (1) we measure cardiac physiology, (2) physiologic changes precede morphologic changes, and (3) the earlier the detection of pathophysiology, the more likely that cardiac damage is arrested or reversed. Indeed, the now popular concept of predictive health[1] promotes the goal of using techniques such as molecular imaging to detect and treat disease even before it has ever been expressed.[2] This argument highlights the superiority of nuclear cardiology over other competing modalities but also points out that our success is coupled to our ability to accurately quantify our images,[3] an important property of AC.

This article describes what is meant by AC and provides an argument as to why it is an essential component of our manifest destiny. The article also

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describes why AC should be part of our present and future armamentarium, as well as how we should use it. It also dispels some of the myths as to why AC should not be used. Although the arguments in this article relate more directly to MPI, the mainstay of nuclear cardiology, similar arguments hold true for nuclear metabolic, innervation, and molecular cardiovascular imaging.

WHAT IS OUR GOAL?

Our primary goal is to improve diagnostic or prognostic accuracy, resulting in improved patient management (ie, improved outcomes). In implementing any kind of new technology, the first question we should ask is whether it is consistent with these goals. Our secondary goal should be to realize this improvement at a similar or reduced cost to the health care system.

One problem with realizing our primary goal is that it is difficult to show diagnostic improvement when comparing our physiologic technique with a morphologic technique such as conventional coronary arteriography as a gold standard. Even when trying to equate these 2 phenomena, it is well known that coronary arteriography is usually evaluated subjectively (usually by 1 interpreter), suffers from interobserver variability, has been shown by CT angiography to have difficulty in detecting soft plaques, is a relative technique not accounting for absolute lumen cross-sectional area, and is practiced with a strong bias for finding disease to treat. It is difficult to explain how many investigators, particularly in evaluating any new technology, can achieve such high agreement between our physiologic results and these anatomic results. The answer is that the initial test population is probably carefully selected with a clear-cut distinction between abnormal and normal patients. This is why the accuracy of a new technique decreases over time as it is tested in more realistic populations and clinical settings by investigators independent of those who developed the technology. This is commonly called the difference between efficacy (the former) and effectiveness (the latter).

In part, because of the understanding of these limitations, proxies for a gold standard have been used in our literature. One such proxy is the normalcy rate—that is, the rate at which patients with a low likelihood of disease are detected as normal. Unfortunately, investigators are increasingly using patients known to have normal tracer distributions to test the normalcy rate, rather than finding independent tests for normality from the technology being tested. Even more concerning is that investigators are beginning to use these low-likelihood patients to measure specificity, without an independent verification of the absence of disease in these patients.

Prognosis has been another proxy for a gold standard that has been used. The logic is that if we are comparing two techniques, the technique that is a stronger prognosticator is the better technique. Although this argument does make some sense, prognostic investigations often determine optimal thresholds between techniques that show significant differences without ever testing them prospectively on other populations, and the results may be strongly influenced by a few more endpoints having been reached by one of the techniques in comparison to the other. These are hardly attributes that lend themselves to optimizing or validating new technology.

Thus, without a proper physiologic gold standard, it is difficult and perhaps even detrimental to continue to depend on our comparisons to morphologic techniques, particularly when the accuracy of our objective, quantitative techniques may be surpassing the accuracy of the anatomic techniques. These limitations are also the reason why the fairest comparison of two technologies is in the same exact patient population, as had been the case in the clinical trials evaluating SPECT with AC versus SPECT with no AC.

The cost to health care of implementing the new technology should also be considered. This is not just the cost of purchasing and using AC, in our case, but the implication of the cost on the entire health care system. It has been shown that new technologies, and even expensive technologies to start up such as cardiac PET imaging, can save health care dollars if their diagnostic accuracy is significantly improved over other techniques.[4] This is true because the most expensive aspect of managing a cardiac patient is the treatment (such as bypass surgery or stenting) rather than the diagnosis, so the more accurate diagnosis results in more appropriate and less expensive treatments because health care dollars are not wasted on the wrong treatments.

WHAT DO WE REALLY MEAN BY AC?

AC, to many, means compensation for those photons emitted from the myocardium that, instead of being counted by the SPECT camera, are absorbed by a combination of the photoelectric and Compton scatter effects from atoms in the patient, yielding a reduced regional count density, confounding the perception or measurement of the true tracer concentration (ie, true myocardial perfusion). The loss of counts varies angularly, increasing for projections where the most tissue is located, between the heart and the detector, and this causes inconsistencies during the reconstruction process, leading to imaging artifacts.

This soft-tissue attenuation is what commonly gives rise to reduced counts in the anterior or lateral walls in women as a result of breast attenuation and reduced

counts in the inferior wall in men as a result of preferential diaphragmatic attenuation.[5] This reduction in counts is usually seen on both the stress and rest images, giving rise to the appearance of a fixed perfusion defect mimicking a myocardial infarction. If the relative position of the attenuating soft tissue is altered between the stress and rest study, it may give rise to an apparent reversible perfusion defect mimicking ischemia. Imaging a female patient with her bra on during stress and her bra off during rest is an example of a situation that would mimic a reversible perfusion abnormality.

Correction for photon absorption usually uses a transmission scan from which attenuation coefficients along the thorax may be measured and used to mathematically correct for the absorption. This transmission scan is obtained either with sealed radioactive sources, such as gadolinium 153, or with x-ray sources, such as CT scanners.

Today, *attenuation correction* has become a catchall phrase that means compensation for all phenomena that prevent the recovery of the true tracer concentration, sometimes called *absolute quantification*. At a minimum, this requires, in addition to correction for absorption, correction for Compton scatter and correction for the degradation of resolution with depth.[6]

Compton scatter refers to photons that are emitted from the patient and interact with the patient's atoms, not enough to be totally absorbed but enough to change direction and lose energy. Many of these scattered photons are absorbed, but others reach the camera and are counted as though they followed a straight path. This phenomenon yields more counts than expected, and these counts are incorrectly located, giving rise to a reduction in image contrast, including making perfusion defects appear smaller or totally absent. The lower the energy of the emitted photons, the worse the Compton scatter contribution and also the more photons that are absorbed by the patient. For example, the transition from imaging the 70 keV from thallium 201 to the 140 keV of technetium 99m tetrofosmin or sestamibi yielded a reduction in photon absorption of approximately 20% but a 50% reduction in counting Compton-scattered counts in the myocardium, significantly improving the faithfulness of the relationship between counts and concentration in our images. AC with Tc-99m is applied more easily and more accurately than AC with Tl-201 because of the higher dose of the Tc-99m studies and because Tc-99m emits a monoenergetic photon with higher energy in contrast to the multiple, lower-energy photons emitted by Tl-201. Compton scatter correction usually uses some form of measuring or modeling the scatter contribution in the images, which is then subtracted.

The change of resolution with depth results in a degradation of resolution the farther an object is imaged away from the detector. This is due, for the most part, to the finite length and width of the collimator holes and is reduced by longer-bore collimator holes. In SPECT, when imaging a specific region, such as the cardiac apex, we find that it is located at different distances from the collimator for each projection angle, and thus it is imaged at different resolutions for each projection. This angular difference in resolution may result in reconstruction artifacts such as a photopenic apex as a result of these angular inconsistencies. This artifact is exacerbated by AC because it preferentially increases the counts toward the base of the left ventricle, further highlighting the photopenic apex.[7] This artifact may be reduced in a number of ways including using longer-bore collimators, using circular orbits, centering the left ventricle in the field of view, using 360° orbits, and most commonly, using mathematic techniques to promote uniform resolution.

Exciting new techniques have been introduced recently by several manufacturers for correction with regard to depth-dependent resolution and scatter compensation, which are undergoing clinical validation. The use of these techniques, coupled with AC, is expected to continue to increase the diagnostic and quantitative accuracy of our images and to allow either shorter acquisition times or reduced injected doses.[8]

The techniques used in correcting for the 3 phenomena described previously (photon absorption, Compton scatter, and degradation of resolution with depth), together with quality-control methods specific for properly applying these corrections, form the second-generation AC algorithms that are found in most commercial systems today. The hardware and specific software algorithms used to correct for each of these factors are the reasons for differences in commercially available systems. These differences between systems do require independent clinical validation for each approach.

Beyond correction for these 3 effects, there are other phenomena that degrade our ability to extract the true tracer concentration and for which we are not routinely correcting. One of these is the partial-volume effect. As a result of limited spatial resolution, objects smaller than twice the resolution of the system, such as the myocardial wall, yield regional maximal pixel counts that are directly proportional to the thickness of the wall. This implies that the thinner the myocardial wall, the dimmer it appears, even though its uptake might be the same as the uptake in a contralateral thicker wall.[9] Another image-degrading phenomenon is septal penetration. This occurs when photons travel right through the lead collimator, and it is more common when a radionuclide with higher-energy components is imaged with a lower-energy collimator, such as when imaging iodine 123 with a low-energy collimator.[10] Perhaps the most insidious

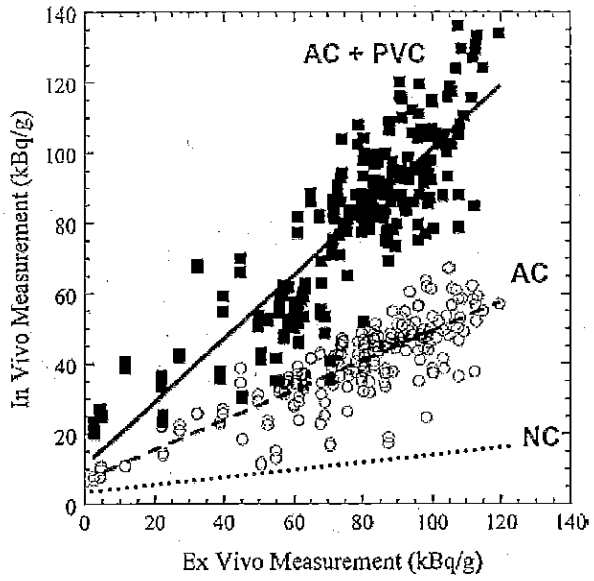

Figure 1. In vivo versus ex vivo Tc-99m sestamibi regional myocardial activity concentration measurement for 8 pigs. *Circles*, Activity concentration measured in every myocardial segment with only AC applied. *Squares*, Activity concentration measured in every myocardial segment with both AC and partial-volume correction (*PVC*) applied. The *dotted line* was added to indicate the activity concentration regression obtained when no correction (*NC*) was used, as is typical in clinical SPECT studies without AC. (Adapted with permission from reference.[13])

problem for which there is no routine correction is the degradation of the inferior wall of the left ventricle from hot liver uptake when the patient's deep breaths cause the liver to move in and out of the inferior wall field of view.[11] Only respiratory gating has a chance to reduce or eliminate this problem.[12]

It is clear that all of these imaging phenomena degrade the faithfulness of the reconstructed regional counts—that is, the brightness that we see on our cardiac images is not necessarily linear with tracer uptake or myocardial perfusion. Similarly, these artifacts degrade the accuracy of our quantitative measurements. One of the main reasons to use AC is that even in the simplest of implementations, the recovered counts from AC are markedly better related to the true tracer concentration than when AC is not used and thus quantitative estimates of measurements that require the true tracer concentration are more accurately determined with AC. For example, it has been shown that without corrections, the measured in vivo activity concentration in a porcine myocardium model was only 10% of the true value.[13] Figure 1 shows that by correcting for both attenuation and partial-volume errors, absolute quantification recovered the tracer concentration in vivo with an accuracy error near 10%.[13] It should also be noted that the increase in slope between the corrected and uncorrected methods demonstrates the marked contrast resolution gained between a region of low concentration and a region of high concentration.

WHY SHOULD WE USE AC?

The most cogent reason for using AC today is that it improves diagnostic accuracy by eliminating or markedly reducing soft-tissue artifacts.[14,15] Usually, the most significant improvement in diagnostic accuracy results from more normal patients being interpreted as having normal studies. Use of AC also promotes higher physician confidence in interpreting all MPI studies.[16] This is partly because the normal attenuation-corrected myocardial perfusion distribution is more homogeneous and has less variance than the uncorrected one and AC reduces or removes the dependence on body habitus of the normal distribution.[17] Thus the attenuation-corrected normal distributions for male patients and female patients are very similar, eliminating the need for considering gender-matched normal files when interpreting these studies visually or quantitatively.[18] These attributes also lead to reduced interobserver and intraobserver variability.[19-21] This independence from body habitus and from body mass[20] also results in the attenuation-corrected normal myocardial perfusion distribution of patients from a large population being similar to the distribution of patients from a smaller population. This obviates the need for developing population-specific normal files, as is currently being considered in Japan and China and often discussed in Europe.

Practically every clinical trial that has been undertaken to determine the diagnostic performance of attenuation-corrected SPECT MPI has resulted in improved diagnostic accuracy over uncorrected studies. This is true whether the interpretation has been done visually or quantitatively[18] and is incremental to improvements resulting from gated MPI.[22,23] The improved diagnostic performance is more evident in a heavier patient population.[18,23] The most common finding in these trials is that, compared with non–attenuation-corrected SPECT, AC significantly improves the normalcy rate and specificity for detecting CAD. Though less common, clinical trials have also demonstrated that AC can significantly improve sensitivity, particularly for the detection of left main[24] and multivessel disease.[25] This is important because of the concern of missing patients with coronary disease in multiple vascular territories that give rise to the so-called balanced reduction of flow, which is a confounding factor in misinterpreting these studies as exhibiting normal perfusion. Table 1 summarizes the results of the major clinical AC trials.[18,23,26-36]

It should be noted from the summary of results from

Table 1. Diagnostic accuracy of detecting CAD with AC and with no AC

	Year	Radionuclide	System	No. of patients	Sensitivity (%)		Specificity (%)		Normalcy (%)	
					NC	AC	NC	AC	NC	AC
Author										
Ficaro et al[26]	1996	Tc-99m	U-Mich	119	78	84	46	82	88	98
Gallowitsch et al[27]	1998	Tl-201	GE-Elscint	49	89	94	69	84	NA	NA
Hendel et al[28]	1999	Tc-99m	Philips-Adac	200	76	78	44	50	86	96
Links et al[29]	2000	Tc-99m	GE-SMV	112	84	88	56	94	74	91
Lenzo et al[30]	2001	Tc-99m	Siemens	171	93	93	84	88	78	85
Shotwell et al[31]	2002	Tl-201	Philips-Picker	118	82	86	NA	NA	74	88
Slart et al[32]	2003	Tc-99m	Siemens	38	100	89	61	92	NA	NA
Banzo et al[33]	2003	Tc-99m	Philips-Adac	99	92	76	46	71	NA	NA
Grossman et al[18]	2004	Tc-99m	Philips-Adac	95	97	90	29	57	52	90
Masood et al[34]	2005	Tc-99m	GE-Hawkeye	118	93	94	56	59	84	97
Utsunomiya et al[35]	2005	Tc-99m	GE-Hawkeye	30	67	76	86	93	NA	NA
Thompson et al[23]	2005	Tc-99m	Philips	118	88	86	50	79	NA	NA
Esteves et al[36]	2006	Tc-99m	Philips	60	80	87	NA	NA	64	92
Total/mean				1327	86	86	57	77	75	92

NC, No correction; *NA*, not available.
Manufacturer information: GE Healthcare Technologies (Waukesha, Wisc); Philips Laboratories (Milpitas, Calif); Siemens Medical Solutions (Malvern, Pa).

13 clinical trials in Table 1 that using AC for the diagnosis of CAD yielded a marked increase in the specificity (77% vs 57%) and normalcy rate (92% vs 72%) at the same sensitivity (86%). Although these results may vary for any one clinical trial because of differences in populations and technique, they clearly demonstrate that AC markedly improves diagnostic accuracy over no AC regardless of (1) clinical site, (2) generation of AC, (3) radionuclide used, (4) camera manufacturer, (5) sealed radioactive source or x-ray source used for transmission scan, (6) whether quantitative versus qualitative techniques are used, (7) whether an obese versus a nonobese population is studied, and (8) whether exercise or pharmacologic stress is used.

After both single-institution trials and multicenter trials demonstrated impressive results, the American Society of Nuclear Cardiology and the Society of Nuclear Medicine followed a 2002 preliminary position statement[14] with a very strong position statement recommending that "when available and technically feasible, attenuation correction should be used in addition to electrocardiography gating with single photon emission computed tomographic (SPECT) myocardial perfusion imaging to maximize its diagnostic accuracy and clinical usefulness."[15] Moreover, these societies stated that it was their position that "incorporation of attenuation correction in addition to ECG [electrocardiography] gating with SPECT myocardial perfusion images will improve image quality, interpretive certainty, and diagnostic accuracy. These combined results are anticipated to have a substantial impact on improving the effectiveness of care and lowering of health care costs."[15]

Use of AC also facilitates the implementation of new clinical applications. For example, use of AC is essential for the implementation of the cost-effective stress-only protocol.[16,37] This is a protocol in which patients undergo imaging after stress, and if the images are normal, the study is terminated. If there is a region of reduced myocardial counts as a result of soft-tissue attenuation, AC can correct this artifact, resulting in a normal study and eliminating the need for a rest study. Otherwise, the wall motion information does not help because wall thickening could be from an ischemic event that created the perfusion defect but the ischemia resolved by the time of imaging. Similarly, AC facilitates the use of MPI at rest in the emergency department to rule out acute coronary syndrome.[38] With this time-sensitive test, with little room for mistakes, soft-tissue attenuation could be misinterpreted as an infarct. A normal attenuation-corrected MPI study increases the clinician's confidence in deciding to discharge the patient.

WHAT ARE THE ARGUMENTS FOR NOT USING AC?

Opponents of AC usually indicate one or more of the following reasons for not using AC: (1) It is not ready for

clinical use. (2) There are other better techniques that accomplish the same goal. (3) Purchasing and using an AC system require additional cost with no additional reimbursement. Below are the counter-arguments for each of these.

AC is not ready for clinical use. This argument is used less frequently these days, but those who continue to make it seem to imply that the expectation for AC is that it should correct our images to yield perfect results (ie, a one-to-one correspondence between counts and tracer concentration). Moreover, they point out that AC also creates new artifacts and that results vary among the camera manufacturers.

This argument originated when AC was first introduced. Those first-generation systems (like most first-generation systems) had many technical flaws and no quality-control procedures to detect them. Most of these have been remedied in the second-generation systems, which generate and require a low noise transmission image; corrections for absorption, scatter, and resolution; corrections for cross-talk in simultaneously acquired emission and transmission scans; and quality-control procedures for truncation and misregistration between the transmission and emission studies when performed sequentially.

The following question arises: when is any technology ready for clinical use? The consensus is when it is widely available and it has been shown to provide diagnostic or other improvements over existing technology. As stated previously, all AC clinical trials, regardless of the camera manufacturer, have shown improved diagnostic accuracy. It is true that AC may overcorrect the inferior wall in some patients with hot gut uptake and that an improperly quality-controlled attenuation-corrected study may cause confounding imaging artifacts. However, the results of the clinical trials clearly indicate that AC corrects significantly many more artifacts than it creates.

Other (less expensive) techniques may be used in place of AC. There are a variety of techniques, other than AC, that have been suggested to overcome attenuation artifacts. The first one is visual recognition of soft-tissue attenuation, usually perceived from the rotating planar images that predict the expected location of the count reduction artifact. Beyond requiring a high level of expertise, the challenge to this approach is that the physician has to assume that the myocardial count reduction is only a result of attenuation and not myocardial hypoperfusion. Clearly, the presence of a dense breast or high diaphragm does not rule out CAD. This uncertainty leads to less-than-confident interpretations.

The second popular technique used to overcome attenuation artifacts is gated MPI. The principle is that fixed myocardial perfusion defects associated with normal resting wall motion or thickening must be a result of attenuation artifacts because infarcted myocardium does not contract normally. This approach has been shown to be useful, but it does not help when there is a reversible defect or abnormal wall motion or thickening. Moreover, in patients with subendocardial myocardial infarctions who have resolved ischemia, these segments would present as a fixed perfusion abnormality with normal resting wall motion or thickening. These limitations are some of the reasons why clinical trials have shown that AC provides additional diagnostic improvement beyond the use of gated MPI.[22,23]

Prone imaging has also been suggested as a proxy for AC. The concept is that attenuation artifacts seen when imaging a patient in the supine position, particularly diaphragmatic attenuation, will be at least partially resolved when the same patient is imaged prone and the heart falls forward in the thorax as a result of gravity, unmasking the inferior myocardial wall. This approach has been shown to be useful in diaphragmatic attenuation, but it does require an additional acquisition, as compared with the supine-only protocol, and has not been shown to reduce breast attenuation or attenuation from underarm fat pads. It has also been shown that AC reduces the number of equivocal studies beyond those resolved by prone imaging.[39] In addition, prone imaging has been shown to reduce image contrast because the heart is being imaged through the table and has also been shown to create other artifacts. The additional acquisition and processing of the prone images are counter-arguments to a lower-cost technique, particularly because it only helps with some of the artifacts.

AC involves additional cost with no additional reimbursement. This is the excuse most often given for not using AC today. The argument is that it costs money to purchase and maintain AC systems, as well as to perform quality-control measures and acquire, process, and interpret images, yet there is no additional reimbursement to defray these costs. It is true that there was an effort by professional societies to establish an add-on code for SPECT AC, which has not been approved by the Centers for Medicare & Medicaid Services. However, this argument is a self-fulfilling prophecy. Reimbursement rates are established periodically after the field is surveyed to determine the overall cost of the equipment, radiopharmaceutical, and technologist and physician labor required for performing an effective diagnostic procedure. The more that nuclear cardiologists use AC, the more likely that its cost would be bundled with the reimbursement rate of the whole procedure. If it does not increase reimbursement, the use of AC should help defray the reductions in reimbursement resulting from other technologic improvements in the efficiency of performing our procedures.

This premise is validated by the example of cardiac PET. Every single PET scanner purchased for performing cardiac PET is equipped with devices for generating a transmission scan to be used for AC. This transmission study is always an additional scan. Every single cardiac PET image is interpreted with AC. Although there is no add-on code for this additional expense, the reimbursement rate for perfusion PET studies is markedly higher than that for perfusion SPECT. This is because the reimbursement rate is accounting for the higher cost of performing the PET study compared with the SPECT study, and the additional cost is justified by the expectation of improved diagnostic accuracy of PET over SPECT. This is exactly the same argument for comparing SPECT studies with AC versus SPECT studies without AC.

Another reimbursement lesson for SPECT imaging that can be learned from PET is that the Centers for Medicare & Medicaid Services and insurance companies refused to pay for PET studies performed with the lower-quality (and lower-cost) coincidence PET cameras, insisting that studies would only be reimbursed if performed with the high-quality conventional PET scanners. These same entities can ask (and have asked) why they should pay for the lower-quality SPECT studies without AC when SPECT studies with AC is widely available.

A technologic solution for eliminating the additional cost argument is hybrid SPECT-CT.[40] These systems are being purchased, in part, to image coronary calcium and, with the more advanced CT systems (≥16 slices), coronary soft plaque. The expected additional reimbursement for providing these services will more than pay for the CT device, which can now also be used for generating a transmission image for AC to yield a diagnostically more accurate SPECT study. As with any new technology, we must be careful to have proper quality-control procedures in place to guarantee the proper alignment of the emission and transmission images used for AC.[41]

MANIFEST DESTINY

To realize our manifest destiny, manufacturers need to also invest in technologic advancements in cardiac SPECT imaging, such as AC and new camera designs, to reach the imaging performance of PET scanners. Just as AC has been essential for cardiac PET to provide accurate measurements, AC for cardiac SPECT is essential for us to accurately extract measurements from dynamic and conventional SPECT studies to measure absolute tracer concentrations, coronary flow and flow reserve, metabolic rates, and so on.

Fortunately, two radically new SPECT camera designs have recently emerged, with at least one design claiming twice the spatial resolution and 10 times the sensitivity of standard SPECT devices.[42] These advancements coupled with AC strongly position SPECT imaging to efficiently and accurately quantify the flow and metabolic parameters mentioned previously. More importantly, these advancements may allow our field to become the imaging modality of choice for the realization of cardiovascular molecular imaging (CMI), where accurate measurement of tracer concentrations from an area of low uptake is often required.[43] It is through CMI that a cardiac patient will enjoy personalized medicine via treatments specific for the disease as manifested in the individual to arrest it or reverse it or to genetically prevent it from ever manifesting itself. It is through this technical sophistication and newly developed SPECT CMI tracers that nuclear cardiology will reach this manifest destiny.

The strength of nuclear cardiology has always been the inherently quantitative nature of our images and our ability to extract these quantitative parameters. Only through the use of correction techniques are we able to eliminate problems that degrade the quantitative nature of our images and recover the true tracer concentrations. Only through obtaining the true tracer concentrations can we obtain true measurements of myocardial physiology, which will continue to gain in importance and advance our field.

CONCLUSION

AC is a comprehensive method to improve the accuracy of how the true tracer concentration is extracted from our images. Numerous clinical trials have shown that AC improves the diagnostic accuracy of MPI for detecting CAD. These clinical trials have convinced our professional societies to strongly endorse the clinical use of AC in myocardial perfusion SPECT imaging. AC is also an essential requirement for accurately extracting quantitative parameters from all types of cardiac radionuclide distributions that should play an essential role in establishing cardiac SPECT for flow, metabolic, innervation, and molecular imaging.

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References

1. Snyderman R, Williams RS. Prospective medicine: the next health care transformation. Acad Med 2003;78:1079-84.
2. Hood L, Heath JR, Phelps ME, Lin B. Systems biology and new technologies enable predictive and preventative medicine. Science 2004;306:640-3.
3. Stodika RZ, Blackwood KJ, Kong H, Prato FS. A method for quantitative cell tracking using SPECT for the evaluation of myocardial stem cell therapy. Nucl Med Commun 2006;27: 807-13.
4. Patterson RE, Eisner RL, Horowitz SF. Comparison of cost-effectiveness and utility of exercise ECG, single photon emission computed tomography, positron emission tomography, and coronary angiography for diagnosis of coronary artery disease. Circulation 1995;91:54-65.
5. DePuey EG, Garcia EV. Optimal specificity of thallium-201 SPECT through recognition of imaging artifacts. J Nucl Med 1989;30:441-9.
6. Garcia EV. Quantitative myocardial perfusion single-photon emission computed tomographic imaging: quo vadis? (Where do we go from here). J Nucl Cardiol 1994;1:83-93.
7. Links JM, Becker LC, Anstett F. Clinical significance of apical thinning after attenuation correction. J Nucl Cardiol 2004;11: 26-31.
8. Borges-Neto S, Pagnanelli R, Shaw L, Coleman R. Clinical validation of the wide beam reconstruction method for shortening scan time of gated cardiac SPECT perfusion studies [abstract]. J Nucl Med 2006;47:272P.
9. Galt JR, Garcia EV, Robbins W. Effects of myocardial wall thickness on SPECT quantification. IEEE Trans Med Imaging 1990;9:144-50.
10. Chen J, Garcia EV, Galt JR, Folks RD, Carrio I. Improved quantification in 123-I cardiac SPECT imaging with deconvolution of septal penetration. Nucl Med Comm 2006;27:551-8.
11. Pitman AG, Kalff V, Van Every B, et al. Contributions of subdiaphragmatic activity, attenuation, and diaphragmatic motion to inferior wall artifact in attenuation-corrected Tc-99m myocardial perfusion SPECT. J Nucl Cardiol 2005;12:401-9.
12. Pitman AG, Kalff V, Van Every B, et al. Effect of mechanically simulated diaphragmatic respiratory motion on myocardial SPECT processed with and without attenuation correction. J Nucl Med 2002;43:1259-67.
13. Da Silva AJ, Tang HR, Wong KH, et al. Absolute quantification of regional myocardial uptake of 99mTc-sestamibi with SPECT: experimental validation in a porcine model. J Nucl Med 2001;42: 772-9.
14. Hendel RC, Corbett JR, Cullom SJ, et al. The value and practice of attenuation correction for myocardial perfusion SPECT imaging: a joint position statement from the American Society of Nuclear Cardiology and the Society of Nuclear Medicine. J Nucl Cardiol 2002;9:135-43.
15. Heller GV, Links J, Bateman TM, et al. American Society of Nuclear Cardiology and Society of Nuclear Medicine joint position statement: attenuation correction of myocardial perfusion SPECT scintigraphy. J Nucl Cardiol 2004;11:229-30.
16. Heller GV, Bateman TM, Johnson LL, et al. Clinical value of attenuation correction in stress-only Tc-99m sestamibi SPECT imaging. J Nucl Cardiol 2004;11:273-81.
17. Ficaro EP, Fessler JA, Achermann RJ, et al. Simultaneous transmission-emission thallium-201 cardiac SPECT: effect of attenuation correction on myocardial tracer distribution. J Nucl Med 1995;36:921-31.
18. Grossman GB, Garcia EV, Bateman TM, Heller GV, Johnson LL, Folks RD, et al. Quantitative Tc-99m sestamibi attenuation-corrected SPECT: development and multicenter trial validation of myocardial perfusion stress gender-independent normal database in an obese population. J Nucl Cardiol 2004;11:263-72.
19. Prvulovich EM, Lonn AH, Bomanji JB, et al. Effect of attenuation correction on myocardial thallium-201 distribution in patients with a low likelihood of coronary artery disease. Eur J Nucl Med 1997;24:266-75.
20. Kluge R, Sattler B, Seese A, et al. Attenuation correction by simultaneous emission-transmission myocardial single-photon emission tomography using a technetium-99m-labelled radiotracer: impact on diagnostic accuracy. Eur J Nucl Med 1997;24: 1107-14.
21. Ficaro EP. Should SPET attenuation correction be more widely employed in routine clinical practice? Eur J Nucl Med Mol Imaging 2002;29:409-12.
22. Links JM, DePuey EG, Taillefer R, Becker LC. Attenuation correction and gating synergistically improve the diagnostic accuracy of myocardial perfusion SPECT. J Nucl Cardiol 2002;9:183-7.
23. Thompson RC, Heller GV, Johnson LJ, Case JA, Cullom J, Garcia EV, et al. Value of attenuation correction on ECG-gated myocardial perfusion imaging related to body mass index. J Nucl Cardiol 2005;12:195-202.
24. Duvernoy CS, Ficaro EP, Karabajakian MZ, Rose PA, Corbett JR. Improved detection of left main coronary artery disease with attenuation-corrected SPECT. J Nucl Cardiol 2000;7:639-48.
25. Ficaro E, Duvernoy C, Karabajakian M, Corbett J. Evaluation of attenuation corrected SPECT perfusion imaging in patients with multi-vessel disease [abstract]. Circulation 1997;96:I-308.
26. Ficaro EP, Fessler JA, Shreve PD, et al. Simultaneous transmission/emission myocardial perfusion tomography. Diagnostic accuracy of attenuation-corrected 99mTc-sestamibi single-photon emission computed tomography. Circulation 1996;93:463-73.
27. Gallowitsch HJ, Sykora J, Mikosch P, et al. Attenuation-corrected thallium-201 single-photon emission tomography using a gadolinium-153 moving line source: clinical value and the impact of attenuation correction on the extent and severity of perfusion abnormalities. Eur J Nucl Med 1998;25:220-8.
28. Hendel RC, Berman DS, Cullom SJ, et al. Multicenter clinical trial to evaluate the efficacy of correction for photon attenuation and scatter in SPECT myocardial perfusion imaging. Circulation 1999; 99:2742-9.
29. Links JM, Becker LC, Rigo P, et al. Combined corrections for attenuation, depth-dependent blur, and motion in cardiac SPECT: a multicenter trial. J Nucl Cardiol 2000;7:414-25.
30. Lenzo N, Ficaro EP, Kritzman JN, Corbett JR. Clinical comparison of profile attenuation correction and the Michigan STEP methods [abstract]. J Nucl Cardiol 2001;8:S19.
31. Shotwell M, Singh BM, Fortman C, Bauman BD, Lukes J, Gerson MC. Improved coronary disease detection with quantitative attenuation-corrected Tl-201 images. J Nucl Cardiol 2002;9:52-62.
32. Slart RH, Tjin HQ, Dirk J, et al. Effect of attenuation correction on the interpretation of 99mTc-sestamibi myocardial perfusion scintigraphy: the impact of 1 year's experience. Eur J Nucl Med Mol Imaging 2003;30:1505-9.
33. Banzo I, Hernandez AR, Pena FJ, et al. Prospective clinical comparison of non-corrected and attenuation- and scatter-corrected myocardial perfusion SPECT in patients with suspicion of coronary artery disease. Nucl Med Commun 2003;24:995-1002.
34. Masood Y, Liu YH, DePuey G, et al. Clinical validation of SPECT attenuation correction using x-ray computed tomography-derived attenuation maps: multicenter clinical trial with angiographic correlation. J Nucl Cardiol 2005;12:676-86.

35. Utsunomiya D, Tomiguchi S, Shiraishi S, et al. Initial experience with X-ray CT based attenuation correction in myocardial perfusion SPECT imaging using a combined SPECT/CT system. Ann Nucl Med 2005;19:485-9.
36. Esteves FP, Santana CA, Folks RD, Lerakis S, Garcia EV. Attenuation-corrected adenosine stress Tc-99m sestamibi myocardial perfusion SPECT: does it make a difference in image interpretation? [abstract]. J Nucl Cardiol 2006;13:S9.
37. Gibson PB, Demus D, Noto R, et al. Low event rate for stress-only perfusion imaging in patients evaluated for chest pain. J Am Coll Cardiol 2002;39:999-1004.
38. Holly TA, Toth BM, Leonard SM, et al. Incremental value of attenuation correction in SPECT myocardial perfusion imaging for patients with acute chest pain [abstract]. Circulation 1997;96: I-735.
39. Malkemeker D, Brenner R, Martin WH, Delbeke D. X-ray attenuation correction versus prone imaging to decrease equivocal interpretations of rest/stress ^{99m}Tc-tetrofosmin SPECT MPI [abstract]. J Nucl Cardiol 2006;13:S6.
40. O'Connor MK, Kemp BJ. Single-photon emission computed tomography/computed tomography: basic instrumentation and innovations. Semin Nucl Med 2006;36:258-66.
41. Chen J, Caputlu-Wilson SF, Shi H, Galt JR, Faber TL, Garcia EV. Automated quality control of emission-transmission misalignment for attenuation correction in myocardial perfusion imaging with SPECT-CT systems. J Nucl Cardiol 2006;13:43-9.
42. Patton J, Sandler M, Berman D, et al. D-SPECT: a new solid state camera for high speed molecular imaging [abstract]. J Nucl Med 2006;47:189P.
43. Li S, Dobrucki LW, Sinusas AJ, Liu YH. A new method for SPECT quantification of targeted radiotracers uptake in the myocardium. Med Image Comput Comput Assist Interv Int Conf Med Image Comput Comput Assist Interv 2005;8(Pt 2): 684-91.

ORIGINAL ARTICLE

Clinical value of stress-only Tc-99m SPECT imaging: Importance of attenuation correction

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Background. In selected patients, stress-only SPECT imaging has been proposed as an alternative to rest-stress SPECT imaging to improve laboratory efficiency and reduce radiation exposure. The impact of attenuation correction (AC) upon interpretation, post-test patient management and cardiac risk stratification in relation to stress-only imaging is not well understood.

Objectives. The purpose of this study was to determine the clinical value for laboratory throughput and predicting outcomes of normal and abnormal stress-only SPECT imaging with AC in a consecutive series of clinically referred patients.

Methods. A retrospective analysis of 1,383 consecutive patients who were scheduled for stress-only SPECT imaging for symptom assessment of suspected myocardial ischemia was performed. All images had been interpreted and categorized using the standard 17-segment model without AC followed by AC. Follow-up data for 2.1 ± 1.3 years after SPECT imaging for the occurrence of cardiac events (non-fatal MI, cardiac death, and cardiac revascularization) previously collected by routine methods were reviewed.

Results. Non-AC SPECT image interpretation revealed that 58% (802/1383) of patients had abnormal stress images. AC image interpretation of the abnormal non-AC images re-classified 83% (666/802) of these as normal. Among patients with abnormal stress images after AC (136/1383), 63% (86/136) returned for additional rest scans, while the remaining 37% (50/136) were clinically managed without further rest images. The incidence of cardiac death or non-fatal MI was very low in patients with normal stress-only scans (0.7%).

Conclusion. A strategy of stress-only imaging with AC in symptomatic patients is an efficient method which appropriately identifies at risk and low-risk patients yielding a low percentage requiring rest imaging. Clinical decisions can be made based on abnormal stress-only imaging without further rest imaging if clinically appropriate. (J Nucl Cardiol 2013;20:27–37.)

Key Words: Attenuation correction • stress-only • SPECT • myocardial perfusion imaging

INTRODUCTION

Rest-stress Tc-99m single-photon emission computed tomography (SPECT) imaging is a widely used non-invasive technique for the assessment of patients with known or suspected coronary artery disease (CAD). Unfortunately, this procedure requires 3-4 hours to complete, with considerable time spent on a rest study that often is not necessary or useful. Stress-only imaging in selected patients has emerged as an alternative means of reducing both procedure time and radiation exposure.[1,2] With this approach, the necessity for a comparative rest study is dependent upon the presence of an abnormal finding on stress imaging which frequently is due to attenuation artifact and has been estimated to occur in 50%-78% of studies.[3] The use of attenuation correction (AC) with SPECT has been shown to significantly reduce false positive studies for both rest-stress and stress-only imaging.[3,4]

The value of stress-only imaging with normal results has been confirmed by outcomes data from previous studies.[1,5-7] While most of these studies utilized AC, there

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is insufficient information on the impact of this technique with stress-only imaging regarding post-test patient management (necessity for additional rest imaging) and cardiac risk stratification. Accordingly, the purpose of this study was to determine the clinical value of stress-only SPECT imaging with AC in a consecutive series of clinically referred patients with symptoms suggestive of myocardial ischemia.

METHODS

Patient Selection

This study was approved by and conducted within guidelines established by the Institutional Review Board of Hartford Hospital. This was a single-center, retrospective study. Consecutive patients referred for chest pain evaluation scheduled for stress-only Tc-99m SPECT imaging between January 2003 and December 2006 were identified in the Nuclear Cardiology Laboratory clinical database at Hartford Hospital. Complete demographics and medical history of all patients were obtained and systematically recorded in this clinical database prior to stress testing. History of CAD, congestive heart failure (CHF), and other risk factors was obtained by the stress lab physician from patient interview, referring physician's office notes and requisitions for stress testing. Pretest probability of CAD was calculated for all patients using the standard Diamond and Forrester classification.[8] Most patients referred for stress nuclear imaging for chest pain evaluation who did not have a history of CAD underwent a stress-only protocol. Routinely, patients with evident previous myocardial infarction (MI) or coronary artery bypass grafting (CABG) were discouraged from stress-only imaging assuming a high likelihood of a subsequent rest study being needed. The general considerations for utilizing a stress-only protocol are listed in Table 1. Patients were followed for necessity of rest imaging and cardiac events including revascularization.

Table 1. Patient selection for stress-only protocol versus standard rest-stress protocol

Patient characteristic	Stress only/ stress first protocol	Rest-stress protocol
Chest pain evaluation with no prior history of CAD	Yes	No
Known CAD (with or without prior PCI) without any history of MI/CABG	Yes	No
Previous MI/CABG	No	Yes
Morbid obesity	No	Yes
Cardiomyopathy/ preoperative evaluation	No	Yes

Stress Protocols

Patients were scheduled for a specific stress modality according to the discretion of their referring physician, based upon perceived functional ability. Exercise was performed using symptom-limited treadmill testing according to the standard or modified Bruce protocol and within the guidelines recommended by the ACC/AHA. Vasodilator stress (with standard infusion of dipyridamole or adenosine) was performed either solely or with the addition of exercise (for those patients perceived unable to perform adequate exercise).

Imaging Protocol

Stress and, if obtained, rest images were acquired 15-60 minutes following injection of 30-45 mCi of Tc-99m sestamibi or tetrofosmin based upon body habitus. Resting images were acquired the following day on a subset of these patients to determine whether ischemia, scar, or attenuation artifact was present. All procedures followed ACC/ASNC guidelines. Specifically, all patients were imaged using 64 projections per study with at least 25-30 second per projection. Images were acquired using either Cardio 60 Vertex or Cardio MD fixed-90° dual-head SPECT cameras each outfitted with commercially available line source AC hardware and software (VantagePro [Philips Medical Systems, Milpitas, California] and ExSPECT II [Emory University, Atlanta, Georgia and Cardiovascular Imaging Technologies, Kansas City, Missouri]).

Image Reconstruction

Non-attenuation corrected (non-AC) myocardial perfusion and ECG-gated transverse images were reconstructed with filtered back-projection after low-pass filtering for noise. Butterworth filters with a cutoff of 0.46 times the Nyquist and an order of 5.0 and with a cutoff of 0.32 times the Nyquist and an order of 5.0 were used. Attenuation maps were reconstructed using a previously described algorithm that uses a Bayesian prior approach with Butterworth filter preprocessing with a cutoff of 0.43 and an order of 5.0.21. The attenuation map reconstruction used 12 iterations with a uniform initial estimate. AC of the emission images used maximum likelihood reconstruction with 30 iterations and uniform initial estimate.

Image Interpretation

Processed images with ECG gating, if performed, were displayed via the short-axis, vertical long-axis, and horizontal long-axis images in monochrome and color tables. Our

standard clinical practice involved image interpretation by at least two board certified readers during daily reading sessions using the standard 17-segment model and scoring system.[9] Each stress study was interpreted sequentially beginning with non-AC images first and then compared with AC images. Both non-AC and AC data were collected and recorded in our clinical database. Each segment was visually assessed and scored on a scale of 0-4 (0 = normal, 1 = mild, 2 = moderate, 3 = severe, 4 = absent photon activity). Both non-AC and AC data were included in the final reports, but the final conclusion was primarily based on AC image interpretation. Summed stress scores (SSS) were calculated by adding the 17-segment scores at stress. Based upon previous data, AC images were considered abnormal if the SSS > 0.[10] An AC SSS of 1-8 was considered mildly abnormal and >8 considered moderate to severely abnormal.[10] For the purpose of this study, non-AC images with SSS ≥ 1 were considered abnormal because small perfusion defects on stress imaging often prompt additional rest imaging. Summed rest scores (SRS) and summed difference scores (SDS) were calculated in patients who underwent additional rest imaging. Ejection fraction (EF) was reported separately in patients where gating could be performed. An EF < 50% was considered abnormal. For the purpose of this study, abnormal EF was not criteria to categorize an image as abnormal. An abnormal ECG response or chest pain during exercise or pharmacologic stress testing was routinely reported, but the final conclusion of the study was based on the SSS. For example, a patient who developed chest tightness with pharmacologic stress and T wave inversions on the ECG, but displayed normal perfusion and normal function on SPECT imaging, the final conclusion was reported as a normal study, even though the clinical symptoms and ECG changes were mentioned under stress test findings.

Follow-Up

Patient follow-up was routinely obtained by mailed questionnaires approximately 2 years after SPECT imaging. This is a tool that asks for endpoints including cardiac revascularization, non-fatal MI, and death from any cause. If there was no response or more information was needed, scripted telephone interviews were attempted. An investigator, unaware of clinical stress testing, and ECG-gated SPECT data, confirmed events by reviewing hospital records and the public social security database.

The endpoints for this study were cardiac revascularization including percutaneous coronary intervention (PCI) or CABG, non-fatal MI or cardiac death. The primary endpoint for the study was a composite of cardiac death or non-fatal MI. Cardiac death was defined as death due to heart failure, arrhythmia, or acute coronary syndrome. Patients with either non-fatal MI or cardiac death were censored after the first event.

Statistical Analysis

All statistical analysis was performed using SPSS version 17 (Chicago, IL).Clinical and demographic characteristics were expressed as percentages or mean ± standard deviation. Inter-group comparisons were performed using χ^2 tests for categorical variables and t tests or ANOVA for continuous variables. Annualized cardiac event rates were calculated as the number of events divided by the sum of each individual follow-up period in years. A P value <.05 was considered significant in all analyses.

RESULTS

Fifteen hundred and seven consecutive patients were scheduled for clinically indicated stress-only SPECT imaging. Complete follow-up was obtained in 92% (1,383/1,507) of these patients, which constituted the study cohort. All patients were followed for a mean of 2.1 ± 1.3 years. Patient characteristics are shown in Table 2. The mean age of the study population was 54 ± 12 years; 54% was males, 27% had diabetes, and 1% had prior CABG. Almost half of the study cohort (49% [681/1,383]) underwent pharmacologic stress. The mean pretest probability of CAD in the study cohort was 25 ± 27 (intermediate probability).[8] By design, a history of prior MI or CABG was very low in the study cohort.

Impact of AC on Image Interpretation

Without AC, SPECT image interpretation revealed that 58% (802/1,383) of the stress images were abnormal, with only 42% (581/1,383) initially considered normal (Figure 1). Evaluation of the AC image re-classified 83% (666/802) of the abnormal stress images as completely normal, while 17% (136/802) remained abnormal (Figure 1). A majority (80% [532/666]) of the abnormal non-AC images that were re-classified as normal with AC had a non-AC SSS < 4 (mean 2.95 ± 1.6).

Gated SPECT Data

ECG-gating could be performed in 88% (1,219/1,383) of the study patients. The mean EF of the study cohort was 64% ± 8%. Patients with normal AC images had a mean EF of 65% ± 8% whereas those with abnormal AC images had a mean EF of 60% ± 8%.

Clinical Decision With Versus Without Additional Rest Imaging

Referring physicians were provided with both non-AC and AC data. For those studies with abnormal AC images (n = 136), a rest study was requested and obtained in 67% (86/136) of patients. This constituted 6.2% of the entire study cohort (86/1,383). For the remaining 33% (50/136) of patients with an abnormal AC image, a clinical decision was made by the referring physician based on stress-only

Table 2. Demographic characteristics of patients undergoing stress-only imaging

Patient characteristics	Total study cohort (n = 1,383)
Age	54 ± 12
Pretest probability	25 ± 27
BMI	33 ± 9
Males	750 (54%)
Hx of CAD	64 (4.6%)
Hx of myocardial infarction	42 (3%)
Hx of CABG	16 (1.2%)
Hx of PTCA	18 (1.3%)
Hx of congestive heart failure	33 (2.3%)
Hx of diabetes	373 (27%)
Hx of hypertension	760 (55%)
Family Hx	548 (40%)
Hx of hyperlipidemia	574 (42%)
Hx of tobacco use	610 (44%)
Pharmacologic stress	681 (49%)

BMI, Body mass index; *Hx*, history of; *CAD*, coronary artery disease; *CABG*, coronary artery bypass grafting; *PTCA*, percutaneous transluminal coronary angioplasty.

scan results. The demographic and SPECT MPI result differences between normal and abnormal imaging results are presented in Table 3. The mean SSS after AC in the abnormal stress-only group was significantly higher than the mean SSS after AC in the abnormal stress-rest group (5.4 ± 5.6 vs 4.6 ± 3.7, $P = .03$). In general, for patients with higher AC SSS on stress imaging, referring physicians made management decisions without additional rest scans.

A small percentage of patients with normal AC stress images returned for a rest study (3.4% [42/1,247]). This was probably because of indeterminate abnormalities on stress scans and lack of interpretive confidence without a comparative rest image. Upon reviewing both stress and rest images with AC, ultimately all these studies were considered normal.

Follow-Up for Cardiac Events

In follow-up, 0.6% (8/1,383) of patients sustained a non-fatal MI, 0.4% (6/1,383) suffered cardiac death and 2% (27/1,383) underwent coronary revascularization (Table 4). The annualized event rate for adverse cardiac outcomes (defined as cardiac death or non-fatal MI) was very low for patients with normal stress-only imaging results (0.7%, Figure 2). In patients with normal stress images who underwent additional rest imaging (3.4% [42/1,247]), there were no adverse cardiac events. The annualized event rate for adverse cardiac outcomes (cardiac death or non-fatal MI) in patients with abnormal imaging studies was very low in both the stress-only and stress-rest groups (0.9% and 0.4%, respectively, $P = .6$; Figures 1, 2).

Early cardiac revascularization rates were also examined to determine the impact of stress-only imaging results on clinical decision making. As illustrated in Figure 2, 18% (9/50) of patients with abnormal stress-only images underwent early cardiac revascularization (within 60 days of SPECT) compared to 0.4% (5/1,247) of those with normal stress-only images ($P < .001$). In patients with abnormal stress-only images, the mean SSS after AC in those undergoing early cardiac revascularization (9/50) was 12.9 ± 6.3 versus 3.6 ± 3.5 in those who did not undergo early cardiac revascularization (41/50; $P = .001$). In the abnormal stress-rest group, 4.7% (4/86) of patients underwent early cardiac revascularization (mean AC SSS 8.6 ± 6.9) (Table 4).

Considering that a significant number of studies normalized after AC, cumulative adverse cardiac events were compared between patients with normal non-AC images and those with abnormal non-AC images which normalized with AC. A similarly low cumulative adverse cardiac event rate was observed within each normal scan group (1.2% without AC vs 0.9% with AC, $P = .6$; Table 5).

Two examples of patients who underwent cardiac catheterization and eventual revascularization based upon stress-only imaging results are shown in Figures 3 and 4. The first example (Figure 3) was a 63-year-old male with a history of chest pain but no previous CAD. After AC, a medium-size inferior and inferolateral perfusion abnormality persisted. ECG-gated SPECT imaging demonstrated normal wall motion. At catheterization, a 70% stenosis in the first circumferential marginal branch was noted with subsequent successful revascularization. A second example (Figure 4) was a 62-year-old male who also presented with chest pain and no history of CAD. After AC, a medium sized, mid and basal inferior defect of moderate to severe intensity was present with mild hypokinesis by ECG gating. At catheterization, a 90% proximal right coronary artery stenosis was identified with successful revascularization.

DISCUSSION

The concept of stress-only SPECT imaging has gained considerable momentum as a means of improving laboratory efficiency and reducing radiation exposure for selected patients.[1,2] In order for this strategy to be successful, rest imaging should be minimized, and the results (either normal or abnormal) carry appropriate risk of future cardiac events. Previous stress-only studies without AC have suggested the

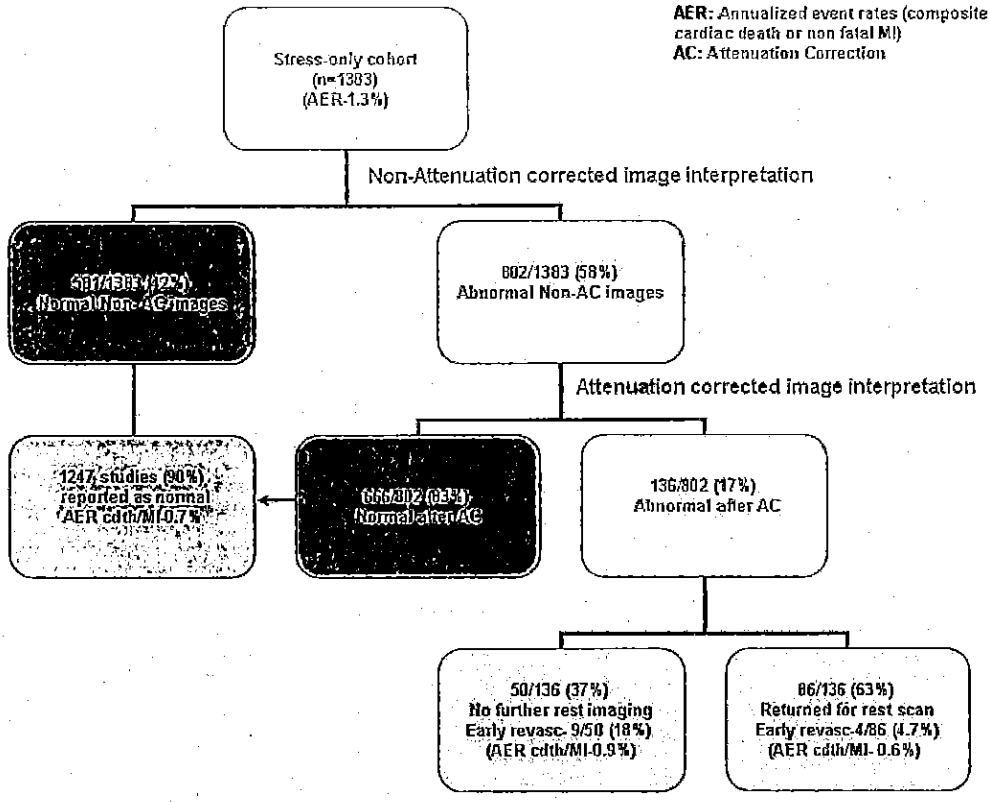

Figure 1. Image interpretation results and outcomes before and after AC. Flowchart summarizes this study by demonstrating the results of stress SPECT image interpretation before and after AC as well as a subgroup where additional rest imaging was performed. This figure shows how AC normalizes the majority of stress images initially considered abnormal without AC, subsequently resulting in a lesser need for additional rest imaging.

Table 3. Differences in patients with abnormal AC SSS (n = 136) who did or did not undergo further rest imaging

Characteristic	Normal stress-only N = 1,247	Abnormal stress-only N = 136		
		No rest study (n = 50)	Rest study performed (n = 86)	*P* value
Age >75	8%	4%	17%	.02
Males	54%	48%	62%	.7
Diabetes	26%	28%	33%	.8
Hx of CAD	4.3%	12%	5.8%	.6^
				.04#
Abnormal ECG	27%	34%	33%	.9
Pharmacologic agent used	47%	60%	65%	.7
Mean EF	65 ± 8	60 ± 8	61 ± 7	.9
Mean AC SSS	0	5.4 ± 5.6	4.6 ± 3.7	.03

AC, Attenuation correction; *SSS*, summed stress score.
^ No significant difference between abnormal SO versus abnormal SR; # significant difference between normal SO versus abnormal SO/SR groups combined together.

Table 4. Cumulative follow-up of cardiac events

Follow-up event	Study cohort (n = 1,383)	Normal SO (n = 1,247)	Abnormal SO group (n = 50)	Abnormal SR group (n = 86)	*P* value (abnormal SO vs abnormal SR)
Early revasc (<60 days)	19 (1.4%)	6 (0.6%)	9 (18%)	4 (4.7%)	.01
Late revasc (>60 days)	8 (0.6%)	2 (0.2%)	2 (4%)	4 (4.7%)	.8
Non-fatal MI	8 (0.6%)	8 (0.6%)	0 (0)	0 (0)	N/A
Cardiac death	6 (0.4%)	4 (0.3%)	1 (2%)	1 (1.2%)	.6

SO, Stress-only; *SR*, stress rest; *revasc*, revascularization; *MI*, myocardial infarction.

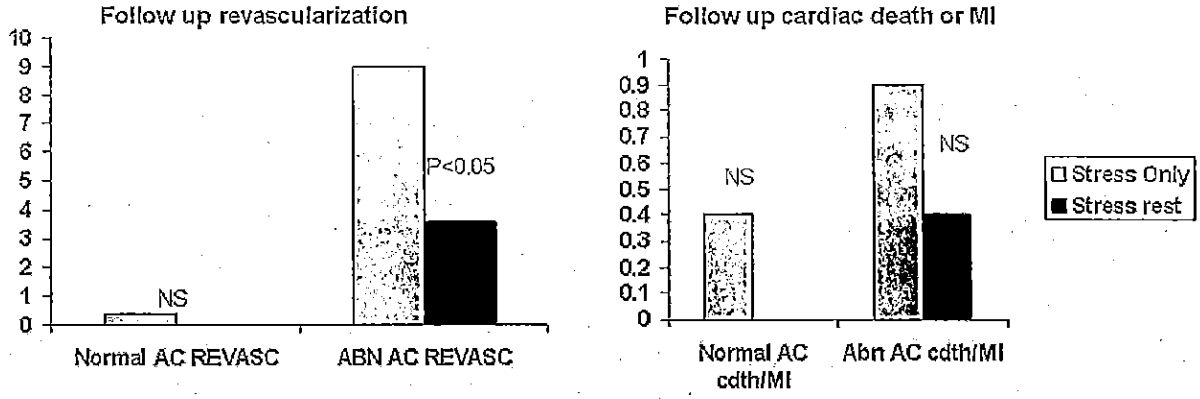

Figure 2. Follow-up cardiac events in normal and abnormal stress-only studies and stress-rest cohorts: This *bar diagram* compares follow-up cardiac revascularization rates (revasc) and cardiac death or non-fatal myocardial infarction rates (cdth/MI) in stress-only and stress-rest cohorts based on normal or abnormal attenuation corrected (AC) SPECT images. A significant number of patients underwent revascularization based on abnormal stress-only imaging. Adverse cardiac events including cardiac death or non-fatal MI rates were very low for all groups of patients (normal and abnormal stress-only as well as stress-rest cohorts). This shows that a clinical decision based on abnormal stress-only imaging is a safe approach and is associated with very low cardiac morbidity or mortality.

Table 5. Cumulative follow-up cardiac events

Follow-up event	Normal non-AC A (n = 581)	Normal AC B (n = 1,247)	Abnormal AC C (n = 136)	*P* value
Non-fatal MI or cardiac death	7 (1.2%)	12 (0.9%)	2 (1.4%)	A vs B: .6 B vs C: .4

necessity for rest imaging to be as high as 50%-78%, rendering the procedure inefficient.[3,6,11] The American Society of Nuclear Cardiology has concluded in recent statements that the best use of a stress-only imaging strategy is likely to be in a population for whom it is anticipated that the stress study would be normal, or if abnormal, a clinical decision could be made without a rest study.[12] This society has also recognized a need for additional studies addressing clinical outcomes of patients undergoing stress-only imaging.[13] Two recent editorials emphasized the societal need for stress-only imaging.[14,15]

To this end, we examined 1,383 patients who were scheduled for clinically indicated stress-only imaging with Tc-99m AC SPECT and were successfully followed for cardiovascular-related procedures and outcomes.

Figure 3. Example 1 of abnormal stress-only imaging in which subsequent cardiac catheterization occurred: Non-AC images are on *top* and AC images on *bottom* for short axis, vertical long axis, and horizontal axis. A medium inferior and inferolateral defect is present with moderate to severe reduction of activity and little change with AC.

Without AC, less than half of the studies were considered normal. With AC, a high percentage of the studies were interpreted as normal.

During follow-up, the incidence of adverse cardiac outcomes (cardiac death or non-fatal MI) within the entire cohort was very low (0.9%). In a substantial proportion of patients, clinicians were able to make management decisions based upon attenuation-corrected stress imaging data alone with a very low percentage requiring a rest study. A considerable proportion of patients with abnormal stress images after AC underwent early cardiac revascularization without the need for additional rest imaging. Thus, our findings confirm that stress-only imaging with AC is a reasonable strategy for evaluating selected patients with symptoms suggestive of myocardial ischemia.

The group of patients with abnormal stress only imaging results also had similarly low adverse cardiovascular

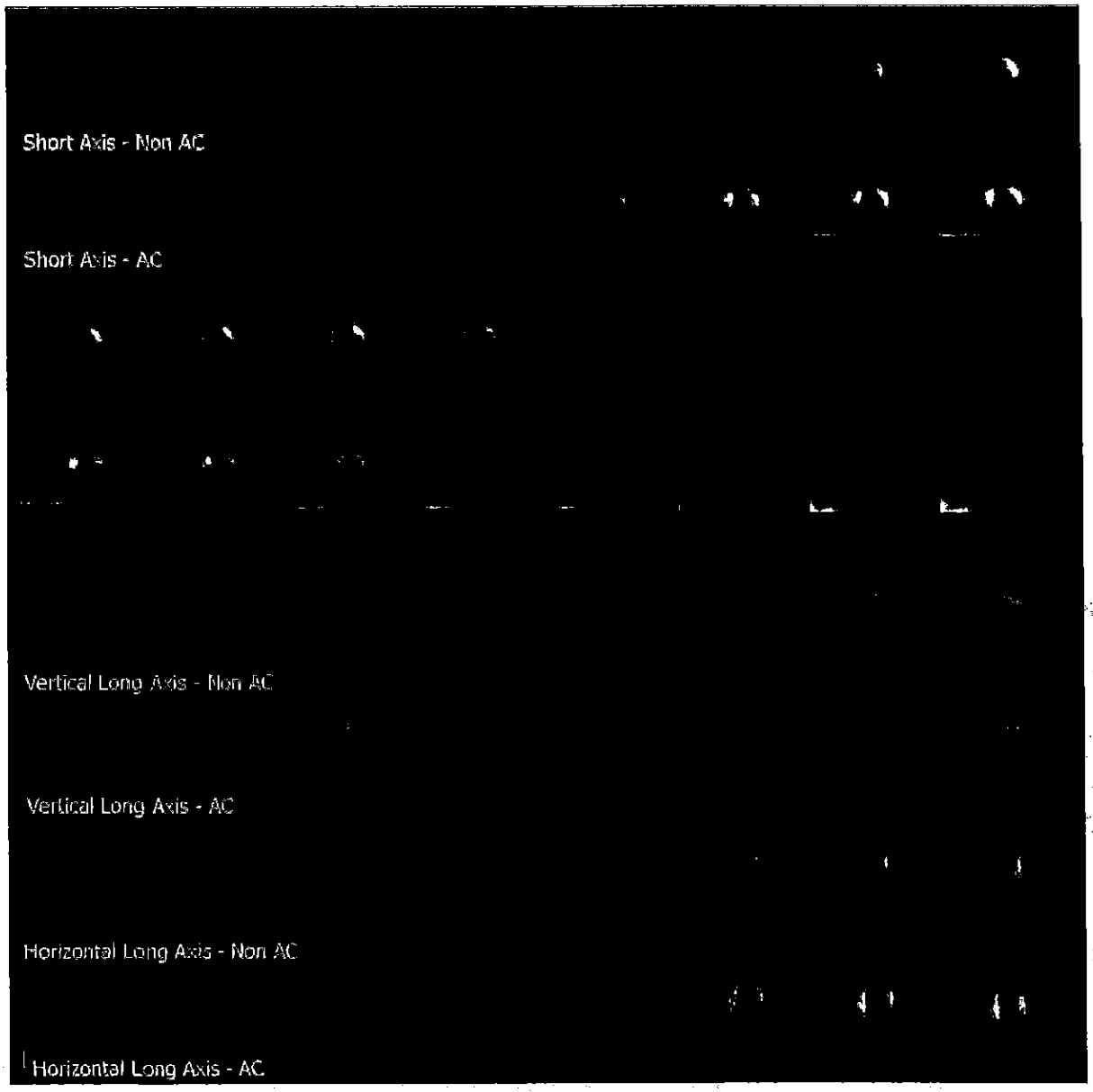

Figure 4. Example 2 of abnormal stress-only imaging in which subsequent cardiac catheterization occurred: Non-AC images are on *top* and AC images on *bottom* for short axis, vertical long axis, and horizontal axis. A medium inferior and septal defect is present with moderate to severe reduction of activity and little change with AC.

outcomes (1.4% cumulative MI or cardiac death). This is most likely explained by the fact that aggressive medical therapy with or without revascularization therapy instituted after identification of coronary disease in this patient population resulted in favorable short-term follow-up outcomes.

Recent studies examining stress-only imaging in selected patients continue to provide documentation of its clinical value, especially in those with normal scans.[1,5-7] This report emphasizes two important additional findings: first, the inherent value of AC which results in very few patients requiring additional rest imaging and second, the confidence of physicians in that if the stress image is abnormal, clinical decisions often can be made without an additional rest scan (high cardiac revascularization rate in patients with abnormal stress-only images).

Table 6. Published data on clinical outcomes in patients with normal stress-only Tc-99m SPECT imaging

Study	Total N (11,722)	Mean follow-up period	Event rates
Gibson et al[6]	652	22.3 months	0.6% (cardiac events)
Gal and Ahmad[7]	116	1 year	0 mortality
Chang et al[1]	8,034	5 years	2.5% (all cause mortality)
Duvall et al[5]	1,673	40 months	0.4% (cardiac death); 2.7% (all cause mortality)
Mathur et al[#]	1,247	2.1 years	0.7% (cardiac death or MI)

SPECT, Single-photon emission computed tomography.
[#] Current study.

Table 7. Demographic characteristics of study cohort and patients lost to follow-up

Patient characteristics	Total study cohort with follow-up (n = 1383)	Study cohort Lost to follow-up (n = 124)	*P* value
Age	54 ± 12	52 ± 11	.6
BMI	33 ± 9	31 ± 8	.7
Males	750 (54%)	69 (56%)	.7
Hx of myocardial infarction	42 (3%)	4 (3.2%)	.7
Hx of CABG	16 (1.2%)	1 (0.8%)	.6
Hx of PTCA	18 (1.3%)	2 (1.6%)	.6
Hx of CAD	64 (4.6%)	5 (4%)	.6
Hx of congestive heart failure	33 (2.3%)	3 (2.4%)	.7
Hx of diabetes	373 (27%)	35 (28%)	.6
Hx of hypertension	760 (55%)	57 (45%)	.04
Family Hx	548 (40%)	39 (31%)	.05
Hx of hyperlipidemia	574 (42%)	54 (43%)	.8
Hx of tobacco use	610 (44%)	49 (39%)	.07
Pharm stress test	681 (49%)	62 (50%)	.8
% with rest scan done	129 (9.3%)	5 (4%)	.06
Abnormal AC SSS	137 (9.9%)	8 (6.5%)	.2
Mean EF	64 ± 8	63 ± 7	.1

BMI, Body mass index; *Hx*, history of; *CABG*, coronary artery bypass grafting; *PTCA*, percutaneous transluminal coronary angioplasty; *CAD*, coronary artery disease.

Reducing radiation exposure during imaging studies has been an ongoing issue. The American Society of Nuclear Cardiology in collaboration with other organization has issued guidelines based on the principle "as low as reasonably achievable" (ALARA) policy which recommends assessing the appropriateness of stress radionuclide imaging and if appropriate, to consider procedures with the lowest radiation dose such as a stress-only protocol and NH_3 with PET imaging.[16] A stress-only imaging strategy reduces the effective radiation dose from 9.3 to 11.3 mSv range for a traditional same day rest-stress Tc-99m sestamibi or tetrofosmin study to the 6.6-8 mSv range.[17]

Gibson et al[6] in their outcome study of stress-only imaging in 652 patients demonstrated that 37% of the non-AC images had significant breast and diaphragmatic artifact and all these were eliminated with AC. Bateman et al[18] in their study applying line source AC to half time stress-only imaging demonstrated no difference in image quality and diagnostic accuracy emphasizing the

necessity of AC in stress-only imaging. This study provides further confirmation that AC is an important requirement for the successful implementation of a stress-only imaging protocol in routine clinical practice.

Our findings as well as those from previous studies[1,5-7] demonstrate that normal AC stress-only imaging is associated with a very low incidence of short-term cardiac events (>11,722 patients in aggregate, including 1,247 from this study, Table 6) and suggests that such patients do not need to undergo additional rest imaging.

The feasibility of stress-only imaging has also been demonstrated to be very effective in an emergency room chest pain unit[19] as well as in preoperative risk assessment for bariatric surgery.[20] A recent study by Ryan et al[21] suggests that rest images from prior studies can be effectively used in conjunction with more recent stress-only imaging in certain patient populations.

As there is no reference image for comparison, concern has been expressed that this approach may miss patients with balanced ischemia, in whom transient ischemic dilation in the absence of perfusion abnormalities is a marker of adverse cardiac outcome. The very low adverse cardiac event rate we have observed in a large number of patients argues that the incidence of balanced ischemia is minimal in patients selected for stress-only imaging (Table 6).

Selection Process for Stress-Only Imaging

The patients selected for stress-only imaging generally did not include those with a history of CABG or prior MI, based upon the assumption that such patients were more likely to require rest imaging for clinical decision-making. Thus, stress-only imaging might best be confined to patients without such histories, and not be the procedure for every patient in the laboratory. Table 1 delineates the general considerations we follow in our lab for utilizing a stress-only versus a rest-stress protocol. This selected approach has also been suggested by the recent information statements from the American Society of Nuclear Cardiology.[13]

LIMITATIONS

The clinical interpretations were not blinded and both AC and non-AC data were provided to referring clinicians. A SSS > 0 was considered abnormal for both non-AC and AC images for the purpose of this study based on a previous study by Baghdasarian et al.[10] We feel this threshold is justified as even small abnormalities, likely due to attenuation artifact, may require rest imaging. Therefore, completely normal perfusion is an important prerequisite for effectively utilizing a stress-only protocol. The decision for additional rest imaging as well as cardiac catheterization in our study was made by physicians and was not protocol-driven.

Approximately 8% of the patients who were scheduled for stress-only imaging was lost to follow-up. Demographic characteristics and the risk profile of these patients, however, were very similar to those in whom follow-up was complete (Table 7). Thus, it is unlikely that this degree of lost follow-up would have altered the study findings. Finally, there is a lack of comparator group in this study. A controlled, study whereby patients are randomized to either a stress-only or a conventional rest-stress imaging protocol is needed to confirm our findings. Previous outcomes data from Chang et al[1] did compare follow-up results between stress-only and rest-stress imaged patients and reported similar findings.

CONCLUSION

A strategy of stress-only imaging with AC in symptomatic patients is an efficient method which appropriately identifies at risk and low-risk patients yielding a low percentage requiring rest imaging. Clinical decisions can be made based on abnormal stress-only imaging without further rest imaging if clinically appropriate.

Disclosure

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References

1. Chang SM, Nabi F, Xu J, Raza U, Mahmarian JJ. Normal stress-only versus standard stress/rest myocardial perfusion imaging: Similar patient mortality with reduced radiation exposure. J Am Coll Cardiol 2009;55:221-30.
2. Iskandrian AE. Stress-only myocardial perfusion imaging a new paradigm. J Am Coll Cardiol 2010;55:231-3.
3. Heller GV, Bateman TM, Johnson LL, et al. Clinical value of attenuation correction in stress-only Tc-99m sestamibi SPECT imaging. J Nucl Cardiol 2004;11:273-81.
4. Thompson RC, Heller GV, Johnson LL, et al. Value of attenuation correction on ECG-gated SPECT myocardial perfusion imaging related to body mass index. J Nucl Cardiol 2005;12:195-202.
5. Duvall WL, Wijetunga MN, Klein TM, et al. The prognosis of a normal stress-only Tc-99m myocardial perfusion imaging study. J Nucl Cardiol 2010;17:370-7.
6. Gibson PF, Demus D, Noto R, Hudson W, Johnson LL. Low event rate for stress-only perfusion imaging in patients evaluated for chest pain. J Am Coll Cardiol 2002;39:999-1004.
7. Gal R, Ahmad M. Cost-saving approach to normal technetium-99m sestamibi myocardial perfusion scan. Am J Cardiol 1996; 78:1047-9.
8. Diamond GA, Forrester JS. Analysis of probability as an aid in the clinical diagnosis of coronary-artery disease. N Eng J Med 1979; 300:1350-8.

9. Cerqueria MD, Weissman NJ, Dilsizian V, et al. Standardized myocardial segmentation and nomenclature for tomographic imaging of the heart: A statement for healthcare professionals from the Cardiac Imaging Committee of the Council on Clinical Cardiology of the American Heart Association. Circulation 2002;105: 539-42.
10. Baghdasarian SB, Noble GL, Ahlberg AW, Katten D, Heller GV. Risk stratification with attenuation corrected stress Tc-99m sestamibi SPECT myocardial perfusion imaging in the absence of ECG-gating due to arrhythmias. J Nucl Cardiol 2009;16:533-9.
11. Schroeder-Tanka JM, Tiel-van Buul MM, van der Wall EE, Roolker W, Lie KI, van Royen EA. Should imaging at stress always be followed by imaging at rest in Tc-99m MIBI SPECT? A proposal for a selective referral and imaging strategy. Int J Card Imaging 1997;13:323-9.
12. Mieres JH. JNC Prez Page. J Nucl Cardiol 2009;16:1008-10.
13. Des Prez RD, Dahlberg ST, Einstein AJ, et al. ASNC clinical update: Stress-only myocardial perfusion imaging. J Nuc Cardiol 2009;16:329-31.
14. Mahmarian JJ. Stress only myocardial perfusion imaging: Is it time for a change? J Nucl Cardiol 2010;17:529-35.
15. Bhavnani SP, Heller GV. Stress-only myocardial perfusion imaging. it is time for a change! J Nucl Cardiol 2011;18:836-9.
16. Cerqueira MD, Allman KC, Ficaro EP, Hansen CL, Nichols KJ, Thompson RC, et al. Recommendations for reducing radiation exposure in myocardial perfusion imaging. J Nucl Cardiol 2010;17:709-18.
17. Einstein AJ, Moser KW, Thompson RC, Cerqueira MD, Henzlova MJ. Radiation dose to patients from cardiac diagnostic imaging. Circulation 2007;116:1290-305.
18. Bateman TM, Heller GV, McGhie AI, Courter SA, Golub RA, Case JA, et al. Multicenter investigation comparing a highly efficient half-time stress-only attenuation correction approach against standard rest-stress Tc-99m SPECT imaging. J Nucl Cardiol 2009;16:726-35.
19. Duvall WL, Wijetunga MN, Klein TM, Hingorani R, Bewley B, Khan SM, Stress-only Tc-99m myocardial perfusion imaging in an emergency department chest pain unit. J Emerg Med 2011, Aug 27.
20. Gemignani AS, Muhlebach SG, Abbott BG, Roye GD, Harrington DT, et al. Stress-only or stress/rest myocardial perfusion imaging in patients undergoing evaluation for bariatric surgery. J Nucl Cardiol 2011;18:886-92.
21. Ryan JJ, Mehta R, Thiruvoipati T, Ward RP, Williams KA. Stress-only imaging in patients with prior SPECT MPI: A simulation study. J Nucl Cardiol 2012;19:311-8.

SPECT/CT*

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In view of the commercial success of integrated PET/CT scanners, there is an increasing interest in comparable SPECT/CT systems. SPECT in combination with CT enables a direct correlation of anatomic information and functional information, resulting in better localization and definition of scintigraphic findings. Besides anatomic referencing, the added value of CT coregistration is based on the attenuation correction capabilities of CT. The number of clinical studies is limited, but pilot studies have indicated a higher specificity and a significant reduction in indeterminate findings. The superiority of SPECT/CT over planar imaging or SPECT has been demonstrated in bone scintigraphy, somatostatin receptor scintigraphy, parathyroid scintigraphy, and adrenal gland scintigraphy. Also, rates of detection of sentinel nodes by biopsy can be increased with SPECT/CT. This review highlights recent technical developments in integrated SPECT/CT systems and summarizes the current literature on potential clinical uses and future directions for SPECT/CT in cardiac, neurologic, and oncologic applications.

Key Words: scintigraphy; SPECT; CT; PET; hybrid imaging

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Hybrid imaging techniques allow the direct fusion of morphologic information and functional information. Since its introduction to clinical medicine in 2001, PET/CT has become the fastest growing imaging modality (*1,2*). CT coregistration has led to definite diagnoses by PET and more acceptance of functional imaging. Recently, integrated SPECT/CT scanners have been made available. With SPECT/CT, lesions visualized by functional imaging can be correlated with anatomic structures. The addition of anatomic information increases the sensitivity as well as the specificity of scintigraphic findings (Fig. 1). SPECT/CT has an additional value in sentinel lymph node (SLN) mapping, especially in head and neck tumors and tumors draining into pelvic nodes. In addition to improved anatomic localization of scintigraphic findings, SPECT/CT offers the opportunity to add true diagnostic information derived from CT imaging. Given the growing number of studies demonstrating the added value of hybrid SPECT/CT relative to single imaging modalities, it appears likely that this promising technique will play an increasingly important role in clinical practice. The broad spectrum of existing SPECT tracers and their widespread availability suggest that SPECT/CT can be complementary to PET/CT.

TECHNICAL ASPECTS OF SPECT/CT

Before the introduction of dedicated SPECT/CT cameras, various software algorithms were established to allow image fusion for anatomic imaging (CT or MRI) and functional imaging (SPECT) (*3*). In the early 1980s, efforts were made to allow image fusion in brain studies. Current software algorithms permit highly accurate coregistration of anatomic and functional datasets. This kind of nonrigid image coregistration is therefore a regular component in daily clinical practice, such as image-guided surgery or radiation treatment planning. However, motion artifacts markedly affect image fusion in the thorax, abdomen, pelvis, or head and neck region when CT and SPECT acquisitions are obtained separately (*4,5*). Functional images of the thorax or the abdomen contain little or no anatomic landmarks that can be correlated with anatomic reference points. Moreover, the chest and the abdomen do not represent rigid structures. Differences in patient positioning and respiratory motion make the correct alignment of anatomic and functional images even more complicated. More recently, 3-dimensional elastic transformations or nonlinear warping has been established to further improve the accuracy of image fusion. With these modern approaches, the accuracy of software-based image coregistration is in the range of approximately 5–7 mm (*6*). Although software algorithms are not in widespread clinical use for image coregistration of the abdomen or the thorax, this technology will still play an important role by allowing the correction of misregistrations attributable to patient motion or breathing artifacts, which may also arise from integrated SPECT/CT cameras.

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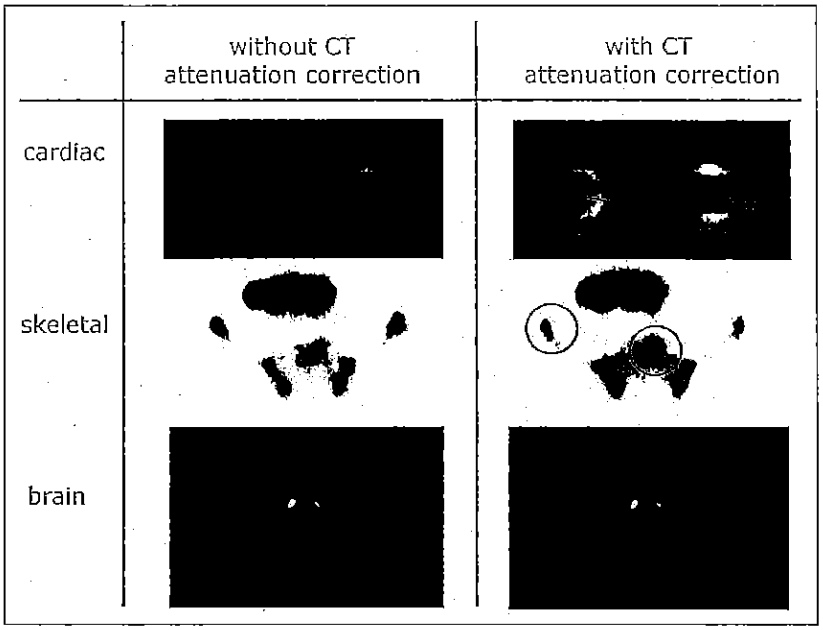

FIGURE 1. Impact of CT attenuation correction. Upper row (myocardial perfusion scintigraphy) shows attenuation of ^{99m}Tc-MIBI uptake in inferior myocardium. CT-corrected image demonstrates normal perfusion of inferior myocardium (green circles). Middle row (skeletal scintigraphy with ^{99m}Tc-hydroxymethylene diphosphonate) shows superior localization of bone metastasis in os sacrum (green circle) after CT attenuation correction. Lower row shows CT attenuation correction of brain study (^{99m}Tc-iodobenzamide SPECT). Without CT attenuation correction, background activity may be overestimated, especially in peripheral structures (red circles) and may appear with similar intensity as pathologic findings (e.g., skeletal scintigraphy, middle row).

Initial work was done by Hasegawa et al., who introduced a system that is capable of simultaneous CT and SPECT acquisitions (*7*). This group was the first to demonstrate that CT data can be used for attenuation correction, allowing superior quantification of radiotracer uptake. This technology translated into the first commercial SPECT/CT system, Hawkeye, which was introduced by GE Healthcare (*8*). Here, the modalities are combined, allowing sequential CT and SPECT acquisitions with only an axial shift of the patient between measurements. An enhanced version developed by GE Healthcare contained a 4-row multidetector CT capable of acquiring four 5-mm slices instead of one 10-mm slice. Philips combined a 6- or 16-slice CT scanner with a Skylight double-head camera system (Precedence). Philips also introduced a system for scientific purposes combining SPECT with 64-slice CT. Siemens Medical Solutions combined an E-Cam dual-detector γ-camera system with optional 1-, 2-, or 6-slice CT. With both systems, slice thickness can be adjusted from 0.6 to 10 mm, and the scan speed is <30 s for a 40-cm axial field of view. With the availability of coregistered CT information for the patient, methods that include spatially dependent collimator deblurring become feasible (*9*). Algorithms that combine this approach with attenuation on scatter correction (both based on CT information) have been implemented in SPECT/CT systems and may enable quantitative SPECT (*10*).

SUGGESTED PROTOCOLS FOR SPECT/CT

Although planar imaging and SPECT are routinely performed studies and respective protocols have been documented for various clinical settings, the roles of CT coregistration and specific imaging protocols have not yet been clearly defined. In general, instead of standard protocols, combined SPECT/CT procedures should be selected on an individual basis and should reflect clinical needs. The radiation dose delivered by CT is a major issue in this regard, because diagnostic CT can increase the overall radiation dose by up to 14 mSv (*11*). Low-dose CT is associated with relatively low radiation doses of 1–4 mSv and should be sufficient for anatomic referencing of SPECT lesions and attenuation correction (Table 1). Usually, if a recent contrast-enhanced diagnostic CT scan is available, there is no need to perform another contrast-enhanced CT scan during SPECT/CT. Also, when SPECT/CT is performed for treatment monitoring and follow-up, low-dose CT should be sufficient. Therefore, the use of low-dose, nonenhanced spiral CT can be recommended in most cases when SPECT/CT is performed for anatomic referencing or attenuation correction. The standard protocol for integrated SPECT/CT at our institution (Siemens Symbia 6) is shown in Table 1.

When SPECT/CT is performed for tumor staging or restaging, the detection of small pulmonary nodules that may be negative on functional imaging is important. Therefore, the acquisition of an additional low-dose CT scan of the thorax during maximal inspiration should be considered for patients at risk for the presence of lung metastases (Table 1). This strategy applies especially to patients who have high-risk differentiated thyroid cancer and are undergoing radioiodine scintigraphy. In this setting, an additional 40-mA low-dose CT scan acquired during inspiration is a feasible approach, because it has been demonstrated that a reduction of the tube current to 40 mA results in satisfactory image quality and reduces overall radiation exposure (*11*).

TABLE 1
Suggested CT Protocols* for Inclusion in Noncardiac SPECT/CT Protocols

Protocol	Parameter	Comments
SPECT-guided low-dose CT	Indications (general)	Preferred protocol when recent diagnostic CT is available and when follow-up studies are performed (monitoring of response to treatment)
	Indications (specific)	Further anatomic localization or characterization of focal pathology present on planar or SPECT images, e.g., at bone scintigraphy, ^{131}I scintigraphy (thyroid cancer), sentinel node scintigraphy, ^{99m}Tc-MIBI SPECT (parathyroid tumors), ^{123}I-MIBG SPECT (adrenocortical tumors), or ^{111}In-pentetreotide imaging (neuroendocrine tumors)
	Field of view	Including all areas with nonclassifiable scintigraphic lesions, e.g., cervical, thoracic, and abdominal regions, pelvis, skull, extremities, or any combination of these
	CT overview (topogram)	Covering field of view as indicated earlier
	CT scan (tomogram)	
	Scan direction	Caudocranial
	Tube current	20–40 mA
	Tube voltage	130 kV
	Collimation	Depending on CT scanner; thinnest possible collimation for optimal multiplanar reconstructions; in areas prone to breathing artifacts, thicker collimation may be necessary to reduce scan duration and to minimize motion artifacts
	Slice thickness	5 mm; increment of 2.5 mm; thinnest possible slice thickness with overlap in reconstruction increment necessary for optimal 3-dimensional reconstructions
	Breathing protocol (general)	Shallow breathing; breath holding in expiration when lower thorax is scanned
	Breathing protocol (screening for lung metastases)	Maximum inspiration during acquisition of CT
	Radiation dose (in addition to that of SPECT)	2–4 mSv (depending on field of view in *z*-axis)
SPECT-guided diagnostic CT	Indications (general)	Preferred protocol when recent diagnostic CT is not available and when detailed anatomic information is mandatory to address clinical needs
	Indications (specific)	Further anatomic localization or characterization of lesions present at bone scintigraphy, ^{131}I scintigraphy (thyroid cancer, cervical region), ^{99m}Tc-MIBI SPECT (parathyroid tumors), ^{123}I-MIBG SPECT, or ^{111}In-pentetreotide imaging, especially when sufficient diagnostic accuracy cannot be expected from low-dose CT (e.g., when lesions are suspected in mediastinum or in proximity of liver or intestinal structures)
	Field of view	Including areas with lesions present on planar or SPECT images or areas with suspected lesions (e.g., upper gastrointestinal tract for detection of pheochromocytoma)
	CT overview (topogram)	Covering field of view as indicated earlier
	CT scan (tomogram)	Specific protocols should be selected according to clinical needs (e.g., 3-phase CT of liver)
	Scan direction	Caudocranial
	Scan delay	60–80 s after start of intravenous injection of contrast material (depending on field of view in *z*-axis)
	Tube current	100 mA
	Tube voltage	130 kV
	Collimation	Depending on CT scanner; thinnest possible collimation for optimal multiplanar reconstructions; in areas prone to breathing artifacts, thicker collimation may be necessary to reduce scan duration and to minimize motion artifacts
	Slice thickness	5 mm; increment of 2.5 mm; thinnest possible slice thickness with overlap in reconstruction increment necessary for optimal 3-dimensional reconstructions
	Breathing protocol (general)	Shallow breathing; breath holding in expiration when lower thorax is scanned
	Breathing protocol (screening for lung metastases)	Breath holding in maximum inspiration during acquisition of CT
	Radiation dose (in addition to that of SPECT)	6–14 mSv (depending on field of view in *z*-axis)

*Performed directly before or after SPECT acquisition.

TABLE 2
Suggested CT Protocols for Inclusion in Cardiac SPECT/CT Protocols

Protocol	Parameter	Comments
Low-dose cardiac CT	Indications	Coronary artery calcium (CAC) scoring; attenuation correction
	CT overview (topogram)	140–180 mm
	CT scan (tomogram)	Electrocardiographic gating mandatory for CAC scoring
	Field of view	Sternum–thoracic spine (140–180 mm)
	Acquisition	Diastolic phase
	Tube current	20–40 mA
	Tube voltage	130 kV
	Slice thickness	≤3 mm; increment of ≤3 mm
	Breathing protocol	Breath holding
	Radiation dose (in addition to that of SPECT)	1–3 mSv
Diagnostic cardiac CT (64-slice CT)	Indications	CT coronary angiography
	CT scan (tomogram)	Electrocardiographic gating mandatory
	Field of view	Sternum–thoracic spine (140–180 mm)
	Acquisition	Diastolic phase
	Scan delay	"Smart preparation" (~10 s after start of intravenous injection of contrast material [100 mL]; flow rate of 4 mL/s)
	Tube current	≤900 mA
	Tube voltage	130 kV
	Collimation	Thinnest possible collimation necessary for optimal 3-dimensional reconstructions
	Slice thickness	≤3 mm; increment of ≤3 mm; thinnest possible slice thickness with overlap in reconstruction increment necessary for optimal 3-dimensional reconstructions
	Breathing protocol	Breath holding
	Radiation dose (in addition to that of SPECT)	4–14 mSv

Compared with PET/CT, diagnostic CT protocols including intravenous or oral contrast agent enhancement are seldom performed at SPECT/CT but may be appropriate in certain clinical situations (Tables 1 and 2). These protocols will have to be implemented and modified continually, especially with the availability of new scanners offering very high spatial resolution (64-slice CT). Potential CT protocols suitable for cardiac imaging are discussed later (Table 2).

SPECT/CT FOR SLN MAPPING

For patients with cancer, accurate lymph node staging is mandatory for appropriate treatment planning. A combination of lymphoscintigraphy before surgery and mapping with blue dye during surgery has been demonstrated to be a practicable approach for accurately localizing the SLN. Although most sentinel nodes can be identified during surgery with a hand-held probe, SLN identification may be impossible in certain cases. Localization with CT coregistration before surgery may facilitate surgical access and thus improve overall detection rates. The added value of CT coregistration for SLN mapping has been demonstrated by several groups. Although inguinal and lower axillary nodes can be reliably detected on planar scintigrams, anatomic coregistration represents a valuable tool for SLN detection in the pelvis, the mediastinum, or the head and neck region. For patients with melanoma of the head and neck or the trunk, a pilot study indicated that SPECT/CT enabled the detection of sentinel nodes in up to 43% of patients with negative planar scintigrams (*12*). For patients with early-stage cervical cancer (*13*) and invasive bladder cancer (*14*), better detection of sentinel nodes by SPECT/CT than by planar scintigrams was described. The CT portion of the examination was especially helpful for the identification of SLNs during surgery. For 20 patients with head and neck cancer, Khafif et al. reported a sensitivity of SPECT/CT of 87.5% (*15*). SPECT/CT further improved SLN identification and localization over those provided by planar images for 6 patients (30%). For a series of 34 patients, SPECT/CT identified sentinel nodes in 94% of patients (32/34) and identified additional nodes in 15 (47%) of those 32 patients (*16*). More accurate localization of SLNs in oral cavity squamous cell carcinoma was described by Keski-Santti et al. (*17*). Superior topographic SLN identification was described in 2 further studies of head and neck cancer or melanoma (*12,18*).

Husarik and Steinert examined the added value of SPECT/CT in breast cancer (Fig. 2) (*19*). For 41 consecutive patients, findings from planar scintigrams and SPECT/CT were identical in only 7 patients (17%); SPECT/CT indicated the correct anatomic localization in 29 patients (70%), according to the American Joint Committee on Cancer staging system

FIGURE 2. Accurate anatomic localization of sentinel node in patient with breast cancer by sentinel node scintigraphy (^{99m}Tc-Nanocoll; Amersham) and CT coregistration. Correct anatomic localization of sentinel node in left axilla is illustrated by 3-dimensional projections of fused images.

(levels I–III). For 6 patients, additional SLNs were detected. For 26 patients (63%), exact anatomic localization could be derived exclusively from SPECT/CT; 3 sentinel nodes close to the injection site were not detected by SPECT but could be clearly visualized by SPECT/CT. Similar findings were described earlier by Lerman et al. (*20*). For 157 consecutive patients, 13% of sentinel nodes were visualized by SPECT/CT but not on planar scintigrams. Unexpected sites of drainage and non–node-related hot spots were identified for 33 patients. For a prospective series of 51 patients, sentinel nodes could be assigned to axillary levels I–III on the basis of SPECT/CT data but not on the basis of planar images (*21*). In a pilot study by van der Ploeg et al., SPECT/CT was superior to SPECT for SLN detection; for 4 of 31 patients, 6 additional SLNs were detected by SPECT/CT, leading to a change in management for 5% of patients because of upstaging in the axilla (*22*). SPECT/CT has been shown to be especially useful in overweight patients. In a prospective study of 220 patients with breast cancer, 122 patients had a body mass index of greater than 25 (*23*). For 49 patients (22%), planar images failed to identify a sentinel node. However, for 29 of these 49 patients (59%), sentinel nodes could be identified by SPECT/CT. Overall, the sensitivity of SPECT/CT in overweight patients was 89%. SPECT/CT was also superior to blue dye labeling during surgery and identified sentinel nodes in 75% of patients in whom the blue dye technique failed to detect sentinel nodes. Although the current literature does not indicate a major role for SPECT/CT in SLN identification in breast cancer, this modality may be helpful when the standard approach fails to identify the SLN.

SPECT/CT IN SKELETAL DISEASES

For more than 30 y, planar bone scintigraphy has been used as a valuable method for sensitively detecting or characterizing focal bone pathology; more recently, SPECT has been used in this capacity (*24*). Although functional bone imaging is a highly sensitive method, it lacks specificity (*25*). Therefore, radiography, CT, or MRI is frequently performed after bone scintigraphy to further characterize lesions evident on bone scans. Integrated SPECT/CT offers a direct correlation of focal bone pathology with anatomic structures and therefore minimizes the number of equivocal findings.

Applications in Malignant Skeletal Diseases

Screening for bone metastases and evaluation of the treatment response are the most frequent indications for bone scanning. Although the majority of bone metastases appear as hot spots, some appear as cold lesions. Benign lesions, such as hemangioma, may also appear as cold, making the differential diagnosis problematic. The differentiation of benign and malignant lesions can usually be achieved with CT coregistration and is a major advantage of SPECT/CT (Fig. 3). In addition, fused images can be used to further guide biopsies of bone lesions.

A normal tracer distribution on planar bone scans usually makes the use of SPECT/CT unnecessary. Although in many cases the correct diagnosis can be derived from planar bone scans, SPECT/CT is necessary to make the correct diagnosis in cases of undefined lesions. In particular, scintigraphic lesions in the spine or pelvis frequently may not be defined exactly, requiring the additional use of CT or MRI. Recently, image coregistration was demonstrated to be superior to planar radiographic techniques or SPECT and proved useful in further characterizing benign skeletal abnormalities. The presence of accompanying complications, such as fractures or compression of the spinal cord, can also be diagnosed in a single examination (*26*).

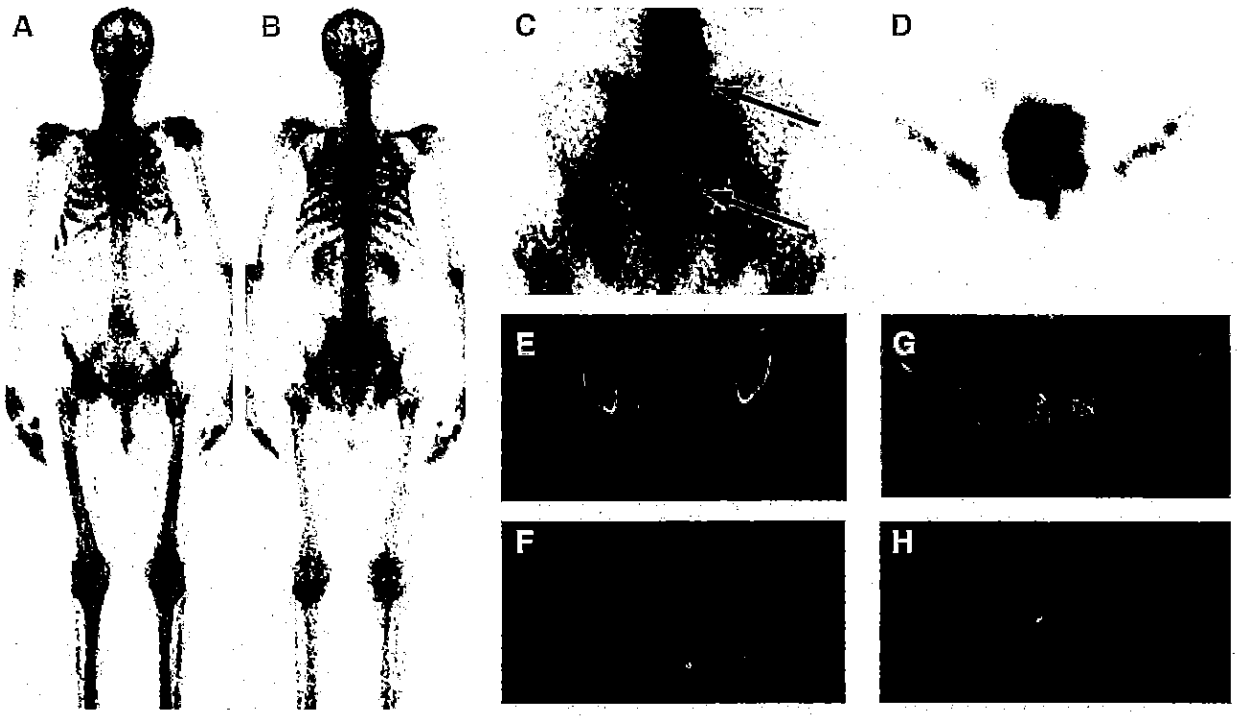

FIGURE 3. Patient with lung cancer and 2 hot spots, in lower lumbar spine and pelvis (os sacrum). (A and B) Planar scintigrams from skeletal scintigraphy (^{99m}Tc-hydroxymethylene diphosphonate). (C) Detailed view of pelvis with 2 hot spots (arrows). (D) Transverse section of upper lesion in lumbar vertebra 5. (E) Small osteolytic lesion with intense tracer uptake indicating bone metastasis in lower pelvis. (F) Fused image. (G and H) Spondylarthrosis of right facet joint with intense tracer uptake indicating degenerative lesion.

The first report demonstrating the superiority of SPECT/CT over planar imaging or SPECT was published by Römer et al. (*27*). In this retrospective study, SPECT-guided CT was reported to clarify more than 90% of bone lesions that were indeterminate at SPECT: 63% of indeterminate findings could be definitely assigned as benign lesions involving mostly osteochondrosis, spondylosis, or spondylarthrosis of the spine; 29% of lesions could be clearly assigned as osteolytic or osteosclerotic bone metastases; and 4 lesions (8%) remained indeterminate at SPECT/CT because of a missing anatomic correlate. The majority of these lesions were located in the ribs or scapula. Because the performance of MRI in the thorax is affected by motion artifacts, the authors concluded that even MRI might not be able to confirm or exclude bone metastases in such lesions. The study also indicated that exact matching of functional and anatomic data may be necessary, especially in small anatomic structures. Small osteolytic bone metastases were observed in close proximity to facet joints, potentially causing misinterpretation of lesions at SPECT. The concept of Römer et al. (*27*) included the use of SPECT data for determination of the field of view for CT, resulting in reduced additional radiation exposure. On a per-patient basis, the mean radiation exposure from additional CT was as low as 2.3 mSv. SPECT-guided CT therefore results in acceptable overall radiation exposure. The use of CT data for attenuation correction may also increase the performance of SPECT, but this issue has not been studied in detail (*28,29*).

Using a combination of a dual-head SPECT camera and a nondiagnostic low-dose CT scanner, Horger et al. were also able to correctly classify 85% of unclear foci; in comparison, 36% of such foci were correctly classified by SPECT alone (*30*). Integrated SPECT/CT also seems to be superior to side-by-side reading of SPECT and CT images. Using juxtaposed CT and SPECT scanners, Utsunomiya et al. demonstrated that fused images were superior to side-by-side reading for the differentiation of malignant from benign lesions (*31*).

Applications in Benign Skeletal and Infectious Diseases

Even-Sapir et al. reported recently that SPECT/CT allowed a definite diagnosis for the majority of indeterminate scintigraphic findings in nononcologic situations (*32*). Infectious bone lesions, such as osteomyelitis, may be diagnosed by 3-phase bone scintigraphy with ^{99m}Tc-labeled diphosphonates. This approach has high sensitivity but lacks specificity. Another option is the use of radiolabeled autologous leukocytes (WBC), still considered the gold standard for localizing an area of infection by scintigraphic procedures. A more practicable approach is the use of ^{99m}Tc-labeled monoclonal antigranulocyte antibodies directed against the CD66 antigen, which is expressed on

granulocytes and macrophages. ^{99m}Tc-labeled ciprofloxacin was recently suggested to specifically detect infection through the accumulation of the radiotracer in living bacteria. CT coregistration may improve the specificity as well as the sensitivity of these scintigraphic techniques. CT is able to detect small areas of cortical destruction and to identify soft-tissue abscesses or empyema located in neighboring soft-tissue structures. CT data can be correlated with the accumulation of granulocytes or increased bone turnover, as indicated by scintigraphy, thus confirming or excluding infectious bone lesions. It is obvious that combined imaging makes the interpretation of SPECT and CT easier and more reliable.

The added value of SPECT/CT for diagnosing infections has been demonstrated by several authors (*33–40*). Bar-Shalom et al. recently evaluated the role of SPECT/CT in the diagnosis and localization of infections by using ^{67}Ga- or ^{111}In-labeled WBC (*33*). The patients examined had fever of unknown origin and suspected osteomyelitis, soft-tissue infection, or vascular graft infection. SPECT/CT provided additional information for the diagnosis and localization of infections in 48% of patients (39/82). For 4 patients with physiologic bowel uptake, SPECT/CT allowed the exclusion of infection, and the diagnosis based on SPECT/CT was incorrect in 2 other patients. The authors concluded that SPECT/CT with ^{67}Ga- or ^{111}In-labeled WBC made an incremental contribution to scintigraphy by improving the diagnosis, localization, or definition of the extent of disease. Another study evaluated the performance of SPECT/CT in 28 patients with suspected bone infection or infection of orthopedic implants. WBC planar scanning or SPECT accurately detected infections in 18 of 28 patients, with true-negative results in 10 of 28 patients; SPECT/CT provided accurate anatomic localization for all lesions. There was a significant clinical contribution of SPECT/CT in 36% of patients. For patients with osteomyelitis, SPECT/CT was also able to differentiate soft-tissue from bone involvement and allowed the correct diagnosis of osteomyelitis in patients with structural tissue alterations attributable to trauma. The superiority of SPECT/CT with ^{111}In-labeled WBC over side-by-side reading of SPECT and CT images was also suggested by a recent pilot study (*36*).

The added value of integrated SPECT/CT relative to triple-phase bone scintigraphy was evaluated by Horger et al. (*35*). For 31 patients with pathologic results from a triple-phase bone scan, the sensitivity and the specificity of SPECT/CT were 78% and 86%; those of SPECT and planar imaging were 78% and 50%, respectively. However, a combination of SPECT and separately performed MRI, radiography, or CT returned the highest sensitivity. SPECT/CT avoided false-positive findings and reduced the number of equivocal findings, but an additional benefit beyond the benefits of separately performed imaging modalities has not been demonstrated.

SPECT/CT IN DIFFERENTIATED THYROID CANCER

In patients with differentiated thyroid carcinoma, whole-body imaging after oral administration of ^{131}I or ^{123}I is commonly performed to identify residual or metastatic disease. ^{131}I scintigraphy has a higher sensitivity than morphologically based imaging modalities. However, the interpretation of ^{131}I images may be difficult because of the absence of anatomic landmarks. Therefore, precise localization of hot spots is frequently not possible. In addition, physiologic uptake of ^{131}I may cause false-positive findings (Fig. 4). Integrated SPECT/CT potentially allows the differentiation of physiologic, artificial, and pathologic uptake of ^{131}I (*41*). In a retrospective study by Tharp et al., SPECT/CT had an incremental diagnostic value for 41 of 71 patients

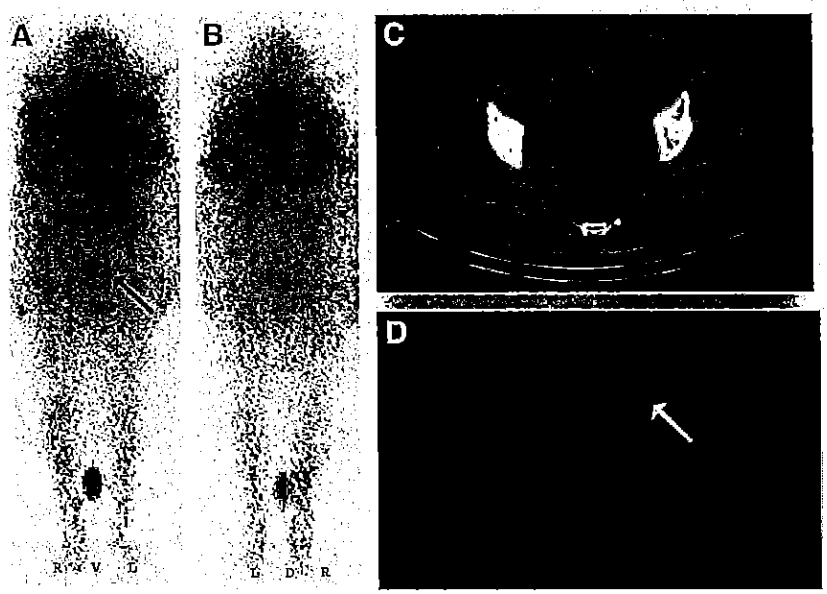

FIGURE 4. Exact delineation of focal pelvic ^{131}I uptake in patient with differentiated thyroid cancer. (A and B) Planar ^{131}I scintigrams (anterior view [A] and posterior view [B]) showing focal tracer uptake in left pelvic region (arrow). Lesion cannot be definitely assigned as benign or solitary bone metastasis. (C and D) Corresponding CT section (C) and fused SPECT/CT image (D) demonstrating nonspecific tracer uptake in diverticulum of colon (arrow).

(58%) (*42*). In particular, in the neck region, SPECT/CT allowed the precise characterization of equivocal lesions for 14 of 17 patients and changed the lesion location for 5 patients. SPECT/CT also improved the characterization of indeterminate findings as definitely benign in 13% of patients (9/71) and the precise assignment of metastases to the skeleton in 17% of patients (12/71) and to the lungs versus the mediastinum in 7% of patients (5/71). SPECT/CT further optimized the assignment of ^{131}I uptake to lymph node metastases versus remnant thyroid tissue and to lung versus mediastinal metastases. Overall, additional findings at SPECT/CT had an impact on management for 41% of patients.

In a study by Yamamoto et al. of 17 patients with differentiated thyroid carcinoma, fusion of SPECT and CT images with external markers improved the diagnosis in 15 of 17 patients (88%), mainly because of better anatomic localization of scintigraphic findings and differentiation of physiologic from specific uptake (*43*). Fused images resulted in a change in management for 4 of 17 patients (24%). A pilot study of 25 patients undergoing ablative radioiodine treatment of the thyroid also indicated an added value of SPECT/CT image fusion. Using an integrated SPECT/CT camera, Ruf et al. reported superior anatomic localization of 44% of suspected lesions (17/39) (*44*). The findings returned by fused images influenced therapeutic management for 25% of patients (6/24).

SPECT/CT IN PARATHYROID TUMORS

In primary hyperparathyroidism, ^{99m}Tc-methoxyisobutylisonitrile (MIBI) scintigraphy plays a minor role, because bilateral neck exploration has a success rate of up to 95%. However, with the increasing use of minimal invasive parathyroidectomy, presurgical imaging and precise localization of a parathyroid adenoma are critical for successful surgery. For a series of 110 patients, Lavely et al. compared the diagnostic performance of planar imaging, SPECT, SPECT/CT, and single- and dual-phase ^{99m}Tc-MIBI parathyroid scintigraphy (*45*). In this prospective study, dual-phase planar imaging, SPECT, and SPECT/CT were significantly more accurate than single-phase early or delayed planar imaging. Early-phase SPECT/CT in combination with any delayed imaging method (planar or SPECT) was superior to dual-phase planar imaging or dual-phase SPECT with regard to sensitivity, area under the curve, and positive predictive value (PPV). Sensitivity ranged from 34% for single-phase planar imaging to 73% for dual-phase studies including an early SPECT/CT scan. The PPV was as high as 86%–91% for dual-phase studies including an early SPECT/CT scan. The specificity was greater than 98% for all of the imaging techniques, and the negative predictive value was greater than 95%. Furthermore, early SPECT/CT had a higher sensitivity and a significantly higher PPV than delayed SPECT/CT. The authors therefore concluded that CT coregistration is a valuable tool for the precise delineation of parathyroid adenomas (Fig. 5).

Superior localization of parathyroid adenomas was also reported by Harris et al. (*46*). For a series of 23 patients, SPECT/CT performed well for the detection and localization of solitary adenomas (89%), but performance for the detection of multifocal disease was reduced. In a pilot study, Ruf et al. performed low-dose CT for attenuation correction and reported that the sensitivity of attenuation-corrected ^{99m}Tc-MIBI SPECT/CT was only slightly higher than that of non–attenuation-corrected SPECT (*47*). Also, Gayed et al. reported that SPECT/CT was only of limited value (8% of patients) (*48*). On the contrary, a retrospective study indicated a change in therapeutic management for 39% of patients (14/36) because of the localization of ectopic parathyroid adenomas or accurate localization in patients with distorted neck anatomy (*49*). Because of some inconsistent reports, a definite role of SPECT/CT in the imaging of parathyroid adenomas has not yet been indicated, and evaluations with larger patient cohorts are needed.

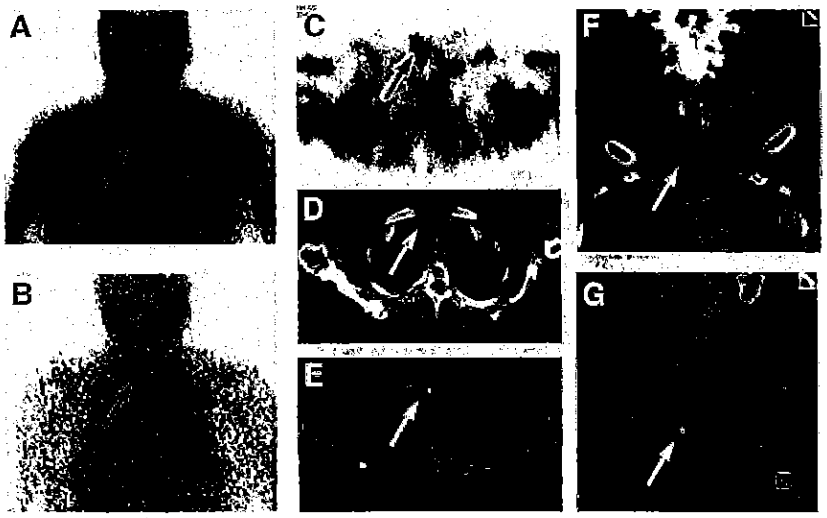

FIGURE 5. Parathyroid scintigraphy with SPECT/CT. (A and B) Planar views of ^{99m}Tc-MIBI scintigraphy 60 min (A) and 15 min (B) after ^{99m}Tc-MIBI injection. Arrows indicate lesions. (C) Transverse section of ^{99m}Tc-MIBI SPECT showing mildly intense focal lesion in right lower neck region (arrow). (D and E) Corresponding CT section (D) and fused image (E) indicating parathyroid adenoma below right thyroid gland (arrows). (F and G) Demonstration of parathyroid adenoma (arrows) in corresponding coronal CT (F) and SPECT/CT (G) images.

SPECT/CT IN TUMORS OF SYMPATHETIC NERVOUS SYSTEM AND ADRENOCORTICAL TUMORS

Morphologic imaging modalities, such as CT or MRI, offer high sensitivity for the detection of tumors of the sympathetic nervous system. The major advantages of radionuclide imaging, such as ^{123}I-metaiodobenzylguanidine (MIBG) SPECT, ^{18}F-L-3,4-dihydroxyphenylalanine PET, or ^{11}C-metahydroxyephedrine (HED) PET, are high specificity, which can be used to better characterize lesions, and superior differentiation of scar tissue and residual tumor after surgery (Fig. 6) (*50,51*). Radionuclide imaging is also helpful for the detection of extraadrenal tumor sites. In a prospective study, Franzius et al. evaluated the clinical use of ^{123}I-MIBG SPECT/CT in 19 patients with a variety of tumors of the sympathetic nervous system, including neuroblastoma and pheochromocytoma (*52*). ^{123}I-MIBG SPECT/CT had a sensitivity (93%) similar to that (99%) achieved by PET/CT with ^{11}C-HED as a tracer. ^{11}C-HED PET/CT was demonstrated to show a higher spatial resolution and to return a final diagnosis within 30 min. SPECT/CT was compromised by a longer examination time and the need for delayed imaging (24 h after tracer administration). However, no superiority of PET/CT over SPECT/CT was observed. Because of the high cost and low availability of ^{11}C, ^{123}I-MIBG SPECT/CT seems to be appropriate for the imaging of tumors derived from the sympathetic nervous system, such as neuroblastoma, pheochromocytoma, ganglioneuroblastoma, and paraganglioma.

Scintigraphic techniques also complement anatomically based imaging modalities for the evaluation of adrenocortical disease. The impact of hybrid SPECT/CT on the performance of functional imaging, such as ^{75}Se-selenomethylnorcholesterol or ^{131}I-iodocholesterol imaging, remains to be determined, because only scant data can be found in the literature. In a pilot study, Even-Sapir et al. reported a change in clinical management for a few patients undergoing ^{75}Se-cholesterol SPECT/CT (*53*). Despite an obvious lack of clinical studies demonstrating the superiority of SPECT/CT over separately performed imaging modalities, it can be speculated that hybrid imaging will increase diagnostic accuracy and may lead to the more frequent use of functional imaging techniques.

SPECT/CT IN NEUROENDOCRINE TUMORS

Neuroendocrine tumors usually exhibit increased expression of somatostatin receptors (SSTR), enabling their detection through the specific binding of radiolabeled ligands, such as ^{111}In-octreotide or ^{111}In-pentetreotide. SSTR scintigraphy is predominantly used for the detection of primary tumors or hepatic or mesenteric metastases but can also be used for assessment of the response to treatment with somatostatin analogs. The number of publications illustrating the added value of CT coregistration for SSTR planar imaging or SSTR SPECT is limited. The largest study to date evaluated SSTR SPECT/CT in 72 patients with various neuroendocrine tumors, including 45 carcinoid tumors, medullary thyroid carcinoma, or islet cell tumors (*54*). No additional information beyond that provided by planar imaging or SPECT was achieved for 48 patients, whereas SPECT/CT improved the localization of scintigraphic findings for 23 patients (32%) and changed clinical management for 14% of patients. For a series of 27 patients with various neuroendocrine tumors, Even-Sapir et al. demonstrated increased accuracy of detection of lesions by ^{131}I, ^{123}I-MIBG, ^{75}Se-cholesterol, or ^{111}In-penetreotide SPECT/CT (*53*). For one third of patients, a change in clinical

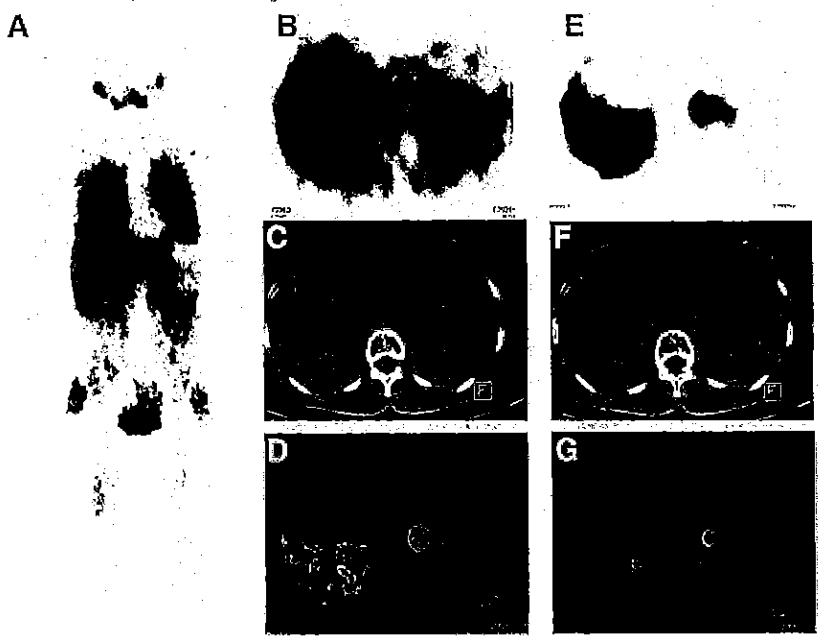

FIGURE 6. Diagnosis of pheochromocytoma with ^{99m}Tc-MIBG SPECT/CT. (A) Planar image showing mildly intense focal lesion extending to left suprarenal area. (B–D) Corresponding sections of SPECT (B), CT (C), and fused SPECT/CT (D) images showing focal uptake extending to enlarged left adrenal gland, indicating pheochromocytoma. (E–G) Corresponding transverse sections of right adrenal gland showing additional hot spot and enlargement of gland, indicating second pheochromocytoma, which was proven histologically. Lesion may be missed on planar image (A) or overexposed transaxial SPECT image (B).

management occurred. A significant impact of SPECT/CT on therapeutic management was also demonstrated by Hillel et al. for 29 patients with carcinoid or other neuroendocrine tumors (*55*). The addition of clinically relevant information for 40% of patients by SPECT/CT compared with SPECT was described by Gabriel et al. (*56*).

SPECT/CT IN CARDIAC IMAGING

As an example of the increased interest in hybrid cardiac imaging, the Society of Nuclear Medicine awarded its 2006 image of the year award to a cardiac SPECT/CT study (*57*). This study demonstrated a defect in the inferior myocardium together with corresponding stenosis on CT angiography (CTA). Combining function and morphology is highly attractive for several reasons: improved diagnosis and logistics as well as illustrative visualization. In this review, we focus on the methodologic perspective for hybrid SPECT/CT in nuclear perfusion imaging (Table 2), because the number of clinical procedures and research studies is still small compared with the number of studies of conventional methods. Where SPECT, CT, and SPECT/CT are positioned best in the clinical decision-making process is outside the scope of this review; discussion of this topic is ongoing and is the focus of recent reviews (*58–60*). Specifically, Berman et al. proposed "possible risk-based strategies through which imaging might be used to identify candidates for more intense prevention and risk factor modification strategies as well as those who would benefit from coronary angiography and revascularization" (*59*). We are convinced that cardiac SPECT/CT will play a prominent role in these scenarios and have compiled arguments ranging from improved attenuation correction to the assessment of complementary information with the potential of reducing radiation burden.

Use of CT for Attenuation Correction

Nonhomogeneous photon attenuation in the thorax is one of the most notable limitations of myocardial perfusion imaging. It creates the appearance of a nonuniform, regional perfusion distribution even for normal hearts, thus limiting clinical specificity. To overcome this obstacle, the correction of photon attenuation requires the assessment of attenuating tissue in the volume of interest (Fig. 1). Unfortunately, cardiac imaging poses a particular problem for attenuation correction because of respiratory and cardiac motion. Technically, SPECT attenuation correction with external sources was introduced in the early 1990s; retrospectively, however, its success appears to be rather limited. Thus, the integration of CT components in 2000 was a major step forward, with clinically relevant results being reported in larger studies (*61,62*).

The technical developments were summarized in recent review articles (*3,63*). Two different technical approaches were previously investigated. The first was a protocol with a radiation burden as low as possible (<0.5 mSv). The second was a CT examination allowing diagnostic imaging that, for cardiac imaging, would be either an assessment of coronary calcifications or, if the CT system were suitable, contrast-based angiography (typically 1–3 mSv for calcium scoring or 4–14 mSv for CTA). It is important to note that the actual doses varied substantially for the imaging hardware and the imaging protocol used and recently showed a trend toward a decrease, at least for CTA studies. For the low-dose approach and the coronary calcification scan, the contribution to the overall dose is moderate; for SPECT and CTA, the contributions are almost the same (Table 2).

PET/CT studies have already shown that very low-dose CT acquisitions are feasible for attenuation correction (*64*). Koepfli et al. (*65*) and a recent study with SPECT/CT confirmed these findings (*66*). However, a potential misalignment between emission and transmission data poses the risk of incomplete correction and thus artificial perfusion defects and requires careful quality control to avoid reconstruction artifacts. PET/CT (*67,68*) and SPECT/CT (*69,70*) studies have shown that the frequency of misalignment is high (≤50%) and that the consequences are clinically significant. Fortunately, a recent study with a digital phantom showed that the effects of misalignment are less severe for SPECT/CT than for PET/CT, mainly because of reduced spatial resolution (*71*). The alignment of SPECT and CT is usually performed manually, a process that contributes to certain variabilities. However, automated approaches for quality control are under investigation (*10,72,73*). It is relevant that even low-quality CT scans for attenuation correction provide clinically useful information. Goetze et al. reported that for 10% of 200 patients, noncardiac-related abnormal findings were detected (*69,70*). Similar data with even higher incidence rates are available from cardiac CT studies (*74,75*). Incidental findings may result in legal liabilities. It is clear that modifications in the clinical reading process are needed.

Cardiac SPECT Versus PET and Absolute Quantification

The superiority of cardiac PET over cardiac SPECT was demonstrated in several publications (*3,58,71,76,77*). However, in almost all of these reports, non–attenuation-corrected SPECT was used. Thus, assuming the availability of reliable CT-based attenuation correction for single-photon imaging and given an increased tolerance of motion artifacts, new studies should provide further insight into whether PET will remain superior. From a technical point of view, the capability of PET for absolute quantification in general and for blood flow quantification in particular is a substantial advantage. Nevertheless, through the use of animal models and a SPECT/CT system, it was shown that absolute activity values can be generated when attenuation correction and partial-volume effects are considered (*78,79*). For assessing absolute flow and coronary flow reserve, imaging with SPECT appears to be promising but requires large-scale validation work (*80–82*).

Integration of Calcium Scoring CT

In general, a trend toward the integration of low- and medium-quality CT systems—as opposed to high-end sys-

tems suitable for contrast-enhanced CT of the coronary arteries—into SPECT/CT devices has been observed. Consequently, those hybrid systems are not necessarily suitable for analysis of the vessel lumen with contrast agents but may be capable of the technically less demanding imaging of coronary calcium as a potential marker of atherosclerosis; however, this hypothesis has been debated in the last few years. It is not the aim of this review to repeat this discussion, but some selected, potential hybrid applications deserve mention.

A recent study investigated the incidence of significant calcifications in 84 patients referred for ^{82}Rb PET with adenosine stress (*83*). Non–contrast-enhanced CT was used for attenuation correction. Thirty-four patients with negative calcium findings also had normal PET results (negative predictive value, 100%). The remaining 50 patients had calcifications, and a myocardial perfusion defect was detected in 13 patients (PPV, 26%; sensitivity, 100%; specificity, 48%). Using this combined approach, the investigators concluded that myocardial perfusion PET could have been obviated in 63% of patients with no smoking history and no prior myocardial infarction or coronary revascularization procedure and in 37% of the total patient cohort. Although this study was a PET/CT study, this approach might allow a nuclear scan in a resting state to be avoided, and the overall radiation dose from SPECT/CT could be markedly reduced. Similarly, Henneman et al. investigated the hypoenhancement resulting from delayed contrast agent washin in CTA studies (*84*). On the basis of the fact that the scar scores calculated from SPECT myocardial perfusion imaging and by CTA washin analysis corresponded well for SPECT and CTA, another approach to avoiding a resting SPECT examination could be envisioned. However, although these studies appear to be promising, the incremental value of assessing coronary calcifications or coronary morphology as part of a nuclear examination needs to be investigated in large prospective studies, and it is too early to answer the question of optimal work flow.

Myocardial Perfusion and CT Coronary Angiography

As with combined PET/CT acquisitions of perfusion and coronary morphology (*85*), visually very attractive displays can be created with SPECT/CT systems (*86*). In one of the largest studies to date, including 56 patients with a high prevalence of coronary artery disease, the authors concluded that "hybrid SPECT/CTCA imaging results in improved specificity and PPV to detect hemodynamically significant coronary lesions in patients with chest pain" (*87*). However, this study also showed that the total radiation burden was as high as 41.5 mSv.

It is interesting that the fusion approach is not restricted to integrated devices (*88,89*). In particular, for CTA studies, the integrated CT component is typically less advanced than stand-alone CT. Thus, the use of external CT is feasible and may even offer a resolution advantage. Technically, SPECT and CT studies must be spatially registered even with hybrid cameras because of differences in breathing positions (expiration vs. averaged respiratory motion). A relevant additional aspect of cardiac contrast-enhanced CT is the imaging of delayed enhancement, as in MRI. The different washout rates for contrast agents in normal myocardium and damaged myocardium are now widely used in MRI (*90*) and recently were used in CT (*91,92*). Thus, delineating scar tissue with low-dose CT after contrast agent injection appears to be feasible.

In summary, the prospects for hybrid cardiac imaging are promising, and new clinical applications are being proposed. Large, prospective, outcome-based studies for proving these concepts are lacking. In addition, economic and biologic aspects must be considered (*93,94*). However, reliable attenuation correction and the integration of complementary, multimodality information into an attractive display facilitating communication with cardiologists will influence the future development of nuclear cardiac imaging.

SPECT/CT IN NEUROLOGIC AND PSYCHIATRIC DIAGNOSES

So far, data on the added value of combined SPECT/CT examinations of the brain remain rather limited. However, the diagnostic value of various cerebral SPECT examinations, such as cerebral perfusion or receptor studies, might be increased, to some extent, by additional CT examinations.

In general, individual CT scan–based attenuation correction of brain SPECT data may lead to improved image quality and more accurate data evaluation (Fig. 1). These features may be particularly important for regional data analysis, such as semiquantitative region-of-interest–based image analysis, as regularly applied for the evaluation of imaging studies of presynaptic dopamine transporters with ^{123}I-2β-carbomethoxy-3β-(4-iodophenyl)tropane (DaTSCAN; GE Healthcare) or postsynaptic dopamine receptors with ^{123}I-iodobenzamide. These examinations are usually applied for the verification of idiopathic Parkinson's disease, respectively, the differentiation from atypical Parkinson syndromes. In both types of studies, ratios of striatal to background tracer uptake are calculated, and predefined thresholds for striatum-to-background ratios are used for the differentiation of normal uptake and pathologic findings reflecting reduced receptor or transporter density. For attenuation correction of these studies, ellipse-based calculated attenuation correction techniques, such as the procedure described by Chang (*95*), are usually applied and have been demonstrated to show sufficient reliability. However, it has been shown that attenuation correction based on individual CT scans produces more accurate results (*96*). In particular, for borderline findings, it is possible that attenuation correction has a significant influence on quantitative assessment and, thus, on the resulting clinical diagnosis. In such cases, individual CT scan–based attenuation correction may lead to a more appropriate diagnosis. In addition to optimized data quality, access to individual coregistered CT data may also improve the standardized definition and

positioning of regions of interest, particularly in datasets with pathologically low uptake (*97*). However, a systematic analysis is required to assess differences between individually measured and conventionally calculated attenuation corrections, and clarification of whether currently applied thresholds need to be modified is also required.

In addition to individualized attenuation correction, the performance of CT scans simultaneously with SPECT examinations may offer several additional advantages. A recent study examined the additional diagnostic value of the low-dose (CT) component of a combined ^{99m}Tc-hexamethylpropyleneamine oxime SPECT/CT examination of cerebral perfusion in a large population (*98*). Interestingly, 25% of the low-dose CT images demonstrated abnormalities such as infarcts, cerebral atrophy, dilated ventricles, basal ganglion calcifications, and other findings, such as subdural hematoma or meningioma. The authors concluded that the CT component of cerebral perfusion SPECT/CT investigations should be routinely reported separately.

Finally, with the advent of modern SPECT/CT hybrid systems containing state-of-the-art CT scanners, it is possible, in principle, to perform high-quality diagnostic CT examinations of the brain in a single session with simultaneous SPECT examinations. This feature may offer opportunities to assess vascular pathologies, such as cerebral ischemia, stroke, or carotid stenosis, and even to diagnose brain death through the examination of cerebral perfusion with ^{99m}Tc-hexamethylpropyleneamine oxime in combination with CT assessment of vascular abnormalities (CT perfusion imaging, or CTA). The value of this type of combined examinations has not yet been sufficiently assessed and needs to be evaluated in specific clinical trials.

COMBINED SPECT/CT FOR OPTIMIZED DOSIMETRY

The complementation of scintigraphic examinations with detailed anatomic information derived from CT offers the possibility of improving organ-specific dosimetry for radiation treatment planning and radionuclide therapy. Dosimetry for treatment planning and for retrospectively ascertaining the absorbed dose delivered during treatment should be regarded as mandatory for all radionuclide therapies, such as radioiodine (^{131}I) treatment of thyroid cancer; radioimmunotherapy of lymphoma with, for example, ^{90}Y-ibritumomab tiuxetan; or therapy of neuroectodermal tumors, such as pheochromocytoma, neuroblastoma, or paraganglioma, with ^{131}I-MIBG. Conventionally, dosimetry for radionuclide treatment has been performed mostly by application of a low dose of the therapeutic radionuclide used for imaging or by application of the therapeutic compound labeled with a different radiotracer more suitable for scintigraphy (e.g., ^{111}In or ^{123}I) followed by tracer uptake measurements in planar scintigrams. However, more accurate dosimetry may require 3-dimensional assessment, proper attenuation correction of the image data, and assessment of organ or target volumes, which can be derived from simultaneously acquired CT scans. Several studies have already demonstrated that 3-dimensional dosimetry based on anatomic information derived for regional organ volumes or masses from CT leads to superior assessments of regionally applied doses in critical organs (*99–103*). Integration of the data collected by multimodality imaging into complex calculation models, such as the Monte Carlo simulation, may significantly improve regional dosimetry for the spatial distribution of the absorbed dose (*104*).

In addition to dosimetry of critical organs at risk, evaluation by multimodality imaging with SPECT/CT may also allow accurate dosimetry of tumor targets for treatment planning and evaluation of the response to radionuclide therapy (*105*). This process may also be valuable for establishing a clear correlation between the absorbed dose and the biologic effect.

In summary, it appears likely that combined SPECT/CT will be highly useful for performing valid and clinically applicable dosimetry, for improving treatment planning, and for ensuring safe and effective radionuclide therapy.

Furthermore, combined SPECT/CT may also be useful for planning radiation treatment for prostate cancer. Hybrid imaging of capromab pendetide (Prostascint; Cytogen) with SPECT and CT has been demonstrated to show increased sensitivity for the identification of prostate cancer. Recently, it was proposed that this combined imaging approach be used to confine the dose escalation of radiation treatment to discrete regions of known disease, as defined by focal uptake on fused radioimmunoscintigraphic and anatomic image sets (*106*). It has been suggested that intensification of treatment directed to tumor targets without an increase in rectal toxicity may be achieved. Suggestions also have been extended toward guiding the implantation of radioactive seeds in brachytherapy (*107*). In general, it may be assumed that SPECT/CT will be equally valid for individualized planning of radiation treatment for other tumor entities, and further clinical research should be encouraged.

CONCLUSION

The role of integrated SPECT/CT is growing, especially in oncologic applications. CT coregistration results in higher specificity as well as sensitivity of scintigraphic findings and markedly reduces the number of indeterminate findings. The superiority of SPECT/CT over planar scintigraphy or SPECT has been clearly demonstrated for the imaging of benign and malignant skeletal diseases, thyroid cancer, neuroendocrine cancer, parathyroid adenoma, and mapping of SLNs in the head and neck and in the pelvic region. Studies demonstrating superiority in other clinical applications are lacking; however, pilot studies have encouraged the use of SPECT/CT in cardiac and neurologic imaging. Interesting developments occurring with less frequently used radiopharmaceuticals and imaging technologies may become clinically relevant in the near future.

REFERENCES

1. Czernin J, Allen-Auerbach M, Schelbert HR. Improvements in cancer staging with PET/CT: literature-based evidence as of September 2006. *J Nucl Med.* 2007;48(suppl 1):78S–88S.
2. von Schulthess GK, Steinert HC, Hany TF. Integrated PET/CT: current applications and future directions. *Radiology.* 2006;238:405–422.
3. O'Connor MK, Kemp BJ. Single-photon emission computed tomography/computed tomography: basic instrumentation and innovations. *Semin Nucl Med.* 2006;36:258–266.
4. Perault C, Schvartz C, Wampach H, Liehn JC, Delisle MJ. Thoracic and abdominal SPECT-CT image fusion without external markers in endocrine carcinomas. The Group of Thyroid Tumoral Pathology of Champagne-Ardenne. *J Nucl Med.* 1997;38:1234–1242.
5. Frank A, Lefkowitz D, Jaeger S, et al. Decision logic for retreatment of asymptomatic lung cancer recurrence based on positron emission tomography findings. *Int J Radiat Oncol Biol Phys.* 1995;32:1495–1512.
6. Forster GJ, Laumann C, Nickel O, Kann P, Rieker O, Bartenstein P. SPET/CT image co-registration in the abdomen with a simple and cost-effective tool. *Eur J Nucl Med Mol Imaging.* 2003;30:32–39.
7. Hasegawa BH, Wong KH, Iwata K, et al. Dual-modality imaging of cancer with SPECT/CT. *Technol Cancer Res Treat.* 2002;1:449–458.
8. Bocher M, Balan A, Krausz Y, et al. Gamma camera-mounted anatomical X-ray tomography: technology, system characteristics and first images. *Eur J Nucl Med.* 2000;27:619–627.
9. Xia W, Lewitt RM, Edholm PR. Fourier correction for spatially variant collimator blurring in SPECT. *IEEE Trans Med Imaging.* 1995;14:100–115.
10. Chen J, Caputlu-Wilson SF, Shi H, Galt JR, Faber TL, Garcia EV. Automated quality control of emission-transmission misalignment for attenuation correction in myocardial perfusion imaging with SPECT-CT systems. *J Nucl Cardiol.* 2006;13:43–49.
11. Kuehl H, Veit P, Rosenbaum SJ, Bockisch A, Antoch G. Can PET/CT replace separate diagnostic CT for cancer imaging? Optimizing CT protocols for imaging cancers of the chest and abdomen. *J Nucl Med.* 2007;48(suppl 1):45S–57S.
12. Even-Sapir E, Lerman H, Lievshitz G, et al. Lymphoscintigraphy for sentinel node mapping using a hybrid SPECT/CT system. *J Nucl Med.* 2003;44:1413–1420.
13. Zhang WJ, Zheng R, Wu LY, Li XG, Li B, Chen SZ. Clinical application of sentinel lymph node detection to early stage cervical cancer [in Chinese]. *Ai Zheng.* 2006;25:224–228.
14. Sherif A, Garske U, de la Torre M, Thorn M. Hybrid SPECT-CT: an additional technique for sentinel node detection of patients with invasive bladder cancer. *Eur Urol.* 2006;50:83–91.
15. Khafif A, Schneebaum S, Fliss DM, et al. Lymphoscintigraphy for sentinel node mapping using a hybrid single photon emission CT (SPECT)/CT system in oral cavity squamous cell carcinoma. *Head Neck.* 2006;28:874–879.
16. Bilde A, Von Buchwald C, Mortensen J, et al. The role of SPECT-CT in the lymphoscintigraphic identification of sentinel nodes in patients with oral cancer. *Acta Otolaryngol.* 2006;126:1096–1103.
17. Keski-Santti H, Matzke S, Kauppinen T, Tornwall J, Atula T. Sentinel lymph node mapping using SPECT-CT fusion imaging in patients with oral cavity squamous cell carcinoma. *Eur Arch Otorhinolaryngol.* 2006;263:1008–1012.
18. Wagner A, Schicho K, Glaser C, et al. SPECT-CT for topographic mapping of sentinel lymph nodes prior to gamma probe-guided biopsy in head and neck squamous cell carcinoma. *J Craniomaxillofac Surg.* 2004;32:343–349.
19. Husarik DB, Steinert HC. Single-photon emission computed tomography/computed tomography for sentinel node mapping in breast cancer. *Semin Nucl Med.* 2007;37:29–33.
20. Lerman H, Metser U, Lievshitz G, Sperber F, Shneebaum S, Even-Sapir E. Lymphoscintigraphic sentinel node identification in patients with breast cancer: the role of SPECT-CT. *Eur J Nucl Med Mol Imaging.* 2006;33:329–337.
21. Gallowitsch HJ, Kraschl P, Igerc I, et al. Sentinel node SPECT-CT in breast cancer: can we expect any additional and clinically relevant information? *Nuklearmedizin.* 2007;46:252–256.
22. van der Ploeg IM, Valdes Olmos RA, Nieweg OE, Rutgers EJ, Kroon BB, Hoefnagel CA. The additional value of SPECT/CT in lymphatic mapping in breast cancer and melanoma. *J Nucl Med.* 2007;48:1756–1760.
23. Lerman H, Lievshitz G, Zak O, Metser U, Schneebaum S, Even-Sapir E. Improved sentinel node identification by SPECT/CT in overweight patients with breast cancer. *J Nucl Med.* 2007;48:201–206.
24. Hamaoka T, Madewell JE, Podoloff DA, Hortobagyi GN, Ueno NT. Bone imaging in metastatic breast cancer. *J Clin Oncol.* 2004;22:2942–2953.
25. Minoves M. Bone and joint sports injuries: the role of bone scintigraphy. *Nucl Med Commun.* 2003;24:3–10.
26. Even-Sapir E. Imaging of malignant bone involvement by morphologic, scintigraphic, and hybrid modalities. *J Nucl Med.* 2005;46:1356–1367.
27. Römer W, Nomayr A, Uder M, Bautz W, Kuwert T. SPECT-guided CT for evaluating foci of increased bone metabolism classified as indeterminate on SPECT in cancer patients. *J Nucl Med.* 2006;47:1102–1106.
28. Seo Y, Wong KH, Sun M, Franc BL, Hawkins RA, Hasegawa BH. Correction of photon attenuation and collimator response for a body-contouring SPECT/CT imaging system. *J Nucl Med.* 2005;46:868–877.
29. Römer W, Reichel N, Vija HA, et al. Isotropic reconstruction of SPECT data using OSEM3D: correlation with CT. *Acad Radiol.* 2006;13:496–502.
30. Horger M, Eschmann SM, Pfannenberg C, et al. Evaluation of combined transmission and emission tomography for classification of skeletal lesions. *AJR.* 2004;183:655–661.
31. Utsunomiya D, Shiraishi S, Imuta M, et al. Added value of SPECT/CT fusion in assessing suspected bone metastasis: comparison with scintigraphy alone and nonfused scintigraphy and CT. *Radiology.* 2006;238:264–271.
32. Even-Sapir E, Flusser G, Lerman H, Lievshitz G, Metser U. SPECT/multislice low-dose CT: a clinically relevant constituent in the imaging algorithm of nononcologic patients referred for bone scintigraphy. *J Nucl Med.* 2007;48:319–324.
33. Bar-Shalom R, Yefremov N, Guralnik L, et al. SPECT/CT using ^{67}Ga and ^{111}In-labeled leukocyte scintigraphy for diagnosis of infection. *J Nucl Med.* 2006;47:587–594.
34. Filippi L, Schillaci O. Usefulness of hybrid SPECT/CT in ^{99m}Tc-HMPAO-labeled leukocyte scintigraphy for bone and joint infections. *J Nucl Med.* 2006;47:1908–1913.
35. Horger M, Eschmann SM, Pfannenberg C, et al. Added value of SPECT/CT in patients suspected of having bone infection: preliminary results. *Arch Orthop Trauma Surg.* 2007;127:211–221.
36. Ingui CJ, Shah NP, Oates ME. Infection scintigraphy: added value of single-photon emission computed tomography/computed tomography fusion compared with traditional analysis. *J Comput Assist Tomogr.* 2007;31:375–380.
37. Nathan J, Crawford JA, Sodee DB, Bakale G. Fused SPECT/CT imaging of peri-iliopsoas infection using indium-111-labeled leukocytes. *Clin Nucl Med.* 2006;31:801–802.
38. Palestro CJ, Love C, Miller TT. Diagnostic imaging tests and microbial infections. *Cell Microbiol.* 2007;9:2323–2333.
39. Roach PJ, Schembri GP, Ho Shon IA, Bailey EA, Bailey DL. SPECT/CT imaging using a spiral CT scanner for anatomical localization: impact on diagnostic accuracy and reporter confidence in clinical practice. *Nucl Med Commun.* 2006;27:977–987.
40. Slart RH, Koopmans KP, Gunneweg P, Luijckx GJ, de Jong BM. Persistent aseptic meningitis due to post-surgical spinal CSF leakage: value of fused ^{111}In-DTPA SPECT-CT cisternography. *Eur J Nucl Med Mol Imaging.* 2006;33:856.
41. Ingui CJ, Shah NP, Oates ME. Endocrine neoplasm scintigraphy: added value of fusing SPECT/CT images compared with traditional side-by-side analysis. *Clin Nucl Med.* 2006;31:665–672.
42. Tharp K, Israel O, Hausmann J, et al. Impact of ^{131}I-SPECT/CT images obtained with an integrated system in the follow-up of patients with thyroid carcinoma. *Eur J Nucl Med Mol Imaging.* 2004;31:1435–1442.
43. Yamamoto Y, Nishiyama Y, Monden T, Matsumura Y, Satoh K, Ohkawa M. Clinical usefulness of fusion of ^{131}I SPECT and CT images in patients with differentiated thyroid carcinoma. *J Nucl Med.* 2003;44:1905–1910.
44. Ruf J, Lehmkuhl L, Bertram H, et al. Impact of SPECT and integrated low-dose CT after radioiodine therapy on the management of patients with thyroid carcinoma. *Nucl Med Commun.* 2004;25:1177–1182.
45. Lavely WC, Goetze S, Friedman KP, et al. Comparison of SPECT/CT, SPECT, and planar imaging with single- and dual-phase ^{99m}Tc-sestamibi parathyroid scintigraphy. *J Nucl Med.* 2007;48:1084–1089.
46. Harris L, Yoo J, Driedger A, et al. Accuracy of technetium-99m SPECT-CT hybrid images in predicting the precise intraoperative anatomical location of parathyroid adenomas. *Head Neck.* 2008;30:509–517.
47. Ruf J, Seehofer D, Denecke T, et al. Impact of image fusion and attenuation correction by SPECT-CT on the scintigraphic detection of parathyroid adenomas. *Nuklearmedizin.* 2007;46:15–21.
48. Gayed IW, Kim EE, Broussard WF, et al. The value of ^{99m}Tc-sestamibi SPECT/CT over conventional SPECT in the evaluation of parathyroid adenomas or hyperplasia. *J Nucl Med.* 2005;46:248–252.
49. Krausz Y, Bettman L, Guralnik L, et al. Technetium-99m-MIBI SPECT/CT in primary hyperparathyroidism. *World J Surg.* 2006;30:76–83.
50. Avram AM, Fig LM, Gross MD. Adrenal gland scintigraphy. *Semin Nucl Med.* 2006;36:212–227.

51. Gross MD, Avram A, Fig LM, Rubello D. Contemporary adrenal scintigraphy. *Eur J Nucl Med Mol Imaging.* 2007;34:547–557.
52. Franzius C, Hermann K, Weckesser M, et al. Whole-body PET/CT with ^{11}C-meta-hydroxyephedrine in tumors of the sympathetic nervous system: feasibility study and comparison with ^{123}I-MIBG SPECT/CT. *J Nucl Med.* 2006; 47:1635–1642.
53. Even-Sapir E, Keidar Z, Sachs J, et al. The new technology of combined transmission and emission tomography in evaluation of endocrine neoplasms. *J Nucl Med.* 2001;42:998–1004.
54. Krausz Y, Keidar Z, Kogan I, et al. SPECT/CT hybrid imaging with ^{111}In-pentetreotide in assessment of neuroendocrine tumours. *Clin Endocrinol (Oxf).* 2003;59:565–573.
55. Hillel PG, van Beek EJ, Taylor C, et al. The clinical impact of a combined gamma camera/CT imaging system on somatostatin receptor imaging of neuroendocrine tumours. *Clin Radiol.* 2006;61:579–587.
56. Gabriel M, Hausler F, Bale R, et al. Image fusion analysis of ^{99m}Tc-HYNIC-Tyr(3)-octreotide SPECT and diagnostic CT using an immobilisation device with external markers in patients with endocrine tumours. *Eur J Nucl Med Mol Imaging.* 2005;32:1440–1451.
57. 2006 Image of the year: focus on cardiac SPECT/CT. *J Nucl Med.* 2006; 47:14N–15N.
58. Berman DS, Hachamovitch R, Shaw LJ, et al. Roles of nuclear cardiology, cardiac computed tomography, and cardiac magnetic resonance: assessment of patients with suspected coronary artery disease. *J Nucl Med.* 2006;47: 74–82.
59. Berman DS, Shaw LJ, Hachamovitch R, et al. Comparative use of radionuclide stress testing, coronary artery calcium scanning, and noninvasive coronary angiography for diagnostic and prognostic cardiac assessment. *Semin Nucl Med.* 2007;37:2–16.
60. Raggi P, Berman DS. Computed tomography coronary calcium screening and myocardial perfusion imaging. *J Nucl Cardiol.* 2005;12:96–103.
61. Dondi M, Fagioli G, Salgarello M, Zoboli S, Nanni C, Cidda C. Myocardial SPECT: what do we gain from attenuation correction (and when)? *Q J Nucl Med Mol Imaging.* 2004;48:181–187.
62. Masood Y, Liu YH, Depuey G, et al. Clinical validation of SPECT attenuation correction using x-ray computed tomography-derived attenuation maps: multicenter clinical trial with angiographic correlation. *J Nucl Cardiol.* 2005;12:676–686.
63. Madsen MT. Recent advances in SPECT imaging. *J Nucl Med.* 2007;48: 661–673.
64. Souvatzoglou M, Bengel F, Busch R, et al. Attenuation correction in cardiac PET/CT with three different CT protocols: a comparison with conventional PET. *Eur J Nucl Med Mol Imaging.* 2007;34:1991–2000.
65. Koepfli P, Hany TF, Wyss CA, et al. CT attenuation correction for myocardial perfusion quantification using a PET/CT hybrid scanner. *J Nucl Med.* 2004;45:537–542.
66. Preuss R, Weise R, Lindner O, Fricke E, Fricke H, Burchert W. Optimisation of protocol for low dose CT-derived attenuation correction in myocardial perfusion SPECT imaging. *Eur J Nucl Med Mol Imaging.* 2008;35:1133–1141.
67. Martínez-Möller A, Souvatzoglou M, Navab N, Schwaiger M, Nekolla SG. Artifacts from misaligned CT in cardiac perfusion PET/CT studies: frequency, effects, and potential solutions. *J Nucl Med.* 2007;48:188–193.
68. Gould KL, Pan T, Loghin C, Johnson NP, Guha A, Sdringola S. Frequent diagnostic errors in cardiac PET/CT due to misregistration of CT attenuation and emission PET images: a definitive analysis of causes, consequences, and corrections. *J Nucl Med.* 2007;48:1112–1121.
69. Goetze S, Brown TL, Lavely WC, Zhang Z, Bengel FM. Attenuation correction in myocardial perfusion SPECT/CT: effects of misregistration and value of reregistration. *J Nucl Med.* 2007;48:1090–1095.
70. Goetze S, Wahl RL. Prevalence of misregistration between SPECT and CT for attenuation-corrected myocardial perfusion SPECT. *J Nucl Cardiol.* 2007;14: 200–206.
71. McQuaid SJ, Hutton BF. Sources of attenuation-correction artefacts in cardiac PET/CT and SPECT/CT. *Eur J Nucl Med Mol Imaging.* 2008;35:1117–1123.
72. Guetter C, Wacker M, Xu C, Hornegger J. Registration of cardiac SPECT/CT data through weighted intensity co-occurrence priors. *Med Image Comput Comput Assist Interv Int Conf Med Image Comput Comput Assist Interv.* 2007; 10:725–733.
73. Kovalski G, Israel O, Keidar Z, Frenkel A, Sachs J, Azhari H. Correction of heart motion due to respiration in clinical myocardial perfusion SPECT scans using respiratory gating. *J Nucl Med.* 2007;48:630–636.
74. Onuma Y, Tanabe K, Nakazawa G, et al. Noncardiac findings in cardiac imaging with multidetector computed tomography. *J Am Coll Cardiol.* 2006;48: 402–406.
75. Schictinger BJ, Bozlar U, Hagspiel KD, et al. The prevalence of extracardiac findings by multidetector computed tomography before atrial fibrillation ablation. *Am Heart J.* 2008;155:254–259.
76. Ballok ZE. Nuclear cardiology. *Heart Lung Circ.* 2005;14(suppl 2):S27–S30.
77. Slomka PJ, Berman DS, Germano G. Applications and software techniques for integrated cardiac multimodality imaging. *Expert Rev Cardiovasc Ther.* 2008; 6:27–41.
78. Kalki K, Blankespoor SC, Brown JK, et al. Myocardial perfusion imaging with a combined x-ray CT and SPECT system. *J Nucl Med.* 1997;38: 1535–1540.
79. Da Silva AJ, Tang HR, Wong KH, Wu MC, Dae MW, Hasegawa BH. Absolute quantification of regional myocardial uptake of ^{99m}Tc-sestamibi with SPECT: experimental validation in a porcine model. *J Nucl Med.* 2001; 42:772–779.
80. Storto G, Sorrentino AR, Pellegrino T, Liuzzi R, Petretta M, Cuocolo A. Assessment of coronary flow reserve by sestamibi imaging in patients with typical chest pain and normal coronary arteries. *Eur J Nucl Med Mol Imaging.* 2007;34:1156–1161.
81. Storto G, Cirillo P, Vicario ML, et al. Estimation of coronary flow reserve by Tc-99m sestamibi imaging in patients with coronary artery disease: comparison with the results of intracoronary Doppler technique. *J Nucl Cardiol.* 2004;11: 682–688.
82. Lodge MA, Bengel FM. Methodology for quantifying absolute myocardial perfusion with PET and SPECT. *Curr Cardiol Rep.* 2007;9:121–128.
83. Esteves FP, Sanyal R, Santana CA, Shaw L, Raggi P. Potential impact of noncontrast computed tomography as gatekeeper for myocardial perfusion positron emission tomography in patients admitted to the chest pain unit. *Am J Cardiol.* 2008;101:149–152.
84. Henneman MM, Schuijf JD, Dibbets-Schneider P, et al. Comparison of multislice computed tomography to gated single-photon emission computed tomography for imaging of healed myocardial infarcts. *Am J Cardiol.* 2008; 101:144–148.
85. Namdar M, Hany TF, Koepfli P, et al. Integrated PET/CT for the assessment of coronary artery disease: a feasibility study. *J Nucl Med.* 2005;46:930–935.
86. Ghersin E, Keidar Z, Rispler S, et al. Images in cardiovascular medicine: hybrid cardiac single photon emission computed tomography/computed tomography imaging with myocardial perfusion single photon emission computed tomography and multidetector computed tomography coronary angiography for the assessment of unstable angina pectoris after coronary artery bypass grafting. *Circulation.* 2006;114:e237–e239.
87. Rispler S, Keidar Z, Ghersin E, et al. Integrated single-photon emission computed tomography and computed tomography coronary angiography for the assessment of hemodynamically significant coronary artery lesions. *J Am Coll Cardiol.* 2007;49:1059–1067.
88. Gaemperli O, Schepis T, Kalff V, et al. Validation of a new cardiac image fusion software for three-dimensional integration of myocardial perfusion SPECT and stand-alone 64-slice CT angiography. *Eur J Nucl Med Mol Imaging.* 2007;34:1097–1106.
89. Gaemperli O, Schepis T, Valenta I, et al. Cardiac image fusion from stand-alone SPECT and CT: clinical experience. *J Nucl Med.* 2007;48:696–703.
90. Kim RJ, Fieno DS, Parrish TB, et al. Relationship of MRI delayed contrast enhancement to irreversible injury, infarct age, and contractile function. *Circulation.* 1999;100:1992–2002.
91. Mahnken AH, Koos R, Katoh M, et al. Sixteen-slice spiral CT versus MR imaging for the assessment of left ventricular function in acute myocardial infarction. *Eur Radiol.* 2005;15:714–720.
92. Lardo AC, Cordeiro MA, Silva C, et al. Contrast-enhanced multidetector computed tomography viability imaging after myocardial infarction: characterization of myocyte death, microvascular obstruction, and chronic scar. *Circulation.* 2006;113:394–404.
93. Picano E. Economic and biological costs of cardiac imaging. *Cardiovasc Ultrasound.* 2005;3:13.
94. Wijns W. Anatomic-functional imaging by single-photon emission computed tomography/computed tomography as the cornerstone of diagnosis and treatment for coronary patients: a glimpse into the (near) future? *J Am Coll Cardiol.* 2007;49:1068–1070.
95. Chang L. A method for attenuation correction in radio-nuclide computed tomography. *IEEE Trans Nucl Sci.* 1978;25:638–643.
96. Hayashi M, Deguchi J, Utsunomiya K, et al. Comparison of methods of attenuation and scatter correction in brain perfusion SPECT. *J Nucl Med Technol.* 2005;33:224–229.
97. Van Laere K, Koole M, D'Asseler Y, et al. Automated stereotactic standardization of brain SPECT receptor data using single-photon transmission images. *J Nucl Med.* 2001;42:361–375.

98. Sulkin TV, Cousens C. SPECTCT cerebral perfusion scintigraphy; is the low-dose CT component of diagnostic value? *Clin Radiol.* 2008;63:289–298.
99. Boucek JA, Turner JH. Validation of prospective whole-body bone marrow dosimetry by SPECT/CT multimodality imaging in ^{131}I-anti-CD20 rituximab radioimmunotherapy of non-Hodgkin's lymphoma. *Eur J Nucl Med Mol Imaging.* 2005;32:458–469.
100. Rajendran JG, Fisher DR, Gopal AK, Durack LD, Press OW, Eary JF. High-dose ^{131}I-tositumomab (anti-CD20) radioimmunotherapy for non-Hodgkin's lymphoma: adjusting radiation absorbed dose to actual organ volumes. *J Nucl Med.* 2004;45:1059–1064.
101. Thierens HM, Monsieurs MA, Bacher K. Patient dosimetry in radionuclide therapy: the whys and the wherefores. *Nucl Med Commun.* 2005;26:593–599.
102. Cremonesi M, Ferrari M, Grana CM, et al. High-dose radioimmunotherapy with ^{90}Y-ibritumomab tiuxetan: comparative dosimetric study for tailored treatment. *J Nucl Med.* 2007;48:1871–1879.
103. Assie K, Dieudonne A, Gardin I, Buvat I, Tilly H, Vera P. Comparison between 2D and 3D dosimetry protocols in ^{90}Y-ibritumomab tiuxetan radioimmunotherapy of patients with non-Hodgkin's lymphoma. *Cancer Biother Radiopharm.* 2008;23:53–64.
104. Prideaux AR, Song H, Hobbs RF, et al. Three-dimensional radiobiologic dosimetry: application of radiobiologic modeling to patient-specific 3-dimensional imaging-based internal dosimetry. *J Nucl Med.* 2007;48:1008–1016.
105. Flux G, Bardies M, Monsieurs M, Savolainen S, Strands SE, Lassmann M. The impact of PET and SPECT on dosimetry for targeted radionuclide therapy. *Z Med Phys.* 2006;16:47–59.
106. Ellis RJ, Kaminsky DA. Fused radioimmunoscintigraphy for treatment planning. *Rev Urol.* 2006;8(suppl 1):S11–S19.
107. Sodee DB, Sodee AE, Bakale G. Synergistic value of single-photon emission computed tomography/computed tomography fusion to radioimmunoscintigraphic imaging of prostate cancer. *Semin Nucl Med.* 2007;37:17–28.

RadioGraphics

SPECT/CT Imaging: Clinical Utility of an Emerging Technology[1]

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LEARNING OBJECTIVES

After reading this article and taking the test, the reader will be able to:

- Describe the basic science principles of SPECT/CT.
- List the areas of clinical practice in which this modality is most useful.
- Identify some potential artifacts that occur on SPECT/CT images.

TEACHING POINTS

See last page

Single-photon emission computed tomography (SPECT) has been a mainstay of nuclear medicine practice for several decades. More recently, combining the functional imaging available with SPECT and the anatomic imaging of computed tomography (CT) has gained more acceptance and proved useful in many clinical situations. Most vendors now offer integrated SPECT/CT systems that can perform both functions on one gantry and provide fused functional and anatomic data in a single imaging session. In addition to allowing anatomic localization of nuclear imaging findings, SPECT/CT also enables accurate and rapid attenuation correction of SPECT studies. These attributes have proved useful in many cardiac, general nuclear medicine, oncologic, and neurologic applications in which the SPECT results alone were inconclusive. Optimal clinical use of this rapidly emerging imaging modality requires an understanding of the fundamental principles of SPECT/CT, including quality control issues as well as potential pitfalls and limitations. The long-term clinical and economic effects of this technology have yet to be established.

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Introduction

Single-photon-emission computed tomography (SPECT) has been used in general nuclear medicine, nuclear cardiology, and nuclear neurology for several decades to provide three-dimensional images of radiotracer distribution (1). Although SPECT data, in general, have proved superior to those of planar imaging, use of SPEGT data has occasionally been less than optimal because of an inability to provide accurate anatomic localization of an identified abnormality. By combining SPECT with an anatomic imaging modality such as computed tomography (CT), it is now feasible to address this limitation. Although SPECT/CT was explored by Hasegawa et al (2) in the early 1990s, only in the past few years with the success of combined positron emission tomography (PET) and CT systems has there been a significant commercial interest in developing and promoting a similar hybrid system for SPECT.

The advantages of SPECT/CT parallel those of PET/CT in many ways. **First, while anatomic imaging techniques allow accurate detection and localization of morphologic abnormalities, nuclear medicine studies reflect the pathophysiologic status of the disease process.** However, both methods also have their limitations. Using a combined system, one can now sequentially acquire both anatomic and functional information that is very accurately fused in a single examination (3). **A second important feature of SPECT/CT imaging is the ability to correct the nuclear emission images for attenuation and photon scatter to obtain more accurate image data.** This should improve the ability of the nuclear medicine physician or radiologist to identify abnormalities in organs that exhibit homogeneous but abnormal tracer uptake, and to provide a more reliable determination of the response to medical or surgical intervention.

Teaching Point

Teaching Point

In this article, we focus on the principles and basic science of SPECT/CT instrumentation (3) and imaging. We then highlight the potential limitations of this imaging technique (4) and its clinical utility in cardiology, musculoskeletal applications, infection, oncology, general nuclear medicine, and neurology.

Basic Science

SPECT is defined as tomographic scintigraphy where computer-generated three-dimensional images of radioactive tracer distribution are produced by detection of single photons from acquired multiple-planar images. By contrast, CT is tomographic imaging performed with an external x-ray source to derive three-dimensional anatomic image data.

Software algorithms for coregistration of anatomic and physiologic images were developed in the 1980s and achieved variable success, starting with fusion of brain images by using external markers. More recently, automated software for image coregistration, such as software based on the mutual information algorithm, has become commercially available and has shown much success in fusing brain images. Coregistration of neck, chest, and abdominal images has proved to be more problematic because of the lack of anatomic reference points on the nuclear medicine images. Also, the regions are not rigid structures, and differences in patient positioning and respiratory motion can easily result in misalignment of the SPECT and CT images. Finally, when imaging studies are performed at different times, positional differences in certain structures, such as the intestinal tract, can adversely affect coregistration.

Hasegawa and his colleagues (2) attempted to devise a system capable of performing simultaneous CT and SPECT studies, which formed the basis for the development of hybrid SPECT/CT systems for clinical use. The first commercial system, called the Hawkeye, was developed by General Electric in 1999. This system mounted an x-ray tube on a ring gantry opposite cadmium tungstate detectors. Although the primary purpose of the CT was to provide a high-quality attenuation map, it also provided fair anatomic images. Other benefits of this compact system were a lower radiation dose to the patient and a reduction in necessary room shielding compared with those of conventional CT. More recently, other vendors have chosen to develop SPECT/CT systems more similar to PET/CT systems. The hybrid cameras from Philips Medical Systems (Precedence) and Siemens Medical Solutions (Symbia) both use a dedicated CT unit. This reduces the time of scanning while providing high-quality CT images but necessitates greater space and shielding requirements.

To correct for attenuation, it is necessary to produce an attenuation map of the spatial distribution of attenuation coefficients for each patient. The attenuation map is then used by an iterative reconstruction algorithm to perform attenuation correction for the emission data. In the past, this attenuation correction was performed with radionuclide-based transmission images but rarely used clinically. Currently, CT-based attenuation correction has become the standard for PET and is rapidly emerging as the standard for SPECT. CT Hounsfield units are converted to attenuation

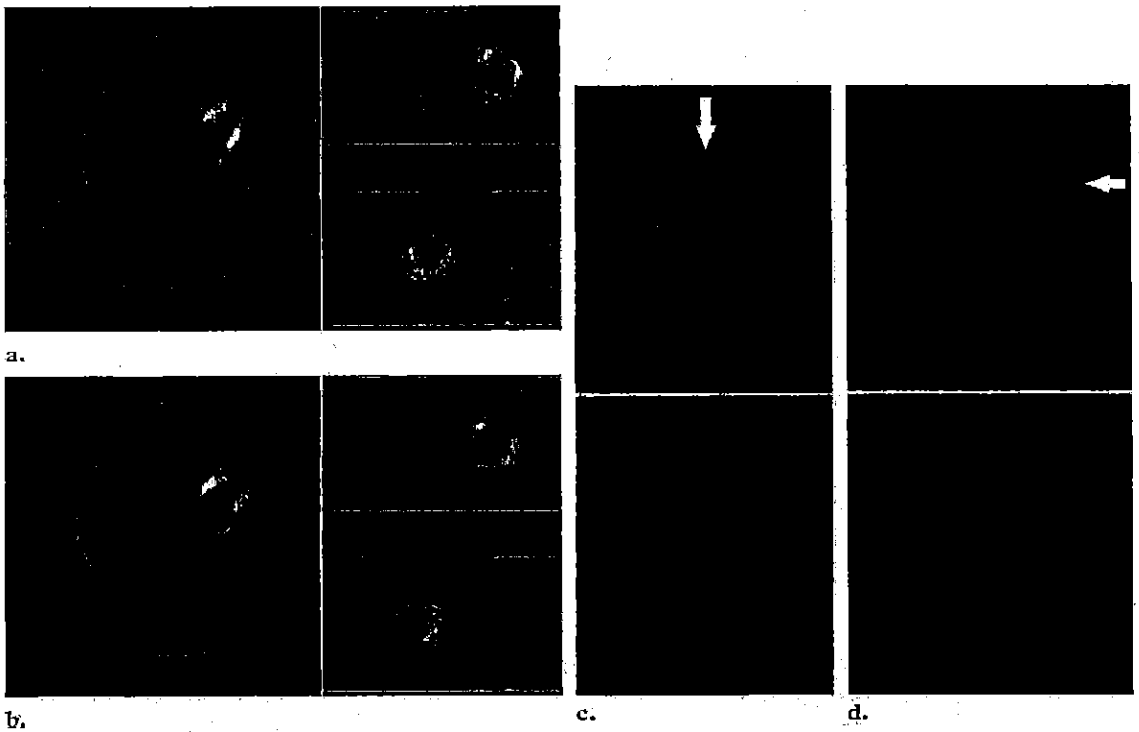


Figure 1. Attenuation correction defect caused by patient movement between studies and misregistration. **(a)** Fused SPECT/CT images show slight misregistration of the imaging data, with the SPECT images moved laterally and posteriorly. **(b)** Fused SPECT/CT images show correction of the misregistration. **(c, d)** Representative short-axis **(c)** and vertical long-axis **(d)** SPECT/CT images of the heart show misregistration of the imaging data (top) and correction of the misregistration (bottom). The apparent defect in the distal anterior wall (arrow) is an artifact from an incorrect attenuation correction map.

coefficients at the energy of the SPECT radionuclide. This conversion of a CT image to an attenuation map can be performed with a segmentation, scaling, or hybrid technique. The CT image matrix size and filter are also modified to match the resolution of the SPECT data (3).

Teaching Point

The benefits of using CT for attenuation correction as opposed to a radionuclide transmission source include less noise, faster acquisition, no influence on CT data by the SPECT radionuclide, and no need to replace decayed transmission sources (5). Unfortunately, a potential disadvantage is that there is sequential acquisition of CT data and then SPECT data; therefore, misregistration can occur, with patient movement leading to an artifact on the corrected scintigraphic images.

In addition to improved attenuation correction, SPECT/CT provides additional value by producing coregistered anatomic images that are obtained in the same study (6,7). This allows more efficient access to both sets of images with an ability to control patient position, as well as a patient benefit of convenience. Current specifications suggest that the coregistration accuracy of SPECT and CT images may be 3 mm or better on the basis of our own phantom studies.

Challenges for SPECT/CT Imaging

Challenges associated with the implementation of SPECT/CT include higher equipment costs (especially if one obtains a 16– or 64–detector row CT unit needed for cardiac CT angiography) and ancillary items such as room renovation; lead shielding; increased space, power, and cooling requirements; and high SPECT/CT camera weight. Some of these issues are minimized with the non–multidetector CT scanner system. Consideration must be given to whether the additional radiation burden associated with the CT component, which can vary from 2 to 80 mSv depending on the system and protocol used, is justified especially with pediatric patients (4).

Teaching Point

Several artifacts can be encountered with SPECT/CT. Patient movement between acquisition of the SPECT and CT images will lead to misregistration (8), which not only affects anatomic localization but also produces an incorrect attenuation map, causing defects on the attenuation-corrected images (Fig 1). Movement can result from respiratory (9) and cardiac motion, sagging

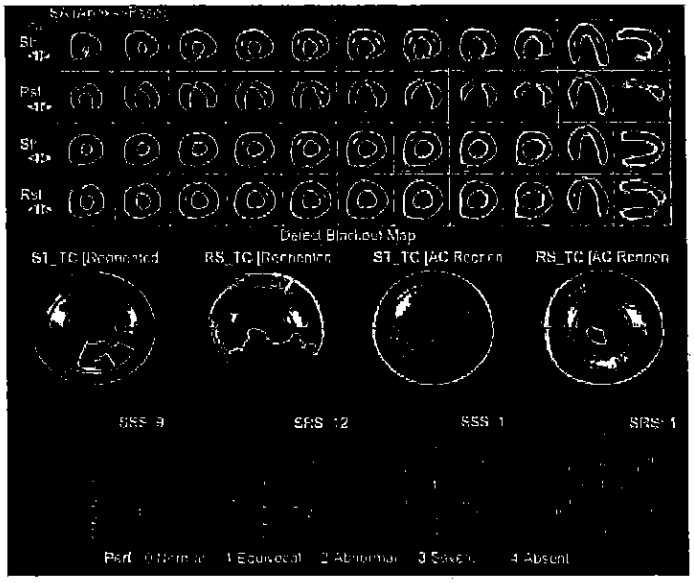


Figure 2. Attenuation artifact on myocardial perfusion images. Short-axis myocardial perfusion SPECT images obtained before attenuation correction (top two rows of images) show an apparent defect of the inferior wall. Corresponding images obtained after attenuation correction (bottom two rows of images) show that the defect has disappeared. The presence and disappearance of the "defect" are also shown on the bull's-eye displays at the bottom of the figure. SPECT images are susceptible to attenuation artifacts, which can be confused with perfusion defects and can obscure real coronary artery disease.

of the emission table, and patient motion between SPECT and CT acquisitions. It is essential that any SPECT/CT system use a coregistration program and associated quality control phantom on a regular basis to ensure correct alignment between the SPECT and CT scanners, in addition to routine quality control for both SPECT and CT. It is also beneficial to have a quality control program to realign the SPECT/CT data before attenuation-corrected SPECT image reconstruction, to correct for patient motion.

Other sources of error include CT truncation, metal artifact, and beam-hardening artifact. Truncation, which occurs because the smaller CT field of view compared with that of SPECT may not account for part of the patient beyond the field of view, can result in an inaccurate attenuation correction map and reduce image quality, particularly in large patients. Artifacts from metal or beam hardening can also affect CT image quality and may lead to artifactual focal uptake on attenuation-corrected SPECT images, which is caused by incorrect scaling of the Hounsfield units into the SPECT attenuation map.

Training and credentialing of nuclear medicine technologists and physicians involved with both components of PET/CT or SPECT/CT is an area of controversy. Nuclear medicine physicians who routinely interpret results of nuclear medicine studies may require additional training in evaluating the CT component of the study and vice versa. Some states do not allow nuclear medicine technologists to operate CT scanners. At present, no consensus has been reached as to who is permitted to perform these studies and interpret their results and the amount of training required before one is considered competent. Finally, because of the breadth of SPECT/CT studies demonstrating possible usefulness, one other potential issue is the difficulty of optimizing work flows and scheduling studies to maximally provide patient benefit, as opposed to performing conventional SPECT alone.

Clinical Applications

Cardiology

Noninvasive cardiac imaging, and specifically SPECT myocardial perfusion imaging, is a cornerstone of clinical management of established or suspected coronary atherosclerotic disease. Use of SPECT/CT for attenuation correction has been recommended by the American Society of Nuclear Cardiology as an adjunct to myocardial perfusion imaging studies when feasible (10). Although transmission source attenuation correction has been available for several years, it has not gained widespread clinical acceptance. The greater interest in SPECT/CT may lead to greater use of attenuation correction in cardiac SPECT. Myocardial perfusion SPECT images are susceptible to attenuation artifact from the breast and dia-

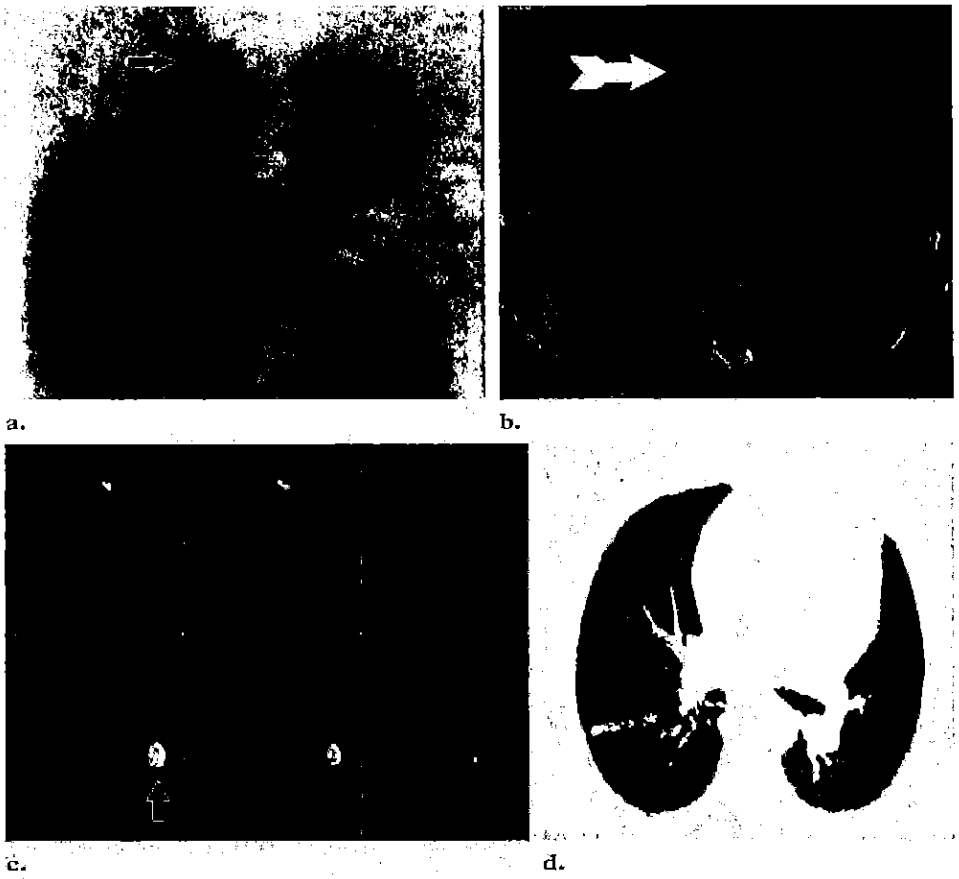
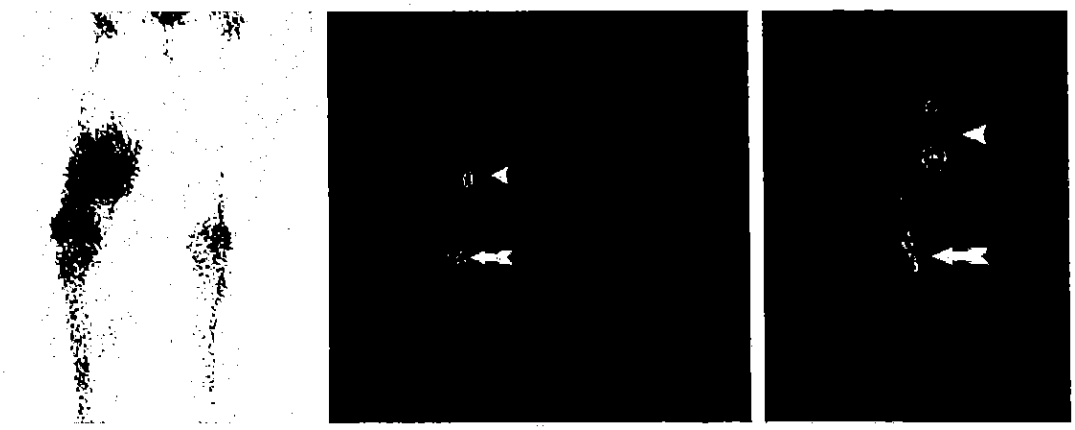


Figure 3. Abnormal extracardiac uptake on myocardial perfusion images. **(a)** Myocardial perfusion SPECT image of a 63-year-old man with episodic chest pain shows focal uptake medial to the heart (arrow). **(b)** Low-dose nonenhanced SPECT/CT image shows that the uptake corresponds to a mediastinal mass (arrow), a finding suggestive of a malignant process. Biopsy demonstrated an incidental malignancy. **(c)** Myocardial perfusion SPECT images, obtained in a patient with multiple cardiac risk factors who underwent pharmacologic stress technetium 99m (^{99m}Tc) tetrofosmin imaging, show a focus of activity (arrow) lateral to the heart on the resting images. **(d)** CT image shows no abnormality. No defect was identified on subsequent stress images; the focal activity was thought to be a false-positive finding related to a radiolabeled blood clot.

phragm; these artifacts can be confused with true perfusion defects and can obscure real coronary disease (Fig 2). Attenuation correction should increase the specificity of the test (11).

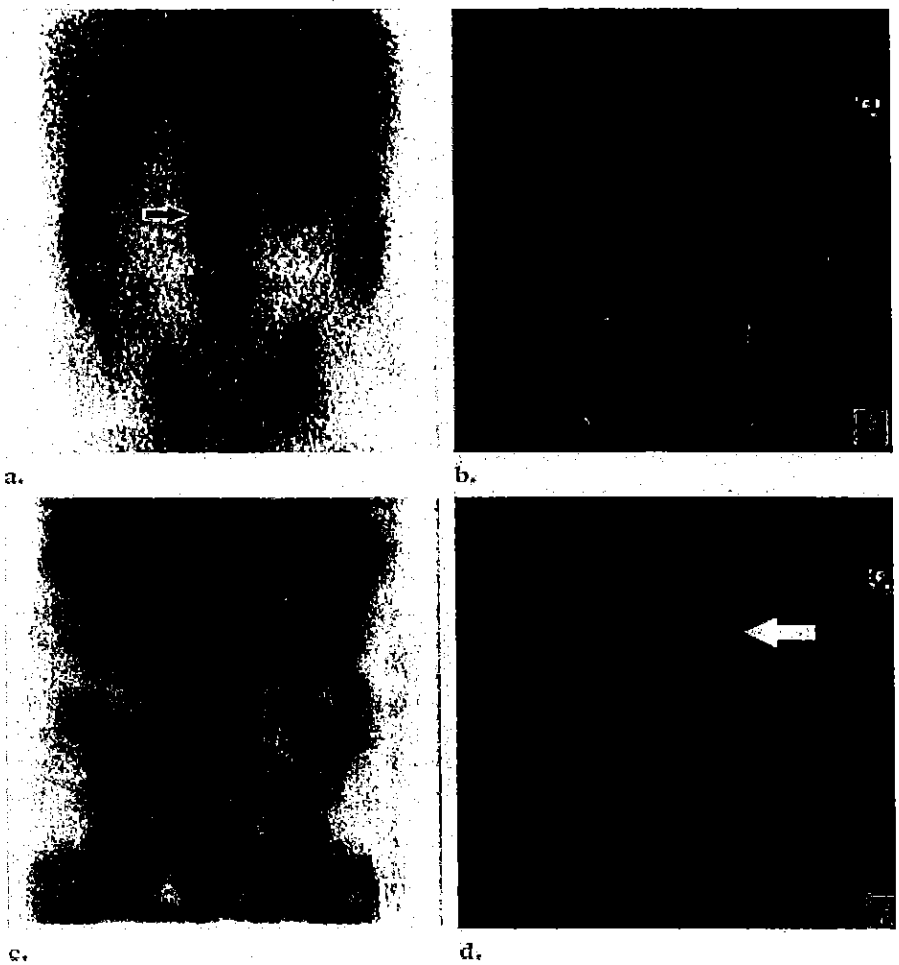
Recently, there has been an emergence of use of CT to evaluate coronary artery calcification and for coronary angiography. Some have suggested combining the functional SPECT data with the anatomic CT information to potentially improve the current standard of practice (12–14). Although there are only limited data to support this idea, it is likely that these imaging technologies will be complementary, especially in predominantly asymptomatic patient populations in whom the diagnosis of coronary artery disease is not established. However, as these testing algorithms are considered for use in various patient populations, it is important to appreciate the radiation burden that the patient sustains, which is substantial (15).

In addition, occasionally abnormal noncardiac uptake of the perfusion tracer is noted on the cardiac images. With concurrent CT imaging, one can efficiently localize the abnormal extracardiac uptake and differentiate between a true abnormality and a false-positive finding (Fig 3). Abnormalities seen at CT can also be evaluated with the functional study (16).



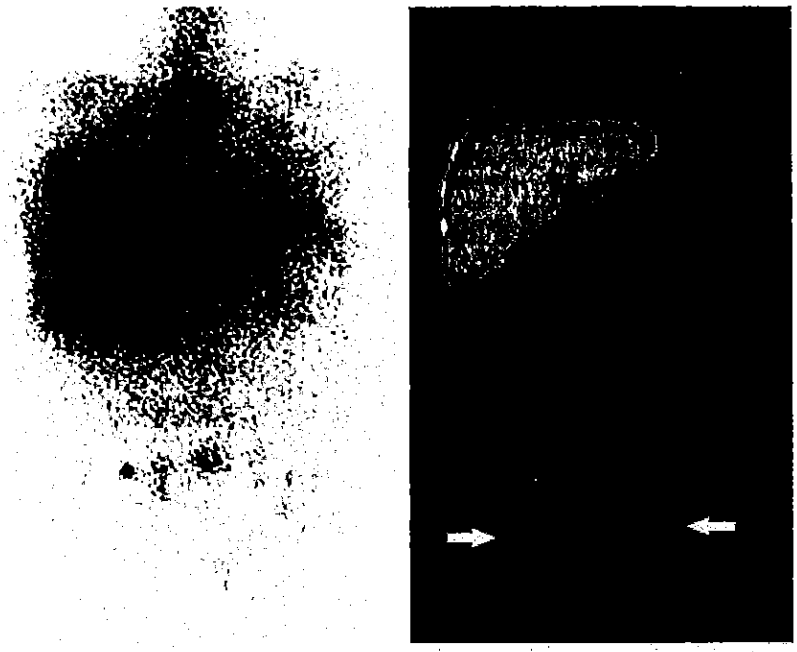
a. b. c.

Figure 4. Demonstration of the extent of malignancy in a young male patient with sarcoma. (a) Anterior whole-body scan shows definite involvement of the medial soft tissue in the lower right thigh. However, the presence of bone involvement is less certain. (b, c) Anterior (b) and lateral (c) fused SPECT/CT images show the soft-tissue involvement (arrowhead) along with osseous disease (arrow). Although bone scanning is typically a sensitive examination, there may be issues with specificity or localization of lesions.



a. b. c. d.

Figure 5. Localization of gallium uptake with SPECT/CT in a patient suspected to have a spine infection. (a) Planar image shows findings indicative of a spine infection (arrow). However, the location of the infection is not clear. (b–d) CT (b), SPECT (c), and fusion (d) images show clear correspondence between the abnormal scintigraphic findings and the defects seen at CT (arrow in d). The diagnosis of discitis with associated bone involvement was made by using both modalities.



a. b.

Figure 6. Localization of malignant disease in an elderly man with a history of prostate cancer and an increasing prostate-specific antigen level. (a) Anterior ^{111}In ProstaScint (Cytogen) whole-body scan shows subtle uptake in the pelvis. (b) Fused SPECT/CT image shows probable metastatic disease in bilateral inguinal lymph nodes (arrows).

Musculoskeletal Imaging

Bone scintigraphy has been a mainstay in the noninvasive evaluation of bone disease for decades. Although other imaging modalities have emerged, bone scanning continues to be widely used. It is generally thought to be a sensitive but nonspecific examination. Although SPECT bone scintigraphy provides better evaluation of abnormal tracer uptake, it still produces less than ideal anatomic localization. Review of the results of two separate studies, either side by side or as fused images, can be helpful but in some situation can be unsatisfactory or very time-consuming. SPECT/CT should increase specificity in most cases.

Several potential applications for SPECT/CT have been described for nononcologic bone scanning (17,18). These include localization of infection or inflammation (discussed in the next section), evaluation of bone trauma such as suspected spondylolysis, and differentiating degenerative changes from more malignant processes (19). Identification of benign skeletal abnormalities is enhanced with SPECT/CT; in equivocal cases of malignancy, SPECT/CT may be necessary to make the correct diagnosis (20–22). Finally, the extent of disease may be determined only with anatomic imaging (Fig 4).

Imaging of Infection

Gallium imaging and white blood cell imaging have long been used clinically to evaluate infection and inflammation. Other newer agents are becoming more common. All of these studies reflect mainly functional data, although some gross anatomic detail is often possible. In some cases, the ability to define fine anatomic detail may be critical in discriminating between pathologic and physiologic uptake (Fig 5). Several studies have shown the benefit of hybrid imaging of infection in relatively low numbers of patients (23–27). In aggregate, these early reports indicate that SPECT/CT increases specificity and may significantly affect disease management.

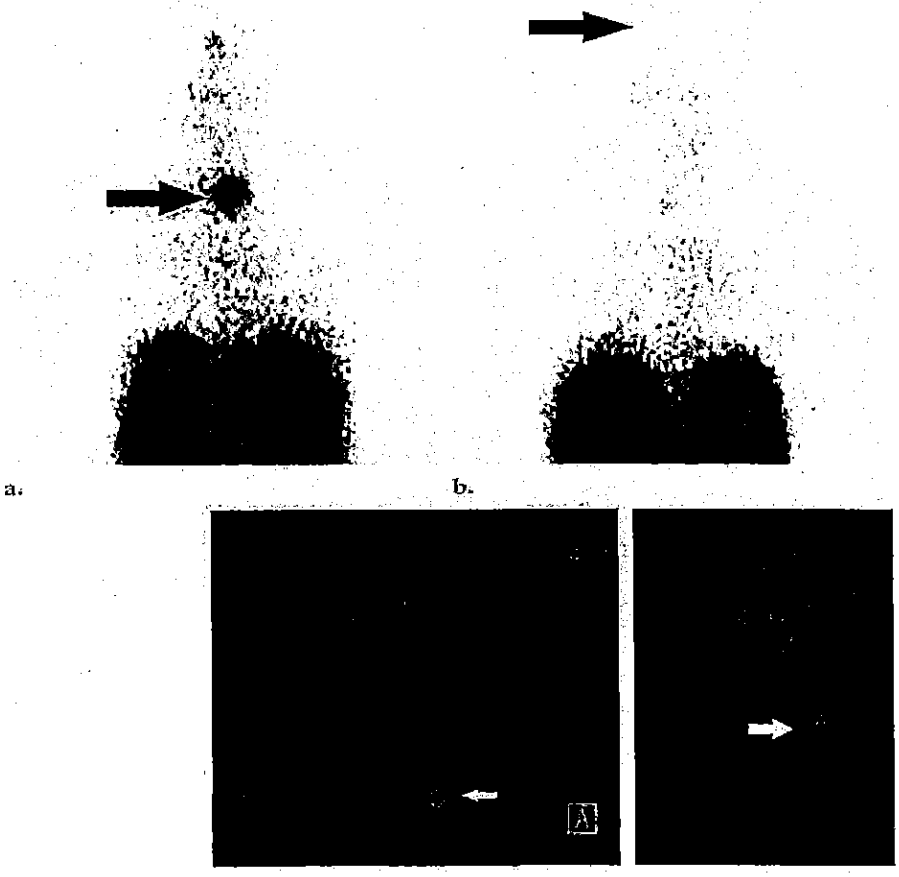
Oncology

Use of radiolabeled monoclonal antibodies such as ProstaScint (indium 111 [^{111}In] capromab pendetide; Cytogen, Princeton, NJ) (Fig 6) or other oncologic imaging agents for the assessment of malignant disease is frequently limited because of poor spatial resolution and a poor signal-to-noise ratio. SPECT/CT imaging provides value to the clinician by allowing accurate

a. b.

Figure 7. Evaluation of uptake with SPECT/CT in a patient suspected to have a left-sided paraganglioma and a left renal mass at CT. Planar imaging showed a focus of uptake in the left abdomen, but there was uncertainty whether the focus correlated with the renal mass or the paraganglioma. SPECT/CT images show that the focus of uptake corresponds to the paraganglioma (arrowhead in **a**) with no uptake in the renal mass (arrowhead in **b**), which proved to be a renal cell carcinoma at biopsy.

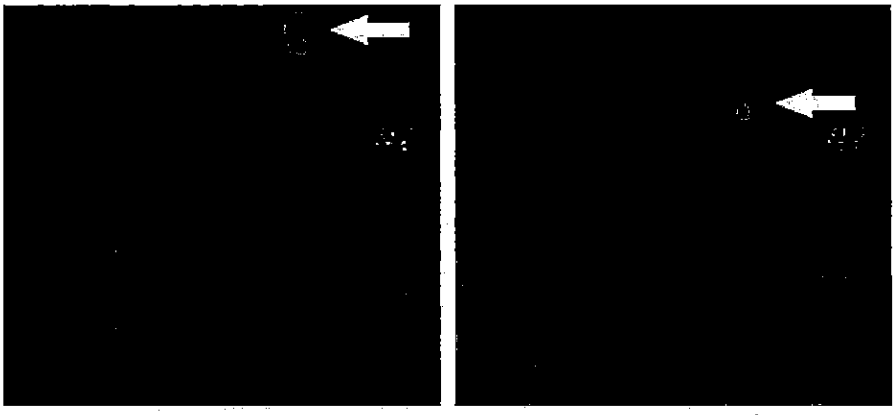
Figure 8. Localization of an incidental finding and improved confidence for reporting a known lesion in a patient with a history of thyroid cancer. An octreotide study of a left temporal intraventricular lesion was performed to evaluate for a possible meningioma. **(a, b)** Planar images show an unexpected finding in the neck (arrow in **a**) and faint uptake in the head (arrow in **b**). **(c)** SPECT/CT image shows the neck lesion (arrow), which was found to be recurrent Hürthle cell cancer at histologic analysis. **(d)** SPECT/CT image shows a somatostatin-positive lesion (arrow) at the site of the CT finding, an appearance consistent with a meningioma or less likely metastatic thyroid cancer.



a. b.

c. d.

Figure 9. Location of sentinel lymph nodes with SPECT/CT in a patient with a melanoma of the left ear. (a) Image from sentinel lymphoscintigraphy shows the injection site in the left ear region (arrow). (b, c) Coronal fused SPECT/CT images show the locations of proximal (arrow in b) and more distal (arrow in c) sentinel lymph nodes. Although detection of sentinel lymph nodes can be performed with planar imaging alone, the addition of CT helps identify the sentinel lymph node sites in an anatomic manner, which greatly aids the surgeon in planning the operation and locating these lymph nodes intraoperatively.



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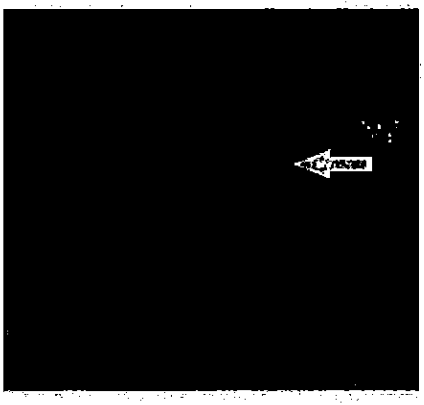

c.

localization of radiopharmaceutical accumulations, detection of occult disease sites, characterization of metabolically active areas of known lesions, and potentially by providing a means of quantifying tracer uptake (28–32). Quantitative serial determinations of tracer uptake at known malignant sites can provide an objective means of measuring the tumor response to therapy; in some instances, they may allow prediction prior to treatment of whether the proposed therapy is likely to be efficacious.

Most neuroendocrine tumors secrete metabolically active substances that are similar to the analogs used for imaging (metaiodobenzylguanidine) or related to their receptor expression (somatostatin or octreotide). Despite the high sensitivity of most neuroendocrine tumors at somatostatin receptor scintigraphy, this technique is limited by small tumor size and lack of anatomic localization. Specificity is reduced because of the normal biodistribution of radiolabeled octreotide. Metaiodobenzylguanidine imaging poses similar challenges. SPECT/CT enhances detection of primary or metastatic disease, provides better delineation of the extent of disease, and permits confirmation of absent uptake at sites of concern with anatomic imaging (33–36) (Fig 7). It may also allow identification of unsuspected concurrent malignancy (Fig 8).

An important recent advance in surgical oncology is use of lymphoscintigraphy for presurgical localization of sentinel lymph nodes, most commonly in breast cancer and melanoma patients. If imaging is requested, the scintigraphy alone is limited because of a lack of anatomic detail. For patients with lesions in the head and neck or pelvis, SPECT/CT imaging provides better localization of sentinel nodes and allows one to minimize the extent of surgical intervention (Fig 9) while avoiding incomplete removal of the sentinel lymph nodes (37–44).

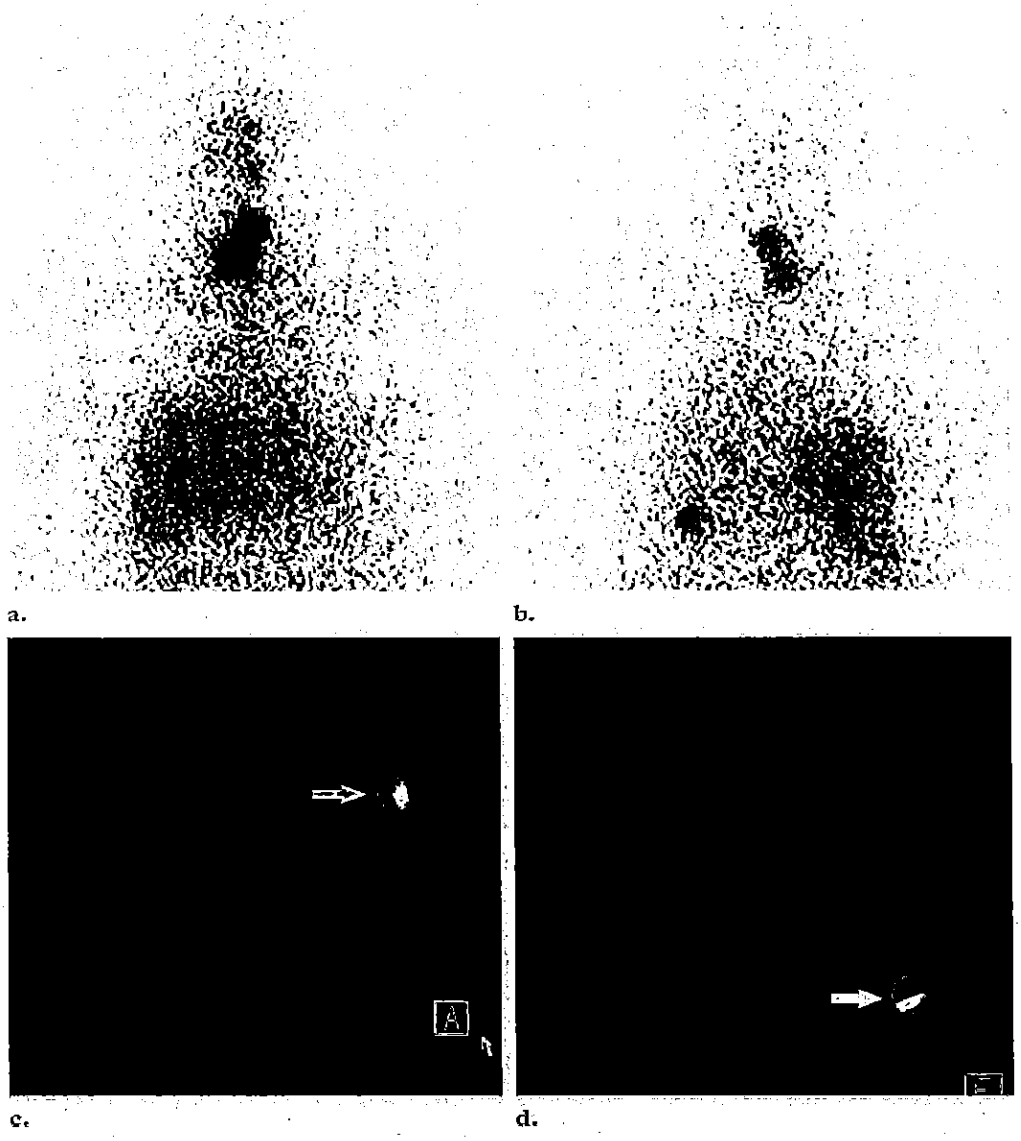

Figure 10. Differentiation between malignancy and benign changes with SPECT/CT in a patient with thyroid cancer who underwent whole-body ^{131}I scanning to assess for residual recurrent disease. **(a, b)** Anterior **(a)** and posterior **(b)** ^{131}I scans show focal activity in the left suprarenal region. **(c, d)** Coronal **(c)** and axial **(d)** SPECT/CT images show that the focus of activity corresponds to metastatic disease in a left lower rib (arrow).

Imaging with iodine 131 (^{131}I) has been used for detection of residual, recurrent, and metastatic thyroid cancer. Abnormalities on whole-body planar images are difficult to interpret because of poor anatomic landmarks, a relatively low count density, and physiologic activity in the salivary glands, gastric mucosa, intestinal tract, and urinary bladder. Image fusion with CT provides incremental information (45). Differentiation of focal uptake between malignant and benign causes (Figs 10, 11) can have an enormous effect on clinical management. Tharp et al (45) showed that SPECT/CT provided incremental value in 57% of their patients. Others have reported similar results (46,47).

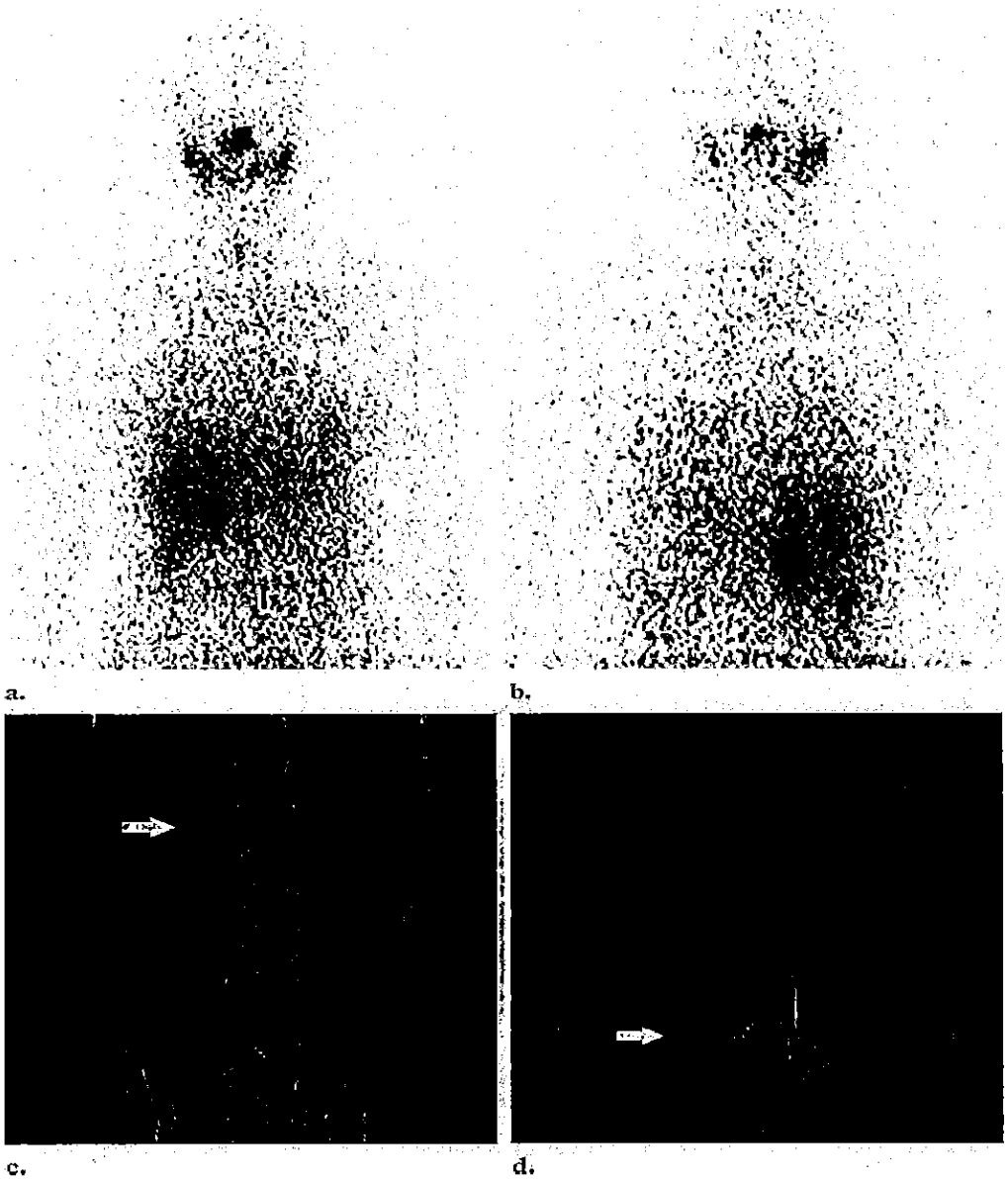

Figure 11. Differentiation between malignancy and benign changes with SPECT/CT in a patient with thyroid cancer who underwent whole-body ^{131}I scanning to assess for residual recurrent disease. **(a, b)** Anterior **(a)** and posterior **(b)** ^{131}I scans show focal activity in the right suprarenal region. **(c, d)** Coronal **(c)** and axial **(d)** SPECT/CT images show that the uptake is located in the renal collecting system (arrow), a finding consistent with physiologic urinary activity.

General Nuclear Imaging

The use of more minimally invasive surgical procedures in patients with primary hyperparathyroidism caused by a solitary adenoma is increasing because of a concern for potentially avoidable hypoparathyroidism and recurrent laryngeal nerve injury with bilateral neck dissection. Additional benefits of minimally invasive surgery include shorter surgical times and hospital stays. For these minimally invasive surgical techniques to be feasible, preoperative localization of the parathyroid adenoma must be effective. ^{99m}Tc sestamibi imaging plays a major role in diagnosis, and in combination with neck ultrasonography

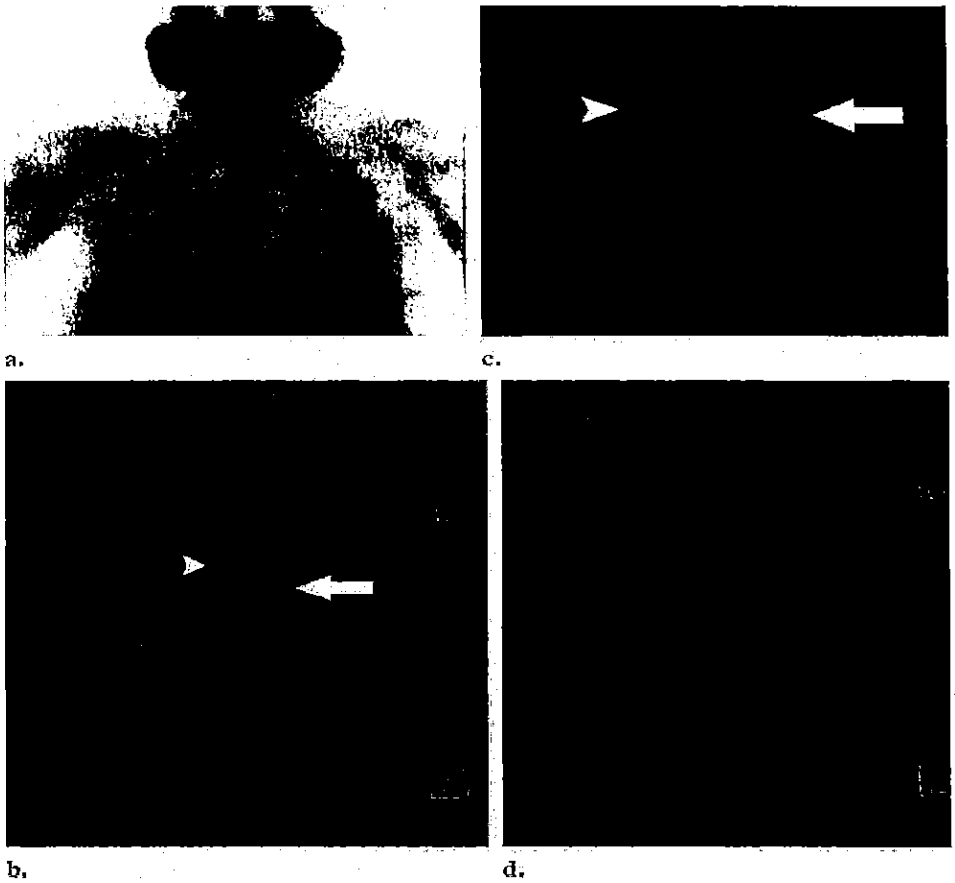

Figure 12. Both true-positive and false-positive findings in a woman with hyperparathyroidism. **(a)** Subtraction (^{99m}Tc sestamibi and iodine 123) planar image shows two foci of uptake. **(b–d)** Coronal **(b)**, axial **(c)**, and sagittal **(d)** SPECT/CT images show that the large left-sided focus corresponds to thyroid tissue (arrow in **b** and **c**), whereas the right-sided activity (arrowhead in **b** and **c**) is external to the thyroid. At surgery, the right-sided abnormality was a parathyroid adenoma, whereas the left-sided abnormality was a thyroid adenoma.

it is the strategy of choice. SPECT imaging increases the sensitivity for detection of parathyroid adenomas, and SPECT/CT is helpful not only for localization of the abnormality and for finding ectopic foci but also for increasing the specificity by demonstrating potential false-positive findings such as thyroid nodules (Fig 12) and brown adipose tissue (48–52).

Several nononcologic nuclear medicine studies in the abdomen potentially can be improved by fusing them with corresponding CT images (53). Studies for evaluation of hepatic hemangiomas (54,55), splenosis (56), inflammatory bowel disease (27), gastrointestinal bleeding, Meckel diverticula (57), and biliary leak (58) have been performed. In a patient suspected to have a postrenal transplantation leak (Fig 13), SPECT/CT imaging was immensely helpful in localizing the urinary leak, resulting in modification of the surgical procedure (59).

Another potential use for SPECT/CT imaging described in the literature is with ventilation-perfusion lung scanning. This technique has been described for cases of pulmonary thromboembolism detection to better correlate perfusion and CT defects (60) and for pre- and postoperative

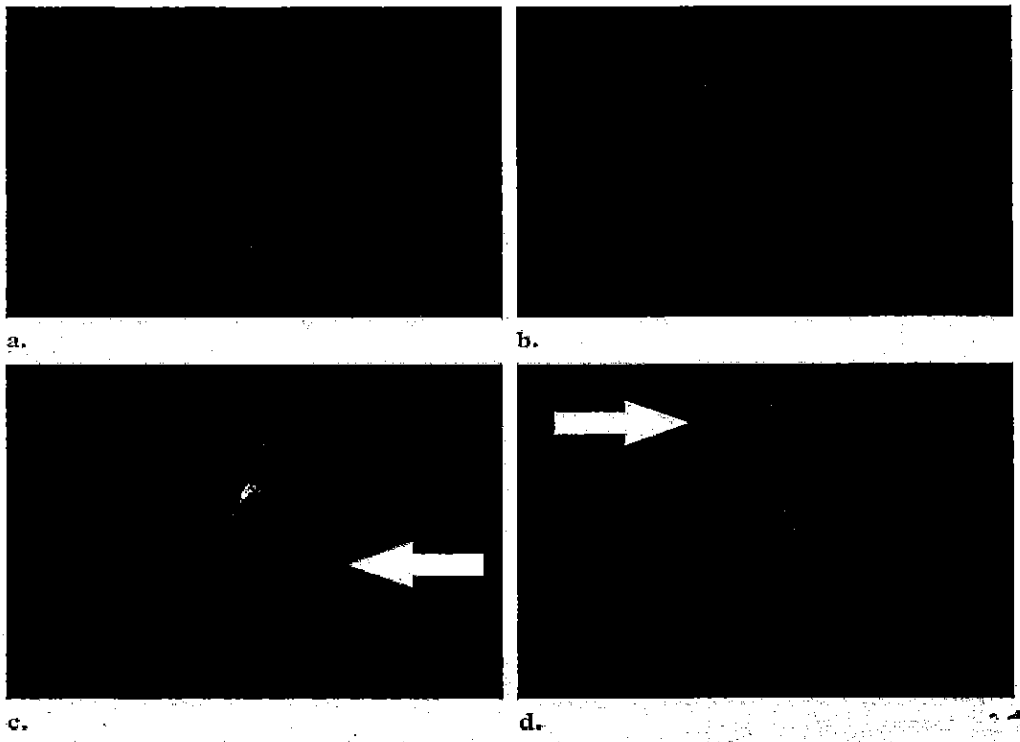

Figure 13. Localization of a urinary leak after renal transplantation. Shortly after transplantation, fluid leakage into the anterior dressings was seen, raising concern about a possible urine leak. Axial images from a ^{99m}Tc mercaptoacetyltriglycine study (displayed from superior **[a]** to inferior **[d]**) show a urine leak (arrow in **d**). The imaging findings guided the surgeons to the exact location of the leak site. A bladder diverticulum on the left side is incidentally noted (arrow in **c**).

assessment of lung function where more precise evaluation of regional pulmonary function and prediction of postoperative lung function may be possible (61).

Neurology

CT and magnetic resonance (MR) imaging are essential for brain assessment, but functional imaging does provide additional important information in many patients. CT will provide anatomic information for brain SPECT images when MR imaging is not feasible. In the assessment of brain tumors with SPECT, particularly after treatment when anatomic imaging studies may not allow differentiation between post–radiation therapy necrosis and residual tumor, SPECT/CT has demonstrated improved diagnostic accuracy with a positive effect on clinical decision making over SPECT alone (62).

The major limitation of brain SPECT study is the attenuation by the skull. The commonly used Chang method of attenuation correction is based on a simple mathematical formula, which is susceptible to technical variation. In diagnosis of dementia with SPECT, it can be difficult to separate the real defect from the attenuation artifact. Variation between images owing to the Chang attenuation correction may generate artifact when ictal-interictal subtraction SPECT scans are used for seizure localization. SPECT/CT will provide more accurate attenuation correction and diagnostic results.

Another useful clinical indication is in patients suspected of having cerebrospinal fluid leaks (63). Localization of the leak is often difficult because of the lack of anatomic detail on the

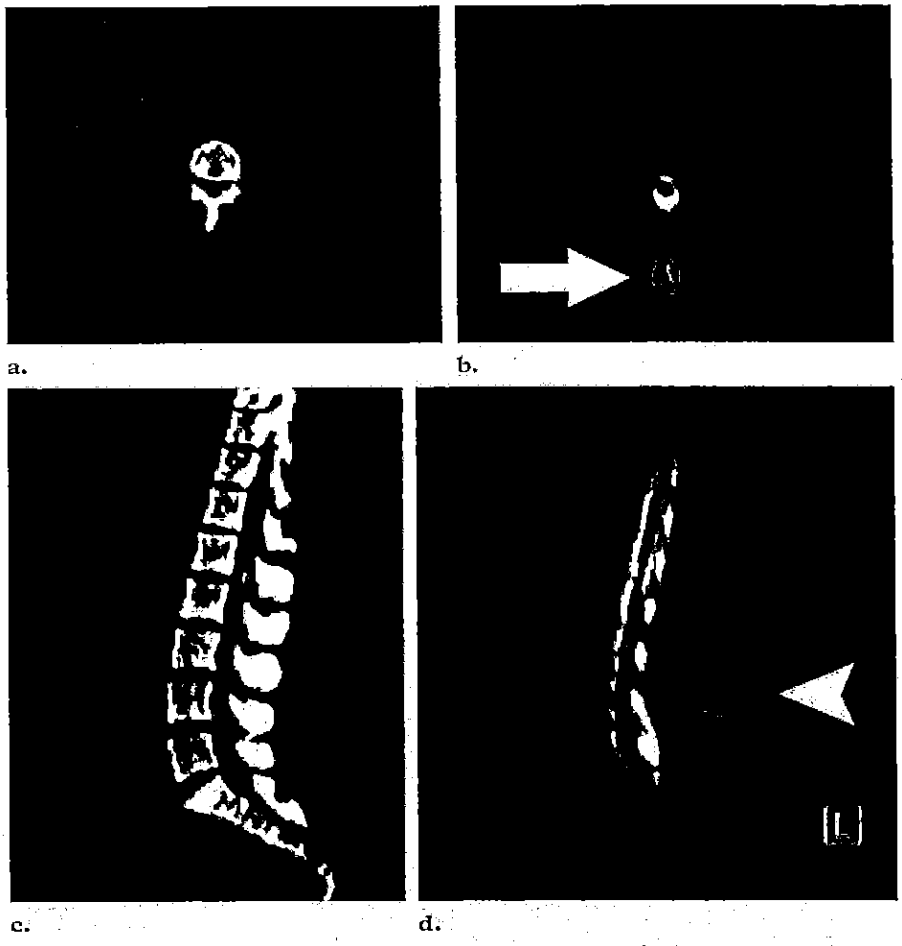

Figure 14. Detection of a cerebrospinal fluid leak with SPECT/CT in a patient with a lumboperitoneal shunt for pseudotumor cerebri who experienced headaches. There was clinical suspicion of a cerebrospinal fluid leak. Axial **(a, b)** and sagittal **(c, d)** images from CT **(a, c)** and scintigraphy **(b, d)** show a cerebrospinal fluid leak (arrow in **b**, arrowhead in **d**), which is not at the site of radiotracer injection and extends posteriorly at the lower lumbar spine level.

scintigraphic images. When CT is fused with SPECT, precise identification of the site of the cerebrospinal fluid leak is more easily made (Fig 14). In addition, the tedious pledget placement or removal by the ear, nose, and throat service might not be necessary.

Future Applications

Many potential applications of SPECT/CT imaging can be envisioned for the future. Estimation of patient radiation dosimetry for radiation therapy planning should be feasible (64–68). Use for hepatic infusion chemotherapy (69,70), after beta-emitter therapy (71), for quantitation in order to develop a measurement similar to the standardized uptake value in PET, and in guided biopsy (to have fused images for defining sites of functional importance) (72) has been described in the literature. In cardiology, a variety of imaging protocols are possible (73). Because the main benefit for SPECT/CT would be attenuation correction and anatomic image fusion, except for possibly cardiac studies, the development of 64– and even 256–detector row CT is unlikely to affect SPECT/CT in most applications.

Conclusions

SPECT/CT is rapidly emerging as an important clinical imaging method with distinct advantages for patients undergoing differing types of nuclear imaging procedures. The additional anatomic localization provided by SPECT/CT imaging has proven beneficial in situations in which SPECT results alone were inconclusive. With appropriately performed attenuation and scatter correction, measurements of tissue tracer uptake can be obtained from the SPECT/CT images and used to quantitatively determine the response to medical intervention. As is true for any advanced imaging procedure, a thorough understanding of the strengths and limitations of the technique is necessary to achieve an optimal clinical benefit.

Teaching Point

At present, the long-term clinical and economic effects of the technology, although promising, are still to be determined.

References

1. Madsen MT. Recent advances in SPECT imaging. J Nucl Med 2007;48(4):661–673.
2. Hasegawa BH, Wong KH, Iwata K, et al. Dual-modality imaging of cancer with SPECT/CT. Technol Cancer Res Treat 2002;1(6):449–458.
3. O'Connor MK, Kemp BJ. Single-photon emission computed tomography/computed tomography: basic instrumentation and innovations. Semin Nucl Med 2006;36(4):258–266.
4. Delbeke D, Coleman RE, Guiberteau MJ, et al. Procedure guideline for SPECT/CT imaging 1.0. J Nucl Med 2006;47(7):1227–1234.
5. Seo Y, Wong KH, Sun M, Franc BL, Hawkins RA, Hasegawa BH. Correction of photon attenuation and collimator response for a body-contouring SPECT/CT imaging system. J Nucl Med 2005; 46(5):868–877.
6. von Schulthess GK. Integrated modality imaging with PET-CT and SPECT-CT: CT issues. Eur Radiol 2005;15(suppl 4):D121–D126.
7. Roach PJ, Schembri GP, Ho Shon IA, Bailey EA, Bailey DL. SPECT/CT imaging using a spiral CT scanner for anatomical localization: impact on diagnostic accuracy and reporter confidence in clinical practice. Nucl Med Commun 2006;27(12): 977–987.
8. Goetze S, Wahl RL. Prevalence of misregistration between SPECT and CT for attenuation-corrected myocardial perfusion SPECT. J Nucl Cardiol 2007; 14(2):200–206.
9. Utsunomiya D, Nakaura T, Honda T, et al. Object-specific attenuation correction at SPECT/CT in thorax: optimization of respiratory protocol for image registration. Radiology 2005;237(2):662–669.
10. Heller GV, Links J, Bateman TM, et al. American Society of Nuclear Cardiology and Society of Nuclear Medicine joint position statement: attenuation correction of myocardial perfusion SPECT scintigraphy. J Nucl Cardiol 2004;11(2):229–230.
11. Liu Y, Wackers F, Natale D, et al. Hybrid SPECT/CT attenuation correction improves specificity and normalcy rate: a multicenter trial. J Nucl Cardiol 2004;11(4):S18.
12. Gaemperli O, Schepis T, Valenta I, et al. Cardiac image fusion from stand-alone SPECT and CT: clinical experience. J Nucl Med 2007;48(5):696–703.
13. Mahmarian JJ. Hybrid SPECT-CT: integration of CT coronary artery calcium scoring and angiography with myocardial perfusion. Curr Cardiol Rep 2007;9(2):129–135.
14. 2006 image of the year: focus on cardiac SPECT/CT. J Nucl Med 2006;47(7):14N–15N.
15. Einstein AJ, Henzlova MJ, Rajagopalan S. Estimating risk of cancer associated with radiation exposure from 64-slice omputed tomography coronary angiography. JAMA 2007;298(3):317–323.
16. Goetze S, Pannu HK, Wahl RL. Clinically significant abnormal findings on the "nondiagnostic" CT portion of low-amperage-CT attenuation-corrected myocardial perfusion SPECT/CT studies. J Nucl Med 2006;47(8):1312–1318.
17. Even-Sapir E, Flusser G, Lerman H, Lievshitz G, Metser U. SPECT/multislice low-dose CT: a clinically relevant constituent in the imaging algorithm of non-oncologic patients referred for bone scintigraphy. J Nucl Med 2007;48(2):319–324.
18. Horger M, Bares R. The role of single-photon emission computed tomography/computed tomography in benign and malignant bone disease. Semin Nucl Med 2006;36(4):286–294.
19. Coutinho A, Fenyo-Pereira M, Dib LL, Lima EN. The role of SPECT/CT with 99mTc-MDP image fusion to diagnose temporomandibular dysfunction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101(2):224–230.
20. Romer W, Nomayr A, Uder M, Bautz W, Kuwert T. SPECT-guided CT for evaluating foci of increased bone metabolism classified as indeterminate on SPECT in cancer patients. J Nucl Med 2006;47(7):1102–1106. [Published correction appears in J Nucl Med 2006;47(10):1586.]
21. Utsunomiya D, Shiraishi S, Imuta M, et al. Added value of SPECT/CT fusion in assessing suspected bone metastasis: comparison with scintigraphy alone and nonfused scintigraphy and CT. Radiology 2006;238(1):264–271.
22. Even-Sapir E. Imaging of malignant bone involvement by morphologic, scintigraphic and hybrid modalities. J Nucl Med 2005;46(8):1356–1367.
23. Filippi L, Schillaci O. SPECT/CT with a hybrid camera: a new imaging modality for the functional anatomical mapping of infections. Expert Rev Med Devices 2006;3(6):699–703.
24. Horger M, Eschmann SM, Pfannenberg C, et al. Added value of SPECT/CT in patients suspected of having bone infection: preliminary results. Arch Orthop Trauma Surg 2007;127(3):211–221.

25. Filippi L, Schillaci O. Usefulness of hybrid SPECT/CT in 99mTc-HMPAO-labeled leukocyte scintigraphy for bone and joint infections. J Nucl Med 2006;47(12):1908–1913.
26. Bar-Shalom R, Yefremov N, Guralnik L, et al. SPECT/CT using 67Ga and 111In-labeled leukocyte scintigraphy for diagnosis of infection. J Nucl Med 2006;47(4):587–594.
27. Filippi L, Biancone L, Petruzziello C, Schillaci O. Tc-99m HMPAO-labeled leukocyte scintigraphy with hybrid SPECT/CT detects perianal fistulas in Crohn's disease. Clin Nucl Med 2006; 31(9):541–542.
28. Schillaci O, Simonetti G. Fusion imaging in nuclear medicine: applications of dual-modality systems in oncology. Cancer Biother Radiopharm 2004;19(1):1–10.
29. Keidar Z, Israel O, Krausz Y. SPECT/CT in tumor imaging: technical aspects and clinical applications. Semin Nucl Med 2003;33(3):205–218.
30. Sodee DB, Sodee AE, Bakale G. Synergistic value of single-photon emission computed tomography/computed tomography fusion to radioimmunoscintigraphic imaging of prostate cancer. Semin Nucl Med 2007;37(1):17–28.
31. Seo Y, Franc BL, Hawkins RA, Wong KH, Hasegawa BH. Progress in SPECT/CT imaging of prostate cancer. Technol Cancer Res Treat 2006;5(4): 329–336.
32. Schillaci O. Single-photon emission computed tomography/computed tomography in lung cancer and malignant lymphoma. Semin Nucl Med 2006; 36(4):275–285.
33. Schillaci O. Functional-anatomical image fusion in neuroendocrine tumors. Cancer Biother Radiopharm 2004;19(1):129–134.
34. Aide N, Reznik Y, Icard P, Franson T, Bardet S. Paraneoplastic ACTH secretion: bronchial carcinoid overlooked by planar indium-111 pentetreotide scintigraphy and accurately localized by SPECT/CT acquisition. Clin Nucl Med 2007; 32(5):398–400.
35. Ingui CJ, Shah NP, Oates ME. Endocrine neoplasm scintigraphy: added value of fusing SPECT/CT images compared with traditional side-by-side analysis. Clin Nucl Med 2006;31(11):665–672.
36. Krausz Y, Keidar Z, Kogan I, et al. SPECT/CT hybrid imaging with 111In-pentetreotide in assessment of neuroendocrine tumours. Clin Endocrinol (Oxf) 2003;59(5):565–573.
37. Even-Sapir E, Lerman H, Lievshitz G, et al. Lymphoscintigraphy for sentinel node mapping using a hybrid SPECT/CT system. J Nucl Med 2003; 44(9):1413–1420.
38. Kim W, Menda Y, Willis J, Bartel TB, Graham MM. Use of lymphoscintigraphy with SPECT/CT for sentinel node localization in a case of vaginal melanoma. Clin Nucl Med 2006;31(4):201–202.
39. Schillaci O, Danieli R, Filippi L, et al. Scintimammography with a hybrid SPECT/CT imaging system. Anticancer Res 2007;27(1B):557–562.
40. Mar MV, Miller SA, Kim EE, Macapinlac HA. Evaluation and localization of lymphatic drainage and sentinel lymph nodes in patients with head and neck melanomas by hybrid SPECT/CT lymphoscintigraphic imaging. J Nucl Med Technol 2007; 35(1):10–16.
41. Husarik DB, Steinert HC. Single-photon emission computed tomography/computed tomography for sentinel node mapping in breast cancer. Semin Nucl Med 2007;37(1):29–33.
42. Krengli M, Ballare A, Cannillo B, et al. Potential advantage of studying the lymphatic drainage by sentinel node technique and SPECT-CT image fusion for pelvic irradiation of prostate cancer. Int J Radiat Oncol Biol Phys 2006;66(4):1100–1104.
43. Bilde A, Von Buchwald C, Mortensen J, et al. The role of SPECT-CT in the lymphoscintigraphic identification of sentinel nodes in patients with oral cancer. Acta Otolaryngol 2006;126(10): 1096–1103.
44. Lerman H, Metser U, Lievshitz G, Sperber F, Shneebaum S, Even-Sapir E. Lymphoscintigraphic sentinel node identification in patients with breast cancer: the role of SPECT-CT. Eur J Nucl Med Mol Imaging 2006;33(3):329–337.
45. Tharp K, Israel O, Hausmann J, et al. Impact of 131I-SPECT/CT images obtained with an integrated system in the follow-up of patients with thyroid carcinoma. Eur J Nucl Med Mol Imaging 2004;31(10):1435–1442.
46. Macdonald W, Armstrong J. Benign struma ovarii in a patient with invasive papillary thyroid cancer: detection with I-131 SPECT-CT. Clin Nucl Med 2007;32(5):380–382.
47. Dumcke CW, Madsen JL. Usefulness of SPECT/CT in the diagnosis of intrathoracic goiter versus metastases from cancer of the breast. Clin Nucl Med 2007;32(2):156–159.
48. Gayed IW, Kim EE, Broussard WF, et al. The value of 99mTc-sestamibi SPECT/CT over conventional SPECT in the evaluation of parathyroid adenomas or hyperplasia. J Nucl Med 2005;46(2):248–252.
49. Sharma J, Mazzaglia P, Milas M, et al. Radionuclide imaging for hyperparathyroidism (HPT): which is the best technetium-99m sestamibi modality? Surgery 2006;140(6):856–863; discussion 863–865.
50. Krausz Y, Bettman L, Guralnik L, et al. Technetium-99m-MIBI SPECT/CT in primary hyperparathyroidism. World J Surg 2006;30(1):76–83.

51. Lavely WC, Goetze S, Friedman KP, et al. Comparison of SPECT/CT, SPECT, and planar imaging with single- and dual-phase (99m)Tc-sestamibi parathyroid scintigraphy. J Nucl Med 2007;48(7):1084–1089.
52. Belhocine T, Shastry A, Driedger A, Urbain JL. Detection of (99m)Tc-sestamibi uptake in brown adipose tissue with SPECT-CT. Eur J Nucl Med Mol Imaging 2007;34(1):149.
53. Schillaci O, Filippi L, Danieli R, Simonetti G. Single-photon emission computed tomography/computed tomography in abdominal diseases. Semin Nucl Med 2007;37(1):48–61.
54. Zheng JG, Yao ZM, Shu CY, Zhang Y, Zhang X. Role of SPECT/CT in diagnosis of hepatic hemangiomas. World J Gastroenterol 2005;11(34):5336–5341.
55. Schillaci O, Danieli R, Manni C, Capoccetti F, Simonetti G. Technetium-99m-labelled red blood cell imaging in the diagnosis of hepatic haemangiomas: the role of SPECT/CT with a hybrid camera. Eur J Nucl Med Mol Imaging 2004;31(7):1011–1015.
56. Alvarez R, Diehl KM, Avram A, Brown R, Piert M. Localization of splenosis using (99m) Tc-damaged red blood cell SPECT/CT and intraoperative gamma probe measurements. Eur J Nucl Med Mol Imaging 2007;34(6):969.
57. Papathanassiou D, Liehn JC, Meneroux B, et al. SPECT-CT of Meckel's diverticulum. Clin Nucl Med 2007;32(3):218–220.
58. Tan KG, Bartholomeusz FD, Chatterton BE. Detection and follow up of biliary leak on Tc-99m DIDA SPECT-CT scans. Clin Nucl Med 2004;29(10):642–643.
59. Gunatunga I, Facey P, Bartley L, Rees J, Singh S, Fielding P. Perinephric urinoma secondary to perforated UPJ obstruction diagnosed using Tc-99m mercaptoacetyltriglycine (MAG3) SPECT/CT. Clin Nucl Med 2007;32(4):317–319.
60. Zaki M, Suga K, Kawakami Y, et al. Preferential location of acute pulmonary thromboembolism induced consolidative opacities: assessment with respiratory gated perfusion SPECT-CT fusion images. Nucl Med Commun 2005;26(5):465–474.
61. Suga K, Kawakami Y, Zaki M, Yamashita T, Shimizu K, Matsunaga N. Clinical utility of coregistered respiratory-gated (99m)Tc-technegas/MAA SPECT-CT images in the assessment of regional lung functional impairment in patients with lung cancer. Eur J Nucl Med Mol Imaging 2004;31(9):1280–1290.
62. Schillaci O, Filippi L, Manni C, Santoni R. Single photon emission computed tomography/computed tomography in brain tumors. Semin Nucl Med 2007;37(1):34–47.
63. Slart RH, Koopmans KP, Gunneweg P, Luijckx GJ, de Jong BM. Persistent aseptic meningitis due to post-surgical spinal CSF leakage: value of fused (111m) In-DTPA SPECT-CT cisternography. Eur J Nucl Med Mol Imaging 2006;33(7):856.
64. Thierens HM, Monsieurs MA, Bacher K. Patient dosimetry in radionuclide therapy: the whys and the wherefores. Nucl Med Commun 2005;26(7):593–599.
65. Ellis RJ, Zhou H, Kaminsky DA, et al. Rectal morbidity after permanent prostate brachytherapy with dose escalation to biologic target volumes identified by SPECT/CT fusion. Brachytherapy 2007;6(2):149–156.
66. Song H, He B, Prideaux A, et al. Lung dosimetry for radioiodine treatment planning in the case of diffuse lung metastases. J Nucl Med 2006;47(12):1985–1994.
67. Boucek JA, Turner JH. Validation of prospective whole-body bone marrow dosimetry by SPECT/CT multimodality imaging in (131) I-anti-CD20 rituximab radioimmunotherapy of non-Hodgkin's lymphoma. Eur J Nucl Med Mol Imaging 2005;32(4):458–469.
68. Ellis RJ, Kaminsky DA. Fused radioimmunoscintigraphy for treatment planning. Rev Urol 2006;8(suppl 1):S11–S19.
69. Ikeda O, Kusunoki S, Nakaura T, et al. Comparison of fusion imaging using a combined SPECT/CT system and intra-arterial CT: assessment of drug distribution by an implantable port system in patients undergoing hepatic arterial infusion chemotherapy. Cardiovasc Intervent Radiol 2006;29(3):371–379.
70. Denecke T, Hildebrandt B, Lehmkuhl L, et al. Fusion imaging using a hybrid SPECT-CT camera improves port perfusion scintigraphy for control of hepatic arterial infusion of chemotherapy in colorectal cancer patients. Eur J Nucl Med Mol Imaging 2005;32(9):1003–1010.
71. Mansberg R, Sorensen N, Mansberg V, Van der Wall H. Yttrium 90 bremsstrahlung SPECT/CT scan demonstrating areas of tracer/tumor uptake. Eur J Nucl Med Mol Imaging 2007;34(11):1887.
72. Fuertes Manuel J, Mena Gonzalez E, Camacho Marti V, et al. 123I-MIBG SPECT-CT combined with gamma probe for radioguided localization of pheochromocytoma [in Spanish]. Rev Esp Med Nucl 2005;24(6):418–421.
73. Gaemperli O, Schepis T, Kalff V, et al. Validation of a new cardiac image fusion software for three-dimensional integration of myocardial perfusion SPECT and stand-alone 64-slice CT angiography. Eur J Nucl Med Mol Imaging 2007;34(7):1097–1106.

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SPECT/CT Imaging: Clinical Utility of an Emerging Technology

Bohdan Bybel, MD, et al

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Pages 1098
First, while anatomic imaging techniques allow accurate detection and localization of morphologic abnormalities, nuclear medicine studies reflect the pathophysiologic status of the disease process.

Page 1098
A second important feature of SPECT/CT imaging is the ability to correct the nuclear emission images for attenuation and photon scatter to obtain more accurate image data.

Page 1099
The benefits of using CT for attenuation correction as opposed to a radionuclide transmission source include less noise, faster acquisition, no influence on CT data by the SPECT radionuclide, and no need to replace decayed transmission sources (5).

Page 1099
Several artifacts can be encountered with SPECT/CT.

Page 1111
At present, the long-term clinical and economic effects of the technology, although promising, are still to be determined.

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Clinical Applications of SPECT/CT: New Hybrid Nuclear Medicine Imaging System

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FOREWORD

Interest in multimodality imaging shows no sign of subsiding. New tracers are spreading out the spectrum of clinical applications and innovative technological solutions are preparing the way for yet more modality marriages: hybrid imaging.

Single photon emission computed tomography (SPECT) has enabled the evaluation of disease processes based on functional and metabolic information of organs and cells. Integration of X ray computed tomography (CT) into SPECT has recently emerged as a brilliant diagnostic tool in medical imaging, where anatomical details may delineate functional and metabolic information.

SPECT/CT has proven to be valuable in oncology. For example, in the case of a patient with metastatic thyroid cancer, neither SPECT nor CT alone could identify the site of malignancy. SPECT/CT, a hybrid image, precisely identified where the surgeon should operate.

However SPECT/CT is not just advantageous in oncology. It may also be used as a one-stop-shop for various diseases.

Clinical applications with SPECT/CT have started and expanded in developed countries. It has been reported that moving from SPECT alone to SPECT/CT could change diagnoses in 30% of cases. Large numbers of people could therefore benefit from this shift all over the world.

This report presents an overview of clinical applications of SPECT/CT and a relevant source of information for nuclear medicine physicians, radiologists and clinical practitioners. This information may also be useful for decision making when allocating resources dedicated to the health care system, a critical issue that is especially important for the development of nuclear medicine in developing countries. In this regard, the IAEA may be heavily involved in the promotion of programmes aimed at the IAEA's coordinated research projects and Technical Cooperation projects.

The IAEA wishes to express its thanks to all experts who have contributed to this publication. The IAEA officer responsible for this publication was N. Watanabe of the Division of Human Health.

EDITORIAL NOTE

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CONTENTS

1. INTRODUCTION

During the past several years there has been growing utilization of PET/CT, based on the fact that functional and morphologic correlative images produced by this methodology improve diagnostic accuracy. Similar progress is now being reported for SPECT/CT, a modality which is rapidly evolving from a somewhat under-utilized technical option to gain an acknowledged status for optimizing the diagnostic capabilities of single photon imaging, with potential impact on patient management.

SPECT and CT are tomographic imaging procedures, each one with separately proven good diagnostic performance. SPECT produces computer-generated images of local radiotracer uptake, while CT produces 3-D anatomic images of X ray density of the human body. Combined SPECT/CT imaging provides sequentially functional information from SPECT and the anatomic information from CT, obtained during a single examination. CT data are also used for rapid and optimal attenuation correction of the single photon emission data.

By precisely localizing areas of abnormal and/or physiological tracer uptake, SPECT/CT improves sensitivity and specificity, but can also aid in achieving accurate dosimetric estimates as well as in guiding interventional procedures or in better defining the target volume for external beam radiation therapy.

Gamma camera imaging with single photon emitting radiotracers represents the majority of procedures in a routine nuclear medicine practice. Many of these examinations are tumour or cardiac imaging studies. The development of better instruments, newer computer based procedures for image analysis and display, new ^{99m}Tc labelled agents for visualizing biologically significant events (such as cellular growth, hypoxia, angiogenesis, apoptosis) may enhance the future value of SPECT/CT in terms of both clinical impact on patient care and cost effectiveness, as compared to PET/CT.

Diagnosis and characterization of disease by CT imaging is based on morphologic criteria such as size, texture and tissue attenuation. CT provides information regarding changes in organ size and tissue density, as well as their precise spatial localization and topographic landmarks. However, structural data do not necessarily correlate with the metabolic status of disease. On the other hand, nuclear medicine imaging is based on the bio-distribution of a radioactive agent over time and space, thus visualizing dynamic physiological and pathophysiological processes that define the functional characteristics of disease. Furthermore, whole body assessment is possible with a single radiation exposure, as the ionizing agent is administered to patients rather than being delivered from an external source to each region of the body to be evaluated, as performed with radiologic imaging (e.g. conventional X ray or CT). However, scintigraphic images lack accurate anatomic landmarks for precise localization and characterization of findings, in spite of the fact that specific radiopharmaceuticals are used for assessment and diagnosis of specific disease processes. The above mentioned considerations explain why morphologic and functional imaging modalities are complementary and not competing techniques, especially if precise image registration is made possible by using a single imaging unit combining the emission based data (SPECT) with the transmission based data (CT, which also serve to correct the emission data for tissue attenuation). Image registration is the process of determining the geometric relationship between multimodality imaging studies, in order to use information provided by one test in the context of the other modality.

2. OVERVIEW OF SPECT/CT TECHNOLOGY

2.1. Update on SPECT/CT installations worldwide

While image fusion techniques have been in clinical use for many years, the first commercial SPECT/CT system was only introduced in 1999. This system combined a low-power X ray tube with separate gamma and X ray detectors mounted on the same slip ring gantry. The X ray system operated at 140 kV with a tube current of only 2.5 mA. This resulted in a significantly lower patient dose than that received during a conventional CT imaging procedure (by a factor of 4–5), but the quality of the CT images was inferior to state of the art CT. Nevertheless, the fan beam formed by the X ray tube on the detectors allowed the measurement of patient attenuation along discrete paths providing significantly higher quality attenuation maps than those available with conventional ^{153}Gd scanning lines sources [1, 2].

This system has recently been equipped with a 4 slice low-dose CT scanner yielding an axial slice thickness of 5 mm with each rotation instead of one 10 mm slice. This tool retains the very compact design of the previous system, delivers a low radiation dose to the patient and requires minimal room shielding [2, 3]. Over the last 2–3 years there has been a large expansion of SPECT/CT technology worldwide and, as at June 2007, there are approximately 600 of these installations around the world and over 200 across the United States. The relatively large distribution of these SPECT/CT systems equipped with a low definition CT tube versus those equipped with high definition, standard diagnostic CT tubes (see below) can be explained by two main factors: 1) this is the first SPECT/CT system made commercially available, and 2) the overall cost of these tomographs (equipped with a low definition CT component) is considerably lower than that of tomographs equipped with a CT component having full diagnostic capabilities.

In this regard, following the commercial success of PET/CT systems that employ multi-slice CT scanners, there has been growing interest in the development of comparable SPECT/CT systems. Thus, in an effort to further improve imaging quality and reduce acquisition time, new hybrid systems employing state of the art spiral CT scanners have been developed. These systems combine dual-head gamma cameras with full diagnostic, up to 16 slice CT scanners that allow variation of CT slice thickness from 0.6 mm up to 10 mm, yielding diagnostic quality CT images with a scan speed shorter than 30 s for a 40 cm axial field of view [2, 3]. However, because of the addition of a separate CT gantry, these systems are considerably larger than conventional SPECT systems and have very different setting and shielding requirements compared with the system equipped with the low definition CT tube. Since their introduction in the market, over 210 such units have been installed worldwide.

Access to hybrid systems is limited in several countries due to their high cost. SPECT/CT systems based on combining a 'gantry-free' commercial SPECT system with a single- or multiple-slice CT scanner have recently been developed [4, 5]. In the future, further cost reduction and technological improvement are desirable in order to encourage a larger diffusion of such devices worldwide.

2.2. General architecture of SPECT/CT devices

SPECT/CT systems have the same SPECT component as conventional nuclear medicine systems, the dual-head gamma cameras are generally used for planar and tomographic imaging of single photon emitting radiotracers. As mentioned above, the CT component of the first-generation hybrid devices used a low resolution CT detector while recently

developed, second-generation SPECT/CT systems incorporate a variety of multi-slice CT scanners. SPECT/CT systems include separate CT and gamma camera devices using common or adjacent mechanical gantries, and sharing the same scanning table. Integration of SPECT and X ray imaging data is performed by a process that is similar to that of PET/CT.

X ray scatter can reach and possibly damage the SPECT detectors designed for radionuclide low count rate imaging. Therefore, in a hybrid system the SPECT detectors are off-set in the axial direction from the plane of the X ray source and detector. In a hybrid system both detectors have to be able to rotate and position accurately for tomographic imaging. In this regard, accuracy of translation and angular motion differs from one imaging system to another. While CT requires the highest accuracy, SPECT (with a lower spatial resolution) can perform clinical images with a motion accuracy of slightly less than one millimetre.

SPECT/CT systems using a low-dose single- or multi-slice CT have both the SPECT and the CT detectors mounted on the same rotating platform. Imaging is performed while the detectors are rotating sequentially around the patient. While this concept has the advantage of using the gantry of a conventional gamma camera for both imaging modalities, it limits the rotational speed of the SPECT/CT option to approximately 20 seconds per rotation. In SPECT/CT systems incorporating diagnostic CT scanners, the gamma camera detectors are mounted on a different platform, separated from the high speed rotating CT device (0.25 to 0.5 s per revolution). This design increases the performance of the CT subsystem, but it also increases the complexity of the gantry and the cost of the technology.

Dual modality imaging requires longer stretchers than single modality imaging devices. While built to support patients weighing up to 500 pounds, these scanning tables, extended to accommodate the needs of both components (SPECT and CT), deflect to some degree while loaded with normal adult patients. The extension and degree of deflection of the table can introduce a patient-dependent mis-registration between CT and SPECT data. One solution to this problem is the design of a table supported on its base at the front of the scanner as well as at the far end of the X ray system, thus minimizing the table deflection. Another solution is to use a table fixed on a base, moving on the floor to introduce the patient into the scanner.

The workstation of the SPECT/CT device is responsible for system control, data acquisition, image reconstruction and display, as well as data processing and analysis. CT data are calibrated in order to obtain attenuation correction maps for the SPECT images. SPECT and CT images are displayed on the same screen in addition to the fused images, which represent the overlay of a coloured SPECT over a grey-scale CT image. A 3-D display with triangulation options allows to locate lesions and sites of interest on the CT image and to redisplay them on the registered SPECT and fused SPECT/CT images.

2.3. SPECT/CT acquisition protocols

Acquisition on SPECT/CT systems is performed in a sequential mode. With devices that have a low-dose CT component, data are typically acquired by rotating the X ray detector 220° around the patient, with the X ray tube operated at 140 kV and 2.5 mA. The CT images obtained have an in-plane spatial resolution of 2.5 mm, and of 10 mm in the axial direction. Scan time is approximately 16 s per slice, for a total study duration of 10 min for the CT. SPECT/CT systems using a diagnostic CT component are characterized by higher spatial resolution and faster scanning time (approximately 30 s for the whole field of view),

associated however with higher radiation doses. An attenuation map is created at the end of the CT acquisition time.

The SPECT component is represented by a rotating, dual-head, variable angle sodium-iodide scintillation camera. The detectors can be placed either in a 180° or a 90° position. Regardless of the type of SPECT/CT that is used, SPECT acquisition currently requires a routine scanning time of approximately 20–30 min, depending on the radiotracer, as for stand-alone SPECT acquisition protocols. SPECT is reconstructed using iterative methods incorporating photon attenuation correction based on the X ray transmission map and scatter correction.

Since X ray and radionuclide data are not acquired simultaneously, SPECT images are not contaminated by scatter radiation generated during the X ray image acquisition. Also, since the patient is not removed from the table, both imaging components are acquired with a consistent and identical patient position, allowing accurate image registration if we assume that the patient has not moved during the entire duration of the SPECT/CT study. CT is usually acquired in matrices of 512 × 512 with the newest CT scanners, or 256 × 256 in older scanners, and has to be resized into slices with the same pixel format and slice width as SPECT. Spatial registration of the CT and SPECT acquisitions is important since misalignment of the attenuation map relative to corresponding radionuclide images can cause 'edge artefacts', bright and dark 'rims' across edges of these regions.

SPECT/CT image mis-registration or blurring may occur, mainly due to patient movement as well as respiration, cardiac motion, and peristalsis. Differences in urinary bladder filling can lead to erroneous co-registration between SPECT and CT acquisitions. With SPECT/CT devices equipped with low-dose X ray tubes, CT is performed during shallow breathing to facilitate image registration. However, the longer acquisition time increases the chances for patient motion. With hybrid devices equipped with multi-slice CT, anatomic imaging is acquired following breath-hold, during tidal breathing, or during a short part of the respiratory cycle, whereas SPECT data are acquired over several minutes. This again can lead to mis-registration. In addition to faulty localization, non-registered attenuation maps can lead to under- or overestimation of radionuclide uptake.

The presence of contrast media in the CT images acquired as part of the SPECT/CT study complicates the attenuation correction process. Also, high concentrations of intra-venous contrast material captured during the CT acquisition may have redistributed by the time the SPECT acquisition is performed. Image segmentation techniques separating different areas inside the images may solve this problem, or alternatively, a very low powered non-contrast CT can be performed prior to the SPECT for attenuation correction, followed by the contrast CT study as the last step.

2.4. Technical staffing for SPECT/CT

A major asset for proper implementation of novel SPECT/CT procedures is the technologist. It is important to take the time to train and educate the technologists so that they can deliver an end product of the highest quality. While it is preferable for technologists to have their work product directly checked by the interpreting physician before the patient leaves the department, in some outpatient settings technologists must make their own decision, and therefore they need to be well trained and using robust and reproducible protocols. The new generation technologists therefore have to be trained in nuclear medicine and CT, to have experience in reviewing scans and to be able to identify artefacts occurring during acquisition

of studies. Instructing the technologists about pertinent history questions and designing a template to be filled out for each patient will ensure that all of the clinical information to further assist in the reading of the images is available. Training requirements for CT and SPECT technologists differ in various countries. Under ideal circumstances a technologist should be fully trained, experienced and certified in both nuclear and X ray/CT technologies.

3. GENERAL NUCLEAR MEDICINE SPECT/CT PROCEDURES

The SPECT component of the SPECT/CT procedure is performed using the acquisition protocols routinely employed for the dual-head gamma camera. This device is equipped with collimators adequate for the specific radioisotope in use, such as low energy, high resolution parallel hole collimators for ^{99m}Tc, or medium energy collimators for ^{67}Ga, ^{111}In or ^{131}I. Imaging is typically performed with the detectors facing each other at 180°, typically acquiring 120 projections over a 360° orbit and using a time per projection of 40–50 s. A 64 × 64 matrix is commonly employed for the low count isotopes, while the higher resolution 128 × 128 matrix can be applied for the higher count rates typically generated by ^{99m}Tc.

CT images are obtained immediately following the SPECT acquisition. For the low-dose CT devices the acquisition parameters include settings at 140 kV, 1–2.5 mA, 13 s/slice, 256 × 256 image matrix, 5 mm slice thickness and slice spacing. For diagnostic CT acquisitions the settings are 140 kV, 80 mA, 1 s/slice, 512 × 512 image matrix, 48 cm reconstruction diameter, 5 mm slice thickness and slice spacing. Skeletal CTs of diagnostic quality can be performed at lower mAs products to reduce the radiation exposure of the patient. A variety of other settings are possible depending on the specific diagnostic question asked of the CT scanner. These include, in particular, protocols to perform low powered CT with the multi-detector scanners, e.g. when a CT of diagnostic quality is already available or high powered CT is not deemed necessary for the particular question under study. Some strategies restrict the CT field of view to the regions exhibiting SPECT abnormalities, thus reducing the radiation dose delivered to the patient even further [6]. Data are reconstructed using filtered back-projection software and filters provided by the manufacturer.

Co-registered CT and SPECT are acquired by translating the patient from one detector to the other while the patient remains lying on the same table. This allows the CT and radionuclide images to be acquired with a consistent scanner geometry and body habitus, and with a minimal delay between the two acquisitions.

3.1. ^{131}I-Iodide SPECT/CT in thyroid cancer

Well differentiated thyroid cancer has an incidence of approximately 1:10 000 [7]. Its standard treatment includes total thyroidectomy and therapy with ^{131}I-iodide [8, 9]. With this combined approach, overall 5 year survival rates exceed 95%. However, the long term prognosis is worse for patients who present with locally advanced tumours or distant metastases at diagnosis, as well as in case of dedifferentiated neoplasms (because of their reduced iodine-trapping property) [10]. This subgroup accounts for approximately 20% of patients with well differentiated thyroid carcinomas and deserves special attention on follow-up.

The therapeutic effect of ^{131}I is provided by its beta-emission. In addition, this isotope of iodine emits 364 keV gamma rays that can be detected by gamma cameras. Therefore, ^{131}I is also used as a diagnostic agent since most, but not all metastases of thyroid carcinoma have

retained the normal thyroid parenchyma's ability to accumulate iodine. The bio-distribution of ^{131}I is usually sufficiently defined by planar scintigraphy. SPECT is only rarely used for this purpose, as the image quality of ^{131}I-SPECT is hampered by the high energy of the gamma radiation emitted by this radionuclide.

^{131}I is only poorly concentrated by most extrathyroidal tissues. The salivary glands, stomach, intestines, and urinary bladder are the most notable exception to this rule. Thus, gamma camera images of ^{131}I distribution in the human body lack anatomical detail, because no clear reference landmarks can be recognized. This renders localization of radioiodine foci difficult, if not impossible at times, and may constitute a problem in those patients in whom surgical removal of metastases is indicated.

Iodine-avid metastases can be small. Furthermore, they may occur in regions exhibiting distorted anatomy due to previous surgery. Their localization using CT or MRI may therefore also not be possible. SPECT/CT co-registration certainly is an elegant method of localization (Fig. 1), although the evidence to this effect is still scarce. Papillary and, albeit to a lesser extent, follicular thyroid carcinomas metastasize frequently to the cervical and mediastinal lymph nodes. Therefore, dissection of the central cervical lymph nodes is, in many cases, part of the initial surgical procedure [11]. Despite a theoretically total thyroidectomy, a variable amount of normal thyroid parenchyma persists within the patient. This provides the rationale for postoperative radioiodine therapy for ablation of thyroid remnants. On the post-therapeutic radioiodine scans, the high activity contained in this parenchymal residue may hamper cervical N staging in many cases. With SPECT/CT, this problem may be overcome (Fig. 2). Preliminary data using SPECT/CT indicate that approximately one fourth of patients may actually harbour cervical lymph node metastases at the time of radioiodine ablation, the majority of which elude detection by planar imaging [12]. Clearly, further longitudinal studies are needed to define the possible clinical impact of this previously unavailable early information on cervical lymph node involvement.

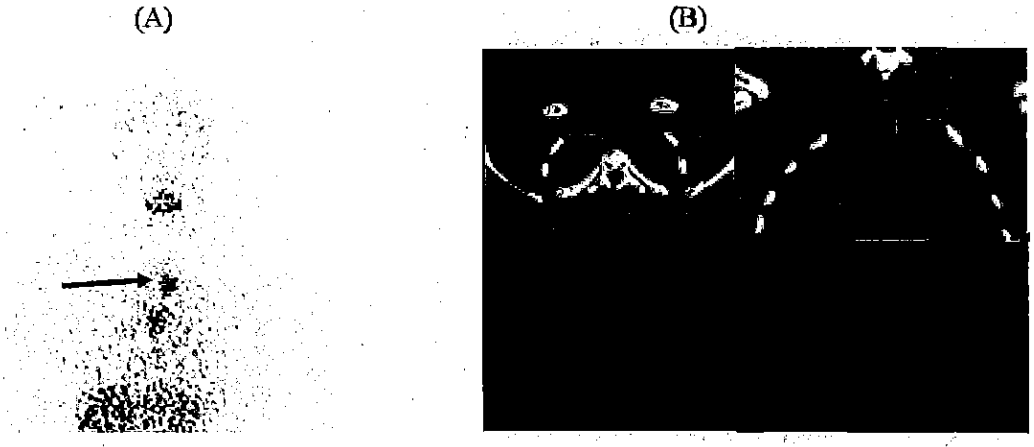

FIG. 1. (A) The planar ^{131}I-iodide scan in a 16 year old patient with thyroid cancer discloses an iodine-avid focus (arrow). The patient had had three surgical procedures (including total thyroidectomy) and 37 GBq of ^{131}I, so that this focus indicates the presence of a further lymph node metastasis. Considering scarring from prior surgeries, exact localization of this lesion is an essential requisite for its surgical resection. This anatomic information can only be achieved by SPECT/CT (B).

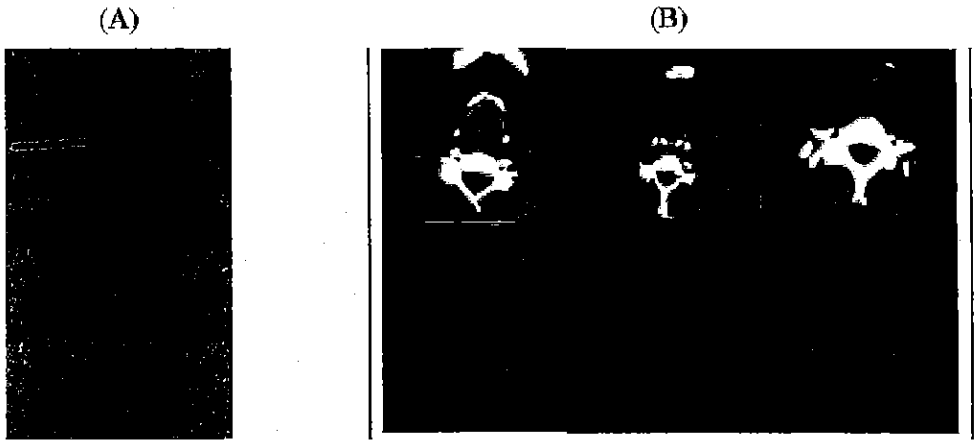

FIG. 2. (A) The planar scan post-radioiodine ablation of thyroid remnants shows radioiodine-avid tissue in the neck of a patient after total thyroidectomy, without the possibility of discriminating ^{131}I uptake in remnant normal thyroid parenchyma from possible lymph node metastasis. (B) SPECT/CT demonstrates two cervical lymph nodes in this patient (arrows) that cannot be differentiated from benign remnant tissue in the planar scan.

Although ^{131}I uptake is quite specific for tissue originating from the thyroid gland, the list of false–positive findings on planar whole body scans is quite long [13]. Only in rare instances, false–positive findings are accounted for by ^{131}I uptake in cancers of non-thyroid origin, such as small-cell bronchial carcinomas. Persisting thymic tissue has been described to concentrate radioiodine and may be the benign correlate of mediastinal ^{131}I accumulation frequently seen in children and young adults. In addition, many false–positive scans are caused by structural abnormalities of organs physiologically excreting radioiodine, or by contaminations of the skin. All such false–positive findings reduce specificity of the scan.

Clearly, ^{131}I uptake in metastases may be mistaken for physiological uptake if it is seen in regions where this usually occurs, thus lowering the sensitivity of ^{131}I scintigraphy. However, probably due to the lack of a reliable gold standard, evidence on sensitivity and specificity of radioiodine scanning is scarce. Furthermore, the recent introduction of ultra-sensitive assays for serum thyroglobulin (a marker of persistent/recurrent disease after surgery and radioiodine ablation of thyroid remnants) is somewhat changing the approach to the follow-up of these patients, especially in the low-risk group [14–18]. Nevertheless, by offering the possibility to precisely localize ^{131}I uptake, SPECT/CT is expected to improve the diagnostic accuracy of radioiodine scanning and therefore to have a significant effect on patient management. As yet two publications have dealt with this issue [12, 19]. Tharp and colleagues retrospectively studied the diagnostic impact of ^{131}I-SPECT/CT imaging in a heterogeneous group of 71 patients with thyroid cancer [12]. In 61 of these, SPECT/CT was used to evaluate the neck, allowing a precise characterization of equivocal lesions on planar imaging in 14/17 patients and changing the assessment of the lesion localization in five patients as compared with planar studies. Thirty-six patients of that group had SPECT/CT for foci of uptake distant from the neck. In this subgroup, SPECT/CT identified equivocal lesions as definitely benign in nine patients. Furthermore, it helped to precisely localize malignant lesions in seventeen patients. The incremental diagnostic value of SPECT/CT was reported to be 57% in the whole group. Ruf et al. investigated the benefit of SPECT/CT hybrid imaging in 25 patients with thyroid carcinoma exhibiting 41 foci of ^{131}I uptake considered inconclusive on planar imaging

[19]. Of these foci, 95% were correctly classified as benign or malignant by hybrid imaging, the gold standard for final classification being represented by clinical follow-up and/or additional ultrasound, CT, or MRI. In the patient based analysis, SPECT/CT was found to change the therapeutic procedure in 25% of the subjects studied.

These pilot studies suggest that diagnostic improvements brought about by SPECT/CT in patients with thyroid carcinoma are considerable. However, considering the variable clinical presentations of differentiated thyroid cancer, validity of the above conclusion should be based on large-scale multi-centre prospective studies enabling stratification of patients into statistically meaningful homogeneous subgroups.

3.2. Neural crest and adrenal tumours

Pheochromocytomas and paragangliomas are chromaffin cell tumours originating from the adrenal medulla and from the paraganglia, respectively. Sympathetic-derived paragangliomas are most frequently located in the retroperitoneum and thorax, while parasympathetic paragangliomas are located near the aortic arch, neck and skull base. These tumours are said to follow in general the 10% rule: approximately 10% are malignant, 10% familial, 10% extra-adrenal, 10% bilateral, and 10% occur in children [20, 21].

Early diagnosis, accurate pre-treatment staging and adequate follow-up are crucial as to the possibility of curing such tumours. Although multi-detector row CT and high-field MRI are reliable for accurate evaluation of these tumours and are usually employed for initial imaging, they are inadequate for whole body assessment (especially MRI).

Radioiodinated metaiodobenzylguanidine (MIBG), an analogue of norepinephrine and guanethidine, was the first radiopharmaceutical capable of specifically depicting and localizing catecholamine-secreting tumours, including pheochromocytomas and paragangliomas. Nowadays, MIBG scintigraphy (generally performed with the ^{123}I labelled radiopharmaceutical) is still regarded as one of the first-choice imaging techniques for diagnosis and follow-up, as it depicts primary and residual or recurrent tumours, as well as metastatic lesions, with an overall accuracy of about 90% [22]. Moreover, in patients with malignant disease, MIBG scintigraphy is an essential step to select patients for ^{131}I-MIBG therapy.

However, the clinical utility of MIBG scintigraphy is often impaired by a lack of accurate anatomical information, in particular with regard to lesion localisation. Nevertheless, the combination of anatomical maps and scintigraphic imaging, as provided by the SPECT/CT hybrid systems, has allowed a significant improvement in localizing MIBG-avid foci (Fig. 3), mainly by more precisely defining the tumoural extension and by increasing specificity (as it permits to exclude disease in foci of tracer uptake identified as sites of physiological accumulation). In this respect, major benefits have been observed in case of tumours located near organs with high physiological tracer uptake, such as liver and myocardium, and when characterizing areas of normal MIBG bio-distribution or excretion, thus avoiding the need for delayed imaging [23, 24].

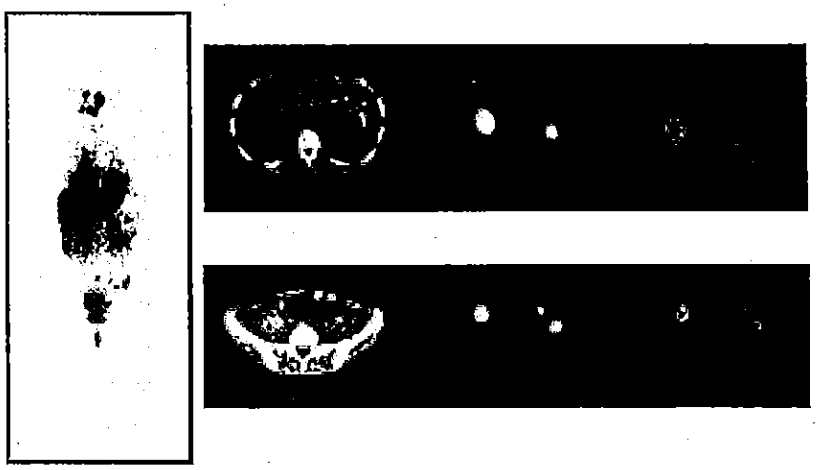

FIG. 3. ^{123}I-MIBG scintigraphy in a 26 year old woman who had undergone laparoscopic left adrenalectomy 5 years earlier because of pheochromocytoma. Despite histological appearance of benign pheochromocytoma, symptoms and biochemical markers of disease recurred, leading to the diagnostic scan. The whole body planar scan (left panel) shows multiple foci of tracer uptake in the abdominal area, most notably in the liver and in other areas suggesting possible lymph node metastases. However, SPECT/CT images (upper and lower right panels) show that such foci represent peritoneal implants rather than visceral or lymph node metastases, possibly secondary to intra-surgical dissemination of benign pheochromocytoma cells.

Ozer et al. have explored the role of fused SPECT/CT imaging for MIBG scintigraphy in a series of 31 patients with suspected pheochromocytoma [25]. In 81% of the cases, fused images correctly characterized the focal tracer uptake detected on planar ^{123}I-MIBG scan as physiological intestinal, renal or hepatic accumulation. Furthermore, SPECT/CT correctly localized focal accumulation in the adrenal glands of four patients and differentiated bone metastases from a local recurrence of pheochromocytoma in two patients. SPECT/CT also discriminated MIBG uptake in a retroperitoneal recurrence from adrenal hyperplasia consequent to contralateral adrenalectomy [26].

Neuroblastomas and ganglioneuroblastomas are poorly differentiated tumours arising from precursors of the sympathetic nervous system that typically occur in infants and young children. Neuroblastoma is the most common extracranial solid tumour of childhood. It may arise anywhere along the sympathetic chain, but most commonly occurs in the adrenal gland, with metastases present in 50–60% of patients at the time of diagnosis. Prognosis is affected by age, site of the primary tumour, and surgical resectability. Ganglioneuroblastomas are transitional tumours of sympathetic cell origin that contain elements of both malignant neuroblastoma and benign ganglioneuroma [21]. The most common tumour sites are the adrenal medulla (35%), retroperitoneum (30–35%), posterior mediastinum (20%), neck (1–5%), and pelvis (2–3%).

MIBG scintigraphy is useful not only for identifying the primary tumours, but also to monitor the pattern of metastatic spread (with an overall 92% sensitivity and 96% specificity) and response to treatment [22]. However, fused SPECT/CT images are expected to further improve its diagnostic accuracy, especially if performed in selected cases, i.e. in patients with inconclusive planar or SPECT imaging with respect to the exact anatomic localization of the lesions detected on the scintigraphy. In particular, given the relatively high frequency of

skeletal metastases in neuroblastomas, SPECT/CT can differentiate between bone and bone marrow involvement. Moreover, hybrid imaging helps to characterize tumour recurrence in close vicinity to the heart or liver, organs with high physiological MIBG uptake. On the other hand, in paediatric patients SPECT/CT may help to clarify the diffuse physiologic tracer uptake in the right heart sometimes misinterpreted as malignant mediastinal, sternal or vertebral sites of tumour involvement [23, 26].

SPECT/CT provides therefore a clinically useful option for localizing sites of abnormal MIBG uptake and for characterizing their benign or malignant nature. In addition to increasing specificity of staging and providing useful anatomic information on surgical resectability, the procedure also has an impact on the selection of patients to be treated with ^{131}I-MIBG.

3.3. ^{111}In-octreotide SPECT/CT for assessing neuroendocrine tumours

^{111}In-octreotide scintigraphy is widely employed to image somatostatin–receptor-positive neuroendocrine tumours. Over the last decades, lesion detection and overall clinical accuracy have improved due to optimized imaging techniques. The currently injected dose of 6 mCi of ^{111}In-octreotide (^{111}In-DTPA-pentetreotide) has doubled as compared to the 3 mCi dose administered in the initial studies. SPECT imaging is now routinely performed.

Neuroendocrine (NE) tumours of the gastrointestinal tract include carcinoid and islet-cell tumours, and surgery is the treatment of choice. Detection of all tumour sites is critical for referring patients to surgery and for its optimal planning. Localization of lesions may be difficult, due to their small diameter and lack of anatomical delineation [27]. The sensitivity of conventional imaging modalities, mainly CT and ultrasound, ranges between 13% and 85%, depending on the type, site and size of the tumour and on the imaging protocol [28].

Many neuroendocrine tumours show an increased expression of somatostatin receptors. A variety of analogues with high binding affinity to somatostatin receptors have been synthesized. One of these is octreotide, an eight amino acid cyclic peptide, with a biologic half-life measured in hours, which is used as an injectable therapeutic agent to inhibit excess secretions from neuroendocrine tumours. Somatostatin receptor scintigraphy is based on the use of octreotide as a carrier of radionuclides for diagnostic imaging or targeting therapy. A tyrosyl moiety in position 3 of the cyclic amino acid ring, the tyrosyl^3-octreotide has been substituted initially with ^{123}I [29]. Since ^{123}I is an expensive and short lived radioisotope, the use of ^{111}In bound to the octreotide molecule, ^{111}In-DTPA-pentetreotide, has been further developed, with the original octreotide eight amino acid molecule covalently bound to DTPA that, in turn, serves to link the radiometal [30].

Diagnosis, staging and follow-up of neuroendocrine tumours have advanced considerably with the advent of ^{111}In labelled pentetreotide scintigraphy. This modality has a reported sensitivity of 82–95%, and can successfully detect previously unknown sites of disease, undetected by conventional imaging techniques, in 30–50% of various NE tumours [31, 32]. Octreotide scintigraphy improves the localization and staging of primary tumours and enables early detection of recurrence [33]. In addition, octreotide scintigraphy facilitates the detection of receptor-dense microscopic foci during radio-guided surgery and is being used to determine if the whole tumour has been resected. Scintigraphy is also being used to define the receptor-status of metastases for octreotide treatment [34–36] or for targeted receptor-mediated radiotherapy [37–39]. It has been previously demonstrated that octreotide scintigraphy induced a change in classification in 24% and in surgical strategy in 25% of

patients with gastro-entero-pancreatic tumours [40], and changed the patient management in 47% of patients with gastrinomas [41].

Despite the valuable contribution of planar and/or SPECT ^{111}In-octreotide scintigraphy to the diagnosis and management of patients with known or suspected neuroendocrine tumours or other processes characterized by the increased expression of somatostatin receptors, the patterns of distribution of ^{111}In-octreotide have raised the need for correlating scintigraphic findings with anatomic imaging results. The overall specificity of scintigraphy may be affected by tracer uptake in physiological sites or in benign conditions. False–positive interpretations may be caused by the high receptor status of normal organs, such as the pituitary gland, thyroid, liver and spleen, or by physiological excretion of the tracer via the kidneys or the bowel. Hepatobiliary excretion, accounting for clearance of 2% of the administered dose, may lead to occasional visualization of the gallbladder which may potentially be misinterpreted as hepatic metastasis [42]. Guidelines for octreotide scintigraphy therefore recommend performing delayed studies that demonstrate changes in tracer kinetics and thus provide the differential diagnosis between benign, physiologic and malignant sites of radiotracer uptake. Neuroendocrine tumours are often localized in the abdomen and it can be difficult to precisely localize a suspicious lesion, or to differentiate whether a focus of abnormal uptake is in the pancreas, small bowel, liver or bone without anatomic correlation. In the region of the liver, it is difficult to distinguish between physiologic gallbladder accumulation versus a lesion in the head of the pancreas, in the right adrenal or in the small bowel.

Octreotide scintigraphy, although highly sensitive, is limited by the lack of precise anatomic localization, and requires correlation with high resolution anatomic imaging modalities in a large number of cases [40, 43]. Side by side interpretation of the two image sets (SPECT and CT) acquired separately, as well as co-registration of separately acquired anatomic (usually CT) and SPECT ^{111}In-octreotide imaging data have been developed. These techniques work quite well for fusion of studies of the brain, as there is no shift of the intra-cranial content from one study to another. In the thorax, there are differences in organ and lesion position depending on respiratory dynamics. Central mediastinal structures have limited excursion so that satisfactory co-registration, although very cumbersome and time-consuming, can be achieved. In the abdomen and the pelvis, there is the potential for significant shift of lesions depending upon patient positioning and variations in stomach, bowel or bladder distension. This represents a challenge for co-registration of separately performed SPECT and CT examinations, even when they are obtained within a close temporal interval, leading to possible mis-alignment of suspicious foci. A software package has been used to fuse helical CT and SPECT images of 28 lesions identified in 10 patients, using either external fiducial markers or internal anatomic landmarks (spleen and kidney contour) [44], and a shift of a few mm in organ location between SPECT and CT has been demonstrated. The use of image co-registration in the preoperative staging of patients with gastro-entero-pancreatic neuroendocrine tumours following ^{111}In-octreotide administration has also been evaluated in 38 patients with 87 lesions [45]. The accuracy of successfully assigning the anatomical location by two independent readers increased from 57% and 61% to 91% and 93%, respectively, using co-registration. Diagnosis and localization of liver metastases to a specific segment improved from 45% and 58% to 98% and 100%, respectively, with relevant information for further therapeutic decisions in 19% of the patients [45]. Nevertheless, the approach of co-registering separately performed octreotide-SPECT and CT studies cannot be considered as the optimal approach for assessment of function and anatomy of neuroendocrine tumours.

SPECT/CT may localize foci of increased tracer activity to normal organs with known physiological activity, without the need for performing delayed scans on additional days. SPECT/CT may also improve image interpretation when the foci of increased tracer uptake can be precisely localized to octreotide-avid benign processes, such as recent surgery or colostomy, increased thyroid uptake in Graves' disease, accessory spleen, parapelvic cyst, benign breast lesions and granulomatous lung disease (e.g. sarcoidosis) [34, 46]. When active malignant disease is diagnosed, SPECT/CT can precisely define the organ involved and determine the presence or absence of invasion into surrounding tissues. Following the diagnosis and localization of neuroendocrine tumours, SPECT/CT may also help in determining the extent of disease, defining it as localized or disseminated, and thus influence the choice of the most appropriate treatment modality [47–49]. When disease is confined to a single organ, a localized mode of organ-specific therapy is suggested, such as surgery or chemoembolization (Figs 4, 5). When a soft-tissue tumour has invaded the adjacent bone, surgery is inadvisable. In extensive, unresectable disease, systemic therapy is required.

Initial studies have shown that SPECT/CT had an impact on patient management in 5 out of 10 patients with neuroendocrine tumours [50]. Further studies have indicated that octreotide SPECT/CT has a specificity of 86% and a positive predictive value of 85% for diagnosis of neuroendocrine tumours, and resulted in a change in management in 3–14% of patients [46, 49]. Pfannenberg et al., in an analysis of 43 patients with neuroendocrine tumours, compared SPECT/CT results to those of SPECT and to high-end CT stand-alone images, histopathology or clinical and imaging follow-up representing the diagnostic standard. Separate SPECT and CT interpretations were in agreement for 56 of 114 lesions overall (49% concordance). For the remaining 58 lesions (51%), consensus readings of the fused SPECT/CT images resulted in a change from the original interpretation of 39 CT and 19 SPECT examinations. Overall, SPECT/CT outperformed significantly both SPECT and high-end CT. The greatest accuracy involved the use of SPECT/CT with side by side availability of high-end CT. In fact, in this report SPECT and side by side high-end CT performed slightly better than SPECT/CT [51]. A preliminary report of ^{111}In-octreotide SPECT/CT in 27 patients with suspected or known neuroendocrine tumours, primarily of the gastro-entero-pancreatic type, indicated that fused images improved the overall diagnostic confidence in 15 of 27 cases [52].

In a large series including 72 patients with neuroendocrine tumours, Krausz et al. evaluated the impact of SPECT/CT on the diagnostic accuracy of octreotide scintigraphy and on further clinical patient management [47]. SPECT/CT improved the study interpretation in 32% of the total study population (52% of the positive studies). SPECT/CT allowed for the precise localization of foci of increased ^{111}In-octreotide activity thereby defining the whole extent of disease in 17 patients, it diagnosed previously unsuspected bone metastases in 3 patients and defined suspicious lesions as sites of physiologic activity, unrelated to cancer, in 3 additional patients. SPECT/CT altered the subsequent management of 10 patients (14%). Results of fused images modified the previously planned surgical approach in 6 patients, spared unnecessary surgery in 2 patients with newly diagnosed involvement of the skeleton, and led to referral of one patient each to liver transplant and to chemoembolization, rather than to systemic therapy.

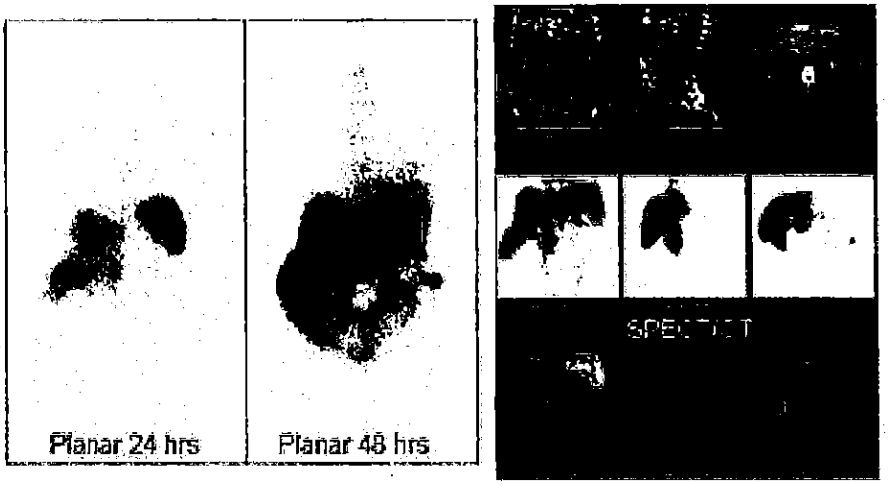

FIG. 4. ^{111}In-octreotide SPECT/CT in duodenal carcinoid. A 56 year old woman with duodenal carcinoid diagnosed following biopsy of a duodenal ulcer was referred for defining extent of disease prior to treatment planning. Whole body planar scans performed at 24 and 48 h after tracer injection are normal. SPECT demonstrates a small focus of abnormal tracer activity in the right mid-abdomen, localized by SPECT/CT fused images to the duodenum, consistent with the known primary tumour. No additional sites of abnormal tracer activity are seen. The patient was referred for surgery.

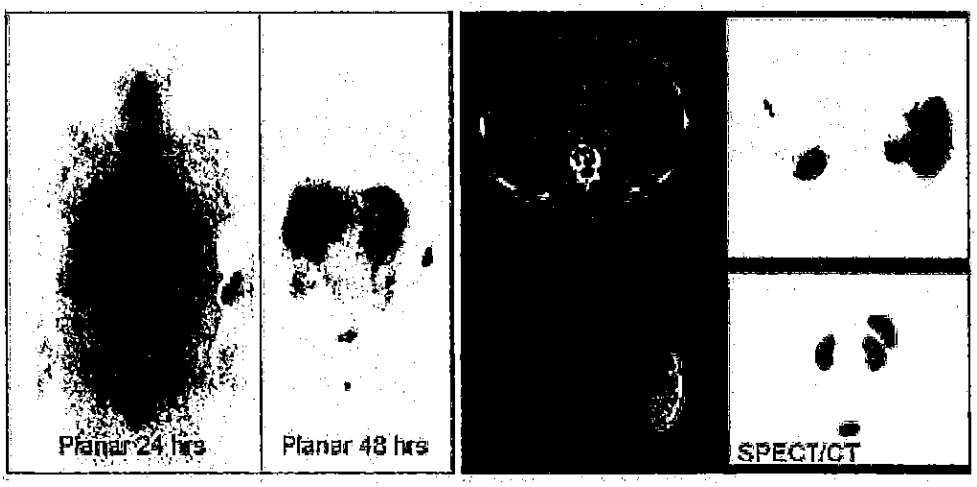

FIG. 5. ^{111}In-octreotide SPECT/CT in pancreatic insulinoma. A 68 year old woman was hospitalized because of severe hypoglycemia. CT indicated a suspicious lesion in the tail of the pancreas. Whole body planar scans performed at 24 and 48 h after tracer injection are normal. SPECT demonstrates a small focus of abnormal tracer activity in the left upper abdomen, in close proximity to the high ^{111}In-octreotide uptake in the spleen. This suspicious lesion is localized by SPECT/CT fused images to the small lesion seen on CT in the tail of the pancreas, consistent with a pancreatic insulinoma. No additional sites of abnormal tracer activity are seen. The patient was referred for surgery.

Octreotide-SPECT/CT provides information regarding the functional status of the tumour, its precise localization and the whole extent of disease. Fused images are therefore useful tools to choose the optimal treatment strategy, mainly in patients with advanced disease. When scintigraphy is negative, SPECT/CT is of no additional value except for verification of receptor density in a tumour visualized on CT. SPECT/CT provides greater accuracy in localization of findings than functional SPECT imaging alone and greater specificity than anatomic CT as a stand-alone procedure.

In summary, despite the favourable impact that ^{111}In-octreotide scintigraphy, particularly SPECT, has had on the diagnosis and management of patients with neuroendocrine tumours, these features improve even further when correlated with anatomic imaging data acquired sequentially during a single imaging session. Criteria for improvement include higher diagnostic sensitivity and specificity, as well as impact on patient management. Thus, it can be concluded that near simultaneous acquisition of both CT and SPECT image sets (hybrid SPECT/CT) represents the state of the art for diagnostic ^{111}In-octreotide imaging of neuroendocrine tumours.

3.4. ^{67}Ga-citrate SPECT/CT in lymphoma

^{67}Ga-citrate scintigraphy has long been shown to be useful for evaluating patients with lymphoma, and SPECT/CT has further improved its diagnostic sensitivity as well as localization of areas with abnormal tracer uptake [53]. In particular, SPECT/CT proved to be very helpful for distinguishing spinal lesions from adjacent nodal involvement. It was also able to clarify the tracer uptake at the edges of the lower chest, projecting over the hepatic dome, ribs or sternum. Furthermore, SPECT/CT imaging has been shown to provide additional information or diagnosis from CT-detected abnormalities leading to significant change in patient's management [54].

3.5. Lymphoscintigraphy

Accurate lymph node staging is essential for the treatment and prognosis in patients with cancer. The sentinel lymph node is the first node to which lymphatic drainage and metastasis from the primary tumour occur. Procedures for sentinel lymph node detection and biopsy have already been implemented into clinical practice [55, 56]. Precise anatomic localization of the sentinel lymph node is critical for minimally invasive surgery and to avoid incomplete removal of the sentinel node, especially in the regions of the head and neck, the chest and the pelvis.

In the head and neck the lymphatic drainage is in the levels I through VII. A node in level I-A is in the subdigastric muscle area, and a node in level I-B is in the submandibular area. A node in level II-A is anterior to the sternocleidomastoid (SCM) muscle, and a node in level II-B is adjacent to the SCM muscle. Nodes in level II are above the hyoid bone. A node in level III is adjacent to the SCM muscle, between the hyoid bone and the cricoid cartilage. A node in level IV is adjacent to the SCM muscle below the cricoid cartilage. A node in level V-A is behind the SCM muscle above the cricoid cartilage, and a node in level V-B is behind the SCM muscle below the cricoid cartilage. A node in level VI is in the anterior middle neck between bilateral SCM muscles, and a node in level VII is in the superior mediastinum.

Axillary lymph node levels are level I (low) lateral to the pectoralis minor (PM) muscle, level II (mid) behind the PM muscle, and level III (high) medial to the PM muscle.

The resection of external iliac *versus* inguinal lymph nodes requires significantly different surgical approaches, and thus precise preoperative localization is crucial for optimal surgical approach. A node above the level of the inferior epigastric artery which is anterior and lateral to the bladder base is an external iliac node, and the nodes below the inferior epigastric artery are inguinal nodes, further subdivided into superficial and deep ones by the sapheno-femoral venous junction.

Only SPECT/CT imaging can precisely locate the sentinel lymph node since CT images provide critical anatomical landmarks such as the hyoid bone, cricoid cartilage, SCM and PM muscles, inferior epigastric artery and sapheno-femoral venous junction.

SPECT/CT increases the sensitivity and specificity of lymphoscintigraphy, and also provides the additional diagnostic information from the CT images [57–62]. A standard dose of 0.5 mCi ^{99m}Tc labelled colloid (5–80 nm) is injected intradermally around the melanoma lesion, interstitially around the breast cancer lesion and subcutaneously around other tumours. SPECT/CT is usually obtained immediately after identifying drainage of the activity on serial planar images (Fig. 6).

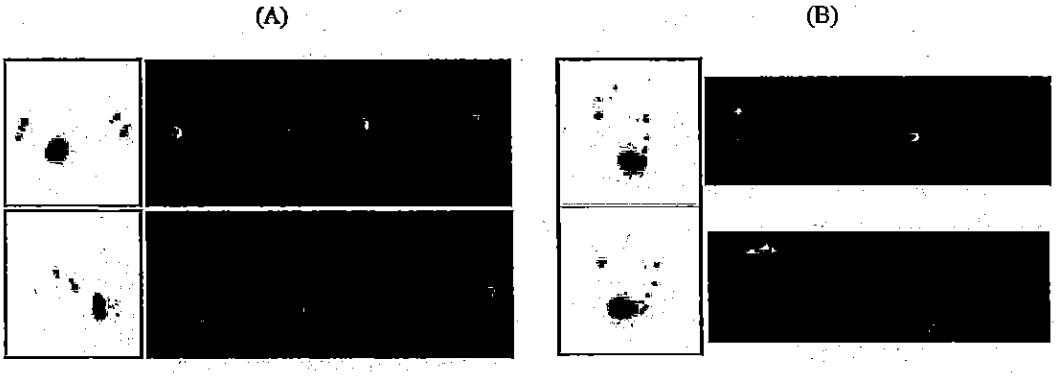

FIG. 6. Additional information over planar scintigraphy provided by SPECT/CT in two patients with malignant cutaneous melanoma submitted to lymphoscintigraphy with ^{99m}Tc-albumin nanocolloid before radioguided sentinel lymph node biopsy. (A) Left panels show the planar posterior (top) and left lateral (bottom) views in a patient with melanoma located on her back: multiple bilateral lymph nodes can be detected, without however clear reference to precise anatomic structures. Right panels show SPECT/CT tomographic sections at different levels, demonstrating bilateral lymphatic draining to both axillary (top) and subscapular (bottom) lymph nodes. (B) Left panels show the planar right oblique (top) and anterior (bottom) views in a patient with melanoma located on his anterior right chest: multiple lymph nodes can be detected, without however clear reference to precise anatomic structures. Right panels show SPECT/CT tomographic sections at different levels, demonstrating lymphatic draining to both axillary and internal mammary chain lymph nodes

3.6. Skeletal scintigraphy for staging malignant disease

Scintigraphic imaging of bone metabolism is a cost efficient way to prove or exclude skeletal metastases in patients with tumours prone to metastasize to the skeleton, such as breast, prostate, or lung carcinomas [63]. Therefore, bone scintigraphy is included in the majority of guidelines addressing management of these neoplastic conditions in many countries and is one of the most frequently performed radionuclide imaging procedures performed worldwide.

In a recent study comparing the diagnostic accuracy of ^{99m}Tc-phosphonate skeletal scintigraphy to that of [^{18}F]FDG-PET in patients with thyroid carcinoma [64], sensitivity of the conventional procedure was not significantly different from that of [^{18}F]FDG-PET. However, its specificity was significantly worse. This result can be considered representative also of other tumours and is not at all unexpected, since there are several highly prevalent benign conditions leading to focally increased uptake of the radiolabelled phosphonates in the skeleton. Most of these conditions reflect degenerative processes of the joints increasing in frequency with age, such as spondylarthrosis or coxarthrosis. Additional benign causes of enhanced uptake are rheumatic disease or benign bone tumours.

Since most of these benign conditions are readily identifiable on CT, SPECT/CT is expected to improve specificity of skeletal scintigraphy without reducing its sensitivity. Besides single case reports illustrating this assumption, several prospective studies have investigated this issue.

In 2004, Horger et al. demonstrated significantly increased specificity when using SPECT/low-dose non-spiral-CT for classifying 104 lesions in 47 subjects exhibiting indeterminate findings on conventional planar imaging [65]. This study is particularly valuable considering that the reference gold standard for final classification of lesions was either histological confirmation or extended clinical follow-up, and thus independent from the results obtained by SPECT/CT.

Römer et al. employed a SPECT/CT camera equipped with a two slice spiral-CT for classifying 52 lesions in 44 patients, defined as indeterminate on SPECT imaging [6]. These authors reported that SPECT/CT enabled correct classification of the scintigraphic abnormalities in 92% of the subjects studied.

Utsunomiya et al. used a hardware set-up comparable to that of a hybrid SPECT/CT camera, by transferring the patient positioned on the same table in an identical position from a stand-alone SPECT camera to a gantry of an 8 slice CT [66]. By studying 45 patients and based on receiver-operation curve (ROC) analysis, they confirmed the significant increase in diagnostic accuracy brought about by co-registration of these two modalities. Furthermore, they also showed that co-registration performs significantly better than side by side viewing of the two sets of images (SPECT and CT, respectively) on the same workstation.

Considering the evidence summarized above, one cannot but conclude that skeletal SPECT/CT is the new imaging gold standard when searching for osseous metastases and that for this purpose conventional scintigraphy becomes obsolete (Fig. 7). Unsettled issues include the quality of the CT integrated into the hybrid system needed for this purpose, as well as the relative diagnostic accuracy of this approach compared to whole body MRI and PET using [^{18}F]FDG or ^{18}F-fluoride. Although these options appear attractive, a cost effectiveness analysis might strengthen the role of SPECT/CT in this context.

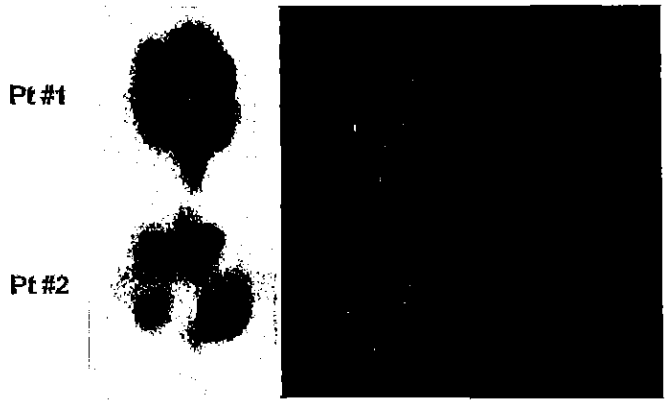

FIG. 7. The upper row shows SPECT, CT, and fused images of a lumbar vertebra in a patient with breast cancer (Pt #1). In this patient, increased uptake of ^{99m}Tc-MDP is due to arthrosis of the facet joint. The lower row depicts similar images in another breast cancer patient (Pt #2). Although the SPECT appearance of the lesion is quite similar to that in Pt #1, the CT overlay proves it to be a small osteolysis.

3.7. Skeletal SPECT/CT in orthopaedics

Up until approximately 20 years ago, planar X ray and skeletal scintigraphy were the imaging procedures of choice in patients with benign orthopaedic disease. Although MRI has brought a dramatic change to the predominance of radionuclide imaging in this field, skeletal scintigraphy still holds the promise of sensitively depicting functional alterations of bone. However, difficulties in precisely localizing abnormalities of bone metabolism relative to the complex anatomy of the skeleton have greatly weakened its clinical role, despite its much lower costs than MRI.

In principle, SPECT/CT would be suited to overcome these problems as demonstrated in several case reports (Fig. 8) [67]. However, so far only one study has systematically studied the clinical benefit of SPECT/CT in orthopaedic disease [68]. Using a SPECT/multi-slice non-spiral CT, Even-Sapir et al. analysed skeletal image data from 89 consecutively studied, non-oncological patients. These patients had non-specific lesions on planar skeletal scintigraphy for which correlation with morphological imaging was considered necessary. The indications for radionuclide bone imaging were pain in 61, prior trauma in 7, suspected infection or inflammation in 6, and fever of unknown origin in the remaining 2 patients. Gold standard for final classification was consensus opinion among the readers, and this represents a possible limitation of the study since it was not independent from SPECT/CT itself. Hybrid imaging enabled a definite diagnosis to be reached in 59% of the patients studied, obviating the need to perform additional imaging. In another 30% of patients, SPECT/CT provided information relevant for their further diagnostic workup. The authors therefore concluded that SPECT/CT is a clinically relevant component of the diagnostic process in patients with non-oncological disease referred for bone scintigraphy.

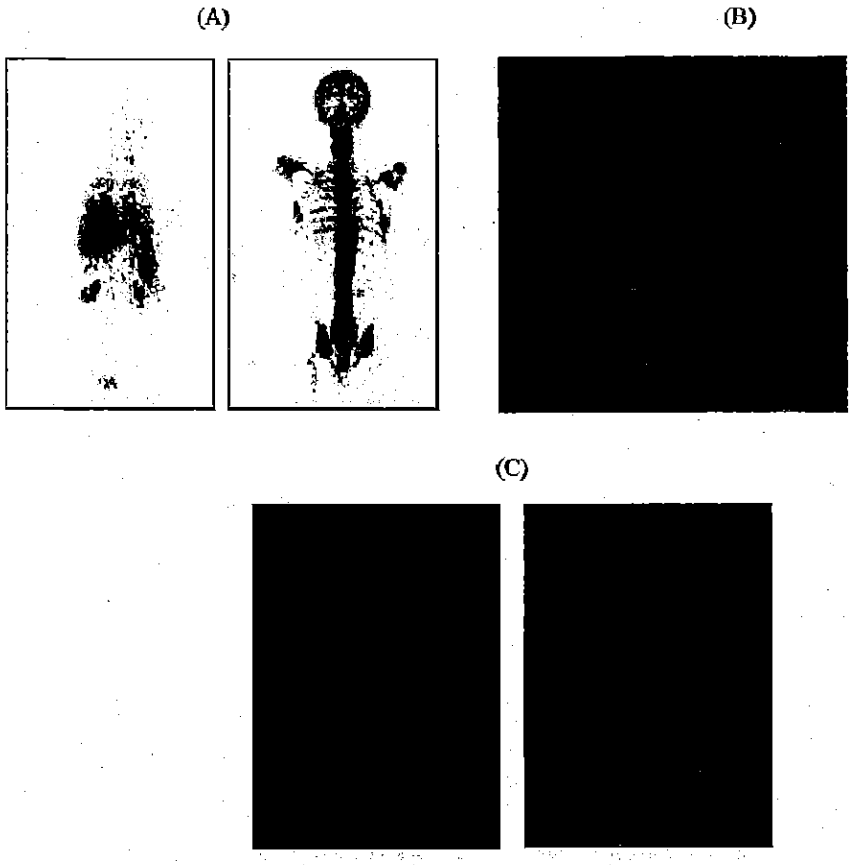

FIG. 8. (A) Early (left panel) and late (right panel) posterior planar skeletal scintigrams of a 74 year old patient after recent trauma, showing enhanced uptake of ^{99m}Tc-MDP in a vertebral body of the lower thoracic spine. 3-D-volume rendering of the SPECT/CT fusion (B) shows that the lesion is in the twelfth vertebral body. The inspection of the fused tomograms (C) proves it to be a fracture; moreover, the one-stop shop examination discloses it to be unstable since the posterior corticalis is involved, thus motivating immediate surgery.

3.8. ^{201}Tl-chloride in cerebral masses

The diagnosis of a postoperative residual brain tumour is a challenging clinical problem, since both contrast-enhanced CT and T1-weighted MRI after surgery are difficult to interpret while precise diagnosis is needed for planning radiation therapy. Likewise, in HIV infected patients, the differential diagnosis between primary lymphoma and cerebral toxoplasmosis is often problematic.

Thallium is a metallic monovalent cationic element in group III-A of the periodic table of elements. ^{201}Tl is cyclotron-generated and is administered in the form of thallous chloride. The cellular uptake of ^{201}Tl after i.v. administration depends on both blood flow and the cellular extraction fraction, which mainly occurs via the Na^+/K^+-ATPase active transport membrane pump in viable cells. A minor fraction of ^{201}Tl uptake is also related to co-transport system, calcium ion channel system, vascular immaturity with 'leakage', and increased cell membrane permeability. Tumour cells have shown greater ^{201}Tl uptake than normal

connective tissue or inflammatory cells. In primary brain tumours alterations in the blood-brain barrier play a key role in ^{201}Tl accumulation [69].

In normal subjects little ^{201}Tl activity is seen in the cerebral substance, since ^{201}Tl cannot pass the blood-brain barrier and diffuse into the brain tissue. Conversely, high radioactivity is seen in the orbits, the base of the skull and nasopharyngeal region, and around the scalp. There are no significant differences between early (10 minutes) and delayed (3 hours) images. In case of brain haematoma, ^{201}Tl uptake seen in early images significantly decreases on delayed scans [70].

Postoperative ^{201}Tl SPECT demonstrated a significantly better accuracy than contrast-enhanced CT in detecting residual tumour in 33 patients [71]. Actually, disruption of the blood-brain barrier during the postoperative period often leads to uncertainty in CT interpretation. Co-registration and fusion of ^{201}Tl SPECT with CT could thus optimize postoperative radiation therapy planning through a truly anatomo-metabolic image.

^{201}Tl SPECT has also been seen to be useful for differentiating brain tumour recurrence from radiation necrosis or gliosis after radiotherapy, with more reliable information than CT and MRI in identifying progression, improvement or no change in brain tumours in follow-up studies [72, 73].

Because ^{201}Tl does not accumulate in normal brain parenchyma, anatomical localization of increased tracer uptake is difficult. Registration and fusion with anatomical images facilitates this task during the clinical workup of patients with brain tumours [74]. Appropriate attenuation correction based on the CT transmission data could also help in the reconstruction of ^{201}Tl SPECT images, which will further improve image contrast and detectability of areas of increased uptake, leading to a higher sensitivity of ^{201}Tl imaging, particularly for infratentorial and small size tumours. Until now, physicians have relied mainly on their spatial sense to mentally reorient and overlap ^{201}Tl images with the anatomic data. This approach is inconsistent and highly subjective and can yield suboptimal results because it does not take full advantage of all the available information [74]. Image fusion allows accurate determination of the anatomic sites of normal and abnormal uptake (Fig. 9). The precise localization of ^{201}Tl accumulation is essential to guide the choice of biopsy site (conventional or stereotactic), in an effort to decrease the potential for tissue sampling error in the pathologic specimen, or for planning radiosurgery [75]. Moreover, the accurate assessment of ^{201}Tl uptake can be of significant value after surgical and/or radiotherapy treatment in planning further therapeutic strategies, such as additional surgery or radiotherapy, because CT and MRI are often unable to distinguish residual tumour from post-therapy changes. Fused images can also help in optimizing the treatment specifically to the viable malignant tissue and in the early diagnosis of recurrence during follow-up.

3.9. ^{99m}Tc-depreotide in solitary pulmonary nodules

The characterization of solitary pulmonary nodules (SPNs) represents an important clinical problem because, although they may be caused by many benign conditions, bronchogenic carcinoma is being increasingly identified as one of the main etiologies, especially in the elderly. Survival rate at 5 years may be ≥80% in patients with resected malignant SPN, while it is <5% for patients with advanced malignant disease. Ideally, diagnostic approaches to SPN would permit definitive resection when possible and avoid resection in patients with benign disease [76].

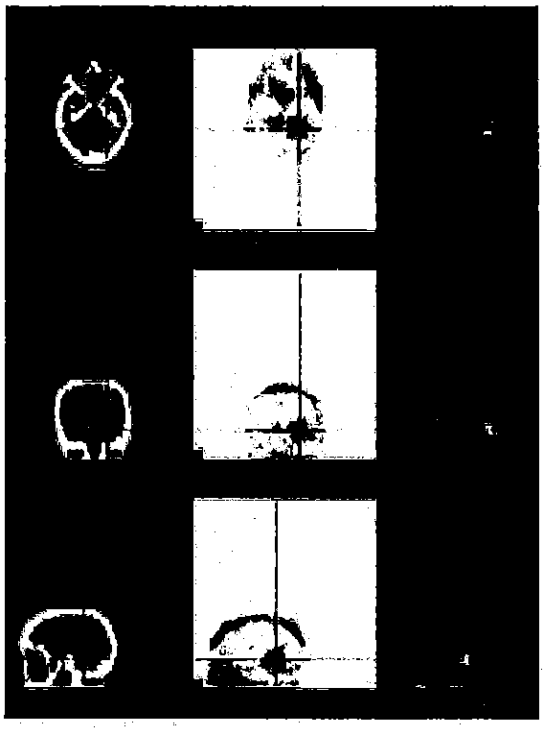

FIG. 9. SPECT/CT performed after administration of ^{201}Tl-chloride in an HIV infected patient referred for differential diagnosis between primary lymphoma and cerebral toxoplasmosis. ^{201}Tl accumulation in the left hemi-cerebellum supports the diagnosis of primary lymphoma.

Depreotide is a synthetic cyclic peptide, an analog of somatostatin, that binds with high affinity to somatostatin receptors 2, 3, and 5. Radiolabelled with ^{99m}Tc, this agent has successfully been used for SPN imaging [77]. In fact, ^{99m}Tc-depreotide has been approved by the US Food and Drug Administration for the noninvasive differentiation of SPN, and it represents a cost effective alternative to [^{18}F]FDG-PET in this application [78]. ^{99m}Tc-depreotide SPECT and [^{18}F]FDG-PET have demonstrated the same specificity (86%) for small (up to 1.5 cm), and equal sensitivity (92%) for large (more than 1.5 cm) SPNs [79]. The role of ^{99m}Tc-depreotide in staging patients with non-small cell lung cancer is still under investigation, although an elevated number of false–positive results have been reported in the hilar/mediastinal regions due to nonspecific tracer uptake [80, 81]. SPECT/CT may help image interpretation by improving specificity at diagnosis and staging and by differentiating physiologic activity (parahilar mediastinal region, bone marrow uptake in the spine, ribs and sternum) from malignant uptake in the primary tumour or into metastatic lymph nodes (Fig. 10). Additionally, the improvement in image quality by the use of X ray based attenuation-correction could increase the detection rate of smaller nodules.

3.10. ProstaScintigraphy

Functional or molecular imaging of prostate cancer presents a challenging problem because of the deep anatomical location of the prostate gland in the pelvis, which causes significant attenuation and scattering problems. Patient's movement, changes of the prostate volume, as well as changes in the shapes and contents of the rectum or bladder during imaging can further exacerbate the problem in image-fusion multimodality imaging visualization of the prostate.

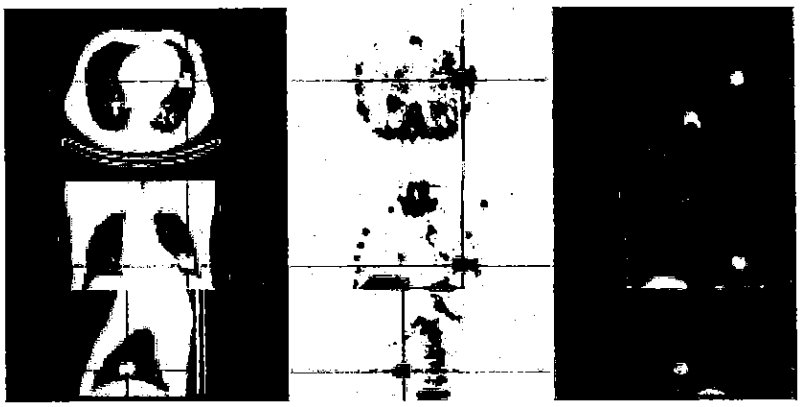

FIG. 10. Transaxial, coronal, and sagittal tomograms of SPECT/CT imaging obtained after injection of ^{99m}Tc-depreotide in a patient with a solitary pulmonary mass occasionally discovered on chest X ray. Intense tracer uptake indicates malignancy, while the fused SPECT/CT images suggest that, while there is no extension of the tumour to infiltrate the chest wall, there is possible involvement of the pericardium.

The overall diagnostic accuracy of imaging using 5 mCi ^{111}In-ProstaScint (monoclonal antibody against the prostate-specific membrane antigen) has been reported to be 76%, with 44% sensitivity and 86% specificity relative to histologic findings [82, 83]. Increased accuracy of the ProstaScint scan for diagnosis of prostate cancer has been reported when fusing SPECT images with either CT or MRI [84, 85]. In addition, ProstaScint imaging can be applied to guide brachytherapy or intensity-modulated external-beam radiation therapy [86], as well as radioimmunotherapy using ^{90}Y-capromab pendetide for recurrent prostate cancer [87].

3.11. SPECT/CT in the preoperative localization of parathyroid adenomas

Parathyroid scintigraphy with ^{99m}Tc-sestamibi (employed either as a single-tracer, dual-phase protocol or in combination with other tracers with exclusive uptake in the thyroid for subtraction imaging) is critical for preoperative localization of parathyroid adenomas, especially in the perspective of applying mini-invasive parathyroid surgery [88–90]. Even before the introduction of hybrid SPECT/CT instrumentation into clinical routine, stand-alone SPECT procedures had already demonstrated clear superiority to planar ^{99m}Tc-sestamibi scintigraphy for imaging and localizing parathyroid adenomas, especially when planning the best surgical approach to ectopic adenomas, mainly located in the mediastinum [91–98].

However, because of the paucity of anatomic landmarks in pure SPECT images, some form of multimodality co-registration often turned out to be useful for better localization of adenomas relative to critical anatomic structures, such as those available through side by side viewing with, e.g. CT images or by post-acquisition image fusion. Useful complementary information as to location of ectopic parathyroid adenomas can also be derived by sequential acquisition, after ^{99m}Tc-sestamibi scintigraphy, of scintigraphic images obtained by injecting a second tracer, e.g. an intravascular indicator such as radiolabelled albumin or red blood cells, to identify the topographic relationships of adenomas with the principal vascular structures [88].

The recent growing-scale implementation of hybrid SPECT/CT equipments has dramatically improved this scenario, by enabling simultaneous acquisition and accurate single hardware

co-registration of functional images (derived from ^{99m}Tc-sestamibi scintigraphy) and of the corresponding morphologic images (derived from CT). Thus, it can be concluded that, at present, SPECT/CT represents the state of the art in preoperative localization of parathyroid adenomas, especially in cases of ectopic location and in the presence of concomitant multinodular goiter (Fig. 11). In all these conditions the localizing performance of SPECT/CT is clearly superior to both planar scintigraphy and stand-alone SPECT.

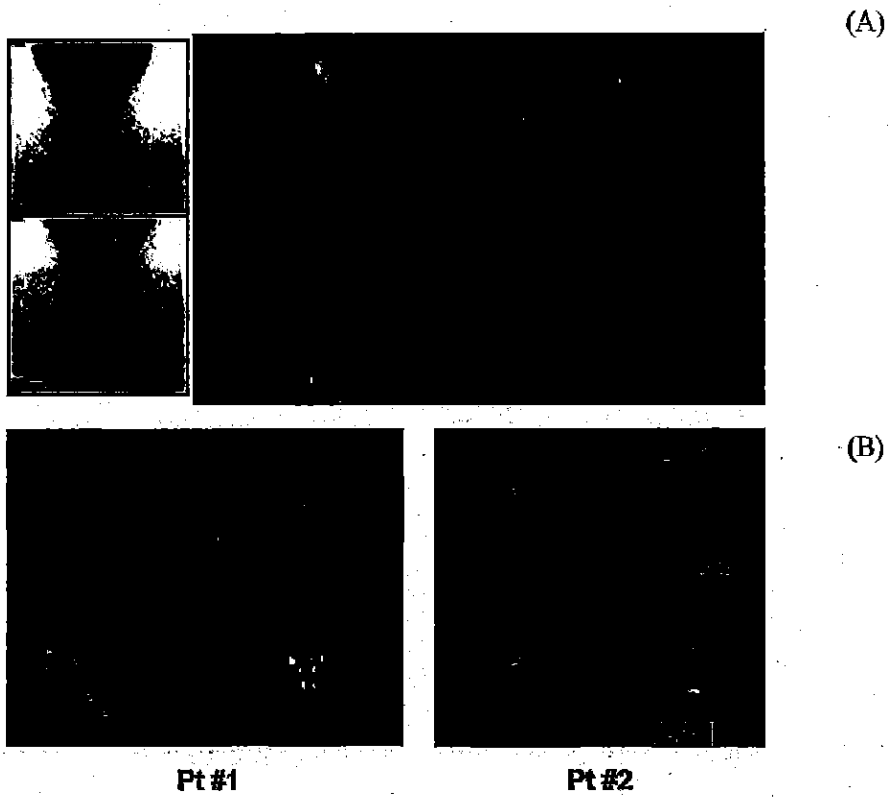

FIG. 11. Patients with parathyroid adenomas in whom hybrid SPECT/CT imaging turned out to be crucial for accurate preoperative localization and for planning the most adequate surgical approach. (A) Early (top left) and delayed (bottom left) planar ^{99m}Tc-sestamibi scans in a patient who had undergone unsuccessful parathyroid surgery during which the left thyroid lobe was also resected because of concomitant nodular goiter (persistent primary hyperparathyroidism despite removal of an enlarged parathyroid gland ectopically located in the anterior mediastinum that had been identified on a planar ^{99m}Tc-sestamibi scan). While both scans (left panels) are negative for parathyroid adenoma, SPECT/CT imaging (right panel) enabled to identify abnormal tracer uptake located posteriorly to the trachea. (B) Two patients in whom SPECT/CT imaging with ^{99m}Tc-sestamibi localized hyperfunctioning parathyroid adenomas and led to plan the optimal surgical approach for their successful resection. In Pt #1 the adenoma was located adjacent to the right wall of the trachea, while in Pt #2 the adenoma was located in the anterior mediastinum.

An early report by Gayed et al. suggested that SPECT/CT had a significant impact on surgical management of patients in only a limited fraction of patients (5 out of 48 cases in their experience), and considered therefore that the added value of CT (with the related radiation exposure) did not justify the routine application of the procedure, except perhaps in patients with ectopically located adenomas [99]. However, more recent reports emphasize the impact of SPECT/CT compared to planar and/or SPECT scintigraphy (either as a stand-alone imaging or as side by side viewing with the corresponding CT images) on surgical

management of patients. This conclusion has been reached by Krausz et al. who report a change in the surgical approach in 10/33 ectopic and 4/23 orthotopic parathyroid adenomas [100].

Similarly, Serra et al. have shown that SPECT/CT improves preoperative localization of parathyroid adenomas, with significant surgical impact in 39% of the cases [101]. In their patients, SPECT alone correctly localized 14/23 parathyroid adenomas (61%), while SPECT/CT correctly localized all 23 lesions (100%, 14 of which were ectopically located). Furthermore, SPECT/CT was crucial in demonstrating the retrotracheal location of an adenoma in three patients. Better performance of SPECT/CT versus planar or stand-alone SPECT has also been reported by Lavely et al. [102], while Ruf et al. have emphasized in particular the role of SPECT/CT for attenuation correction of the SPECT data based on the CT transmission data [103].

In conclusion, image fusion as obtained by hybrid SPECT/CT imaging with ^{99m}Tc-sestamibi is of value for surgical planning in both primary and secondary hyperthyroidism [104]. Concerning in particular secondary hyperparathyroidism, it is crucial that all parathyroid tissue showing ^{99m}Tc-sestamibi uptake is removed, because these parathyroid glands are those responsible for the increased production of parathyroid hormone. When relying only on visual inspection of the surgical field, in the absence of functional information some simply hyperplastic (but not hyperfunctioning) parathyroid glands might be removed unnecessarily. Wider clinical expertise using the hybrid SPECT/CT technology will certainly have a relevant impact in this field.

3.12. SPECT/CT for diagnosing infection and inflammation

Infection and inflammation can represent a major diagnostic challenge for physicians. Diagnosis and precise delineation of infectious foci may be critical in certain clinical scenarios and render decisions concerning further patient management problematic [105, 106].

Both morphologic and functional imaging modalities have been extensively employed for diagnosing and monitoring infections. CT and MR images provide high-quality anatomic details. However, the structural abnormalities underlying the infectious process are, in some cases, non-specific or appreciable only in a subacute or late phase of the disease. Nuclear medicine has gained a crucial role in the evaluation of patients suspected of harbouring infection, especially because of its capability of demonstrating physiologic processes and metabolic changes that often precede anatomic changes by several days or even weeks [106–123].

Although a variety of new radiopharmaceuticals have been explored as to their ability to detect and localize infectious and inflammatory processes, ^{67}Ga-citrate scintigraphy and scintigraphy with ^{111}In- or ^{99m}Tc-HMPAO labelled autologous white blood cell (WBC) remain the functional imaging techniques of choice for diagnostic work-up of infection [105].

However, both ^{67}Ga-scintigraphy and WBC-scintigraphy suffer from poor spatial resolution and somewhat low specificity because of the absence or paucity of anatomic landmarks. These limitations make precise localization and characterization of areas with focal abnormal tracer uptake problematic, even when employing SPECT imaging. At least part of these difficulties can be overcome when contemporary CT images are available, by either side by side viewing

and, even better, by software based image fusion analysis [124, 125]. However, similar as with other scintigraphic applications, the introduction into clinical routine of integrated SPECT/CT scanners for combined anatomic and functional imaging has offered new opportunities for infection imaging, especially for facilitating precise anatomic localization and accurate characterization of infectious foci [2].

Recent reports have explored the contribution of SPECT/CT to a more accurate interpretation of WBC-scintigraphy for an array of clinical indications in different regions of the body, by distinguishing normal physiologic distribution of labelled WBCs from accumulation due to underlying infection. Major advantages have been observed for infectious processes with thoracic or abdominal localization, because of the potential difficulty of characterizing foci of WBC accumulation near the major vessels. In such cases, the hybrid technology helps in discriminating blood-pool activity from infectious sites, with substantial benefits for the evaluation of suspected vascular graft infection and fever of unknown origin [126].

Moreover, SPECT/CT with ^{99m}Tc-HMPAO-WBC can be very useful to image bone and joint infections, by allowing accurate localization of labelled WBC accumulation. In particular, in some cases of bone infection with adjacent soft-tissue involvement, while planar images alone are not able to distinguish soft tissue from bone, hybrid imaging is able to localize additional sites of leukocyte uptake in neighbouring soft tissue and to precisely define the extent of infection, thus modifying clinical patient management and therapeutic approaches in several cases.

After traumatic injury, skeletal changes can often be observed in morphologic imaging (i.e. CT or radiography). Although fusion imaging with a hybrid camera can improve the diagnostic accuracy of SPECT, it cannot be a substitute for conventional high resolution CT, which maintains its diagnostic role in most clinical situations. However, with regard to bone imaging, reports show that even the low-dose CT of the hybrid device may provide sufficient diagnostic anatomic information.

In this regard, Filippi and Schillaci have recently evaluated the usefulness of SPECT/CT for interpreting ^{99m}Tc-HMPAO-WBC scintigraphy in 15 patients with suspected osteomyelitis and 13 patients with suspected infection of orthopaedic prosthesis [127]. SPECT/CT fusion correctly characterized and localized the site of labelled WBC uptake in all patients with osteomyelitis, discriminating soft tissue from bone and having a substantial impact on the clinical management. Moreover, among patients with suspected infection of orthopaedic implants, SPECT/CT offered a more accurate anatomic localization of the site of infection than SPECT alone allowing differentiation between prosthesis and soft-tissue uptake. The authors concluded that hybrid imaging provided additional anatomic information on all patients with positive scan results (64.2%) leading to a more accurate definition of the extent of infection with significant impact in decisions therapeutics. In particular, major benefits were achieved for the diagnosis of relapsing osteomyelitis in patients with structural bone abnormalities after trauma.

Although ^{67}Ga-citrate has been used for scintigraphic imaging of infection and inflammation for many decades, its bio-distribution (with high accumulation in the gastrointestinal tract) and its sub-optimal physical emission characteristics result in a relatively poor imaging quality, making interpretation of abdominal imaging quite problematic. In an attempt to improve the quality of ^{67}Ga-citrate imaging, Bar-Shalom et al. have explored the added value provided by hybrid SPECT/CT imaging as an adjunct to ^{67}Ga-scintigraphy (in 47 patients)

and to ^{99m}Tc-HMPAO-WBC scintigraphy (in 31 patients) [126]. The contribution of SPECT/CT was analysed on a patient- and site-basis and was compared for the two tracers and for various clinical indications. SPECT/CT provided an additional contribution for diagnosis and localization of infection in 48% of the patients and in 47% of the sites. Although SPECT/CT, because of its capability to localize abdominal uptake within the bowel, enabled the correct exclusion of infection in four patients undergoing ^{67}Ga-scintigraphy, the investigators found that the clinical added value of SPECT/CT was significantly higher for WBC-scintigraphy than for ^{67}Ga scanning (63% versus 36% of patients). This data can be explained by the high specificity of WBC, with low background activity and therefore limited anatomic information.

New agents such as radiolabelled anti-granulocyte monoclonal antibodies, radiolabelled ciprofloxacin, radiolabelled biotin, may benefit from hybrid imaging, as reported in some preliminary studies. Biotin (or vitamin H) is utilized by growing bacteria at the site of infection according to the rate of their metabolism. This feature is the basis for the successful utilization of ^{111}In-biotin for imaging infection, especially in difficult to interpret conditions such as the spondylo-discitis. However, since Biotin does not appreciably accumulate in normal bone and/or bone marrow, the exact identification of the vertebral body harbouring infection can be problematic. Therefore, in order to improve diagnostic accuracy and to differentiate between vertebral and soft tissue paravertebral infection, SPECT/CT acquisitions may be performed. In a preliminary study, Lazzeri et al. have investigated the role of ^{111}In-biotin SPECT/CT in 70 patients with suspected spinal infection [128], and have thus confirmed the high diagnostic potential of one-step ^{111}In-biotin hybrid imaging. Moreover, these authors demonstrated that SPECT/CT imaging allows accurate evaluation of spinal infection differentiating between vertebral and soft tissue paravertebral involvement.

Other radiopharmaceuticals, such as ^{99m}Tc labelled anti-granulocyte antibodies (AGA), are known to be highly sensitive and specific for diagnosing infectious disease, but image analysis and exact anatomical definition of the infectious foci is often difficult. In a series of 27 patients with suspected chronic post-traumatic osteomyelitis, Horger et al. have evaluated the value of fused SPECT/CT imaging after injection of ^{99m}Tc-AGA [129]. All patients underwent planar and SPECT/CT imaging studies 4 h and 24 h after injection. The authors found high sensitivity (100%) for both planar and SPECT/CT imaging, associated however with different results in terms of specificity (78% for planar versus 89% for SPECT/CT). SPECT/CT correctly localized all abnormal foci of tracer uptake detected on planar and SPECT images, and also enabled accurate discrimination between soft-tissue infection, septic arthritis, and osteomyelitis.

Although the potential of fused SPECT/CT imaging in infectious and inflammatory disease has not yet been fully elucidated and further validation is required, hybrid imaging provides precise anatomic localization with significantly improved diagnostic accuracy over planar or SPECT alone (Figs 12–14). These new techniques, in conjunction with the use of highly specific radiotracers for detection of inflammatory disease, are creating a whole new and powerful armamentarium for diagnosing infectious foci.

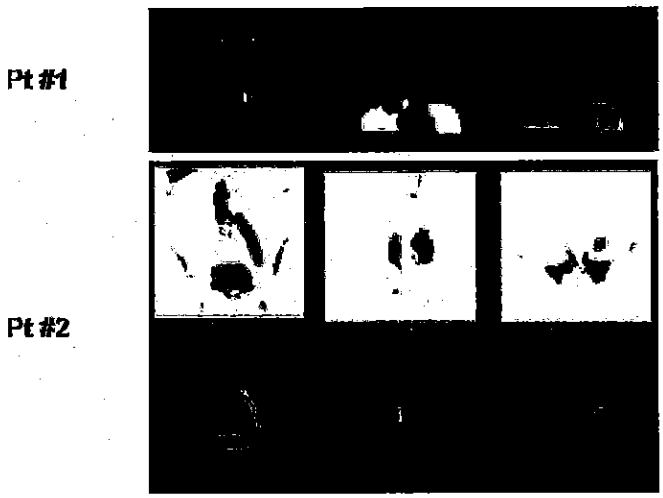

FIG. 12. Patients with cardiovascular infection imaged with autologous ^{99m}Tc-HMPAO-leukocytes and SPECT/CT. Although the most likely site of endocardial infection in Pt # 1 was expected to be a mitral valve implant (visible on the CT component of the examination), SPECT/CT correctly identified the tricuspidal valve as the actual site of infection (top panel). In Pt #2 (previously submitted to implant of aorto-bis-iliac vascular prosthesis), SPECT/CT defined the extent of infection as involving only the left side of the vascular graft (bottom panel).

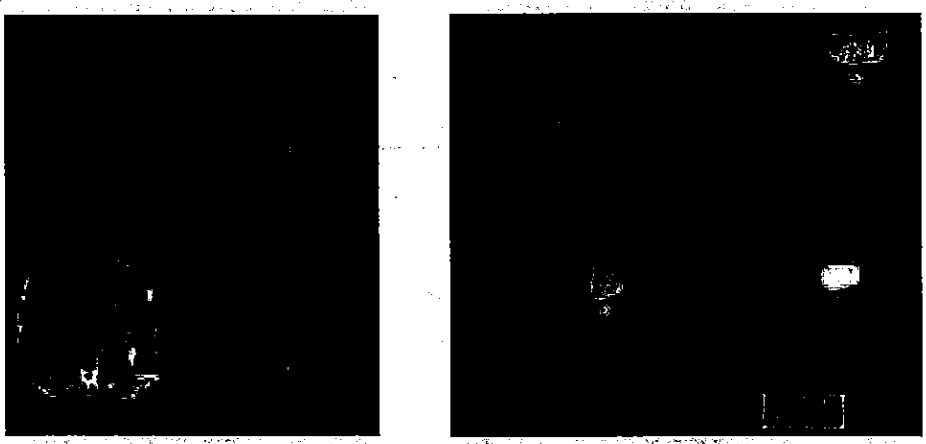

FIG. 13. Patients with infectious foci in the abdominal area. Pt # 1 (left panel) developed persistent fever resistant to antibiotic treatment shortly after combined pancreasectomy and splenectomy, performed because of a pancreatic adenocarcinoma of the tail infiltrating the splenic hilus. SPECT/CT performed as part of autologous ^{99m}Tc-HMPAO-leukocyte scintigraphy reveals a sub-diaphragmatic abscess at the tip of the draining catheter that had been placed during surgery. Pt #2 (right panel) had instead fever of unknown origin. During autologous ^{99m}Tc-HMPAO-leukocyte scintigraphy, it is only SPECT/CT that reveals location of an abscess at the upper pole of the left kidney, which on planar scan could only be generically located below the lower pole of the spleen.

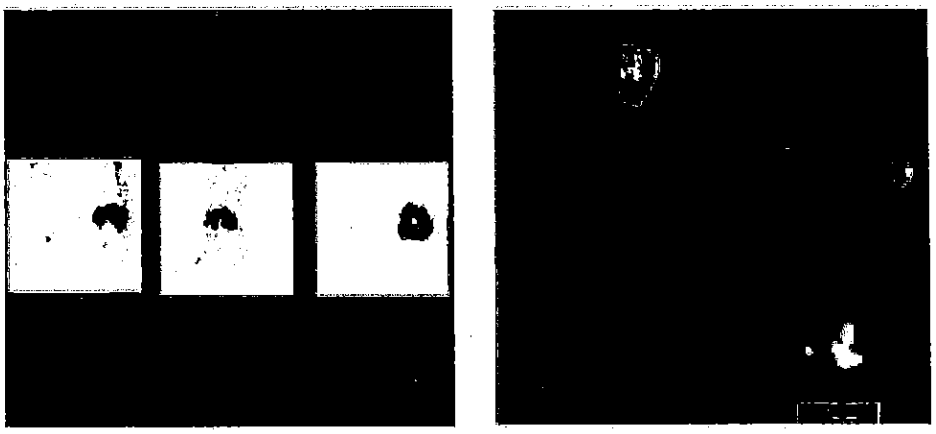

FIG. 14. Patients with different forms of osteomyelitis, with accurate definition of the extent of infection by SPECT/CT. Post-traumatic osteomyelits of the left ankle in Pt #1 (left panel), imaged after injection of ^{99m}Tc-anti-granulocyte antibody. In Pt #2 (right panel) SPECT/CT performed during autologous ^{99m}Tc-HMPAO-leukocyte scintigraphy demonstrates that infection arising in a diabetic foot involves not only the soft tissue but also bone structures. Such accurate localization of the disease process was problematic not only on planar scintigraphy but also on stand-alone SPECT.

3.13. Cardiac SPECT/CT procedures

3.13.1. Myocardial perfusion imaging — CT based attenuation correction

Myocardial perfusion imaging (MPI), using ^{201}Tl and ^{99m}Tc labelled radiopharmaceuticals for stress/rest SPECT studies is at present the main non-invasive modality for evaluation of coronary artery disease [130]. Its accuracy is, however, limited by image artefacts that can cause false–positive perfusion defects and therefore reduce the test specificity. Although the initial validation of MPI-SPECT performed in luminary sites reported a specificity of greater than 90%, further large-scale clinical use of the technique has been associated with specificity in the range of 60% or lower [131, 132]. One of the most common image artefacts is caused by non-uniform reduction of photon activity from attenuation by soft tissue. This can be recognized, or at least suspected by experienced readers, because of the typical location and shape relative to the heart. Attenuation artefacts usually occur in the anterior wall in women with large breasts and in the inferior wall in obese men [133–135]. Although the true prevalence of soft tissue artefacts is unknown, estimates range between 20% and 50% of patients [136, 137].

Several approaches have been used to address the issue of spurious false positive results in MPI due to photon attenuation including, among other options, awareness of their potential occurrence and location, routine assessment of raw imaging data, comparative assessment of studies performed following a change in the patient's position (prone versus supine) and gated imaging which assesses wall motion. These approaches improve artefact recognition but they all have limitations. Although guidelines of the American Society of Nuclear Cardiology recommend that attenuation correction should be performed in all patients, there are clearly some patient populations that benefit more from this procedure, generally the largest-size patients. Depending on equipment availability and daily workload, the rest SPECT study is

used in some centres as the criterion for triage decisions for performing attenuation correction acquisition.

In order to determine the true radiotracer distribution in the myocardium, several techniques have been developed with the goal of generating patient-specific attenuation maps. Attenuation maps generated by transmission sources at the time of the scan have, until the last decade, been the most commonly used method of correction. Various transmission geometries have been adopted, including sheet, multiple lines, or scanning line sources, a fixed source positioned at the focal line of a fan-beam collimator, or a moving point source [138]. Commercial systems use mainly Gadolinium-153 (^{153}Gd, 100 keV) with a 100-day half-life, supplied at a maximum of 400–500 mCi/source. With decay of the source, a degradation in the attenuation map leads to a central underestimation of the true attenuation coefficients.

An additional approach has attempted to use anatomic images imported from CT, but has been limited by difficulties in correct matching of the morphologic and scintigraphic data sets since images are acquired on different systems, at different time points, with the patients lying on different stretchers. These limitations are, at least in part, overcome by near-simultaneous acquisition of MPI and CT on a single imaging device. Historically, SPECT/CT systems have been initially developed with the specific goal of achieving optimal CT based attenuation of myocardial perfusion scintigraphy.

Cardiac SPECT is performed using a dual-head gamma camera equipped with low energy, high resolution parallel hole collimators, and with the detectors at 90° to each other. The acquisition is performed over a 180° orbit during a period of 12–20 minutes. Dual isotopes acquisition uses ^{201}Tl for rest and ^{99m}Tc-sestamibi or ^{99m}Tc-tetrofosmin for stress, while single isotope acquisition uses the same isotope, ^{99m}Tc-sestamibi or ^{99m}Tc-tetrofosmin for both rest and stress. For ^{201}Tl, imaging energy windows of 30% and 20% for the 70 keV and 167 keV peaks, respectively, are used, while the energy window width for ^{99m}Tc is 20% for the 149 keV peak. Both the rest and stress SPECT studies are followed by a low-dose CT (20–30 mAs, 140 keV for the diagnostic CT, or 2.5 mA, 140 keV for a camera-mounted CT), which is used for photon attenuation correction of the scintigraphic data. The CT-attenuation correction study is performed only over the area of the heart, as defined by the operator. The patient is asked not to move during study progression, in order to obtain good co-registration between the emission and the transmission scans [139].

CT based attenuation correction has been shown to provide the most reliable and accurate high quality cardiac SPECT images through high resolution, high count-rate and low noise attenuation maps resulting in predictable uniform tracer activity in patients with a low likelihood of haemodynamically significant coronary artery disease. The CT based attenuation correction method can be successfully implemented with all clinical cardiac SPECT protocols, including same-day or 2-days rest-stress, single and dual isotope rest-stress procedures.

3.13.2. Cardiac SPECT/CTA for assessing the significance of coronary artery lesions

Stress/rest MPI is the established imaging modality for non-invasive diagnosis of presence, severity and extent of coronary artery disease (CAD), with high sensitivity and specificity. MPI determines the physiologic significance of angiographically borderline stenosis, and defines the presence of viable but dysfunctional, hypoperfused myocardium. MPI cannot, however, diagnose early atherosclerosis and often underestimates the extent of coronary artery disease. In addition, MPI does not provide accurate anatomical information, essential

prior to coronary revascularization procedures. The recently developed multi-detector CT (MDCT) technology characterized by high spatial, contrast and temporal resolution enables non-invasive CT coronary angiography (CTCA) and provides also accurate information regarding the structure and motion of the heart chambers. CT, however, does not predict the benefit of revascularization [140–142].

Cardiac SPECT/CT is a novel hybrid imaging technique that combines detailed anatomical information of coronary vessels (provided by CTCA) with physiologic information of myocardial perfusion and function (provided by MPI), through accurate spatial alignment of both data sets. This evolving modality has the potential to become the future imaging test of choice for non-invasive assessment of CAD [140–142].

While co-registration of separately performed CT and MPI may provide a very similar type of data, this process is difficult to implement beyond research purposes in dedicated centres, due to its logistical limitations. Single devices combining SPECT/CTCA data are characterized by ease of use and simple logistic set-ups, and have the potential of making cardiac hybrid imaging user-friendly and easy to plan, major factors in their future routine clinical use. SPECT/CT can provide accurate non-invasive diagnosis of the culprit coronary lesion, including its location and morphology, in conjunction with assessment of the physiologic significance of this lesion on myocardial function. SPECT/CT images precisely localize regions of impaired perfusion to the corresponding vascular territory. Cardiac SPECT/CTCA may prove of significance in a series of potential indications, which will however need to be proven by large, multi-centre studies. By allowing visualization of stenoses, the addition of CTCA to MPI can potentially eliminate one of the major reasons for false negative MPI results in patients with advanced 3-vessel disease, showing a balanced reduction of blood flow in all myocardial segments. On the other hand, by assessing the functional consequences of stenosis through its stress/rest MPI component, it may improve the performance of CTCA in patients with dense coronary plaques. CTCA results are often insufficient to guide patient management. A need for functional information will arise in many patients demonstrating anatomic coronary abnormalities on CT.

In summary, reliable attenuation correction of MPI-SPECT enhances significantly the clinical decision making process; decreases morbidity related to invasive procedures and also saves costs related to additional work-up induced by equivocal reports. High speed multislice coronary CT has a growing impact on assessment of patients with known or suspected coronary artery disease. Combined data regarding myocardial perfusion, calcium scoring and the presence or absence of coronary stenosis may, in future, enable better stratification of patients with or without ischemic heart disease. Referral algorithms will have to define patient groups that will benefit from hybrid SPECT/CTCA imaging of both myocardial perfusion and the anatomy of the coronary tree.

3.14. Added values of CT in patients with coronary artery disease

3.14.1. Coronary artery calcium

Calcium accumulates in the coronary arteries as a result of the body's response to contain and stabilize inflamed coronary plaques. Calcified plaque assessment correlates with pathologic assessment of the total amount of calcified plus noncalcified plaques [143]. The burden of coronary artery calcium (CAC) generally reflects an advanced stage of plaque development, and CAC serves as an indirect but proportional marker for global atherosclerotic burden. The CT based method of quantifying CAC was initially developed using electron-beam

tomography (EBT), but multi-slice CT provides measurements of CAC comparable to those derived from EBT [144].

The CAC score is derived using highly reproducible semiautomatic computer methods based on the product of calcified plaque area by the coefficient of its density. The score is calculated as the product of the CAC area by the peak Hounsfield unit (1 for 131–199 HU, 2 for 200–299 HU, 3 for 300–399 HU, and 4 for >400 HU). Visually, coronary calcification can be categorized into mild (minimal), moderate, and marked (extensive) degrees of severity.

Accumulation of CAC is common in adults and increases with age. The presence of CAC is often associated with only insignificant (<50% luminal narrowing) coronary stenosis. However, there is a graded relationship between the extent of CAC and the annual risk of coronary heart disease. Patients with extensive CAC are likely to have marked non-calcified plaques that may be rupture-prone. Plaque erosions are infrequently calcified and associated with acute coronary syndromes [145].

3.14.2. Coronary computed tomography angiography

Coronary computed tomography angiography (CTA) visualizes not only the coronary vessel lumen but also the wall, allowing the non-invasive assessment of the presence and, potentially, the size of non-calcified coronary plaque. Furthermore, the assessment of ventricular function is possible from a single first-pass acquisition of the chest CT data, which may be of value in the emergency department setting, along with the potential to provide assessment of pulmonary embolism, acute coronary syndrome, and aortic dissection in a single study.

The relative roles of myocardial perfusion SPECT and CTA have not yet been defined. In patients with intermediate likelihood of CAD, coronary CTA may be the initial test to perform, attending to the apparently superior sensitivity over SPECT imaging. When a coronary CTA is entirely normal, no further testing would be required. In case of proximal and critical coronary stenoses, invasive coronary angiography would be indicated for possible revascularization therapy. When CTA detects coronary lesions of uncertain significance, SPECT imaging would be appropriate for further diagnostic assessment.

In patients with known disease (or likely having extensive coronary calcium) in whom risk-stratification is needed, SPECT imaging would remain the initial test.

If SPECT imaging has been performed as the initial test, further testing by CTA would be indicated whenever discordant results are obtained. This includes patients with a strong clinical suggestion of CAD after a normal or equivocal SPECT; patients with marked discordance between SPECT and clinical or stress ECG; or patients with SPECT and stress ECG results suggestive of left main or triple-vessel CAD (e.g. transient ischaemic dilation, post-stress LV dysfunction, exercise hypotension with normal SPECT), with balanced reduction of coronary flow in the LV. Coronary CTA can also be of use in patients with suspected nonischaemic cardiomyopathy, patients with coronary anomalies, and young patients undergoing valvular surgery.

Since rest/stress SPECT studies can be performed as routine in conjunction with coronary CTA, SPECT/CT systems provide data about coronary calcium, coronary stenosis and functional significance in one clinical setting, thus allowing more appropriate selection of patients who may benefit from revascularization procedures [146]. A recent study with an

experimental SPECT/CT scanner (16-MSCT) showed that integrated functional and anatomic results improved specificity and positive predictive value to detect haemodynamically significant CAD in patients with angina pectoris [141]. The sensitivity, specificity, positive predictive value, and negative predictive value of CTA were 96%, 63%, 31%, and 99%, respectively, as compared with 96%, 95%, 77%, and 99%, respectively, for SPECT/CT. Patients and arterial segments excluded from the analysis raised to 21% and 23%, respectively. Another investigation described the incremental diagnostic value of integrating SPECT/CT (64-MSCT) data through three-dimensional (3-D) image fusion on the functional relevance of coronary artery lesions [140]. 3-D volume-rendered fused SPECT/CT images were generated from patients with at least one perfusion defect on SPECT imaging, and compared with the findings from the side by side analysis with regard to coronary lesion interpretation by assigning the perfusion defects to their corresponding coronary lesion. In addition to being intuitively convincing, 3-D SPECT/CT fusion images added significant information on pathophysiological lesion severity in 22% of coronary stenoses of 29% of patients. Among equivocal lesions on side by side analysis, the fused interpretation confirmed haemodynamic significance in 35% of lesions and excluded functional relevance in 25% of lesions. In 7.5% of lesions, assignment of perfusion defect and coronary lesion appeared to be reliable on side by side analysis but proved to be inaccurate on fused interpretation. Added diagnostic information by SPECT/CT was more commonly found in patients with stenoses of small vessels and involvement of diagonal branches.

3.15. Pulmonary artery imaging in pulmonary embolism

Pulmonary embolism (PE) is one of the greatest diagnostic challenges in emergency medicine. It should be suspected in any patient with unexplained dyspnea, tachypnea, or chest pain. A negative D-dimer assay reliably excludes PE in low-risk patients. Otherwise, pulmonary CT angiography is now considered by several authors to be the initial imaging study of choice for stable patients. Nevertheless, ventilation/perfusion (V/Q) scans or even perfusion scintigraphy alone (as in the PISA-PED approach [147–152]) still retain a considerable diagnostic accuracy and are valid alternatives to pulmonary CT angiography, in particular when CT is not available, or in patients with contraindications to CT scanning or intravenous contrast.

The results of the Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) study established the diagnostic criteria of V/Q scanning for the diagnosis of PE, as compared with pulmonary angiography [153]. The interpretation ranges from normal to high probability, each with its own diagnostic characteristics. However, more than 60% of patients fell into the low and intermediate probability (or non-diagnostic category), and there was a 4% incidence of PE when the scan was read as normal. Similarly troubling, high probability scans were associated with a 12% false positive rate [153]. Therefore, it is recommended to consider patients with low-to-moderate pretest probability and a normal V/Q scan as not having a significant PE. Nevertheless, if the same patients have a non-diagnostic V/Q scan, the recommendation is that, in order to exclude significant PE without going to pulmonary angiogram, the patient must have a negative whole blood D-dimer, negative bilateral ultrasound in low probability group, or negative serial bilateral ultrasound for the moderate probability group. In patients with high pretest probability a normal V/Q scan can only rule out PE if the patient has a normal chest X ray and no baseline cardiopulmonary disease. Otherwise, the patient must go on to CT angiography.

Because of the high number of indeterminate studies using V/Q scanning [153], pulmonary CT angiography (PCTA) is becoming the initial diagnostic test for PE for stable patients with

no signs and symptoms of deep venous thrombosis. PCTA with 100 ml of iodinated contrast medium and dedicated imaging procedures and protocols can directly visualize thromboembolic filling defects as well as pleural effusions, vascular remodelling, and oligoemia, any of which may be present with PE [154]. In addition, PCTA may reveal alternative diagnoses, such as pneumonia, aortic dissection, tumour or pneumothorax that in the absence of PE may yield a previously unsuspected reason for symptoms mimicking PE [155]. Current multi-slice CT scanners can image the entire pulmonary vasculature in one breath-hold, allowing 1 mm to sub-millimeter resolution, and the data can be transformed into 2-D and 3-D reconstructed images. Such procedure can significantly increase the detection of 'clinically significant' subsegmental thrombi and evaluate pulmonary vasculature down to 6th order branches [156–158].

The PIOPED II study [159] recently reported the high accuracy of multi-slice CT scanners for the diagnosis of PE, with 83% sensitivity, 96% specificity, 95%, 89% and 60% negative predictive values, as well as 96%, 92% and 58% positive predictive values, respectively for high, intermediate, and low clinical probability groups. These data support the use of PCTA for suspected PE as a stand-alone imaging technique in most patients. However, the false negative rate of 17% should be noted. The most likely explanation for this is that multi-slice CT scanners (mainly 4 slice) still miss small, peripheral subsegmental clots that are better detected by V/P scanning or by classic pulmonary angiography. Therefore, clinicians should be cautious with results that are discordant with their clinical judgment, particularly in front of a normal PCTA in a patient with a high clinical probability of PE [160].

While the clinical significance and treatment requirements of small, peripheral subsegmental thrombi are controversial [161], image fusion of SPECT V/Q and PCTA has demonstrated to be feasible. A recent investigation in 30 consecutive patients who underwent both imaging studies during their admission for investigation of potential PE reported good accuracy of co-registered images as determined subjectively by correlation of the anatomical boundaries and co-existent pleuro-parenchymal abnormalities [160]. Nine patients who had positive PCTA performed as an initial investigation had co-localized perfusion defects on the subsequent fused PCTA/SPECT images. Three of the 11 V/Q scans initially reported as intermediate probability could be reinterpreted as low probability owing to co-localization of defects with parenchymal or pleural pathology [162]. Therefore, the introduction of SPECT/CT hybrid systems will probably provide a single diagnostic tool that will overcome limitations of each imaging modality separately.

4. ADVANTAGES OF UTILIZING SPECT/CT

4.1. Anatomical accuracy of image registration in SPECT/CT hybrid imaging

Image registration is defined as the transfer of two image data sets into one common coordinate system. It may be mono or bimodal, i.e. between images acquired by one single modality or by two different modalities. Depending on the nature of the transformations used, rigid or non-rigid approaches can be used for this purpose, the former allowing for non-linear, 'plastic' deformation of the image data sets. A further distinction can be made between software based registration of data sets acquired independently one from each other by two different imaging devices and hardware based registration where the two data sets are obtained by hybrid equipment in a single imaging session.

In the past decade, the clinical impact of interactive software based registration between SPECT and CT data has received some attention in the literature [163, 164]. In particular, it has been repeatedly demonstrated that patient management may benefit significantly from the integration of functional and morphological data.

One major drawback of software based image fusion is logistic in nature: in the daily clinical routine of many institutions, image data sets from different modalities can be exchanged between different departments only with some difficulty. Although the implementation of hospital-embracing picture-archiving systems should overcome these difficulties, software based registration suffers from anatomical inaccuracies stemming from different positioning of the patient in the two separate imaging devices as well as by difficulties in identifying landmarks common to both data sets to be registered. In addition, the more specific a radiopharmaceutical is for a certain tissue, the poorer images of its distribution are with regard to anatomical detail, and the more difficult software based registration becomes.

These limitations are greatly reduced in hardware based registration that should therefore offer a higher anatomical accuracy of image fusion, as it obviously emerges when reviewing articles investigating the quality of alignment between [^{18}F]FDG-PET and CT. In these studies, anatomical accuracy of fusion is usually quantified by determining the average distance between landmarks or lesions identifiable on both images. This distance ranges between 4 and 12 mm for software based fusion of PET and CT images [165–169], but is reduced 3–5 mm for PET/CT hybrid scanning [168, 169], thus confirming the assumption of a higher anatomical accuracy for hybrid imaging.

Nevertheless, similar data for registration between SPECT and CT images are scarce. Förster et al. studied the accuracy of software based fusion between ^{111}In-octreotide SPECT and multi-row CT in a small group of patients [44]. They reported anatomical inaccuracies in the range of 7 mm, similar to those determined for fusion between PET and CT. Nömayr et al. reported a much higher accuracy of image fusion for SPECT/CT hybrid imaging of the lower lumbar spine [170]. In their study, misalignment ranged between 0.7–1.8 mm, smaller than pixel width in the SPECT images. Notably, software based registration performed on the data sets acquired by SPECT/CT could still significantly improve these results and bring misalignment down to values averaging 1 mm. However, their results cannot be extrapolated to regions of the human body involved in respiratory movements affecting SPECT and CT images to a different degree.

The development of hybrid imaging devices witnessed in the last decade marks a new trend in medical imaging involving the registration and fusion of all image data sets of one individual patient using the same computer platform. Current available data has already proven a major clinical impact of this approach, which is also expected to increase cost effectiveness. The field will be driven by the development of new hybrid imaging devices, but also by significant improvements of software based image fusion. Future medical imaging departments will offer a multimodal environment integrating both hybrid imaging and software based image fusion into the daily clinical routine.

4.2. The effects of CT based attenuation correction of SPECT image data sets and potential future applications

Attenuation artefacts considerably degrade the quality of SPECT images, and also hamper accurate quantification of tracer accumulation in specific volumes of interest. Various methods of attenuation correction have been proposed [171, 172], to be further subdivided

into those with and those without transmission measurements. The latter calculate tissue attenuation coefficients on the basis of an assumption of their distribution in the body segment examined, using various methods to determine the body outline. This approach is widely used in studies of brain perfusion, since it is generally assumed that attenuation is homogeneous within the skull.

This assumption does not hold valid for the abdomen or the chest, since these body segments contain tissues with variable attenuation coefficients. Radionuclide transmission scanning has been used to derive maps of abdominal and thoracic attenuation coefficients. However, it has been repeatedly shown that this approach can introduce artefacts that may be difficult to identify [173]. Another major problem inherent to this approach is the low activity of the radioactive sources used for this purpose, leading either to long acquisition times or to attenuation maps with poor quality due to low counting statistics.

This problem is overcome by employing CT data to correct SPECT data for tissue attenuation. A study investigating the visualization of radioactivity in a heart phantom has indeed shown that this variable is homogenized by CT based attenuation correction [174]. Recently, Fricke et al. have demonstrated that the concordance between PET and SPECT studies of myocardial perfusion was improved after using CT based attenuation correction for the SPECT data [175]. Similar results have been reported for skeletal SPECT [176].

Nevertheless, the clinical impact of CT based attenuation correction for SPECT imaging is currently unclear. In a multi-centre trial, Masood et al. demonstrated a moderate, but statistically significant increase in the accuracy of diagnosis of coronary artery disease for myocardial perfusion SPECT [174]. Shiraishi et al. reported a significantly higher accuracy for attenuation-corrected ^{201}Tl-SPECT in staging lung cancer compared to the non-attenuation studies [177]. Likewise, improved identification of sentinel lymph nodes has been shown with the use of attenuation correction [60].

When using CT based attenuation correction for SPECT data, one should be aware of possible artefacts caused by misalignment between SPECT and CT data sets (see above). Figure 15 demonstrates such an artefact in a phantom simulation. In myocardial perfusion SPECT, a 7 mm misalignment between emission and transmission data, corresponding to the width of one pixel in that study, was shown to produce a 15% change in relative regional activity [178]. Similar data have been published for CT based attenuation correction in myocardial SPECT [179] and a method for automated control for misalignment between CT and SPECT has been proposed [180]. In skeletal SPECT, misalignment of the CT by 1 cm was shown to change even the visualization of symmetry of uptake [176]. Therefore, the anatomical accuracy of fusion should be carefully checked before applying CT based attenuation correction.

Attenuation correction of SPECT data constitutes an important step in the development of truly quantitative SPECT, which may improve dosimetric estimates of molecular radiotherapy. More sophisticated phantom studies are needed to better understand variability related to different photon energies. However, for accurate SPECT, quantitation issues related to scatter and partial volume artefacts need to be overcome. In particular, the correction of the latter could also capitalize on the use of CT images aligned to SPECT. Therefore, the new hybrid systems will stimulate research work also along that avenue.

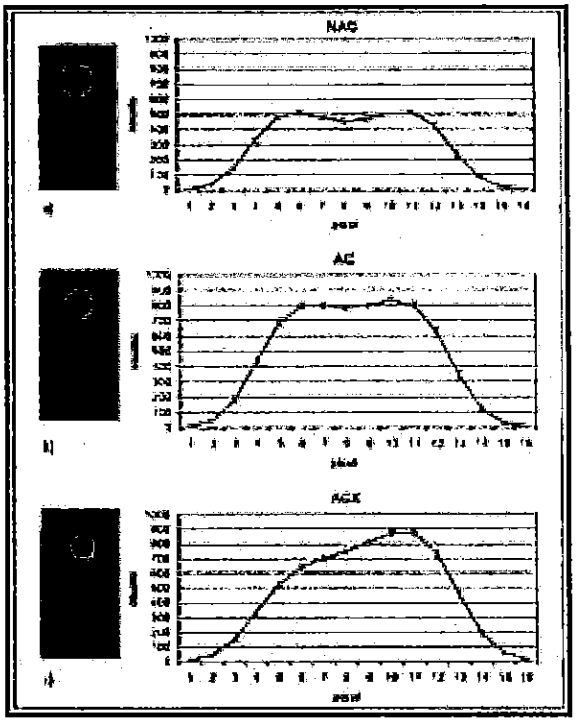

FIG. 15. Transversal SPECT images of two rods in a phantom filled with ^{99m}Tc (a) without (NAC) and (b) with attenuation correction (AC): attenuation correction homogenizes the visualization of activity in the homogeneously filled rods; (c) a CT misalignment by 1 cm in X-direction (ACX) produces a significant artefact in the visualization of activity. The curves are profiles from left to right for the rod filled with the lower activity concentration in NAC, AC, and ACX (from TKL31; with permission).

4.3. Additional information or diagnosis from CT

With continuous higher-speed and thinner sliced CT, small lung lesions (less than 1 cm in diameter) showing interval increase in size may often be detected. Small non-specific lymph nodes, low-density hepatic or renal lesion, and osteolytic or osteoblastic lesion with interval increase in size are also incidentally identified. These lesions are generally beyond the resolution of our current SPECT or PET system and may require further short term follow-up studies to confirm/exclude the diagnosis of new metastases.

4.4. Use of SPECT/CT data for estimating internal radiation dosimetry

As will be better detailed in the next section, the radiation dose is energy absorbed per unit of mass. Accurate dosimetric estimates are extremely critical in radiometabolic therapy, both for calculating radiation dose to the target organ/tissue (generally tumour, but also non-tumour lesions such as hyperfunctioning thyroid parenchyma) and for defining dose-limiting toxicities to normal organs/tissues with high physiologic accumulation of radioactivity (e.g. bone marrow, kidneys). It is well known that internal dosimetry estimates are burdened by a significant degree of estimation regarding absolute concentration of radioactivity in a given organ/tissue, and represent therefore only rough approximations with variabilities that can be

as high as 50% or even 100%. Part of this variability is due to the fact that bio-distribution data are usually derived from planar imaging (such as conjugated-view whole body scans), and a-priori models and assumptions on the organ shapes/sizes are employed for the radiodosimetric analysis. Also stand-alone SPECT entails some unwarranted assumptions, since standard factors are usually applied for attenuation correction. In this regard, SPECT/CT certainly holds the promise for developing more accurate approaches to internal radiation dosimetry estimates, since the CT component of the study enables correct attenuation of the emission map specifically in each single patient.

Few reports have been published on this important application of SPECT/CT. Boucek and Turner employed SPECT/CT data to estimate bone marrow dosimetry following the administration of ^{131}I labelled anti-CD20-monoclonal antibody (rituximab) in patients with non-Hodgkin's lymphoma. These patients are usually heavily pretreated with chemotherapy, and myelosuppression is the dose-limiting toxicity. The authors demonstrated a statistically significant correlation ($p = 0.001$) between whole body effective half-life of the radiolabelled antibody and effective marrow half-life. They also found that bone marrow activity concentration was proportional to administered activity per unit weight, height or body surface area ($p < 0.001$). In their experience, SPECT/CT enabled accurate quantification of activity accumulations and thus validated patient-specific prospective dosimetric estimates methods [181].

SPECT/CT has also been advocated for the quantification of radiation doses delivered during radiometabolic therapy with ^{131}I-MIBG, using CT based tumour volume-of-interest [23]. Although based on a single patient, Song et al. have demonstrated that patient-specific 3-D dosimetry based on SPECT/CT is feasible and important in the dosimetry of thyroid cancer patients with radioiodine-avid lung metastases and prolonged retention in the lungs. In their opinion, this procedure could constitute the breakthrough for rationally planning radionuclide therapy in patients with thyroid cancer [182].

A preliminary report from the Pisa group described a novel SPECT/CT based approach to calculate attenuation- and scatter-corrected dosimetry to the bone marrow and to tumour lesions following the administration of ^{153}Sm-EDTMP for palliation of bone pain in patients with hormone-refractory metastatic prostate cancer [183]. The system was phantom-calibrated for tissue densities, and the CT images were utilized to identify bone structures. Dedicated software was developed for automatic edge recognition of skeletal uptake, which was corrected for attenuation and scatter. An S-value matrix was then derived from the attenuation map voxel-by-voxel for each individual patient (rather than pixel-by-pixel as in conventional evaluations) (Fig. 16). It was found that the conventional approach based on planar imaging and standard-factor corrections overestimated dose to bone marrow by an average 67% versus the SPECT/CT method. The new SPECT/CT based method therefore opens the perspective of calculating radiation dose to the bone marrow and to skeletal lesions (or other sites), and therefore to correlate dosimetry to lesions with efficacy of therapy (bone palliation, or true anti-tumour effect [184]).

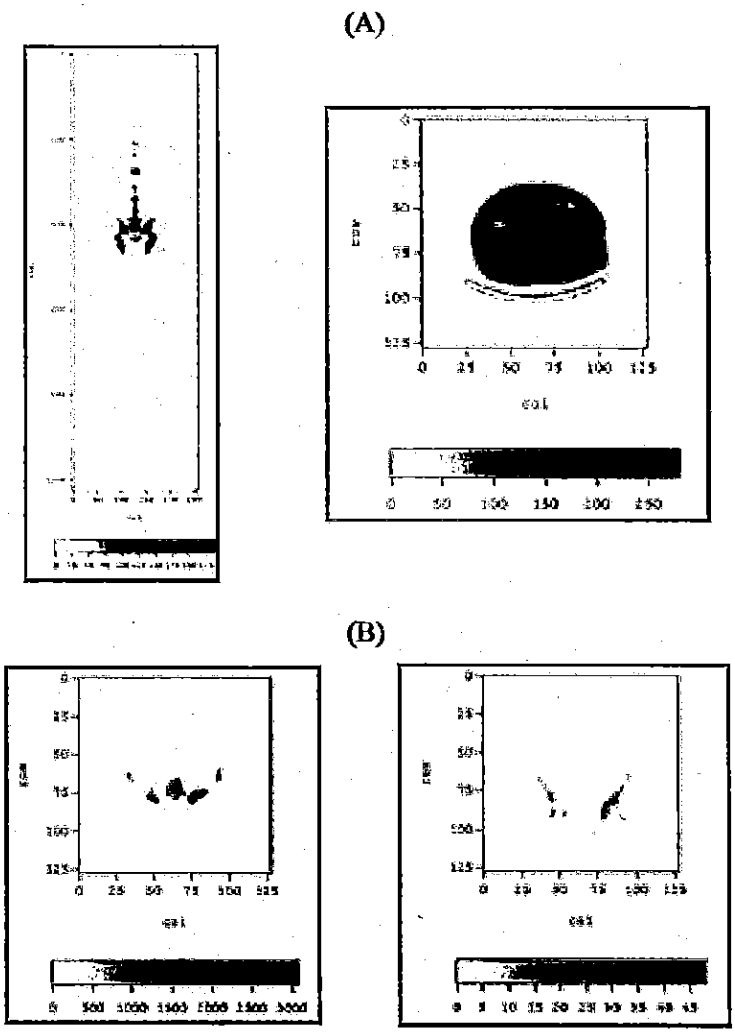

FIG. 16. Sequential steps in the elaboration of the SPECT/CT images obtained after administration of ^{153}Sm-EDTMP given for bone pain palliation purposes in a patient with hormone-refractory prostate cancer. (A) Outline of skeletal uptake of the bone-seeking radiopharmaceutical as derived from an automatic edge-recognition software applied on the planar 24 h whole body scan (left panel). The right panel shows the CT density-reconstructed map acquired at the pelvis. (B) Reconstructed SPECT map (left panel) and tomography of the 3-D dosimetry map in Gy (right panel).

4.5. Radiation dose of CT from SPECT/CT

The radiation absorbed dose delivered to the patient from the use of CT in SPECT/CT study is difficult to measure because of many factors involved, but the CT Dose Index (CTDI) based on scan parameters can be calculated, and represents an index of radiation dose to a standard phantom. The CT scanners generally provide an X ray tube current modulation function that makes uniform image quality and dose for various patient sizes [185]. The system will automatically increase or decrease the tube current (mA) when the user selects a reference effective mA in response to changes in diameter or tissue density of the patient. The effective mA includes the tube current, rotation speed, and pitch used for the scan. The user-selected

scan parameters that affect patient dose in CT examinations are effective mA, kVp, detector collimation setting (affecting the width of the radiation beam in table-travel direction), beam-shaping filter associated with the scan type (body or head), and number of scans over the same section of the body. If the dose distribution from the centre to the edge of the phantom as well as the pitch used in the scan is taken into account, a term called CTDIvol can be used to represent the dose index to the volume of the phantom. The radiation dose is energy absorbed per unit mass. The CTDIvol associated with a single CT scan covering one SPECT bed position is the same as the CTDIvol for a CT scan covering two non-overlapped SPECT bed positions if the same CT scan parameters are used. However, there is a factor of two variation in the radiation risk to the patient between these two cases. The CTDIvol in milli-Gray (mGy) is multiplied by the length of the CT scan in cm, to yield the dose-length product (DLP). Once the DLP is determined, an effective dose can be estimated using conversion factors for the relative radiosensitivity of the organs within the range of the scan. Some CT scanners save the CDTIvol and DLP values for a specific patient scan at the end of the examination. If there are multiple CT scans of the same region of the patient, each scan adds to the radiation dose and risk.

The effective dose and CTDIvol values from typical CT scans to the chest and abdomen have been calculated [186], and they are 4 mSv and 8 mGy, respectively. The value to the head and neck are 4 mSv and 10–20 mGy, respectively. These doses are for one SPECT bed position, relating to a 39 cm CT scan length, acquired using a fixed technique at the reference mA. Doses can be scaled linearly with the actual scan effective mA for the patient study. In case of a CT for a two-bed SPECT/CT, the appropriate effective dose values are added together. A planning CT view is obtained prior to determining the scan extent and location with low (about 20) mA for the postero-anterior projection and with the beam direction such that the beam enters the table prior to passing through the patient. These measures ensure an adequate planning view with the lowest dose to the patient, which is about the same as for a single view of the chest X ray.

5. FURTHER DEVELOPMENT OF SPECT/CT WITH NEW RADIOPHARMACEUTICALS

There is a continuous interest to label biologically important drugs or agents with easily available and cheaper isotopes than PET tracers, such as ^{99m}Tc labelled tracers (Table 1) for SPECT/CT to diagnose, differentiate, and stage cancers and also to evaluate as well as to predict therapeutic responses. L,L-ethylenedicystein, the most successful example of N_2S_2 chelates, can be labelled with ^{99m}Tc with high radiochemical purity, and the preparation remains stable for several hours [187]. Reliable molecular imaging that: assesses cellular targets at low cost, treatment response more rapidly, provides a good differential diagnosis, predicts correctly therapeutic response and allows for better radiation dosimetry for internal radiotherapy, would be very valuable.

6. CT TRAINING IMAGING FOR NUCLEAR PHYSICIANS AND TECHNOLOGISTS

The Societies of Nuclear Medicine, Computed Body Tomography and Magnetic Resonance, and the American College of Radiology have recently agreed that only properly trained qualified physicians should interpret PET/CT images [189]. The issue of training nuclear physicians to interpret the CT images produced by SPECT/CT devices is similar to that for

PET/CT. In this regard, earning 100 hours of CT continuing medical education credits and interpreting 500 CT cases under the supervision of qualified diagnostic radiologists were recommended. The CT cases should include reasonable numbers of head and neck, chest, abdomen and pelvis examinations. According to these recommendations, both radiology and nuclear medicine residents are required to interpret SPECT/CT images.

TABLE 1. SPECIFIC RADIOTRACERS [187, 188]

Character of cancer cells	Compounds
Cellular growth	^{99m}Tc-deoxyglucose ^{99m}Tc-guanine
Hypoxia	^{99m}Tc-metronidazole
Angiogenesis	^{99m}Tc-endostatin ^{99m}Tc-bevacizumab (against VEGF receptor)
Apoptosis	^{99m}Tc-annexin-V
Hormones	^{99m}Tc-estradiol

SPECT/CT and PET/CT present therefore similar practical issues regarding education, training and certification of nuclear medicine technologists to become properly qualified and competent to perform the CT portion of the study. The American Registry of Radiologic Technologists has adapted its CT certification examination and has allowed certified or registered nuclear medicine technologists who have met the required prerequisites to take this examination.

Nevertheless, the choice of the optimal way to achieve adequate training for interpreting multimodality imaging examinations will differ between countries owing to differences in infrastructure and legislation. The European Association of Nuclear Medicine (EANM) and the European Society of Radiology (ESR) have agreed to work together to produce a common position paper regarding multimodality imaging systems [190, 191]. Both organizations recognize the importance of coordinating working practices for multimodality imaging and that undertaking the nuclear medicine and radiology components of imaging with hybrid systems requires different skills. Training should be properly structured and comprehensive and should be conducted in accredited training centres. It should incorporate the principles and all modalities of both specialties to allow the trainee to acquire a full understanding of the possibilities and difficulties of each technique and its medical background, and provide the basis for participating in the evolution of multimodality imaging. Refresher type courses can prepare for specific training or refresh knowledge, but cannot replace appropriate on site training. It is not acceptable for training to be focused on a single technique.

Three different training models have been proposed [190]:

- Comprehensive training in both specialties, clinical radiology and nuclear medicine, in those countries where it is possible for the individual to practice both specialties and where such dual specialty training can be obtained. Such training gives the trainee the possibility of ultimately practicing in one or both of the specialties and of billing appropriately. The duration of the entire training programme in both specialties would most likely be neither politically nor economically acceptable in many European countries.

- An adequate period of training in the other specialty in addition to full training in the primary specialty. This model would facilitate acquisition by nuclear medicine specialists or radiologists of the necessary training in the other specialty after having completed full training in their primarily chosen specialty. Such adjusted additional training programme should be defined to provide a broad foundation of knowledge in the second specialty and should not be confined to a single technique such as CT or SPECT or a single clinical application. For nuclear medicine specialists, besides relevant radioprotection issues, training will include the physical principles and practical clinical skills of CT imaging. For radiologists, besides relevant radioprotection issues, training will include knowledge of radiopharmacy and radiotracer biokinetics and the physical principles and practical skills of SPECT. Training needs not to include therapeutic interventional radiology or radionuclide therapy. The core of the additional training would be dedicated to hybrid imaging. For radiologists, part of the nuclear medicine component should be undertaken during the fourth and fifth year of training. Maintenance of radiology skills during this time would be mandatory. For nuclear medicine specialists, part of the radiology component should be undertaken during the fourth and fifth years of training. Maintenance of nuclear medicine skills during this time would be mandatory. The remaining part of the training would then be obtained with an additional year fully dedicated to the second specialty, giving a total of 6 years' training for both specialties. The exact duration of the training is subject to local regulations, which may vary from country to country. Nonetheless, the general time scale as outlined in this option should be considered as the model. Such additional training will lead to a special competency certification.

- Potential future integration of training: an incorporated training in nuclear medicine and radiology taking the form of a cross-over or integrated training programme, where both specialties agree and recognize a training curriculum which encompasses the principles of all imaging modalities of both specialties. The curricula of both specialties would be adapted to include knowledge of anatomy, cell biology, genetics and physiology as well as the normal requirements of the physical basis of all imaging modalities and patient safety.

Each country should establish a training schedule that ensures the accomplishment of appropriate education in both specialties, bearing in mind that this cannot be achieved by merely performing a certain number of studies with one or the other technique. Only thorough training will give the necessary insight into anatomical and functional aspects of the various modalities, their interpretation with respect to patient-tailored treatment and risk assessment, and finally the further development and refinement of multimodality imaging.

During the interim period while these training models are set up, the nuclear medicine specialist would manage and report the nuclear medicine component of the examination and the radiologist would manage and report the anatomical and pathological component, with consultation between the two specialists to combine the data into a final diagnosis. Each specialist would provide a report with regard to the part of the study that he/she is directly responsible for. The benefit of this strategy is that those fully trained in the specific modalities would interpret the images jointly, thus providing a high-quality result. At a practical level this concept requires careful organization, cooperation and discussion between nuclear medicine and clinical radiology specialists.

7. REFERRAL CRITERIA FOR SPECT/CT

Local logistics and availability of different medical specialties dictate how diagnostic algorithms are applied in the clinical routine when patients are referred for diagnosis and/or characterization of their disease, and in particular to SPECT/CT. These examinations should be performed with the purpose of, whenever possible, avoiding the use of invasive procedures, when surgery is contemplated as part of treatment, or prior to adopting mini-invasive approaches. Clearly, a combined imaging technique such as SPECT/CT provides all the morpho-functional information enabling the surgeon to plan the surgical approach most suited to the individual patient. Referring clinicians have learned to regard radionuclide studies as useful tests that may confirm a suspected clinical diagnosis and characterize disease processes with information that can be relevant to treatment of the disease. This review has been designed to provide a summary of a methodological radionuclide based approach, SPECT/CT, a still evolving procedure with the final goal of enhancing diagnostic information and guiding therapy. It includes the methodology, analysis and estimation of usefulness of these examinations with an emphasis on more recently published data. Based on this review and on the experience accumulated by each centre represented in this panel of experts, referral criteria for a SPECT/CT examination can briefly be summarized in the indications that follow.

Indication to perform a SPECT/CT examination can be raised on primarily clinical ground. Such indications include:

- High suspicion for active disease, or known structural pathology, as SPECT/CT may localize multiple sites and define extent of disease;
- Planning treatment (medical, surgical, or radiation therapy);
- Monitoring response to treatment.

In some other cases, indication can also originate on the basis of data from previous anatomic imaging, including situations such as:

- Abnormal structural findings of equivocal functional significance, either at diagnosis or post-treatment;
- Absence of overt structural pathology in the presence of high clinical suspicion.

It is sometimes necessary to clarify inconclusive results of prior functional imaging (usually planar scintigraphy), showing foci of increased radiotracer uptake of unclear localization and clinical significance. Inconclusive scintigraphic studies can be due to tracer-related factors (because of poor physical characteristics, high target-specificity with paucity of non-target anatomic landmarks, physiologic bio-distribution with the lesion close to excretion sites). Alternatively, inconclusive radionuclide imaging can be due to patient/disease-related factors, such as complex regional anatomy or anatomic distortion post-treatment (surgical and/or radiation therapy).

Finally, emphasis should be placed on the use of the CT component of a SPECT/CT examination for correcting, on a patient-specific basis, the single photon emission data for attenuation and scatter. This is crucial for proper estimation of radioactivity concentration in specific organs/tissues on a volumetric basis.

8. CONCLUDING REMARKS

In summary, a high quality SPECT/CT study requires a reliable, well functioning hybrid scanner which has met acceptance testing criteria and which is regularly monitored for quality of performance. The study must be designed to answer the specific question asked by the referring physician, and the patient must be appropriately educated and compliant with the preparations for the scan, including fasting if so indicated. The technical staff must be well trained to perform and monitor both components of the study according to a well defined protocol. The acquisition and processing protocols must be carefully followed. The images must be reviewed for technical and diagnostic quality before the patient leaves the department. Finally, the images must be interpreted by skilled readers who are well aware of the clinical history of the patient, using workstations that allow integrated viewing of the functional and anatomic data. In this way, a high quality study will provide useful diagnostic information for further clinical management and patient care. As the quality of SPECT/CT devices improves, it is expected that new applications will emerge.

The impact on reader confidence and increased credibility with referring clinicians is an important add-on feature for SPECT/CT. The concept of incremental confidence is difficult to quantify. It is clear that evaluating the impact of combined SPECT/CT remains a subjective process. While nuclear medicine physicians interpret a study, referring clinicians often remain in doubt because of the difficulties visualizing the location of the finding on scintigraphy alone. Correlation with CT data through precise image registration makes the interpretation of high signal-to-background functional images, combined with better anatomic information, less dependant upon individual expertise. Thus, SPECT/CT results in more meaningful communication with referring physicians, as the hybrid imaging study interpretation is more credible to the clinician who is able to see the location of the functional, tracer-avid focus.

REFERENCES

[1] KEIDAR, Z., ISRAEL, O., KRAUSZ, Y., SPECT/CT in tumor imaging: technical aspects and clinical applications, Semin Nucl Med 33 (2003) 205–218.

[2] O'CONNOR, M.K., KEMP, B.J., Single-photon emission computed tomography/computed tomography: basic instrumentation and innovations, Semin Nucl Med 36 (2006) 258–266.

[3] MADSEN, M.T., Recent advances in SPECT imaging, J Nucl Med 48 (2007) 661–673.

[4] BAILEY, D.L., ROACH, P.J., BAILEY, E.A., et al., Development of a cost-effective modular SPECT/CT scanner, Eur J Nucl Med Mol Imaging 34 (2007) 1415–1426.

[5] ROACH, P.J., BAILEY, D.L., Combining anatomy and function: the future of medical imaging, Intern Med J 35 (2005) 577–579.

[6] RÖMER, W., NÖMAYR, A., UDER, M., BAUTZ, W., KUWERT, T., SPECT-guided CT for evaluating foci of increased bone metabolism classified as indeterminate on SPECT in cancer patients, J Nucl Med 47 (2006) 1102–1106.

[7] PARKIN, D.M., WHELAN, S.I., FERLAY, J., Cancer Incidence in Five Continents, Vol. 7, IARC Scientific Publication 143, International Agency for Research on Cancer, Lyon (1997).

[8] McDOUGALL, I.R., Thyroid Cancer in Clinical Practice, Springer, London (2007).

[9] SCHLUMBERGER, M., PACINI, F., Thyroid Tumors, Nucléon, Paris (2003).

[10] GREENE, F.I., PAGE, L.I., FLEMING, I.D., et al., AJCC Cancer Staging Handbook, Springer, New York (2002).

[11] GIMM, O., BRAUCKHOFF, M., THANH, P.N., SEKULLA, C., DRALLE, H., An update on thyroid surgery, Eur J Nucl Med Mol Imaging 29 Suppl. 2 (2002) S447–S452.

[12] THARP, K., ISRAEL, O., HAUSMANN, J., et al., Impact of ^{131}I-SPECT/CT images obtained with an integrated system in the follow-up of patients with thyroid carcinoma, Eur J Nucl Med Mol Imaging 31 (2004) 1435-1442.

[13] SHAPIRO, B., RUFINI, V., JARWAN, A., et al., Artifacts, anatomical and physiological variants, and unrelated diseases that might cause false-positive whole-body I-131 scans in patients with thyroid cancer, Semin Nucl Med 30 (2000) 115–132.

[14] PACINI, F., CAPEZZONE, M., ELISEI, R., CECCARELLI, C., TADDEI, D., et al., Diagnostic 131-iodine whole-body scan may be avoided in thyroid cancer patients who have undetectable stimulated serum Tg levels after initial treatment, J Clin Endocrinol Metab 87 (2002) 1499–1501.

[15] MAZZAFERRI, E.L., ROBBINS, R.J., SPENCER, C.A., et al., A consensus report of the role of serum thyroglobulin as a monitoring method for low-risk patients with papillary thyroid carcinoma, J Clin Endocrinol Metab 88 (2003) 1433–1441.

[16] PACINI, F., MOLINARO, E., CASTAGNA, M.G., et al., Recombinant human thyrotropin-stimulated serum thyroglobulin combined with neck ultrasonography has the highest sensitivity in monitoring differentiated thyroid carcinoma, J Clin Endocrinol Metab 88 (2003) 3668–3673.

[17] SCHLUMBERGER, M., BERG, G., COHEN, O., et al., Follow-up of low-risk patients with differentiated thyroid carcinoma: a European perspective, Eur J Endocrinol 150 (2004) 105–112.

[18] PACINI, F., SCHLUMBERGER, M., DRALLE, H., ELISEI, R., SMIT, J.W., et al., European consensus for the management of patients with differentiated thyroid carcinoma of the follicular epithelium, Eur J Endocrinol 154 (2006) 787–803.

[19] RUF, J., LEHMKUHL, L., BERTRAM, H., et al., Impact of SPECT and integrated low-dose CT after radioiodine therapy on the management of patients with thyroid carcinoma, Nucl Med Commun 25 (2004) 1177–1782.

[20] KALTSAS, G.A., BESSER, G.M., GROSSMAN, A.B., The diagnosis and medical management of advanced neuroendocrine tumors, Endocr Rev 25 (2004) 458–511.
[21] RHA, S.E., BYUN, J.Y., JUNG, S.E., et al., Neurogenic tumors in the abdomen: tumor types and imaging characteristics, Radiographics 23 (2003) 29–43.
[22] RUFINI, V., CALCAGNI, M.L., BAUM, R.P., Imaging of neuroendocrine tumors, Semin Nucl Med 36 (2006) 228–247.
[23] KRAUSZ, Y., ISRAEL, O., Single-photon emission computed tomography/computed tomography in endocrinology, Semin Nucl Med 36 (2006) 267–274.
[24] SCHILLACI, O., Hybrid SPECT/CT: a new era for SPECT imaging? Eur J Nucl Med Mol Imaging 32 (2005) 521–524.
[25] OZER, S., DOBROZEMSKY, G., KIENAST, O., et al., Value of combined XCT/SPECT technology for avoiding false positive planar ^{123}I-MIBG scintigraphy, Nuklearmedizin 43 (2004) 164–170.
[26] KEIDAR, Z., ISRAEL, O., KRAUSZ, Y., SPECT/CT in tumor imaging: technical aspects and clinical applications, Semin Nucl Med 33 (2003) 205–218.
[27] NORTON, J.A., FRAKER, D.L., ALEXANDER, H.R., et al., Surgery to cure the Zollinger-Ellison syndrome, N Engl J Med 341 (1999) 635–644.
[28] LAMBERTS, S.W.J., CHAYVIALLE, J.A., KRENNING, E.P., The visualization of gastroenteropancreatic endocrine tumors, Metabolism 41 Suppl. 2 (1992) 111–115.
[29] KRENNING, E.P., BAKKER, W.H., BREEMAN, W.A., et al., Localization of endocrine-related tumors with radioiodinated analogue of somatostatin, Lancet 1 8632 (1989) 242–244.
[30] KRENNING, E.P., BAKKER, W.H., KOOIJ, P.P., et al., Somatostatin receptor scintigraphy with indium-111-DTPA-D-Phe-1-octreotide in men: metabolism, dosimetry and comparison with iodine-123-Tyr-3-octreotide, J Nucl Med 33 (1992) 652–658.
[31] KRENNING, E.P., KWEKKEBOOM, D.J., OEI, H.Y., et al., Somatostatin-receptor scintigraphy in gastroenteropancreatic tumors: an overview of European results, Ann NY Acad Sci 733 (1994) 416–424.
[32] SHI, W., JOHNSTON, C.F., BUCHANAN, K.D., et al., Localization of neuroendocrine tumors with [^{111}In] DTPA-octreotide scintigraphy (Octreoscan): a comparative study with CT and MR imaging, QJM 91 (1998) 295–301.
[33] WEISS, M., YELLIN, A., HUSZAR, M., et al., Localization of adrenocorticotropic hormone-secreting bronchial carcinoid by somatostatin-receptor scintigraphy, Ann Intern Med 121 (1994) 198–199.
[34] KRENNING, E.P., KWEKKEBOOM, D.J., BAKKER, W.H., et al., Somatostatin receptor scintigraphy with [^{111}In-DTPA-D-Phe^{1}]- and [^{123}I-Tyr^{3}]-octreotide: the Rotterdam experience with more than 1000 patients, Eur J Nucl Med 20 (1993) 716–731.
[35] KWEKKEBOOM, D.J., KRENNING, E.P., Somatostatin receptor imaging, Semin Nucl Med 32 (2002) 84–91.
[36] KRAUSZ, Y., BAR-ZIV, J., DE JONG, R.B., et al., Somatostatin-receptor scintigraphy in the management of gastroenteropancreatic tumors, Am J Gastroenterol 93 (1998) 66–70.
[37] OTTE, A., MUELLER-BRAND, J., DELLAS, S., et al., Yttrium-90-labelled somatostatin-analog for cancer treatment [letter to editor], Lancet 351 (1998) 417–418.
[38] DE JONG, M., BREEMAN, W.A., BERNARD, H.F., et al., Therapy of neuroendocrine tumors with radiolabeled somatostatin-analogs, Q J Nucl Med 43 (1999) 356–366.

[39] DE JONG, M., VALKEMA, R., JAMAR, F., et al., Somatostatin receptor-targeted radionuclide therapy of tumors: preclinical and clinical findings, Semin Nucl Med **32** (2002) 133–140.

[40] LEBTAHI, R., CADIOT, G., SARDA, L., et al., Clinical impact of somatostatin receptor scintigraphy in the management of patients with neuroendocrine gastroenteropancreatic tumors, J Nucl Med **38** (1997) 853–858.

[41] LUBBERINK, M., TOLMACHEV, V., WIDSTROM, C., et al., ^{110m}In-DTPA-D-Phe^{1}-octreotide for imaging of neuroendocrine tumors with PET, J Nucl Med **43** (2002) 1391–1397.

[42] KRAUSZ, Y., SHIBLEY, N., DE JONG, R.B.J., et al., Gallbladder visualization with ^{111}In-labeled Octreotide, Clin Nucl Med **19** (1994) 133-135.

[43] CAPLIN, M.E., BUSCOMBE, J.R., HILSON, A.J., et al., Carcinoid tumor, Lancet **352** (1998) 799–805.

[44] FÖRSTER, G.J., LAUMANN, C., NICKEL, O., KANN, P., RIEKER, O., et al., SPET/CT image co-registration in the abdomen with a simple cost-effective tool, Eur J Nucl Med Mol Imaging **30** (2003) 32–39.

[45] AMTHAUER, H., RUF, J., BOHMIG, M., et al., Diagnosis of neuroendocrine tumors by retrospective image fusion: is there a benefit? Eur J Nucl Med Mol Imaging **31** (2004) 342–348.

[46] GIBRIL, F., REYNOLDS, J.C., CHEN, C.C., et al., Specificity of somatostatin receptor scintigraphy: a prospective study and effects of false-positive localizations on management in patients with gastrinomas, J Nucl Med **40** (1999) 539–553.

[47] KRAUSZ, Y., KEIDAR, Z., KOGAN, I., et al., SPECT/CT hybrid imaging with In111-pentetreotide in assessment of neuroendocrine tumors, Clin Endocrinology **59** (2003) 565–573.

[48] ALEXANDER, H.R., FRAKER, D.L., NORTON, J.A., et al., Prospective study of somatostatin receptor scintigraphy and its effect on operative outcome in patients with Zollinger-Ellison syndrome, Ann Surg **228** (1998) 228–238.

[49] ORLOFF, S.L., DEBAS, H.T., Advances in the management of patients with Zollinger- Ellison syndrome, Surg Clin North Am **75** (1995) 511–524.

[50] EVEN-SAPIR, E., KEIDAR, Z., SACHS, J., et al., The new technology of combined transmission and emission tomography in evaluation of endocrine neoplasms, J Nucl Med **42** (2001) 998–1004.

[51] PFANNENBERG, A.C., FACHMANN, S.M., HORGER, M., et al., Benefit of anatomical-functional image fusion in the diagnostic work-up of neuroendocrine neoplasms, Eur J Nucl Med Mol Imaging **30** (2003) 835–843.

[52] MIRTCHEVA, R.M., KOSTAKOGLU, L., GOLDSMITH, S.J., Hybrid imaging using ^{111}In octreotide SPECT/CT in evaluation of somatostatin receptor positive tumors (abstract), J Nucl Med **44** (2003) 73P.

[53] PALUMBO, B., SIVOLELLA, S., PALUMBO, L., et al., Ga-67 SPECT/CT with a hybrid system in the clinical management of lymphoma, Eur J Nucl Med Mol Imaging **32** (2005) 1011–1017.

[54] CARRERA, D., BAJEN, M.T., MORA, J., et al., Clinical utility of fused Ga-67 SPECT/CT scan images in patients with lymphoma, Rev Esp Med Nucl **25** (2006) 3–9.

[55] MARIANI, G., MORESCO, L., VIALE, G., et al., Radioguided sentinel lymph node biopsy in breast cancer surgery, J Nucl Med **42** (2001) 1198–1215.

[56] MARIANI, G., GIPPONI, M., MORESCO, L., et al., Radioguided sentinel lymph node biopsy in malignant cutaneous melanoma, J Nucl Med **43** (2002) 811–827.

[57] EVEN-SAPIR, E., LERMAN, H., LIEVSHITZ, G., et al., Lymphoscintigraphy for sentinel node mapping using a hybrid SPECT/CT system, J Nucl Med 44 (2003) 1413–1420.

[58] KHAFIF, A., SCHNEEBAUM, S., FLISS, D.M., et al., Lymphoscintigraphy for sentinel node mapping using a hybrid single photon emission CT (SPECT)/CT system in oral cavity squamous cell carcinoma, Head Neck 28 (2006) 874–879.

[59] LERMAN, H., METSER, U., LIEVSHITZ, G., et al., Lymphoscintigraphic sentinel node identification in patients with breast cancer: the role of SPECT/CT, Eur J Nucl Med Mol Imaging 33 (2006) 329–337.

[60] LERMAN, H., LIEVSHITZ, G., ZAK, O., METSER, U., SCHNEEBAUM, S., et al., Improved sentinel node identification by SPECT/CT in overweight patients with breast cancer, J Nucl Med 48 (2007) 201–206.

[61] MAR, M.V., MILLER, S.A., KIM, E.E., MACAPINLAC, H.A., Evaluation and localization of lymphatic drainage and sentinel lymph nodes in patients with head and neck melanomas by hybrid SPECT/CT lymphoscintigraphic imaging, J Nucl Med Technol 35 (2007) 10–16.

[62] VAN DER PLOEG, I.M., VALDES OLMOS, R.A., NIEWEG, O.E., RUTGERS, E.J., KROON, B.B., HOEFNAGEL, C.A., The additional value of SPECT/CT in lymphatic mapping in breast cancer and melanoma, J Nucl Med 48 (2007) 1756–1760.

[63] EVEN-SAPIR, E., Imaging of malignant bone involvement by morphologic, scintigraphic, and hybrid modalities, J Nucl Med 46 (2005) 1356–1367.

[64] ITO, S., KATO, K., IKEDA, M., et al., Comparison of ^{18}F-FDG PET and bone scintigraphy in detection of bone metastases of thyroid cancer, J Nucl Med 48 (2007) 889–895.

[65] HORGER, M., ESCHMANN, S.M., PFANNENBERG, C., VONTHEIN, R., BESENFELDER, H., et al., Evaluation of combined transmission and emission tomography for classification of skeletal lesions, AJR 183 (2004) 655–661.

[66] UTSUNOMIYA, D., SHIRAISHI, S., IMUTA, M., et al., Added value of SPECT/CT fusion in assessing suspected bone metastasis: comparison with scintigraphy alone and nonfused scintigraphy and CT, Radiology 238 (2006) 264–271.

[67] RÖMER, W., OLK, A., HENNIG, F.F., KUWERT, T., Assessment of aseptic loosening of the acetabular component in a total hip replacement with Tc-99m-DPD-SPECT/spiral-CT hybrid imaging, Nuklearmedizin 44 (2005) N58–N60.

[68] EVEN-SAPIR, E., FLUSSER, G., LERMAN, H., LIEVSHITZ, G., METSER, U., SPECT/multislice low-dose CT: a clinically relevant constituent in the imaging algorithm of nononcological patients referred for bone scintigraphy, J Nucl Med 48 (2007) 319–324.

[69] KAPLAN, W.D., TAKVORIAN, T., MORRIS, J.H., et al., Thallium-201 brain tumor imaging: a comparative study with pathologic correlation, J Nucl Med 28 (1987) 47–52.

[70] KIM, K.T., BLACK, K.L., MARCIANO, D., et al., Thallium-201 SPECT imaging of brain tumors: methods and results, J Nucl Med 31 (1999) 965–969.

[71] DATTA, N.R., PASRICHA, R., GAMBHIR, S., et al., Postoperative residual tumour imaged by contrast-enhanced computed tomography and Tl-201 single photon emission tomography: can they predict progression-free survival in high-grade gliomas? Clin Oncol (R Coll Radiol) 16 (2004) 494–500.

[72] LORBERBOYM, M., BARAM, J., FEIBEL, M., et al., A prospective evaluation of thallium-201 single photon emission computerized tomography for brain tumor burden, Int J Radiat Oncol Biol Phys 32 (1995) 249–254.

[73] VALLEJOS, V., BALANA, C., FRAILE, M., et al., Use of Tl-201 SPECT imaging to assess the response to therapy in patients with high grade gliomas, J Neurooncol **59** (2002) 81–90.

[74] SCOTT, A.M., MACAPINLAC, H., ZHANG, J.J., et al., Clinical applications of fusion imaging in oncology, Nucl Med Biol **21** (1994) 775–784.

[75] HEMM, S., RIGAU, V., CHEVALIER, J., et al., Stereotactic coregistration of Tl-201 SPECT and MRI applied to brain tumor biopsies, J Nucl Med **46** (2005) 1151–1157.

[76] OST, D., FEIN, A.M., FEINSILVER, S.H., Clinical practice. The solitary pulmonary nodule, N Engl J Med **348** (2003) 2535–2542.

[77] GOTTHARDT, M., BEHE, M.P., ALFKE, H., et al., Imaging lung tumors with peptide-based radioligands, Clin Lung Cancer **5** (2003) 119–124.

[78] BLUM, J., HANDMAKER, H., LISTER-JAMES, J., et al., A multicenter trial with a somatostatin analog Tc-99m depreotide in the evaluation of solitary pulmonary nodules, Chest **117** (2000) 1232–1238.

[79] HALLEY, A., HUGENTOBLER, A., ICARD, P., et al., Efficiency of ^{18}F-FDG and ^{99m}Tc-depreotide SPECT in the diagnosis of malignancy of solitary pulmonary nodules, Eur J Nucl Med Mol Imaging **32** (2005) 1026–1032.

[80] MENDA, Y., KAHN, D., Somatostatin receptor imaging of non-small cell lung cancer with Tc-99m depreotide, Semin Nucl Med **32** (2002) 92–96.

[81] DANIELSSON, R., BÅÅTH, M., SVENSSON, L., et al., Imaging of regional lymph node metastases with Tc-99m depreotide in patients with lung cancer, Eur J Nucl Med Mol Imaging **32** (2005) 925–931.

[82] MANYAK, M.J., HINKLE, G.H., OLSEN, J.O., et al., Immunoscintigraphy with In-111 capromab pendetide evaluated before definitive therapy in patients with prostate cacner, Urology **54** (1999) 1058–1063.

[83] HAN, M., PARTIN, A.W., Current applications of In-111 capromab pendetide scan, Rev Urol **3** (2001) 165–171.

[84] SCHETTINO, C.J., KRAMER, E.L., NOZ, M.E., et al., Impact of fusion of In-111 capromab pendetide volume data sets with those from MRI or CT in patients with recurrent prostate cancer, AJR **183** (2004) 519–524.

[85] SODEE, D.B., NELSON, A.D., FAULHABER, P.F., et al., Update on fused capromab pendetide imaging of prostate cancer, Clin Prostate Cancer **3** (2005) 230–238.

[86] JANI, A.B., SPELBRING, D., HAMILTON, R., et al., Impact of radioimmuonoscintigraphy on definition of clinical target volume for radiotherapy after prostatectomy, J Nucl Med **45** (2004) 238–246.

[87] KAHN, D., AUSTIN, J.C., MAGUIRE, R.T., et al., A phase II study of Y-90 capromab pendetide in the treatment of men with prostate cancer recurrence following radical prostatectomy, Cancer Biother Radiopharm **14** (1999) 99–111.

[88] MARIANI, G., GULEC, S.A., RUBELLO, D., et al., Preoperative localization and radioguided parathyroid surgery, J Nucl Med **44** (2003) 1443–1458.

[89] RUBELLO, D., PELIZZO, M.R., BONI, G., et al., Radioguided surgery of primary hyperparathyroidism using the low ^{99m}Tc-Sestamibi dose protocol: multi-institutional experience from the Italian Study Group on Radioguided Surgery and ImmunoScintigraphy (GISCRIS), J Nucl Med **46** (2005) 220–226.

[90] RUBELLO, D., GROSS, M.D., MARIANI, G., AL-NAHHAS, A., Scintigraphic techniques in hyper-parathyroidism: from pre-operative localization to intra-operative imaging, Eur J Nucl Med Mol Imaging **34** (2007) 926–933.

[91] BILLOTEY, C., SARFATI, E., AURENGO, A., et al., Advantages of SPECT in technetium-99m-sestamibi parathyroid scintigraphy, J Nucl Med **37** (1996) 1773–1778.

[92] PATTOU, F., HUGLO, D., PROYE, C., Radionuclide scanning in parathyroid disease, Br J Surg (1998) 85 1605–1616.
[93] FRANCIS, I.S., LONEY, E.L., BUSCOMBE, J.R., THAKRAR, D.S., BERGER, L., et al., Technetium-99m-sestamibi dual-phase SPECT imaging: concordance with ultrasound, Nucl Med Commun 20 (1999) 487–488.
[94] LONEY, E.L., BUSCOMBE, J.R., HILSON, A.J.W., DAVENPORT, A., FRANCIS, I.S., Preoperative imaging of parathyroid glands, Lancet 354 (1999) 1819–1820.
[95] MOKA, D., VOTH, E., DIETLEIN, M., LAREAN-AVELLANDA, A., SCHICHA, H., Technetium 99m-MIBI-SPECT: a highly sensitive diagnostic tool for localization of parathyroid adenomas, Surgery 128 (2000) 29–35.
[96] O'DOHERTY, M.J., KETTLE, A.G., Parathyroid imaging: preoperative localization, Nucl Med Commun 24 (2003) 125–131.
[97] SPANU, A., FALCHI, A., MANCA, A., et al., The usefulness of neck pinhole SPECT as a complementary tool to planar scintigraphy in primary and secondary hyperparathyroidism, J Nucl Med 45 (2004) 40–48.
[98] RUBELLO, D., MASSARO, A., CITTADIN, S., et al., Role of ^{99m}Tc-sestamibi SPECT in accurate selection of primary hyperparathyroid patients for minimally invasive radio-guided surgery, Eur J Nucl Med Mol Imaging 33 (2006) 1091–1094.
[99] GAYED, I.W., KIM, E.E., BROUSSARD, W.F., et al., The value of ^{99m}Tc-sestamibi SPECT/CT over conventional SPECT in the evaluation of parathyroid adenomas or hyperplasia, J Nucl Med 46 (2005) 248–252.
[100] KRAUSZ, Y., BETTMAN, L., GURALNIK, L., et al., Technetium-99m-MIBI SPECT/CT in primary hyperparathyroidism, World J Surg 30 (2006) 76–83.
[101] SERRA, A., BOLASCO, P., SATTA, L., et al., Role of SPECT/CT in the preoperative assessment of hyperparathyroid patients, Radiol Med 111 (2006) 999–1008.
[102] LAVELY, W.C., GOETZE, S., FRIEDMAN, K.P., et al., Comparison of SPECT/CT, SPECT, and planar imaging with single-and dual-phase ^{99m}Tc-sestamibi parathyroid scintigraphy, J Nucl Med 48 (2007) 1084–1089.
[103] RUF, J., SEEHOFER, D., DENEKE, T., STELTER, L., RAYES, N., et al., Impact of image fusion and attenuation correction by SPECT-CT on the scintigraphic detection of parathyroid adenomas, Nuklearmedizin 46 (2007) 15–21.
[104] PIGA, M., SERRA, A., UCCHEDDU, A., LAI, L.M., FAA, G., Decisive presurgical role of MIBI SPECT/CT in identifying within a calcific thyroid nodule the parathyroid responsible for primary hyperparathyroidism, Surgery 140 (2006) 837–838.
[105] PALESTRO, C.J., TORRES, M.A., Radionuclide imaging in orthopedic infections, Semin Nucl Med 27 (1997) 334–345.
[106] LOVE, C., PALESTRO, C.J., Radionuclide imaging of infection, J Nucl Med Technol 32 (2004) 47–57.
[107] ZHUANG, H., YU, J.Q., ALAVI, A., Applications of fluorodeoxyglucose-PET imaging in the detection of infection and inflammation and other benign disorders, Radiol Clin North Am 43 (2005) 121–134.
[108] ANNOVAZZI, A., BAGNI, B., BURRONI, L., D'ALESSANDRIA, C., SIGNORE, A., Nuclear medicine imaging of inflammatory/infective disorders of the abdomen, Nucl Med Commun 26 (2005) 657–664.
[109] LOVE, C., TOMAS, M.B., TRONCO, G.G., PALESTRO, C.J., FDG PET of infection and inflammation, Radiographics 25 (2005) 1357–1368.
[110] TERMAAT, M.F., RAIJMAKERS, P.G., SCHOLTEN, H.J., BAKKER, F.C., PATKA, P., et al., The accuracy of diagnostic imaging for the assessment of chronic osteomyelitis: a systematic review and meta-analysis, J Bone Joint Surg Am 87 (2005) 2464–2471.

[111] JAMES, S.L., DAVIES, A.M., Imaging of infectious spinal disorders in children and adults, Eur J Radiol **58** (2006) 27–40.
[112] VOS, F.J., BLEEKER-ROVERS, C.P., CORSTENS, F.H., KULLBERG, B.J., OYEN, W.J., FDG-PET for imaging of non-osseous infection and inflammation, Q J Nucl Med Mol Imaging **50** (2006) 121–130.
[113] STUMPE, K.D., STROBEL, K., ^{18}F FDG-PET imaging in musculoskeletal infection, Q J Nucl Med Mol Imaging **50** (2006) 131–142.
[114] RINI, J.N., PALESTRO, C.J., Imaging of infection and inflammation with ^{18}F-FDG-labeled leukocytes, Q J Nucl Med Mol Imaging **50** (2006) 143–146.
[115] PRANDINI, N., LAZZERI, E., ROSSI, B., ERBA, P., PARISELLA, M.G., et al., Nuclear medicine imaging of bone infections, Nucl Med Commun 27 (2006) 633–644.
[116] CONCIA, E., PRANDINI, N., MASSARI, L., et al., Osteomyelitis: clinical update for practical guidelines, Nucl Med Commun **27** (2006) 645–660.
[117] LEE, E., WORSLEY, D.F., Role of radionuclide imaging in the orthopedic patient, Orthop Clin North Am **37** (2006) 485–501.
[118] EL-MAGHRABY, T.A., MOUSTAFA, H.M., PAUWELS, E.K., Nuclear medicine methods for evaluation of skeletal infection among other diagnostic modalities, Q J Nucl Med Mol Imaging **50** (2006) 167–192.
[119] PAKOS, E.E., TRIKALINOS, T.A., FOTOPOULOS, A.D., IOANNIDIS, J.P., Prosthesis infection: diagnosis after total joint arthroplasty with antigranulocyte scintigraphy with ^{99m}Tc-labeled monoclonal antibodies – a meta-analysis, Radiology **242** (2007) 101–108.
[120] PINEDA, C., VARGAS, A., RODRIGUEZ, A.V., Imaging of osteomyelitis: current concepts, Infect Dis Clin North Am **20** (2006) 789–825.
[121] MELLER, J., SAHLMANN, C.O., SCHEEL, A.K., ^{18}F-FDG PET and PET/CT in fever of unknown origin, J Nucl Med **48** (2007) 35–45.
[122] CHRISTIAN, S., KRAAS, J., CONWAY, W.F., Musculoskeletal infections, Semin Roentgenol **42** (2007) 92–101.
[123] AULER, M.A., BAGG, S., GORDON, L., The role of nuclear medicine in imaging infection, Semin Roentgenol **42** (2007) 117–121.
[124] BUNYAVIROCH, T., AGGARWAL, A., OATES, M.E., Optimized scintigraphic evaluation of infection and inflammation: role of single-photon emission computed tomography/computed tomography fusion imaging, Semin Nucl Med **36** (2006) 295–311.
[125] INGUI, C.J., SHAH, N.P., OATES, M.E., Infection scintigraphy: added value of single-photon emission computed tomography/computed tomography fusion compared with traditional analysis, J Comput Assist Tomogr **31** (2007) 375–380.
[126] BAR-SHALOM, R., YEFREMOV, N., GURALNIK, L., et al., SPECT/CT using ^{67}Ga and ^{111}In-labeled leukocyte scintigraphy for diagnosis of infection, J Nucl Med **47** (2006) 587–594.
[127] FILIPPI, L., SCHILLACI, O., Usefulness of hybrid SPECT/CT in ^{99m}Tc-HMPAO-labeled leukocyte scintigraphy for bone and joint infections, J Nucl Med **47** (2006) 1908–1913.
[128] LAZZERI, E., ERBA, P.A., PERRI, M., TASCINI, C., DORIA, R., et al., Role of one-step radiolabeled biotin SPECT/CT in the diagnosis of spinal infection, J Nucl Med **48** Suppl. 2 (2007) 280P.
[129] HORGER, M., ESCHMANN, S.M., PFANNENBERG, C., et al., The value of SPET/CT in chronic osteomyelitis, Eur J Nucl Med Mol Imaging **30** (2003) 1665–1673.

[130] GIBBONS, R.J., CHATTERJEE, K., DALEY, J., et al., ACC/AHA/ACP-ASIM guidelines for the management of patients with chronic stable angina: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Management of Patients with Chronic Stable Angina), J Amer Coll Cardiol 33 (1999) 2092–2197.

[131] VAN TRAIN, K.F., GARCIA, E.V., MADDAHI, J., et al., Multi-center trial validation for quantitative analysis of same-day rest-stress technetium-99m-sestamibi myocardial tomograms, J Nucl Med 35 (1994) 609–618.

[132] FLEISCHMANN, K.E., HUNINK, M.G.M., KUNTZ, K.M., et al., Exercise echocardiography or exercise SPECT imaging? A meta-analysis of diagnostic test performance, JAMA 280 (1998) 913–920.

[133] CORBETT, J.R., FICARO, E.P., Clinical review of attenuation-corrected cardiac SPECT, J Nucl Cardiol 6 (1999) 54–68.

[134] FRIEDMAN, T.D., GREENE, A.C., ISKANDRIAN, A.S., et al., Exercise thallium-201 myocardial scintigraphy in women: correlation with coronary arteriography, Am J Cardiol 49 (1982) 1632–1637.

[135] GOODGOLD, H.M., REHDER, J.G., SAMUELS, L.D., et al., Improved interpretation of exercise Tl-201 myocardial perfusion scintigraphy in women: characterization of breast attenuation artifacts, Radiology 165 (1987) 361–366.

[136] DESMARIAS, R., KAUL, S., WATSON, D., et al., Do false positive thallium-201 scans lead to unnecessary catheterization? Outcome of patients with perfusion defects on quantitative planar thallium scintigraphy, J Am Coll Cardiol 21 (1993) 1058–1063.

[137] HOLLY, T.A., PARKER, M.A., HENDEL, R.C., The prevalence of non-uniform soft tissue attenuation in myocardial SPECT perfusion imaging and the impact of gated SPECT, J Nucl Cardiol 4 (1997) S103 (abstract).

[138] TAN, P., BAILEY, D.L., MEIKLE, S.R., et al., A scanning line source for simultaneous emission and transmission measurements in SPECT, J Nucl Med 34 (1993) 1752–1760.

[139] GOETZE, S., BROWN, T.L., LAVELY, W.C., et al., Attenuation correction in myocardial perfusion SPECT/CT: effects of misregistration and value of re-registration, J Nucl Med 48 (2007) 1090–1095.

[140] GAEMPERLI, O., SCHEPIS, T., VALENTA, I., et al., Cardiac image fusion from stand-alone SPECT and CT: clinical experience, J Nucl Med 48 (2007) 696–703.

[141] RISPLER, S., KEIDAR, Z., GHERSIN, E., et al., Integrated single-photon emission computed tomography and computed tomography coronary angiography for the assessment of hemodynamically significant coronary artery lesions, J Am Coll Cardiol 49 (2007) 1059–1067.

[142] WIJNS, W., Anatomic-functional imaging by single-photon emission computed tomography/computed tomography as the cornerstone of diagnosis and treatment for coronary patients: a glimpse into the (near) future? J Am Coll Cardiol 49 (2007) 1068–1070.

[143] RUMBERGER, J.A., SIMONS, D.B., FITZPATRICK, L.A., et al., Coronary artery calcium area by electron-beam computed tomography and coronary atherosclerotic plaque area. A histologic correlative study, Circulation 92 (1995) 2157–2162.

[144] DANIELL, A.L., WONG, N.D., FRIEDMAN, J.D., et al., Concordance of coronary artery calcium estimates between MDCT and electron beam tomography, AJR 185 (2005) 1542–1545.

[145] VIRMANI, R., BURKE, A.P., FARB, A., et al., Pathology of the vulnerable plaque, J Am Coll Cardiol 47 Suppl. 8 (2006) C13–C18.

[146] MAHMARIAN, J.J., Hybrid SPECT-CT: integration of CT coronary artery calcium scoring and angiography with myocardial perfusion, Curr Cardiol Rep **9** (2007) 129–135.
[147] MINIATI, M., PISTOLESI, M., MARINI, C., et al., Value of perfusion lung scan in the diagnosis of pulmonary embolism: results of the Prospective Investigative Study of Acute Pulmonary Embolism Diagnosis (PISA-PED), Am J Respir Crit Care Med **154** (1996) 1387–1393.
[148] MINIATI, M., PREDILETTO, R., FORMICHI, B., et al., Accuracy of clinical assessment in the diagnosis of pulmonary embolism, Am J Respir Crit Care Med **159** (1999) 864–871.
[149] MINIATI, M., PISTOLESI, M., Assessing the clinical probability of pulmonary embolism, Q J Nucl Med **45** (2001) 287–293.
[150] MARINI, C., PALLA, A., GIUNTINI, C., Pulmonary embolism: lung scan and computed tomography, Ital Heart J **6** (2005) 811–817.
[151] PALLA, A., BARDI, G., RIBAS, C., Diagnosis of pulmonary embolism, Semin Thromb Hemost **32** (2006) 822–830.
[152] McLEAN, R.G., CAROLAN, M., BUI, C., et al., Comparison of new clinical and scintigraphic algorithms for the diagnosis of pulmonary embolism, Br J Radiol **77** 917 (2004) 372–376.
[153] THE PIOPED INVESTIGATORS, Value of the ventilation/perfusion scan in acute pulmonary embolism: results of the prospective investigation of pulmonary embolism diagnosis (PIOPED), JAMA **263** (1990) 2753–2759.
[154] SCHOEPF, J.U., GOLDHABER, S.Z., COSTELLO, P., Spiral computed tomography for acute pulmonary embolism, Circulation **109** (2004) 2160–2167.
[155] GARG, K., WELSH, C.H., FEYERABEND, A.J., et al., Pulmonary embolism: diagnosis with spiral CT and ventilation-perfusion scanning: correlation with pulmonary angiographic results or clinical outcome, Radiology **208** (1998) 201–208.
[156] GHAYE, B., SZPAIRE, D., MASTORA, I., et al., Peripheral pulmonary arteries: how far in the line does multi-detector row spiral CT allow analysis? Radiology **219** (2001) 629–236.
[157] SCHOEPF, U., HOLZKNECHT, N., HELBEREGR, T.K., et al., Subsegmental pulmonary emboli: improved detection with thin-collimation multi-detector row spiral CT, Radiology **222** (2002) 483–490.
[158] PATEL, S., KAZEROONI, E.A., CASCADE, P.N., Pulmonary embolism: optimization of small pulmonary artery visualization at multi-detector row CT, Radiology **227** (2003) 455–460.
[159] STEIN, P.D., FOWLER, S.E., GOODMAN, L.R., et al., Multidetector computed tomography for acute pulmonary embolism, N Engl J Med **354** (2006) 2317–2327.
[160] PERRIER, A., BOUNAMEAUX, H., Accuracy or outcome in suspected pulmonary embolism, N Engl J Med **354** (2006) 2383–2385.
[161] LE GAL, G., RIGHINI, M., PARENT, F., VAN STRIJEN, M., COUTURAUD, F., Diagnosis and management of subsegmental pulmonary embolism, J Thromb Haemost **4** (2006) 724–731.
[162] HARRIS, B., BAILEY, D., ROACH, P., BAILEY, E., KING, G., Fusion imaging of computed tomographic pulmonary angiography and SPECT ventilation/perfusion scintigraphy: initial experience and potential benefit, Eur J Nucl Med Mol Imaging 34 (2007) 135–142.
[163] HUTTON, B.F., BRAUN, M., THURFJELL, L., LAU, D.Y.H., Image registration: an essential tool for nuclear medicine, Eur J Nucl Med **29** (2002) 559–577.
[164] SLOMKA, P.J., Software approach to merging molecular with anatomic information, J Nucl Med **45** Suppl. 1 (2004) 36S–45S.

[165] COHADE, C., OSMAN, M., MARSHALL, L.N., WAHL, R.N., PET-CT: accuracy of PET and CT spatial registration of lung lesions, Eur J Nucl Med Mol Imaging **30** (2003) 721–726.

[166] NÖMAYR, A., RÖMER, W., HOTHORN, T., et al., Anatomical accuracy of lesion localization: retrospective interactive rigid image registration between ^{18}F-FDG-PET and X-ray CT, Nuklearmedizin **44** (2005) 149–155.

[167] WOLZ, G., NÖMAYR, A., HOTHORN, T., HORNEGGER, J., RÖMER, W., et al., Comparative anatomical accuracy of interactive and automated rigid registration between CT and FDG-PET, Nuklearmedizin **46** (2007) 43–48.

[168] KIM, J.H., CZERNIN, J., ALLEN-AUERBACH, M.S., et al., Comparison between ^{18}F-FDG PET, in-line PET/CT, and software fusion for restaging of recurrent colorectal cancer, J Nucl Med **46** (2005) 587–595.

[169] KRISHNASETTY, V., FISCHMAN, A.J., HALPERN, E.L., AQUINO, S.L., Comparison of alignment of computer-registered data sets: combined PET/CT versus independent PET and CT of the thorax, Radiology **237** (2005) 635–639.

[170] NÖMAYR, A., RÖMER, W., STROBEL, D., BAUTZ, W., KUWERT, T., Anatomical accuracy of hybrid SPECT/spiral CT in the lower spine, Nucl Med Commun **27** (2006) 521–528.

[171] ROSENTHAL, M.S., CULLOM, J., HAWKINS, W., MOORE, S.C., TSUI, B.M., et al., Quantitative SPECT imaging: a review and recommendations by the Focus Committee of the Society of Nuclear Medicine Computer and Instrumentation Council, J Nucl Med **36** (1995) 1489–1513.

[172] ZAIDI, H., HASEGAWA, B., Determination of the attenuation map in emission tomography, J Nucl Med **44** (2003) 291–315.

[173] CELLER, A., DIXON, K.L., CHANG, Z., BLINDER, S., POWE, J., et al., Problems created in attenuation-corrected SPECT images by artifacts in attenuation maps: a simulation study, J Nucl Med **46** (2005) 335–343.

[174] MASOOD, Y., LIU, Y.H., DEPUEY, G., et al., Clinical validation of SPECT attenuation correction using x-ray computed tomography-derived attenuation maps: multicenter clinical trial with angiographic correlation, J Nucl Cardiol **12** (2005) 676–686.

[175] FRICKE, E., FRICKE, H., WEISE, R., et al., Attenuation correction of myocardial SPECT perfusion images with low-dose CT: evaluation of the method by comparison with perfusion PET, J Nucl Med **46** (2005) 736–744.

[176] SCHULZ, V., NICKEL, I., NÖMAYR, A., et al., Effect of CT-based attenuation correction on uptake ratios in skeletal SPECT, Nuklearmedizin **46** (2007) 38–42.

[177] SHIRAISHI, S., TOMIGUCHI, S., UTSUNOMIYA, D., et al., Quantitative analysis and effect of attenuation correction on lymph node staging of non-small cell lung cancer on SPECT and CT, AJR **186** (2006) 1450–1457.

[178] MATSUNARI, I., BÖNING, G., ZIEGLER, S.I., et al., Effects of misalignment between transmission and emission scans on attenuation-corrected cardiac SPECT, J Nucl Med **39** (1998) 411–416.

[179] FRICKE, H., FRICKE, E., WEISE, R., KAMMEIER, A., LINDNER, O., et al., A method to remove artifacts in attenuation-corrected myocardial perfusion SPECT introduced by misalignment between emission scan and CT-derived attenuation maps, J Nucl Med **45** (2004) 1619–1625.

[180] CHEN, J., CAPUTLU-WILSON, S.F., SHI, H., GALT, J.R., FABER, T.L., et al., Automated quality control of emission-transmission misalignment for attenuation correction in myocardial perfusion imaging with SPECT-CT systems, J Nucl Cardiol **13** (2006) 43–49.

[181] BOUCEK, J., TURNER, J.H., Validation of prospective whole body bone marrow dosimetry by SPECT/CT multimodality imaging in I-131 anti-CD 20 rituximab radioimmunotherapy of non-Hodgkin's lymphoma, Eur J Nucl Med Mol Imaging 32 (2005) 458–469.

[182] SONG, H., HE, B., PRIDEAUX, A., DU, Y., et al., Lung dosimetry for radioiodine treatment planning in the case of diffuse lung metastases, J Nucl Med 47 (2006) 1985–1994.

[183] GENOVESI, D., DI MARTINO, F., LOI, A., LAZZERI, M., BONI, G., et al., Use of SPECT-CT for optimizing dosimetry estimates in patients with metastatic bone disease treated with ^{153}Sm-EDTMP, Q J Nucl Med Mol Imaging 51 (2007) 380 (abstract).

[184] RICCI, S., BONI, G., PASTINA, I., et al., Clinical benefit of bone-targeted radiometabolic therapy with ^{153}Sm-EDTMP combined with chemotherapy in patients with metastatic hormone-refractory prostate cancer, Eur J Nucl Med Mol Imaging 34 (2007) 1023–1030.

[185] O'DANIEL, J.C., STEVENS, D.M., CODY, D.D., Reducing radiation exposure from survey CT scans, AJR 185 (2005) 509–515.

[186] NUNEZ, R., ERWIN, W.D., WENDT, R.E., et al., Acquisition parameters for oncologic imaging with a new SPECT/multislice CT scanner, RadioGraphics 2007 (in review).

[187] YANG, D.J., AZHDARINIA, A., KIM, E.E., Tumor specific imaging using Tc-99m and Ga-68 labeled radiopharmaceuticals, Curr Med Imag Rev 1 (2005) 25–34.

[188] YANG, D.J., KIM, C.G., SCHECHTER, N.R., et al., Imaging with ^{99m}Tc ECDG targeted at the multifunctional glucose transport system: feasibility study with rodents, Radiology 226 (2003) 465–473.

[189] COLEMAN, R.E., DELBEKE, D., GUIBERTEAU, M.J., et al., Concurrent PET/CT with an integrated imaging system: intersociety dialogue from the joint working group of the American College of Radiology, the Society of Nuclear Medicine, and the Society of Computed Body Tomography and Magnetic Resonance, J Nucl Med 26 (2005) 1225–1239.

[190] BISCHOF DELALOYE, A., CARRIO, I., CUOCOLO, A., et al., White paper of the European Association of Nuclear Medicine (EANM) and the European Society of Radiology (ESR) on multimodality imaging, Eur J Nucl Med Mol Imaging 34 (2007) 1147–1151.

[191] GOURTSOYIANNIS, N., McCALL, I., REISER, M., et al., White paper of the European Society of Radiology (ESR) and the European Association of Nuclear Medicine (EANM) on multimodality imaging, Eur J Radiol 17 (2007) 1926–1930.

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CONTRIBUTORS TO DRAFTING AND REVIEW

Mariani, G.	University of Pisa Medical School, Regional Center of Nuclear Medicine, Italy
Flotats, A.	Autonomous University of Barcelona, Nuclear Medicine Department, Spain
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Kim, E.E.	MD Anderson Cancer Center, University of Texas, United States of America
Kuwert, T.	Universitätsklinikum Erlangen, Nuklearmedizinische Klinik, Germany

Consultants Meeting on Recent Advances on SPECT/CT,
Vienna, Austria, 25–27 June 2007

CVs

MARNA PARKE BORGSTROM

Home: 458 Three Mile Course
Guilford, Ct. 06437
(203) 453-8782

Business: Yale-New Haven Hospital
20 York Street
(203) 688-2608

EDUCATION

1977-1979 Yale University School of Medicine
Department of Epidemiology and Public Health
Program in Hospital Administration, M.P.H.

1972-1976 Stanford University
Bachelor of Arts in Human Biology awarded June, 1976

EXPERIENCE

2005-Present President and Chief Executive Officer: Yale New Haven Health System (YNHHS)

Yale New Haven Health System is a regional, integrated health care delivery system composed of three local health care delivery networks. Anchored by Yale-New Haven Hospital, the Yale-New Haven Children's Hospital, and the Yale-New Haven Psychiatric Hospital totaling 944-beds, the System includes a Bridgeport network led by the 425-bed Bridgeport Hospital and a Greenwich network anchored by 160-bed Greenwich Hospital. Westerly Hospital (Rhode Island) is also a network participant. In total, the System has 1,545 beds, over 80,000 admissions, 11,610 employees, 3,476 medical staff members, and annual net revenues of over $1.5 billion.

2005-Present President and Chief Executive Officer: Yale-New Haven Hospital and Delivery Network (YNHH)

Yale-New Haven, a private not-for-profit 944-bed hospital founded in 1826. It serves as the primary teaching hospital for the Yale University School of Medicine and provides tertiary and quaternary patient care for the State of Connecticut and Southern New England, as well as general acute care services for the Greater New Haven metropolitan area. In FY 2006 there were 50,369 discharges and 669,422 outpatient visits. The institution's net revenues were over $900 million with approximately 7,200 employees, and a Medical Staff numbering over 2,400.

1993-2005 Executive Vice President & Chief Operating Officer: Yale-New Haven Hospital
Executive Vice President and Secretary: Yale-New Haven Health Services Corporation

Responsible for New Haven Delivery Network operations ($850 million operating budget), included Yale-New Haven Hospital operations, finance, human resources and planning and marketing; and Yale-New Haven Ambulatory Services Corporation, which operates two independent surgery centers and a large, full-service radiology business in New Haven and Guilford. Served as the senior Hospital interface for Yale School of Medicine operational issues.

Represented the YNHH Delivery Network in all Health System strategic and operational activities.

Major Accomplishments:

- Achieved nearly 14% growth in inpatient volume and grew operating gain from .7% to 4.1% between 2000-2004.
- Acquired the assets of an independent Psychiatric facility losing more than $3 million/year and successfully integrated it into Yale-New Haven, eliminating the operating loss.
- Opened the Shoreline Medical Center, integrating services offered by Yale-New Haven Hospital and Yale-New Haven Ambulatory Service Corp.
- Implemented the New Clinical Program Development Fund with Yale University School of Medicine to seed key new clinical programs and program enhancements.
- Completed $51.5 million renovation project in South Pavilion
- Implemented a comprehensive nursing recruitment and retention plan resulting in a registered nurse vacancy rate of 2% at the end of fiscal year 2004.
- As part of organization-wide performance enhancement initiative, implemented training partnership with GE, resulting in more than 40 Six Sigma competent staff who have been redeployed throughout the Hospital.

1992-1993 Senior Vice President, Administration: Yale-New Haven Hospital
Senior Vice President and Secretary: Yale-New Haven Health Services Corporation

Responsible for Hospital strategic planning and marketing, facilities planning and design, risk management and medicolegal affairs, managed care contracting, Service Quality Improvement, Community Relations, Public Affairs and Engineering.

Project Executive for implementation of Yale-New Haven's $156 million Facilities Renewal Project.

1985-1992 Vice President, Administration: Yale-New Haven Hospital

Responsible for Hospital strategic planning and marketing, facilities planning and design, risk management and medicolegal affairs, managed care contracting, Service Quality Improvement, Community Relations, Public Affairs and Engineering. Provided administrative leadership to Yale-New Haven Health Services Corporation corporate affairs and strategic initiatives.

Major Accomplishments:

- Responsible for program and facilities planning associated with the initiation of a $156 million Facilities Renewal Project adding 450,000 square feet of new inpatient space and renovating 390,000 square feet.
- Developed Facilities Master Plan for the Hospital including a phased design and construction plan.
- Project Captain for the acquisition by YNHHS of two independent surgery centers and a large radiology practice.
- Established a Service Quality Improvement initiative for Yale-New Haven.
- Developed and presented YNHHS Corp's response to Memorial Hospital (Meriden, Connecticut) RFP for a managed contract, which was awarded to Yale-New Haven.
- Developed multi-hospital HMO in Connecticut which began with a YNHH-HMO feasibility study and was subsequently implemented with six Hospital/Physician Organizations.
- Established Facilities Planning and Design function responsible for hospital architecture, space planning and real estate acquisition and management.

1984-1985 Assistant Vice President: Yale-New Haven Hospital

Directed the development and implementation of annual Hospital business plan format derived from strategic plan. Completed $6 million renovation of Hospital clinical laboratories. Represented Hospital on underwriting and eligibility and finance activities in malpractice insurance captive.

Dec. 1982-1984 Associate Administrator: Yale-New Haven Hospital

Responsible for Hospital planning activities, including Strategic Planning and general facilities planning and related capital budget activities. Also responsible for Clinical Laboratories ($23 million gross revenue and $11 million expense) and Risk Management and Medicolegal Affairs.

Dec. 1980-Nov. 1982 Assistant Administrator: Yale-New Haven Hospital

Responsible for planning and implementing $11 million renovation program done in concert with major facility replacement project, and for planning and overseeing the move of five major departments and three clinical services (including 80 ICU beds) to a new $73 million facility, during the Spring of 1982. Prepared and presented to the Health Systems Agency and Commission on Hospitals and Health Care, three Certificates of Need; all were approved. Also responsible for Hospital space planning and management, and provided general staff support to the Executive Vice President.

Jan. 1980-Dec. 1980 Administrative Associate: Yale-New Haven Hospital

Provided general staff support to Executive Vice President. Major activities included employee fundraising and campaign to support $73 million facility replacement and renovations program (50% of Hospital employees contributed almost $500,000) and preparation of capital and operating budget materials.

Jan. 1979-Dec. 1980 Administrative Resident: Yale-New Haven Hospital

Summer 1978 Administrative Intern: Alexian Brothers Hospital, San Jose, California

PROFESSIONAL AWARDS:

1992 Up and Comers Award - Sponsored by Modern Healthcare and 3M Health Systems
Women In Leadership Award, 1993 - YWCA
Junior Achievement Hall of Fame, 1998
20 Noteworthy Women, New Haven Business Times, 1999
Gateway Community College Hall of Fame, 2002

MAJOR PROFESSIONAL AFFILIATIONS, BOARDS AND ACTIVITIES:

Yale-New Haven Hospital Board of Trustees,(1994 – present)
Yale New Haven Health System Board of Directors (2005 - present)
Yale Medical Group Board of Governors, (current)
Yale-New Haven Ambulatory Services Corporations, Board President
University HealthSystem Consortium, Board of Directors, (current)
Healthcare Executives Study Society, 2006-present
Greater New Haven Regional Leadership Council, 2005-present
American Hospital Association, Committee on Health Professions
The Connecticut Hospital Association, Vice Chair, Board of Trustees; Member, Executive Committee (2006-), Secretary and Member, Executive Committee (1999-2001)
The Country School, Pre-K through 8, Madison, Connecticut, Board Member; Chair (2002-2007).
Novation, Inc., Dallas, Texas ,Founding Board member – (1998-2000)
Greater New Haven Chamber of Commerce, (1997-1998; Board of Directors, Executive Committee
United Way of Greater New Haven Board of Directors (1995-1998)
The Hole in the Wall Gang Camp Board of Directors (2007)
Fellow – American College of Healthcare Executives (2007)

University Appointments

Yale University – Lecturer, Department of Epidemiology & Public Health, Health Policy & Administration Division.

PERSONAL:
Married: Eric N. Borgstrom (5/27/78)
Children: Christopher (4/14/85) and Peter (8/4/89)

CURRICULUM VITAE

RICHARD D'AQUILA
282 Boston Post Road
Westbrook, CT 06498
Telephone: (860) 669-0871

PERSONAL DATA:
Married
U.S. Citizen
Birth Date: 6/29/55

BUSINESS ADDRESS:

Yale-New Haven Hospital
20 York Street
New Haven, CT 06510
Telephone: (203)-688-2606

PROFESSIONAL EXPERIENCE:

May, 2006 to Present

Executive Vice President and Chief Operating Officer
Yale-New Haven Hospital/Yale New Haven Health System

Organizational Profile

Yale New Haven Health System (YNHHS) is a 1545-bed delivery network formed in 1995 which consists of Yale-New Haven, Bridgeport and Greenwich Hospitals. YNHHS has revenues in excess of $1.1 billion in FY '05 based on 80,000 discharges and 1.3 million outpatient visits. Yale-New Haven Hospital is a 944-bed tertiary referral medical center that includes the 201-bed Yale New Haven Children's Hospital and the 76-bed Yale New Haven Psychiatric Hospital. Both Yale New Haven Health System and Yale-New Haven Hospital are formally affiliated with Yale University School of Medicine.

Responsibilities

Overall responsibility for all aspects of day to day operations for Yale-New Haven Hospital (YNHH) and the senior network leader at the Yale New Haven Health System representing the YNHH delivery network. Hospital leadership responsibilities include direct accountability for the senior leadership team, strategic planning, organizational performance, quality improvement, labor relations and human resources management, system integrations, external relations and service line development. Senior leadership and implementation responsibility for all aspects of the hospital's annual business (operating) plan. Senior level oversight of the hospital's facility plan including construction of a 112-bed, $450 million Comprehensive Cancer Pavilion commencing construction in the fall of 2006.

August, 2000 to April, 2006

Senior Vice President/Chief Operating Officer
New York Presbyterian Hospital/
Weill Cornell Medical Center
New York, New York

Organizational Profile
New York Presbyterian Hospital is a 2,369 bed Academic Medical Center created from the merger between the New York Hospital and the Presbyterian Hospital in the City of New York. The Weill Cornell Medical Center consists of an 880 bed acute care facility in Manhattan and the 239 bed Westchester Division campus in White Plains specializing in behavioral health.

Responsibilities
Overall responsibility for all aspects of day to day operations for the Weill Cornell Medical Center and the Westchester Division, a two campus Academic Medical Center of 1120 beds. Direct responsibility for a total operating expense budget in excess of $450,000,000 and revenues of $850,000,000. Senior leadership and implementation for all aspects of the Medical Center's operating plan including quaternary and tertiary service development, medical staff relations and recruitment, employee relations and labor strategy. System level member of the Corporate Management Team with involvement in strategic and facilities planning, service line development, information technology and performance improvement.

May 1992 to June 2000

Executive Vice President/Chief Operating Officer
St. Vincent's Medical Center
Bridgeport, Connecticut

President
Vincentures, Inc.

President
St. Vincent's Development Corporation, Inc.

Chief Operating Officer of 391 bed, university-affiliated acute care hospital and health system. President/CEO of affiliated subsidiaries with management responsibility at the Medical Center and corporate level. Medical Center responsibilities including day to day operations oversight

for patient care services; support services and facilities planning and development. Corporate responsibilities including information systems, ambulatory network development, managed care contracting network oversight and real estate/satellite facility development.

January 1987-April 1992

President/CEO
Health Initiatives Corporation
Providence, Rhode Island

Chief Executive Officer of a consulting practice specializing in strategic planning, business development and project implementation assistance for acute care and specialty hospitals, state planning agencies and private investors. Specific responsibilities included:

- Practice Leadership
- Engagement Planning and Management
- Project Supervision and Control
- Client Interface
- Practice Marketing and Business Development

June 1984-December 1986

Vice President
The Mount Sinai Hospital Corporation
Hartford, Connecticut

June 1981-June 1984

Vice President, Division of Planning and Community Services
The Mount Sinai Hospital
Hartford, Connecticut

June 1979-June 1981

Assistant Executive Director
The Mount Sinai Hospital
Hartford, Connecticut

January 1979-May 1979

Administrative Resident
The Mount Sinai Hospital
Hartford, Connecticut

OTHER APPOINTMENTS:

November 2000
To Present

Member, Board of Directors
Voluntary Hospitals of America/Metro New York
New Rochelle, New York

January 1995-
June 2000

Member, Board of Directors
Goodwill Industries
Bridgeport, Connecticut

December 1993- June 2000	**Founding Board Member** Park City Primary Care Center Bridgeport, Connecticut
May, 1992- June 2000	**Member, Board of Directors** St. Vincent's Development Corporation Vincentures, Inc. Omicron, Inc. Connecticut Health Enterprises Bridgeport, Connecticut
January 1992- December 1994	**Member, Board of Directors** Visiting Nurses Association of Fairfield County Bridgeport, Connecticut
January 1989- December 1991	**Member, Board of Directors** Easter Seal Society/Meeting Street Rehabilitation Center, Inc. of Rhode Island Providence, Rhode Island
January 1980- December 1989	**Member, Board of Directors** Combined Hospitals Alcohol Program Hartford, Connecticut

September 1985- December 1986	**President, Board of Directors** Regional Alcohol and Drug Abuse Resources, Inc. Hartford, Connecticut
September 1981- December 1986	**Adjunct Faculty/Lecturer** University of Hartford, Barney School of Business and Public Administration West Hartford, Connecticut
January 2001 - Present	**Adjunct Faculty/Residency Preceptor and Lecturer** Robert F. Wagner Graduate School of Public Service New York University New York, N.Y.
December 2000 - Present	**Adjunct Faculty/Lecturer** Weill Medical College of Cornell University Department of Public Health, New York New York, N.Y.

EDUCATION:

Yale University School of Medicine
Graduate Program in Hospital Administration
Academic Distinctions: Research Excellence Award (1979)
1979 Graduate

Central Connecticut State University
Bachelor of Arts: Economics/Business
Academic Distinctions: Omicron Delta Epsilon
Economics Honor Society
1977 Graduate

PROFESSIONAL AFFILIATIONS:
Fellow, American College of Health Care Executives
Yale Hospital Administration Alumni Association
Connecticut Hospital Association

CURRICULUM VITAE

NAME: James M. Staten
BIRTHDATE: September 26, 1958
EDUCATION: 1980 – B.S. – Business / Economics / State University College of NY

Yale New Haven Health System (YNHHS) and Yale-New Haven Hospital (YNHH)

October 2000 - Present

Executive Vice President of Finance and Corporate Services, YNHHS
Senior Vice President and CFO, YNHH

Yale New Haven Health system is a regional, integrated health care system composed of three regional health care delivery networks. The New Haven-based delivery system is anchored by Yale-New Haven Hospital, the Yale-New Haven Children's Hospital, and the Yale-New Haven Psychiatric Hospital, which total 944-beds. The system includes a Bridgeport-based delivery system led by the 425-bed Bridgeport Hospital and Greenwich-based delivery system anchored by 160-bed Greenwich Hospital. The System is also affiliated with the Westerly Hospital in Rhode Island. The Yale New Haven Health System has a formal affiliation with the Yale University School of Medicine, as does Yale-New Haven Hospital which serves as the Medical School's primary teaching hospital. System services include acute care hospitals, ambulatory surgery and outpatient diagnostic imaging centers, as well as primary care centers. In total, the System has 1,500 beds, 74,000 admissions, 10,000 employees, assets of $1.6 billion, and annual net revenues of over $1.4 billion.

Responsible for financial and corporate services of YNHHS including managed care, information systems, materials management, admitting/registration, and medical records, as well as all financial responsibilities such as accounting, budgeting, financial and operational reporting, tax, reimbursement, and treasury.

OTHER EMPLOYMENT

New York-Presbyterian Hospital (NYPH) and New York-Presbyterian Healthcare System (NYPHS)

July 1999 – October 2000 Senior Vice President of Finance

Responsible for assuring the financial viability of a $3 billion Health System, including monitoring financial condition of approximately 15 corporately-controlled Sponsored/Member Hospitals and other healthcare related organizations. Report regularly to the NYPHS Board and NYPH Board Executive Committee on financial performance.

January 1997 - June 1999 Vice President of Financial Planning
June 1993 - December 1996 Director of Financial Planning

Responsible for complete integration of financial planning at all Sponsored Hospital Members including NYPH and leading the financial group of approximately 70 professionals in performing budget, reimbursement, managed care contracting, decision support and business plan development functions.

Ernst & Young

January 1991 - June 1993 Senior Manager - Consulting Services

Directed and coordinated Ernst & Young's New York State Reimbursement Consulting Services.

Pannell Kerr Forster

October 1980 – December 1990 Partner

Elected Partner in June 1990 after working 10 years in the firm's large healthcare practice as a certified public accountant. 11th Largest Public Accounting Firm in United States during late 1980s.

PROFESSIONAL MEMBERSHIPS

American Institute of Certified Public Accountants (1982 – 1998)
New York State Society of Certified Public Accountants (1982 – 1996)
- Healthcare Committee (1988 – 1991)
- Chairman of the Hospital Sub-Committee (1990/1991)

Healthcare Financial Management Association (1984 – 1994)
- Chairman of various Committees (1984 – 1994)
- Trustee (1990/1991)
- President Elect (1993/1994)

Greater New York Hospital Association
- Fiscal Policy Committee (1993 – 2000)
- Managed Care Committee (1995 – 2000)

Connecticut Hospital Association
- Finance Committee (2000 – 2004)
- Special Committee on Medicaid Reimbursement (2000 – 2004)

Blue Ribbon Committee on the Future of Healthcare in Connecticut (2000 – 2003)

OTHER PROFESSIONAL ACTIVITIES

Presenter at New Jersey Health Care Financing Authority on Medicare Payment System
Presenter on Hospital Reimbursement Issues for the NYS Society of CPAs
Presenter on Accounts Receivable Issues for the Connecticut Hospital Association
Guest Speaker at NYU's graduate program in Hospital Administration on Healthcare Financing
Guest speaker at Cornell University's Sloan Program in Health Services on Managed Care
Presenter on Mergers and Acquisitions to New York State Hudson Valley HFMA
Guest speaker at Chicago Municipal Bond Analysts Society on New York State Hospital Deregulation
Guest speaker at Yale's School of Epidemiology and Public Management on Health Systems

CURRICULUM VITAE

Date of this revision: May 21, 2013

Name: David W. Cheng, M.D., Ph.D.

Proposed for Promotion to: Associate Professor, Clinician Educator track, Department of Diagnostic Radiology

Term: July 1, 2012 – June 30, 2017

School: Yale University School of Medicine

Reason for Promotion: (to be written by department chair or section chief; inserted after candidate submits materials to Department)

Education:

B.S. Biochemistry, University of California, Los Angeles, 1983
M.S. Chemistry, California State University, Los Angeles (CSULA), 1986
Ph.D. Biomedical Physics, University of California, Los Angeles (UCLA), 1992
M.D. Albert Einstein College of Medicine (AECOM), Bronx, NY, 1996

Career/Academic Appointments: If a Clinician, please include the month & year (MM/YYYY) for credentialing purposes

1987	Instructor in Chemistry at Glendale Community College, Glendale, CA
1988	Consultant for Nissin Corporation, Los Angeles, CA
1990-1992	MCAT Instructor for Stanley H. Kaplan Educational Center, Los Angeles, CA
1993-1995	Tutor in Medical Biochemistry at Albert Einstein College of Medicine
1996- 2000	Combined residency in Internal Medicine and Nuclear Medicine at Montefiore Medical Center, Bronx, NY
1999-2000	Co-chief resident in Nuclear Medicine at Montefiore Medical Center (MMC, official affiliate of Albert Einstein College of Medicine), Bronx, NY
2000-2001	ICMIC/PET Fellow at Memorial Sloan-Kettering Cancer Center (MSKCC), New York, NY
2001-2007	Assistant Professor, Department of Diagnostic Radiology, Nuclear Medicine Section, Yale University School of Medicine
2002-2004	Interim Clinical Director of Yale University PET Center, Yale University School of Medicine
2003-2004	Acting Director, Nuclear Medicine Section, Department of Diagnostic Radiology Yale University School of Medicine
2003-2004	Interim Director of Yale University PET Center, Yale University School of Medicine
2004-2008	Clinical Director, Nuclear Medicine Section, Department of Diagnostic Radiology Yale University School of Medicine
2003-Present	Nuclear Radiology and PET/CT Fellowship Training Program Director Nuclear Medicine Section, Department of Diagnostic Radiology Yale University School of Medicine
2007-Present	Associate Professor, Clinician Educator track, Department of Diagnostic Radiology, Nuclear Medicine Section, Yale University School of Medicine
2008-Present	Director, Nuclear Medicine Section, Department of Diagnostic Radiology

	Yale University School of Medicine
2003-2011	Nuclear Medicine Residency Training Program Director, Nuclear Medicine Section, Department of Diagnostic Radiology, Yale University School of Medicine
2011-Present	Medical Director of Yale University PET Center, Yale University School of Medicine

Administrative Positions: If a Clinician, please include the month & year (MM/YYYY) for credentialing purposes

2008-Present	Director, Nuclear Medicine Section, Department of Diagnostic Radiology, Yale University School of Medicine, New Haven, CT
2011-Present	Medical Director, Yale University PET Research Center, Yale University School of Medicine, New Haven, CT

Board Certification:
American Board of Nuclear Medicine, 2000, 2010

Professional Honors & Recognition (list from most recent to earliest):

International/National/Regional
1987: NSF travel award to NATO conference at Cape Sounion, Greece

University

1980	National Dean's List
1979-1980	College Honors at UCLA

Grant History (list from most recent to earliest; total % effort on active grants and clinical trials must not exceed % effort toward research listed on CV Supplement)

Current Grants:

Agency:	Baxter Healthcare Corporation
I.D. #:	160701
Title:	A Randomized, Double-Blind, Placebo-Controlled, Two Dose-Arm, Parallel Study of the SAFETY and Effectiveness of Immune Globulin Intravenous for the Treatment of Mild-to-Moderate Alzheimer's Disease (160701)
P.I.:	Christopher van Dyck, MD
Role on Project:	Co-investigator
Percent effort:	
Direct costs per year:	
Total costs for project period:	
Project Period:	October 2009 – December 2012

Agency:	Genentech, Inc.
I.D. #:	HIC#1206010395
Title:	Multicenter, Randomized, Double-Blind, Placebo-Controlled, Parallel-Group Two Year Study to Evaluate the Effect of Subtaneous RO49009832 on Cognition and Function in Prodromal Alzheimer's Disease
P.I.:	Christopher van Dyck, MD

Role on Project: Sub-investigator
Percent effort:
Direct costs per year: $/$ (est)
Total costs for project period: $/$ (est)
Project Period: November 2012 – November 2014

Agency: BioGen
I.D. #: HIC# 1207010508
Title: A Randomized, Double-Blinded, Placebo-Controlled Multiple Dose Study to Assess the Safety, Tolerability, Pharmacokinetics, and Pharmacodynamics of BIIB037 in Subjects with Prodromal or Mild Alzheimer's Disease
P.I.: Christopher van Dyck, MD
Role on Project: Sub-investigator
Percent effort:
Direct costs per year: $/$ (est)
Total costs for project period: $/$ (est)
Project Period: December 2012 – December 2014

Agency: Eisai Inc.
I.D. #: HIC #: 1211011120
Title: A Placebo-controlled, Double-blind, Parallel-group, Bayesian Adaptive Randomization Design and Dose Regimen-finding Study to Evaluate Safety, Tolerability, and Efficacy of BAN2401 in Subjects with Early Alzheimer's Disease
P.I.: Christopher van Dyck, MD
Role on Project: Sub--Investigator
Percent effort:
Direct costs per year: $/$ (est)
Total costs for project period: $/$ (est)
Project Period: May 2013 – May 2015

Agency: Merck & Company
I.D. #: HIC# 1204009991
Title: A Randomized, Placebo Controlled, Parallel-Group, Double Blind Efficacy and Safety Trial of MK-8931 in Subjects with Mild to Moderate Alzheimer's Disease.
P.I.: Christopher van Dyck, MD
Role on Project: Sub-investigator
Percent effort:
Direct costs per year: $/$ (est)
Total costs for project period: $/$ (est)
Project Period: May 2013 – May 2015

Agency: Alzheimer's Association
I.D. #: HIC #: 0702002301
Title: Amyloid Imaging in Subjects with and at risk for Alzheimer's Disease: A Positron Emission Tomography (PET) Study
P.I.: Christopher van Dyck, MD
Role on Project: Sub-investigator
Percent effort:
Direct costs per year: $/$ (est)
Total costs for project period: $/$ (est)
Project Period:

Agency: NIH/NIA
I.D. #: HIC#: 1011007597
Title: Alzheimer's Disease Neuroimaging Initiative 2 (ADNI-2)
P.I.: Christopher van Dyck, MD
Role on Project: Sub-investigator
Percent effort:
Direct costs per year:
Total costs for project period:
Project Period: September 2004 – August 2015

Past Grants

Agency: Avid Radiopharmaceuticals
I.D.#: ELN115727-301:
Title: F-AV-45-A15-ADNI-GO: Safety Evaluation of Florbetapir F 18 (^{18}F-AV-45) in Subjects Participating in the ADNI-GO Protocol
P.I.: Christopher van Dyck, MD
Role on Project: Co-investigator
Percent effort:
Total costs for project period:
Project Period: July 12, 2010-June 22, 2012

Agency: JANSSEN Alzheimer Immunotherapy
I.D. #:
Title: A Phase 3, Multicenter, randomized, Double-Blind, Placebo-Controlled, Parallel-group, Efficacy and Safety trial of Bapineuzumab (AAB-001, ELN115727) in Subjects with Mild to Moderate Alzheimer's Disease who are Apolipoprotein E4 Non-Carriers
P.I.: Christopher van Dyck, MD
Role on Project: Co-investigator
Percent effort:
Total costs for project period:
Project Period: 11//8/08 – 11/8/11

Agency: National Institutes of Health
I.D.#: FDA IND# 104,493

Title: The Use of [11C] PKAB to Image the Kappa Opioid Receptor with Positron Emission Tomography (PET)
P.I.: Thomas Carpenter, MD
Role on Project: Co-investigator
Percent effort:
Total costs for project period:
Project Period: September 1, 2006 – August 31, 2011

Agency:
I.D #:
Title: The Role of Parathyroid Hormone in the Pathogenesis of Skeletal Disease in X-linked Hypophosphatemia
P.I.: Julie Vose, MD (study chairperson) / Dennis Cooper, MD and Stuart Seropian, MD of Yale Stem Cell Transplant Service
Role on Project: Co-investigator
Percent effort:
Total costs for project period:
Project Period: September 2006-August 2009

Agency: NIH, National Heart, Lung, and Blood Institute, and NCI (BMT CTN Protocol 0401)
I.D.#:
Title: Phase III Rituxan/Beam vs. Bexxar/BEAM with Autologous Hematopoietic Stem Cell Transplantation (ASCT) for Persistent or Relapsed Chemotherapy Sensitive Diffuse Large B-cell Non-Hodgkin's Lymphoma
P.I.:
Role on Project:
Percent effort:
Total costs for project period:
Project Period:

Agency: Pfizer (competitive funding: PI initiated)
I.D.#:
Title: Increasing FDG-PET specificity with Kreb Cycle through flux using MR Spectroscopy
P.I. David Cheng, M.D., Ph.D.
Role on Project: Principal Investigator
Percent effort: 10%
Total costs for project period: $588,301
Project period: January 1, 2005- December 31, 2006

Agency: NIH
I.D.#:
Title: Radioisotope Therapy Targeting the Somatostatin Receptor
P.I. John Murren, M.D.

Role on Project: Co-Investigator
Percent effort: 10%
Total costs for project period: $327,000
Project period: 2002-2005

Past Clinical Trials
???

Invited speaking Engagements, Presentations, Symposia & Workshops Not Affiliated With Yale:
(list from most recent to earliest)

International/National

2012: Novel investigation of dose reduction in FDG-PET scanning. Presented at Workshop entitled: Optimization of patient exposure in Nuclear Medicine at Fondazione Toscana CNR/Regione Toscana per la Ricerca Medica e di Sanita Pubblica in Pisa, Italy (invited lecture given on November 2, 2012)

2012: Staging using P.E.T. CME course given at the American College of Chest Physicians (ACCP) CHEST 2012 meeting in Atlanta, GA (invited lecture given on October 25, 2012)

2012: Understanding Radioiodine Treatment of Thyroid Cancer from the Yale New Haven Hospital perspective. Given at: The 5th World Cancer Congress, Beijing, China (invited lecture given on May 20, 2012)

2012: Approaches to dose reduction in FDG-PET scanning. Given at the Physics Project Meeting at Peter McCallum Cancer Center, Melbourne, Australia (invited lecture given on May 14, 2012)

2010: The Value of Hybrid Imaging in Thyroid Cancer. Presented at the 10th Annual Stowe Weekend of Hope in Stowe, Vermont with institutional involvement from the University of Vermont

2008: Role of Nuclear Medicine in the Management of Thyroid Cancer: presented at Stowe Weekend of Hope meeting for cancer survivors in Stowe, VT with institutional involvement from the University of Vermont.

2006: The Role of Nuclear Medicine in Management of Oncology Patients. Presented at Active Communications International's Sixth National Conference on Adding, Updating and Expanding Comprehensive Cancer Programs and Services, Palo Alto, CA

2005: Radioiodine Imaging and Therapy: presented at Stowe Weekend of Hope meeting for cancer survivors in Stowe, VT with institutional involvement from the University of Vermont.

1990: Working with PET. Presented at the Department of Radiation Oncology noon conference, UCLA

Regional

2011: Contributions of Nuclear Isotopes in Medicine, a Perspective. Presented at American Nuclear Society, Connecticut Section in Rocky Hill, CT.

2011: Nuclear Medicine for Hospitalists. Presented at Yale-New Haven Hospital Internal Medicine Department noon conference in New Haven, CT.

2010: How Compartment Modeling Help with C-11 Labeled Pharmaceuticals in Pre-Clinical Trial Investigation. Presented at Albert Einstein College of Medicine, Department of Nuclear Medicine Grand Rounds, Bronx, New York.

2005: Role of FDG-PET Scanning in Management of Lung Cancer. Presented at Annual Connecticut State Chest Conference, New Haven, CT

2003: Role of FDG-PET Scanning in Management of Lung Cancer. Presented at Annual Connecticut State Chest Conference, New Haven, CT

1999: Herceptin: a new treatment in cancer. Presented at Department of Nuclear Medicine Grand Rounds at Montefiore Medical Center, Bronx, NY
1999: Imaging in Gene Therapy. Presented at Department of Nuclear Medicine Grand Rounds at Montefiore Medical Center, Bronx, NY
1995: Intussusception. Presented at Department of Surgery Grand Rounds at Bronx-Lebanon Hospital, NY
1995: Chinese medicinal philosophy behind acupuncture. Presented to the Department of Family Medicine at AECOM, Bronx, NY
1994: Clozapine: an "atypical" neuroleptic with "atypical" concerns. Presented to the Department of Psychiatry at Montefiore Medical Center, Bronx, NY
1994: Premature birth. Presented to the Department of OB/GYN at Jack C. Weiler Hospital, Bronx, NY

Peer-Reviewed Presentations & Symposia Given at Meetings Not Affiliated With Yale: (list from most recent to earliest)

International/National:

Regional:

Professional Service

Peer Review Groups/Grant Study Sections (list from most recent to earliest):

10/2012-Present	Member, Dosimetry Committee of the European Association of Nuclear Medicine
5/2011- Present	FDA Orphan Grant Reviewer
July 2012	Clinical Consultant (Bayer Blinded Reader)
January 2011	Clinical Consultant (Bayer Blinded Reader)
2003 - Present	Radiation disaster response team for Yale-New Haven Hospital and the state of Connecticut
2003 - Present	Radiation Exposure Task Force Committee for the Department of Diagnostic Radiology at Yale-New Haven Hospital
2003 - Present	Medical Advisor, Gateway Community College radiology training programs
2003 – 2005	Vice President and co-founder of the PET Society of Connecticut
2005 - 2008	President of the PET Society of Connecticut

Journal Service
Editor/Associate Editor:
N/A

Reviewer:
8/2011- Present Reviewer for the Journal of Nuclear Medicine

Professional Service for Professional Organizations (list from most recent to earliest):
N/A

Meeting Planning/Participation

N/A

Yale University Service: (list from most recent to earliest):

University Committees
2004 – Present Member, Yale University Radiation Safety Human Use Committee
2004 – Present Member, Radioactive Drug Research Committee, Yale University

Medical School Committees
N/A

Departmental Committees
N/A

Hospital Boards & Committees
2005 – Present Member, Yale-New Haven Hospital Cancer Center Committee

Public Service:
N/A

Bibliography: (list from earliest to most recent and number consecutively)

Peer-Reviewed Original Research

1. Yee RE, **Cheng DW**, Huang SC, Namavari M, Satyamurthy N, and Barrio JR. Blood-brain barrier and neuronal membrane transport of 6-[^{18}F] fluoro-L-DOPA. *Biochem Pharmacol* 62(10):1409-1415, 2001.
2. Pappu S, Donovan P, **Cheng DW,** and Udelsman R. Sestamibi scans are not all created equally. *Arch Surg* 140:383-386, 2005.
3. Dainiak N, Domenico DC, Bohan BS, **Cheng DW**, et al. Development of a statewide hospital plan for radiologic emergencies. *Int J Radiation Oncology Biol Phys* 65(1):16-24, 2006.
4. Detterbeck F, Puchalski J, Rubinowitz A and **Cheng DW.** Classification of the Thoroughness of Mediastinal Staging of Lung Cancer. *Chest* 137; 436-442, 2010.
5. Vastone MB, Udelsman RD, **Cheng DW** and Carpenter TO. Rapid Correlation of Bone Mass after Parathyroidectomy in an Adolescent with primary Hyperparathyroidism. J Clin Endocrinol Metab 96: E347- E350, 2011.
6. Ersahin D., Doddamane I, and **Cheng DW**. Targeted Radionuclide Therapy. *Cancers* 3(4): 3838-3855, 2011.
7. Chen MK, Yasrebi M, Samii J, Staib L, Doddamane I, and **Cheng, DW.** The Utility of I-123 pretherapy scan in I-131 radioiodine therapy for thyroid cancer. *Thyroid* 22(3): 304-309, 2012.

Chapters, Books and Reviews

8. Travin MI and **Cheng DW.** Myocardial perfusion imaging as a prognostic tool. In:_*Nuclear Medicine Annual* (ed. L. M. Freeman), 173-209. Lippincott Williams & Wilkins, Philadelphia, PA, 2000.
9. Zuckier LS and **Cheng DW.** The Schilling Test. In: *The pathologic basis of nuclear medicine* (ed. A. Elgazzar), 344-349. Springer-Verlag, Berlin, 2001.
10. **Cheng D**, Ludwig JA, and Scoutt L. Parathyroid imaging. In: *Thyroid and parathyroid surgery* (ed. D. Oertli and R. Udelsman), 245-259. Springer-Verlag, Berlin, 2007.
11. Wang T, **Cheng D,** and Udelsman R. Contemporary imaging for thyroid cancer. *Surgical Oncology Clinics of North America* 16(2): 431-445, 2007.
12. Chen MK, Doddamane I and **Cheng DW.** Recombinant human thyroid-stimulating hormone as an alternative for thyroid withdrawal in thyroid cancer management. *Current Opinion in Oncology* 22:6-10, 2010.

Peer-Reviewed Educational Materials
N/A

Invited Editorials and Commentaries
N/A

Practice Guidelines, Standards and Consensus Statements
N/A

Case Reports, Technical Notes, Letters

13. Kuo PH and **Cheng DW.** Artifactual spinal metastases imaged by PET/CT: A case report. *J Nucl Med Technol* 33:230-231, 2005.
14. Kuo PH, **Cheng DW,** and Sadar R. Diagnosis of septic joint in an immunosuppressed patient by twenty-four hour delayed imaging with Tc-99m HMPAO labeled white blood cell scan. *Clin Nucl Med* 30 (12): 808-809, 2005.
15. Kuo PH, Cooper D L, and **Cheng DW**. Recurrence of lymphoma presenting as asymmetrically increased testicular activity on FDG-PET/CT. *Sem. Nucl Med* 105-107, 2006.
16. Shetty-Alva N and **Cheng DW**. Low-Dose P32 Therapy in Essential Thrombocytopenia. *Clin Nuc Med* 31(12): 790-791, 2006.
17. Brian S, **Cheng, DW,** and Goldberg, PA. An unusual case of amiodarone-induced thyrotoxicosis: the "illicit" use of a technetium scan to diagnose a transiently toxic thyroid nodule. *Endocrine Practice* 13(4): 413-416, 2007.

Scholarship In Press:
N/A

CURRICULUM VITAE

Albert J. Sinusas, M.D., FACC, FAHA
Yale University School of Medicine
Section of Cardiovascular Medicine, DANA-3
P.O. Box 208017
New Haven, CT 06520-8017
(203) 785-5005

Born: September 14, 1957; Huntington, New York

Education: M.D., University of Vermont, College of Medicine 8/79 - 6/83
B.S., Cum Laude Biology, Rensselaer Polytechnic Institute 9/75 - 5/79

Career:

7/83-6/84: Internship, Medicine, University of Oklahoma, Health Science Ctr., Oklahoma City, OK

7/84-6/86: Residency, Medicine, University of Oklahoma, Health Science Ctr., Oklahoma City, OK

7/86-6/89: Fellowship, Cardiology, University of Virginia, Health Science Ctr., Charlottesville, VA

7/89-12/89: Instructor, Cardiology, University of Virginia, Health Science Ctr., Charlottesville, VA

1/90-6/95: Assistant Professor Medicine & Diagnostic Radiology, Yale University, New Haven, CT

1/90-12/05: Associate Director, Cardiovascular Nuclear Imaging & Stress Laboratory, Yale University, New Haven, CT

8/91- Director, Animal Research Laboratories, Section of Cardiovascular Med., Yale University, New Haven, CT

7/95-6/05 Associate Professor Medicine & Diagnostic Radiology
Yale University, New Haven, CT

7/05- Professor Medicine & Diagnostic Radiology
Yale University, New Haven, CT

1/06- Director, Cardiovascular Nuclear Imaging & Stress Laboratory,
Yale University, New Haven, CT

9/08- Director, Cardiovascular Imaging,
Yale University, New Haven, CT

9/10- Director, Yale Translational Research Imaging Center (Y-TRIC)
Yale University, New Haven, CT

10/12- Board of Directors, YNHH Heart & Vascular Center

Board Certification:

National Board of Medical Examiners, Diplomat, 7/2/84
American Board of Internal Medicine, Internal Medicine, 9/10/86 (permanent)
American Board of Internal Medicine, Cardiovascular Diseases, 11/8/89 (permanent)
Certification Council of Nuclear Cardiology, Nuclear Cardiology, 12/1/97, 2007-2017
Certification Board Cardiovascular Computed Tomography (CCCT), 2009-2019

Medical Licensing:

State of Connecticut 1/26/90- present License #: 030554
Commonwealth of Virginia 11/86 - 9/90
State of Oklahoma 8/84 - 8/86

Academic Honors/Awards:

Hermann Blumgart Award, Society of Nuclear Medicine, 2008
M.A. *Privatim* (honorary Master's degree) from Yale University, 2006
Best Doctors in America 2001-2002, 2005-2006, 2007-2008, 2009-2010, 2011-2012
Top Doctors for Women, Cardiovascular Medicine, Connecticut Magazine 5/2002
Cardiovascular Young Investigator Competition 1991, Society of Nuclear Medicine, 3rd place
Cardiovascular Young Investigator Competition 1990, Society of Nuclear Medicine, 2nd place
National Research Service Award; National Heart, Lung, and Blood Institute (7/88 - 6/90)
Proposal title: Evaluation of Ischemic Dysfunction with Tc99m MIBI
Sponsor: George A. Beller, M.D.
University of Vermont Century Club Award for Undergraduate Research

Professional Memberships:

Founding Member, American Society of Nuclear Cardiology
Fellow, American College of Cardiology (FACC)
Fellow, American Heart Association (FAHA)
Fellow, American College of Physicians (FACP)
Member, Society of Nuclear Medicine
Member, The American Physiological Society
Member, Academy of Molecular Imaging
Member, Society of Cardiovascular Magnetic Resonance
Member, American Society of Echocardiography

Professional Service:

National

1. Associate Editor, Journal of Nuclear Medicine – 1/2011- present
2. National Institutes of Health, Center of Scientific Review
   Clinical & Integrative Cardiovascular Sciences [CICS]:
   Permanent Standing Member – 8/31/05-6/30/07
   Ad Hoc Reviewer – 3/2004, 11/2004, 3/2005, 2/2009, 4/2009, 6/2009, 6/2012, 10/2012
   NIBIB, Special Emphasis, ZEB1 OSR-D(J1)S, Review T32 and R25 grants: 10/2012
   Shared Instrumentation Imaging Grants – ZRG1 SBIB-R: 6/2005
   NIBIB, Special Emphasis Panel – ZRG1 SBIB-F: 7/2004
   Clinical Cardiovascular Sciences (CCVS) –
   7/2000, 12/2000, 4/2001, 7/2001, 4/2002, 11/2002, 11/2003
   Experimental Cardiovascular Sciences Study Section [ECS]: 3/2003
   Council ZRG1 F10 20 (post-doctoral) – 2/2002
   Council ZRG1 F10 29 (pre-doctoral) – 2/2002

3. Society of Nuclear Medicine
   Board of Directors, Cardiovascular Council, 1993–1995, 2001-2003, 2003-2005, 2006-2010, 2011-2013
   President, Cardiovascular Council, 2005-2006
   Board of Directors, Molecular Imaging Center of Excellence (MICoE), 2006-2008
   Chairperson, Cardiology Working Group of SNM Committee on Outreach
   February 18, 2011 through June 2012
4. American Society of Nuclear Cardiology
   Board of Directors - 2002-2006
   Quality Assurance Committee – 2006-2009
   Education Committee 2003-2006
   Research Grants Committee 2001-2004
   Director, Cardiovascular Molecular Imaging Task Force 2002
   Scientific Program Committee, Basic Scientists Sub-Committee 2002-2004
   Government Relations Committee 2002-2004
   Imaging Guidelines for Nuclear Cardiology Procedures:
   Quality Assurance: Planar Perfusion Imaging
   National Committee Chairman 1996-1998
   National Committee 1999-2001
5. Journal of Nuclear Cardiology, Associate Editor, 6/93–12/03
6. American Heart Association, National
   Cardiovascular (Patho)Physiology 1 Study Committee, 7/1998-6/2003
7. American Heart Association, Heritage Affiliate
   Research Grant Peer Review Committee, Northeast One, 1998-2001
8. American Journal of Cardiac Imaging, Guest Editor, 1993
   Symposium: "Myocardial Reperfusion Imaging: Basic and Clinical"

Institutional (Yale University School of Medicine)

1. Diagnostic Radiology Search Committee 4/13 - present
2. Dean's Faculty Allotment Committee 7/08 – 6/11
3. PET Center Steering Committee 1/07- present
4. Radiation Safety Committee 9/05-9/07, 9/09 - present
5. Animal Users Group 6/01- present, (Chairman, starting 1/2010 - present)
6. Advisory Committee ,Yale Magnetic Resonance Research Center (MRRC) 2/02 – present
7. Funds and Fellowships Committee 9/03-12/06
8. Yale Animal Care and Use Committee 1/98-6/03
9. Yale New Haven Hospital, Clinical Pathways Committee - "MI with Cath", 1995-1996

Hospital (Yale New Haven Hospital (YNHH))

1. Co-Chair – Clinical Investigations Sub-Committee, YNHH BOD H&VC – 3/13 – present
2. Member, Growth/Strategic Sub-Committee, YNHH BOD H&VC – 2/13 - present
3. Board of Directors – YNHH Heart & Vascular Center (BOD H&VC) - 10/12 - present
4. Chest Pain Center Accreditation Committee – 3/09 - present
5. Expansion of Stress Echocardiography - 1/09 – 6/2012
6. CTA Credentialing Committee - 2007- present

Grant History for last 12 years:

Active:

1. R01 HL113352-01A1 (Sinusas, AJ/Akar, JG) 2/1/2013 - 1/31/2017
NIH-NHLBI $421,836/year
Title: "Molecular Imaging Predicts Atrial Remodeling and Fibrillation Vulnerability"
The project will non-invasively identify the substrate that predisposes to atrial fibrillation (AF) before the development of irreversible change in order to provide early preventative intervention. The focus is on MMP targeted SPECT/CT imaging.
Effort: 15% Role: Co-PI
2. R01 HL112992-01A1 (Sadeghi, M) 2/1/2013-1/31/2017
NIH-NHLBI $250,000/year
Title: Macrophage Elastase and Its Imaging in Vascular Inflammation and Remodeling
The main goals of the proposal are to develop novel tracers for imaging macrophage elastase activation, investigate expression of macrophage elastase on inflammatory cells and validate macrophage elastase-targeted imaging for imaging vessel wall inflammation and remodeling in atherosclerosis and aneurysm.
Effort: 5% Role: Co-Investigator
3. NFL Charities (Sinusas, AJ) 7/1/2012- 12/30/2013 $100,000
Title: "Non-Invasive Quantitative Imaging of Muscle Growth and Vascularization in College Football Athletes"
The study evaluates the effect of weight training on muscle growth and associated vascularization in linemen versus position players.
Role: Principal Investigator
Effort: 3% Role: PI
4. BIOMAGSCAR Yale-UCL (Martin, J) 3/1/12- 2/28/16 €483,830 (over 4 years)
EU Grant Agreement #: 278313 €483,830 (over 4 years)
Title: "Biodegradable magnetic stent for coronary artery luminal regeneration"
Effort: 5% Role: Co-Investigator
5. PPG (Simons, M) 3/1/2012 – 2/28/2017 $140,000/year
Core B: SURGICAL AND IMAGING CORES (Core PI: Sinusas)
Title: "Molecular control of collateral development"
Effort: 5% Role: Core PI
6. T32 Training Grant (Sinusas, AJ/Duncan JS) 9/21/2010 - 8/31/2015
NIH-NRSA 5T32HL098069-02 $216,552/year
Title: "Training in Multi-modality Molecular and Translational Cardiovascular Imaging"
A multi-disciplinary post-doctoral training program in which the research conducted will be vital for the advancement and management of cardiovascular diseases and provide advancement in imaging technologies and translational cardiovascular research.
Effort: no effort Role: Co-PI
7. R01- HL085093-01 (Sadeghi, MM) 09/01/07-06/30/12 $250,000
"Molecular Imaging of Vascular Remodeling"
The major goal of this project is to address the functional significance of $\alpha v\beta 3$ and MMP activation in models of vascular remodeling using a non-invasive imaging approach.Principal
Effort: 5% Role: Co-Investigator

8. R21 HL103463 (Peters, DC) 6/15/11 - 5/31/13 $125,000
"In Search of the Arrhythmogenic Grey Zone within Myocardial Scar Using Late Gadolinium Enhancement Cardiovascular Magnetic Resonance"

The major goal of this proposal is to improve late gadolinium enhancement imaging and analysis methods to identify arrythmogenic myocardial scar.
Effort: 3% Role: Collaborator

9. R21 HL098573 (Peters, DC) 8/24/11 - 6/30/12 $182,781
Title: "Late Gadolinium Enhancement Cardiovascular MR for the Detection of Pre-Existent Left Atrial Scar in Patients with Atrial Fibrillation"
The objective of this work is to detect the arrhythmic substrate which may cause atrial fibrillation, by improving the sensitivity of standard scar imaging methods, and studying patients with atrial fibrillation.
Effort: 5% Role: Collaborator
10. Yale CCI Scholar Award(Liu, C) 7/1/2011 - 6/30/2013 $25,000
Title: "Quantitative SPECT Imaging of Myocardial Blood Flow"
This grant is to study the feasibility of quantifying myocardial blood flow using dynamic SPECT/CT in porcine models.
Role: Mentor and investigator
11. Siemens Healthcare (Liu, C) 10/1/2011 - 3/31/2013 $178,666
Title: "Myocardial Blood Flow: Preclinical and Clinical Evaluation on the mCT"
This grant is to develop algorithms for motion correction and 4D reconstruction algorithms, and to optimize myocardial blood flow quantification on Siemens mCT using canine models and human subjects.
Effort: 1% Role: Co-Principal Investigator

12. Astellas Pharma Global (Sinusas, AJ) 7/1/2011-7/1/2013
"Detecting Heart Disease Using First Pass Imaging with Gated SPECT Perfusion."
The primary aims of this Phase IV clinical trial are two-fold: 1) to determine if stress first pass imaging in conjunction with gated SPECT will improve the sensitivity for detecting heart disease and 2) to determine if first pass imaging provides a more reproducible approach for evaluation of both rest and stress global LV function over gated SPECT perfusion imaging compared with 3D echocardiography.
13. Lantheus Medical Imaging, Inc. (Sinusas, AJ) 4/1/2011 – 4/1/2013
"A Phase 3: Open-Label Multicenter Study for the Assessment of Myocardial Perfusion using Positron Emission Tomography (PET) Imaging of Flurpiridaz F18 injection in Patients with Suspected or Known Coronary Artery Disease"
To acquire data for the evaluation of Flurpiridaz F18 injection in PET myocardial perfusion imaging.

Previously Funded:

1. NIH-NHLBI: 2R01 HL65662-05 7/2001-5/31/2011(NCE) $1,000,000 ($250,000/yr)
"Non-invasive Methods for Imaging Angiogenesis"
Principal Investigator: Albert J. Sinusas, M.D.
The major goal is to apply radiotracers targeted at the $\alpha v\beta 3$ integrin in combination with CT angiography using hybrid microSPECT/X-ray CT imaging strategies for the *in vivo* evaluation of the interdependent roles of angiogenesis and arteriogenesis in limb salvage in peripheral arterial disease (PAD). The *in vivo* hybrid methodology will be tested by

evaluating the role of the αvβ3 integrins and nitric oxide (NO) in the regulation of these processes in murine models.
Effort: 18% Role: PI

2. NIH (subcontract): R08881 6/01/08-5/31/11 (NCE) $99,197
"Collagenase Inhibition in Heart Failure"
Principal Investigator: Francis G. Spinale, MD. PhD. (Medical University of South Carolina)
Effort: 5% Role: Co-investigator
3. BRP HL082640-01A1 (Duncan, JS) 9/01/06-6/30/11 $7.2M ($250,000/yr as Partner)
"LV Strain Quantification from 4D Echocardiography"
In this BRP, four partners from two academic institutions and industry will develop and validate an integrated imaging/image analysis system that will accurately, robustly andreproducibly quantify regional LV strain and strain rate from four-dimensional (3 spatial dimensions and time) echocardiographic (4DE) image sequences.
Effort: 25% Role: Co-Investigator, Cardiology Partner
4. CT Department of Public Health (Sampath, S) 1/15/2011-1/15/2012
"Magnetic resonance imaging (MRI) assessment of peripheral artery disease at 3 tesla"
This project's purpose is to identify non-invasive magnetic resonance imaging markers to assess peripheral artery disease (PAD) and perform initial testing in normal volunteers and porcine animal models of PAD.
Effort: 5% Role: Co-investigator
5. R01HL077810-01A2 8/1/06-6/30/11 (NCE) $250,000/yr
"Segmentation of Ultasound Images"
Principal Investigator: Hemant Tegare, PhD
Effort: 3% Role: Co-Investigator
6. NIH - NHLBI 5P01 HL70295-03 6/30/01-8/01/11 (Project 3, $250,000/yr)
"Chronic DTH and IFN-g in human graft arteriosclerosis" (PI: Jordon Pober, M.D., Ph.D.)
Project 3, Imaging DTH, IFN-gamma Response and GA in Human Arteries,"
Co-Investigator: Albert J. Sinusas, M.D., Project 3 (PI: Jeffrey Bender, M.D.)
Effort: 3%
7. NIH-NHLBI: R01 HL077357-01 (Min, W) 04/01/2007 – 03/31/2011
"TNF receptor-2 signaling in arteriogenesis/angiogenesis."
The major goal of this project will be to characterize defects of angiogenesis and arteriogenesis in TNFR2-KO mice and dissect TNFR2 signaling in ECs, and define the role of EC-expressed TNF2 in inflammatory angiogenesis using transgenic mouse models.
Effort: 3% Role: Co-Investigator
8. R01 HL080176 12/1/05- 11/30/10 (NCE) $250,000/yr
"Cardiovascular effects of endothelial-derived neuregulin"
Principal Investigator: Kerry Russell, MD, PhD
Effort: 2% Role: Co-Investigator

9. NIH: 1R13HL096375-01 4/30/09 – 4/29/10 $15,000
"Multimodality Cardiovascular Molecular Imaging Symposium"
Principal Investigator: Albert J. Sinusas, M.D.
The proposed two-day symposium will bring together individuals from multiple scientific disciplines; including chemistry, engineering, physics, molecular biology, cardiovascular physiology, and imaging sciences with the goal of promoting the nascent field of cardiovascular molecular imaging.

10. NIH-1S10RR025555-01 4/01/09 – 3/31/10 $500,000
"Hybrid Volumetric SPECT/CT Imaging System"
Principal Investigator: Albert J. Sinusas, M.D.
The state-of-the-art SPECT/CT imaging system will support the translational research of multiple current NIH funded investigators at Yale University School of Medicine, from Departs. Medicine, Diagnostic Radiology, Surgery, and Anesthesiology, and Depart. Biomedical Engineering Yale University. The imaging system will allow for the testing and validation of experimental molecular imaging agents and bioengineered blood vessels.
11. NIH-NHLBI: R01 HL078650-01 9/04-8/10 (NCE) $1,538,122 (>$350,000/yr)
"Imaging of MMP Activation and Myocardial Strains"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 18%
The major goal of this project is to develop and validate a quantitative non-invasive approach for serial evaluation of MMP activation following myocardial infarction and relate changes in MMP activation to changes in regional myocardial strain and microstructure.
12. Lantheus Medical Imaging, Inc. 5/2009 -5/2010 $194, 099.00
(Budget for Normal Volunteers)
"A Mulitcenter, A Single-Dose, Phase I, Dosimetry, Biodistribution, and Safety Trial of LMI1195 in Healthy Subjects and patient with Heart Failure"
Principal Investigator - Albert Sinusas, MD
13. American Society of Nuclear Cardiology 2009-2010 $30,000
Fellowship Award
"Determining MBF and reserve in cardiac transplant receipients by Rb-82 PET"
Principal Investigator: Ajay Srivastava, MD
Faculty Sponsor: Albert J. Sinusas, MD
14. R01 HL079104-01A2 6/1/2007–5/31/2009
"3-OST-1 Regulation of Antithrombin Isoform Partitioning"
Principal Investigator: Shworak, N (Dartmouth)
Role: co-investigator (PI - subcontract)
Effort: 3%
15. Bristol-Myers Squibb 9/15/05-12/30/10, $66,535
"Noninvasive Imaging of Matrix Metalloproteinase in Chronic Rat Models of Myocardial Ischemic Injury: Implications for Early Prediction of LV Remodeling"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 1%
16. Boehringer Ingelheim Pharmaceuticals, Inc. 1/1/08-12/31/08
"Effect of Telmisartan on MMP activation and LV Remodeling in Chronic Rat Models of Myocardial Infarction: Role of Noninvasive Imaging of Matrix Metalloproteinase and/or Angiotensin II type 1 receptor"
Principal Investigator: Albert J. Sinusas, M.D.
17. AHA SDG 7/2004 - 6/2008
"Imaging $\alpha v\beta 3$ integrin in injured arteries"
Principal Investigator: Mehran M. Sadeghi, M.D.
Investigator: Albert J. Sinusas, M.D.

Effort: 3% (no cost)

18. JDRF – 5-2005-1259 10/01/05-3/30/07, $100,000
"Targeted Imaging of Angiogenesis and Angiogenesis and Angiogenic Therapy in Type 1 Diabetes"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 5%

19. GE Healthcare 7/1/05-6/30/07, $260,629
"Evaluation of ventricular remodeling in dogs using SPECT imaging after myocardial infarction"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 3%

20. NIH Fellowship, F32HL083651 7/2006-6/2007
"Quantification of transmural injury after myocardial infarction using strains from 3D echocardiography"
Fellow: Zakir Sahul, Ph.D.,M.D.
Sponsor: Albert J. Sinusas, M.D.

21. NIH - NHLBI 5RO1 HL65662-04 7/2001–6/2006, $976,000 ($244,000/year)
"Non-invasive methods for imaging myocardial angiogenesis"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 25%

22. Amersham International Industrial research grant,
10/2002-10/2005, $336,000 ($112,000/year)
"Imaging of Vitronectin Receptor in Animal Models of Ischemia: Potential Targeted Marker of Myocardial Angiogenesis"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 3%

23. NIH - NIBIB
1R21 EB001774-01 9/2003-8/2005, $300,000 ($150,000/year)
"Small Animal imaging and hotspot quantification methods"
Principal Investigator: YiHwa Liu, Ph.D.
Co-Investigator: Albert J. Sinusas, M.D.
Effort: 5%

24. Hong Kong Research Grants Council 9/2003 - 8/2006
HKUST6151/03E
"Robust estimation of myocardial kinematics and material properties"
Principal Investigator: Pengcheng Shi, Ph.D. (Hong Kong University of Science and Technology)
Co-Investigator: Albert J. Sinusas, M.D.
Effort: 3% (no cost)

25. Brown-Coxe Fellowship 7/2005-6/2006
'Non-invasive evaluation of nitric oxide mediated angiogenesis in murine model of hindlimb ischemia"
Fellow: Wawrzyniec Dobrucki, Ph.D.
Sponsor: Albert J. Sinusas, M.D.

26. AHA Fellowship 7/2005-6/2006

"Quantification of transmural injury after myocardial infarction using strains from 3D echocardiography"
Fellow: Zakir Sahul, Ph.D.,M.D.
Sponsor: Albert J. Sinusas, M.D.

27. NIH - National Center for Research Resources
Shared Instrumentation Grant, 1 S10 RR018039-01 4/2004– $500,000
"Dedicated Animal SPECT X-ray CT"
Principal Investigator: Albert J. Sinusas, M.D.

28. NIH – National Center for Research Resources
Shared Instrumentation Grant, 1 S10 RR16732-01, 3/2003– $180,000
"Ultrasound Imaging System"
Principal Investigator: Albert J. Sinusas, M.D.

29. NIH - NIBIB 8RO1 EB002068-11 2000-2005, $1,007,708 ($237,190/year)
"Dynamic Analysis of LV Deformation from 4D Images"
Principal Investigator: James S. Duncan, Ph.D.
Co-investigator: Albert J. Sinusas, M.D.
Effort: 15%

30. Cardiovascular Therapeutics 3/2004-6/2005 $154,883
"Pre-clinical Evaluation of a Selective Adenosine A_{2A} Agonist (CVT-3146) for Stress Myocardial MR Perfusion Imaging"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 2%

31. AHA, Heritage Affiliate Grant-in-Aid 7/2001 - 6/2005
"Modeling the Effect of Pharmacological Stress on the Myocardial Perfusion and Tracer Patterns: Experimental Validation"
Principal Investigator: Purushothaman, Kailasnath PhD
Investigator: Albert J. Sinusas, M.D.
Effort: 3% (no cost)

32. ASNC Fellowship 8/2004-7/2005
"Targeted Imaging of Matrix Metalloproteinase Activity in Relationship to Regional Cardiac Deformation"
Fellow: James Song, M.D.
Sponsor: Albert J. Sinusas, M.D.

33. American Heart Association, National
Grant-in-Aid, 1/2000-12/2003, $210,000 ($70,000/year)
"Development of non-invasive imaging strategies for evaluation of angiogenesis."
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 30%

34. CV Therapeutics
Industrial research grant, 8/2001–12/2003, $50,000, ($25,000/year)
"Pre-clinical evaluation of a selective A2a agonist (CVT-3146) for stress myocardial SPECT perfusion imaging"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 3%

35. American Heart Association, Heritage Affiliate, 9850014T

Grant-in-Aid, 1998-2000, $88,000 ($44,000/year)
"Alterations of left ventricular deformation affects coronary flow."
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 30%

36. NIH - Cardiovascular Study Section
RO1 244803-01A3, 1996-2000, $1,007,708 ($237,190/year)
"Dynamic Analysis of LV Deformation from Images"
Principal Investigator: James S. Duncan, Ph.D.
Co-investigator: Albert J. Sinusas, M.D.
Effort: 10%

37. American Heart Association, Heritage Affiliate,
Grant-in-Aid, 1998-2000, $88,000 ($44,000/year)
"Noninvasive assessment of coronary stenosis severity using novel MR imaging techniques."
Principal Investigator: R. Todd Constable, Ph.D.
Co-Investigator: Albert J. Sinusas, M.D.
Effort: 5%

38. Nihon Mediphysics
1996-1999, $194,000 ($97,000/year)
"Dynamic SPECT BMIPP Imaging comparison with Perfusion and FDG Accumulation"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 20%

39. American Heart Association, Connecticut Affiliate
Fellowship - John Carr, M.D., 1997-1998, $13,800
"Ischemic LV deformation affects remote deformation and CFR."
Sponsor: Albert J. Sinusas, M.D.

40. NIH DHHS, 2R44HL53086-02
1997-1998, $50,000
"Evaluation of LVEF using a proportional multiwire gamma camera and short-lived tantalium-178"
Principal Investigator: Proportional Technologies Inc.
Role: Site Co-Investigator
Effort: 5%

41. United States Surgical Corporation
1997-1998, $184,000
"Delivery system for transmyocardial revascularization by excimer laser
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 20%

42. Amersham International Plc.
1997-1998, $44,000
"Evaluation of Tc99m-HL91 imaging for the detection of regional ischemia"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 10%

43. American Heart Association, National, 94011600
Grant-in-Aid, 1994-1997, $120,000 ($40,000/year)

"Multimodality 3 - dimensional assessment of flow and functional reserve for determination of myocardial viability" Principal Investigator: Albert J. Sinusas, M.D.
Effort: 30%

44. Whitaker Foundation
1993-1997, $240,000 ($67,000/year)
"Development of advanced MRI techniques for in vivo cardiac analysis"
Principal Investigator: R. Todd Constable, Ph.D.
Collaborating Investigator: Albert J. Sinusas, M.D.
Effort: 5%

45. Whitaker Foundation
1994-1997, $240,000 ($67,000/year)
"Multiresolution analysis of 3D heart motion heterogeneity"
Principal Investigator: Hemant Tegare, Ph.D.
Collaborating Investigator: Albert J. Sinusas, M.D.
Effort: 5%

46. American Heart Association, Connecticut Affiliate,
Fellowship - Eliot Heller, M.D., 1994-1996, $50,000 ($25,000/year)
"Myocardial Viability determined using spatial and temporal parameters of LV motion."
Sponsor: Albert J. Sinusas, M.D.

47. Whitaker Foundation
1993-1996, $180,000 ($60,000/year)
"Methods for the assessment of myocardial viability by multimodality image analysis of flow and function from MR and SPECT"
Principal Investigator: Lawrence Staib, Ph.D
Co-Investigator: Albert J. Sinusas, M.D.
Effort: 15%

48. NIH - Cardiovascular Study Section
RO1 244803-01A3, 1992-1995, $967,000 ($228,000/year)
"4D Flow field analysis of regional LV function".
Principal Investigator: James S. Duncan, Ph.D.
Co-investigator: Albert J. Sinusas, M.D.
Effort: 15%

49. Picker International
1994-1995, $20,000
"Experimental Validation of Simultaneous Emission and Transmission Converging Tomography"
Principal Investigator: Albert J. Sinusas, M.D
Effort: 5%

50. Medco Research, Inc
1994, $30,000
"Assessment of myocardial viability with dynamic SPECT 123IPPA imaging"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 5%

51. Gensia Pharmaceutical
1993-1994, $44,800
"Comparison of dobutamine with arbutamine in Tl-201 imaging

Principal Investigator: Albert J. Sinusas, M.D.
Effort: 10%

52. American Heart Association, Connecticut Affiliate,
Grant-in-Aid, 1992-1994, $60,000 ($30,000/year)
"Assessment of viability and vessel patency post reperfusion"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 50%
53. Bristol Myers Squibb
1993-1994, $20,000
"Evaluation of Tc99m-nitroimidazole imaging for the detection of regional ischemia"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 5%
54. Squibb Diagnostics
1991-1992, $20,000
"Evaluation of serial Tc99m-teboroxime imaging for the early assessment of myocardial viability and vessel patency post coronary reperfusion"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 5%
55. Dupont DeNemours & Co.
1990-1992, $40,000
"Tc99m-sestamibi for the assessment of myocardial viability by simultaneous analysis of regional myocardial perfusion and function"
Principal Investigator: Albert J. Sinusas, M.D.
Effort: 40%

Lectures, Courses:

A. Professional Society Sponsored Courses (Organizer, Chairman, Invited Lecturer)

1. **American College of Cardiology,** Annual Meeting, San Francisco, CA, March 9-11, 2013
Invited Lecture: "Advances in Nuclear Imaging Techniques for Heart Failure Patients"
2. **SNMMI MidWinter Meeting,** New Orleans, LA, January 25-27, 2013
CVC Session: Translational Cardiovascular Molecular Imaging (organizer)
Invited Lecture: "Molecular Targets on the Verge of Clinical Translation"
3. **IEEE Healthcare Innovation Conference,** Houston, TX, Nov. 7-9, 2012
Keynote Lecture: "Engineering and Medicine: Multidisciplinary team for cardiovascular molecular and translational imaging"
4. **American Heart Association**, Annual Scientific Sessions, Los Angeles, CA, Nov. 3-7, 2012
Invited Lecture: "Molecular imaging in CHF"
5. **American Society Echocardiography (ASE):** Cardiovascular Ultrasound Technology and Research Summit, Los Angeles, CA, Nov. 3, 2012
Title: "Myocardial Deformation"; What work remains to be done to ensure interoperability? Which applications of strain imaging are main stream? Which applications should be and how do we move them forward?
6. **American Society of Nuclear Cardiology,** Baltimore MD, Sept. 6-9, 2012
Invited Lecture: "SPECT Imaging in PAD"

7. Copenhagen, Denmark, September , 2012
   Invited Lecture: ""
   Invited Lecture:
8. **Society of Nuclear Medicine (SNM) Annual Meeting**, Miami, FL, June 9-13, 2012
   Invited Lecture: "CZT Multipinhole Cameras: Clinical and Research Experience"
   Invited Lecture: "Molecular Imaging of the Heart for the Lay Person"
   Invited Lecture: "Molecular Imaging of Heart Failure Pathophysiology and Regenerative Therapy"
   Invited Lecture: "Is Assessment of Absolute Myocardial Perfusion with SPECT Ready for Prime Time?"
9. **Society of Nuclear Medicine; 3rd Multimodality Cardiovascular Molecular Imaging Symposium**, Bethesda, MD, April 19-21, 2012
   Program Chairman: Albert J. Sinusas
   Invited Lecture: "Introduction and Overview"
   Invited Lecture: "
10. **American College of Cardiology (ACC) Annual Scientific Session**,
    Chicago, IL, March 24-27, 2012
    Invited Lecture: Molecular Applications of SPECT Imaging: Atherosclerosis, Apoptosis and Beyond
11. **Society of Nuclear Medicine (SNM) Mid-Winter Meeting**, Orlando, FL, January 26-29, 2012
    Invited Lecture: "Translating Molecular Imaging into Clinical Practice"
12. **Radiological Society of North America**, Inc. (RSNA) 97th Scientific Assembly and Annual Meeting, Chicago, IL, November 27 – December 2, 2011
    Invited Lecture: "Emerging Techniques in Cardiovascular Molecular Imaging"
13. **Buenos Aires Multimodalities in Molecular Imaging of the Cardiovascular System Symposium 2011,** Buenos Aires, Argentian; September 16-17, 2011
    Program Organizer
    Invited Lecture: "Targeted Imaging of Angiogenesis"
14. Siemens Innovation Center, Mountain View, CA, Collaboration Discussion, September 12, 2011
15. **American Society of Nuclear Cardiology,** 16th Annual Scientific Session (ASNC)_2011, Denver, Colorado; September 8-11, 2011
    Invited Lecture: "Coronary Hyperemia: What to Expect from Different Stressors and Isotopes"
    Invited Lecture: "Molecular Imaging of LV Remodeling"
    Invited Moderator: "ADVANCED: Imaging the Atherosclerotic Plaque: Integrating Anatomy, Physiology, and Molecular Targets"
16. **World Molecular Imaging Conference (WMIC),** San Diego Convention Center, September 7, 2011
    Invited Lecture (on imaging biomarkers):
17. **American Society of Echocardiography (ASE) Annual Scientific Sessions**_2011, Montreal, Quebec, Canada - June 11-14, 2011
    Invited Lecture: "Fusion Imaging – Adding Benefit or Just More Gigabytes?"
18. **Society of Nuclear Medicine (SNM) Annual Meeting**_2011, San Antonio, TX – June 5-9, 2011
    Invited Lecture: "Molecular Imaging and Heart Disease"
    Invited Lecture: "Update on Cardiac Angiogenesis and Remodeling"
    Invited Lecture: "Flow Quantification with SPECT: Can It Be Done?"

Invited Lecture: "Pathophysiology and Imaging of LV Remodeling"

19. **International Conference of Nuclear Cardiology (ICNC) Annual Meeting** 2011, Amsterdam, Netherlands – May 15-18, 2011
Invited Lecture: "Understanding Cardiovascular Disease: From Animal Models to Practice"
20. **CVI Update in Nuclear Cardiology 2011**, Philadelphia, PA – May 12, 2011
Invited Lecture: "Cardiovascular Molecular Imaging: Current and Future Applications"
Case Presentations: "Assessment of Absolute Coronary Flow and Flow Reserve"
21. **Yale CME Full-Day Symposium** (6.5 AMA PRA Category I Credits), Co-Directors, Sinusas and Tandon on May 6, 2011 in TAC Auditorium entitled "Multi-Modality Cardiovascular Imaging in Heart Failure"
Organizer, Chairperson
22. **American College of Cardiology 2011 i2 Summit**, New Orleans, LA - April 2-5, 2011
Invited Lecture: "Imaging to Assess Cardiac Remodeling"
Invited Lecture: "The Molecular Front and MICRO Imaging Aspects of SPECT: A Look into What the Future Holds"
23. **Radiological Society of North America (RSNA) Annual Meeting**, Chicago, IL November 28-December 3, 2010
Invited Lecture: "Emerging Techniques in Cardiovascular Molecular Imaging"
24. **3rd Advanced Cardiac Imaging Course for Interventional Cardiologists**, November 18, 2010
Royal College of Physicians, London, UK
Invited Lecture: New Developments in Scintillation Devices and Hybrid (CT/PET; CT/SPECT) Imaging"
25. **Society of Nuclear Medicine,** Bethesda, MD; July 21-22, 2010
Comparative Effectiveness in Molecular Imaging Workshop
Invited Participant: "Breakout Session I: Articulating Key CER Questions in Molecular Imaging"
26. **American Society of Nuclear Cardiology**, Philadelphia, Pennsylvania September 23-26, 2010
Invited Participant: Moderator: "CORE: Tracers and Stress Modalities"
Invited Participant: Moderator: "Young Investigator Award Competition"
Invited Lecture: "Molecular Imaging-What's in the Pipeline"
27. **Society of Nuclear Medicine Mid-Winter Meeting,** January 27-February 2, 2010
Invited Participant/Lecture: "Update on Imaging Proteolytic Activity and Angiogenesis in Heart Failure"
Invited Participant/Lecture: "Advancement of New Cardiovascular Probes: Challenges in Translation"
28. **NHLBI Working Group**, Bethesda, MD, September 16/17, 2009
"Translation of Cardiovascular Molecular Imaging"
Invited Participant/Lecture: "Radionuclide Imaging"
29. **Society of Nuclear Medicine Annual Meeting**, June 13-17, 2009, Toronto, Canada
Session Organizer: Bench to Bedside: Neuroreceptor Molecular Imaging of the Heart
Invited Lecture: "Beyond Infarction: Molecular Imaging Markers of Ventricular Remodeling"
30. **International Conference of Nuclear Cardiology 2009**
May 10-14, 2009, Barcelona, Spain

Chair Session: Small Animal Imaging
Invited Lecture: "New imaging targets: autonomic nervous system, cell death, LV remodeling"
Invited Lecture: "New probes for cardiac imaging:SPECT"

31. **NIH Symposium: Multimodality Cardiovascular Molecular Imaging**
April 30-May 1, 2009, Bethesda, MD
Organizer, Chairperson
Invited Lecture: "Radiotracer imaging of matrix metalloproteinases and post-MI remodeling"
32. **American College of Cardiology Annual Meeting**
March 30-31, 2009, Orlando, FL
Invited Lecture: Cardiovascular molecular imaging: PET/CT
33. **RSNA, Roundtable Imaging Biomarkers Meeting**
March 16-17, 2009, Chicago, IL
Invited Participant
34. **Society of Nuclear Medicine Midwinter Conference**
February 6-9, 2009, Clearwater, FL
Invited Lecture: "Clinical applications of molecular cardiovascular imaging: Where is it going and when will it get there"
35. **American Heart Association**
November 10, 2008, New Orleans, LA
Chair Session
Invited Lecture: "Molecular Imaging in Evaluation of LV Remodeling"
36. **Integrated Cardiovascular Imaging**
September 17-19, 2008, Cesena, Italy
Invited Lecture: "Molecular Imaging in Evaluation of Post-MI LV Remodeling"
37. **American Society of Nuclear Cardiology Annual Meeting**
September 11-14, 2008, Boston, MA
Invited Lecture: "Molecular Imaging in Evaluation of Post-MI LV Remodeling"
38. **Congress of the International Federation of Societies for Histochemistry and Cytochemistry**
August 25-27, 2008, Gdansk, Poland
Invited Lecture: "Imaging of myocardial angiogenesis"
39. **American Society of Nuclear Cardiology Invitational Conference**
June 28-30, 2008, Annapolis, MD
Invited Lecture:
40. **American Roentgen Ray Society (ARRS),** Washington, DC, 4/14/08
Invited Lecture-Debate: Is Coronary CTA ready for Prime Time? Cons
41. **American College of Cardiology (ACC),** Chicago, IL, 4/1/08
Invited Lecture: Multimodality Myocardial Function Assessment
"Matching the Technique to the Patient"
42. **Society of Nuclear Medicine, Molecular Imaging Summit,** Newport Beach, CA, 2/17-19/08
Invited Lecture: "Cardiovascular Molecular Imaging: Promoting Utilization and Outreach"
43. **Society of Nuclear Medicine (Mid-winter Meeting),** Newport Beach, CA, 2/16/08
Invited Lecture: "Molecular Cardiovascular Imaging: Where is it going and when will it get there?"

44. **AMI/RSNA/SNM/SMI Pre-conference Symposium**, Providence, RI, 9/7-8/07
    Imaging in Molecular Medicine
    Invited Lecture: "Molecular Imaging in Heart Failure: LV Remodeling"
45. **SNM Annual Meeting, Washington**, DC, 6/2-6/2007
    Invited Lecture: "Integration of Cardiac Imaging Techniques and Future Directions"
    Invited Lecture: "Role of Targeted Molecular Imaging for Prediction of Post-MI LV Remodeling"
46. **SNM Mid-Winter Meeting**, 2/16/07-2/18/07, San Antonio, TX
    Invited Lecture: "Imaging of Post-MI remodeling"
47. **Academy of Molecular Imaging (AMI),** Miami, FL, 1/19/07-1/21/07
    Invited Lecture: "Non-invasive evaluation of myocardial infarction"
48. **AHA Scientific Sessions**, 11/11-11/14/06, Chicago, IL
    Invited Lecture: "Imaging cardiac remodeling"
    Invited Lecture: Imaging angiogenesis in small animals
49. **ASNC 9/8/06-9/10/06** Montreal, Canada
    Invited Lecture: Imaging angiogenesis
50. **SNM Molecular Imaging Summit,** Miami, FL, 7/28-7/30/06
    Invited Lecture: Cardiovascular molecular imaging
51. **Society of Nuclear Medicine (SNM) – Annual Meeting**, San Diego, CA, 6/3-6/7/06
    Invited Lecture: "Tracers for Targeting of Ventricular Remodeling"
52. **Academy of Molecular Imaging (AMI)** – Orlando, FL, 3/25-29/06
    Featured Lecture: "Cardiovascular translational research"
    Invited Lecture: "Role of Targeted Molecular Imaging for Prediction of Post-Infarct LV remodeling"
    Invited Lecture: "Clinical Issues for Cardiac Patients Referred for Nuclear Stress Imaging"
53. **American College of Cardiology (ACC)** – Atlanta, GA 3/11-3/14/06
    Invited Lecture: "Evaluation of Gene Therapy: Targeted Imaging of Angiogenesis"
54. **Society of Nuclear Medicine (SNM) – Mid-Winter Meeting**, Tempe, AZ, 2/11/06
    Invited Lecture: "Imaging of Post-Infarct LV Remodeling with MMP Targeted Tracers"
55. **Institute for Pure and Applied Mathematics (IPAM), UCLA**, Los Angelos, CA, 2/6/06
    Heart Modeling: Image acquisition, segmentation, modeling and analysis
    Invited Lecture: "Multi-Modality Non-Invasive Evaluation of Post-MI LV Remodeling"
56. **Society of Cardiovascular Magnetic Resonance (SCMR),** Miami, FL, 1/20/06
    Invited Lecture: "PET/SPECT vs MR molecular imaging"
57. **American Society of Nuclear Cardiology**, Seattle, WA 10/05
    Lecture: "Cardiomyopathic Diseases Role of Targeted Imaging"
58. **American Society of Gene Therapy**, 8th Annual Meeting, St. Louis, MO, 6/1-6/5/05
    Lecture: "Imaging of Angiogenesis and Gene Therapy In Vivo"
59. **International Conference of Nuclear Cardiology (ICNC7),** 5/8/05-5/11/05
    Lisbon, Portugal
    Program Co-Chairman
    Lecture: "Imaging Angiogenesis: conventional and novel approaches"
    Lecture: "Promises and Challenges of Molecular Imaging"
    Lecture: "Imaging of LV remodeling"
60. **American College of Cardiology**, 3/6/05-3/9/05
    Orlando, Florida

Lecture: "Imaging of Gene Expression and Angiogenesis"

61. **Academy of Molecular Imaging**, 3/20/05-3/23/05
Orlando, Florida
Chairman, Coronary Artery Disease: Future Directions
Lecture: "Imaging of Angiogenesis"
62. **Society of Nuclear Medicine, Mid-Winter Meeting**, 1/28/05-1/29/05
Tampa, Florida
Lecture: "Cardiovascular Imaging Update: Radiopharmacy"
63. **Biological Therapeutics Consulting Group (BTCG) 3rd Annual Symposium,** "Therapeutic Angiogenesis and Myogenesis", New Orleans, LA, 11/6/04
Lecture: "Radiolabel Imaging of Myocardial Angiogenesis"
64. **American Society of Nuclear Cardiology, 9th Annual Meeting**, 9/30/04-10/3/04
New York City, NY
Program Chairman, Special Program - Investigator Track
"Evaluation and management of Ischemia and Heart Failure: Role of Cardiovascular Molecular Imaging"
Lecture: "Imaging of remodeling with targeted MMP tracers"
65. **European Association of Nuclear Medicine (EANM), Annual Meeting** 9/4-9/8/04
Helsinki, Finland
Lecture: "Angiogenesis imaging, beyond perfusion"
66. **American Society of Nuclear Cardiology, 7th International Nuclear Cardiology Invitational Conference**; Park City, UT, 7/21/02-7/24/02
Chairman, Radiochemistry Panel,
67. **Society of Nuclear Medicine, Annual Meeting**, 6/19-6/23/04
Philadelphia, PA
Organizer and Chairman, Young Investigator Competition
Lecture: "Imaging Angiogenesis"
Lecture: "Advances in Cardiovascular Molecular Imaging"
Lecture: "Cardiac Imaging in Small Animals"
68. **Symposium on Cardiovascular Molecular Imaging**, 5/3-5/4/04
NIH, Bethesda, MD
Symposium Organizer and Chairman
Lecture: "Targeted imaging of Angiogenesis"
69. **Northeast ASNC Affiliated Working Group Meeting** 4/2/04
Mystic, CT
Lecture: "Molecular Imaging with Nuclear Cardiology"
70. **25th High Country Nuclear Medicine Conference**, 2/27-3/3/2004
Vale, Colorado
Lecture: "Targeted imaging of Angiogenesis"
71. **Society of Nuclear Medicine, Mid-Winter Meeting**, 2/7-2/8/04
Anaheim, CA
Lecture: "Imaging of post-infarction remodeling with MMP targeted tracers"
72. **American Society of Nuclear Cardiology Annual Meeting** 9/11-9/14/03
Indianapolis, IN
"Essentials for research: How do I get started"
"Molecular Imaging of the angiogenesis process"

73. **Society of Nuclear Medicine, Annual Meeting** 6/22/03-6/25/03
Organizer, Continuing Education Program: "Quantitative Analysis"
Moderator, Cardiovascular Young Investigator Award Symposium
Moderator, Cardiovascular Clinical Sciences, Diagnostic Techniques
74. **American Society of Nuclear Cardiology**, Florence, Italy
International Conference Nuclear Cardiology(ICNC) 4/27/03-4/30/03, Program Committee
Chairman, Small Animal Imaging 4/28/03
Lecture: "Promises and challenges of molecular imaging" 4/28/03
Lecture: "Imaging of myocardial angiogenesis" 4/28/03
75. **I Curso Internacional de Imagen Cardiovascular**, Mexico City, Mexico 3/5/03-3/7/03
"Evaluacion no-invasiva del flujo de reserve coronario", 3/5/03
"Nuevos radionuclidos en SPECT: utilidad de los marcadores de acidos grasos", 3/7/03
76. **St.-Gerlach Vascular Biology Workshop**, Maastricht, Netherlands, 1/31/03
Keynote Lecture, "Imaging of Myocardial Angiogenesis"
Chairman: Stem cells in cardiovascular medicine
77. **Society of Nuclear Medicine, Mid-Winter Meeting**, 1/25/03
Symposium Organizer, Cardiovascular Molecular Imaging
Lecture: "Targeted imaging of Myocardial Angiogenesis"
78. **American Society of Nuclear Cardiology, New England Working Groups**; 11/02
Lecture: "Non-invasive evaluation of myocardial angiogenesis"
79. **Working Group Nuclear Cardiology, European Society of Cardiology**, Camogli, Italy, 10/25/02
Lecture: "Imaging of Angiogenesis"
80. **American Society of Nuclear Cardiology, 6th International Nuclear Cardiology Invitational Conference;** Lake Tahoe, CA 7/21/02-7/24/02
Chairman, Angiogenesis Panel,
Lecture: "Targeted Imaging of Myocardial Angiogenesis"
81. **American College of Cardiology, Annual Scientific Session,** 3/02
Invited lecture: "Tc99m perfusion agents: New and new uses for old"
82. **American Society of Nuclear Cardiology, Delaware Working Group**, 11/01
Invited lecture: "New Non-invasive approaches for detection of ischemia"
83. **American College of Cardiology, Annual Scientific Session,** 3/02, Orlando, FL
Symposium Chairman, Advances in evaluation of regional myocardial function
84. **American Society of Nuclear Cardiology, 5th Annual Scientific Session**, 9/23/00
Organizer, Scientific Forum on Angiogenesis
Lecture: "Direct myocardial revascularization"
85. **American Society of Nuclear Cardiology,**
Fourth International Conference Nuclear Cardiology; 4/99 Athens, Greece
Categorical Course; "Technical Advances in Nuclear Cardiology"
Lecture: "Ischemia Imaging Agents"
Categorical Course; "Fundamentals of Cardiology"
Moderate: "Coronary Blood Flow"
86. **American Society of Nuclear Cardiology,**
Fourth International Nuclear Cardiology Workshop, 7/98, Wintergreen, Virginia
Invited Committee Member, "Panel II - New tracers and new approaches"
87. **Society of Nuclear Medicine 45th Annual Meeting**, 6/7/98, Toronto, Canada

Cardiovascular Council Categorical Course, "Myocardial Perfusion Imaging"
Program Organizer: Albert J. Sinusas, M.D.

88. **American Society of Nuclear Cardiology: Northeast Working Groups**
"Pharmacological Stress Imaging in 1998: Changing Concepts"
1/17/98, New York City, NY
Lecture: "Mechanisms of Tracers in Relationship to Blood Flow"
89. **Society of Nuclear Medicine, 44th Annual Meeting**, 6/1/97, San Antonio, TX
Cardiovascular Council Categorical Course
Chairman, "Tracers and Technologies"
90. **American Society of Nuclear Cardiology:**
Third International Nuclear Cardiology Workshop, 7/13-7/16/96, Wintergreen, VA
"New tracers: What is being developed and what will be the future clinical application?"
Lecture: Imaging with Tc99m-tetrofosmin
91. **Society of Nuclear Medicine, 43rd Annual Meeting,**
Cardiovascular Council Categorical Course, Chairman
"Cardiac Nuclear Medicine: State-of-the-Art" , 6/2/96, Denver, CO
92. **Society of Nuclear Medicine : Continuing Education Lecture**
6/6/96, Denver, CO
Lecture: "Nuclear Cardiology: Imaging Guidelines"
93. **American Society of Nuclear Cardiology,**
Second International Nuclear Cardiology Workshop, 7/10-7/13/94, Wintergreen, VA
Lecture: "Value of Nuclear Cardiology Techniques for Assessing Ventricular Function"
94. **American College of Cardiology, Georgia Chapter;**
10/91, Continuing education lecture
95. **FASEB**, 4/90, Invited lecture

B. Institutional Sponsored Courses (Invited Lecturer)

1.
2. Yale-UCL Cardiovascular Device Innovation Summit, London, UK, January 17-18, 2013
Invited Lecture: "
3. Stanford University School of Medicine, CME Radiology Grand Rounds, Stanford, CA, February 16, 2012
Grand Rounds Lecture: "Multimodality Imaging of Post-MI Remodeling"
4. Imaging at Illinois @ Beckman Institute, University of Illinois, Urbana, IL, June 1, 2012
Invited Lecture: "Multimodality Imaging in Remodeling Post-MI: Anatomy Physiology and Molecular Targets.
5. Whitaker Cardiovascular Institute @ Boston University School of Medicine, Boston, MA, April 3, 2012
Invited Lecture: "Multimodality Imaging of Post-MI Remodeling"
6. Montefiore Medical Center Albert Einstein College of Medicine, Bronx, NY - April 26, 2011
Nuclear Medicine Grand Rounds
Invited Lecture: " Emerging Techniques in Cardiovascular Molecular Imaging"
Cardiology Grand Rounds
Invited Lecture: "Multimodality Evaluation of Post-Infarct Remodeling"

7. Yale & UCL Symposium, Yale University, May 8-10. 2009, New Haven, CT
   Invited Lecture: "Imaging Angiogenesis"
8. New England Chapter Society of Nuclear Medicine, April 18, 2009, Cromwell, CT
   Invited Lecture: "Molecular Imaging
56. University of Maryland, Baltimore, MD, February 26, 2009
   Cardiology Grand Rounds: "Multimodality imaging in evaluation of post-MI LV Remodeling"
57. Columbia University, New York, NY, December 9, 2008
   Cardiology Grand Rounds: "Molecular imaging in evaluation of post-MI remodeling"
58. Yale University, October 22, 2008
   Undergraduate Bioengineering Lecture, "Multi-modality Cardiovascular Imaging"
59. University of Pittsburgh, October 6-7, 2008
   Cardiology Grand Rounds: "Evolving application of radionuclide techniques in evaluation and management of ischemic heart disease"
60. University of Buffalo, Buffalo, NY, 2/26/08
   Cardiology Grand Rounds: "Molecular Imaging in Evaluation of Post-MI LV Remodeling"
61. Yale University, New Haven, CT, 1/25/08
   Cardiology Grand Rounds: "Molecular Imaging in Evaluation of Post-MI LV Remodeling"
62. Washington University, St. Louis, MO, 1/22/08
   Nuclear Medicine, Invited Lecture: "Imaging Acute Chest Pain"
63. Washington University, St. Louis, MO, 1/21/08
   CCIR Research Seminar, Mallinckrodt Institute of Radiology
   Invited Lecture: "Molecular Imaging in Evaluation of Post-MI LV Remodeling"
64. Yale University, New Haven, CT 9/23-25/07
   Cambridge-Yale Cardiovascular Research Program
   Invited Lecture: "Targeted imaging of angiogenesis"
65. Vanderbilt University, Institute of Imaging Sciences, Nashville, TN 6/27-29/07
   Frontiers of Biomedical Imaging Science
   Invited Lecture: "Imaging of Cardiac Physiology, Metabolism and Molecular Signals"
66. Yale University, New Haven, CT 6/14/07
   Co-Director CME Course: Non-invasive Evaluation of Ischemic Heart Disease: Anatomy, Perfusion, and Beyond
   Invited Lecture: "SPECT/SPECT-CT with Attenuation Correction"
   Invited Lecture: "Molecular Imaging of the Ischemic Heart"
67. Washington University, St. Louis, MO, 2/22/07
   Invited Lecture: "Imaging of angiogenesis and arteriogenesis"
68. MGH, Harvard, Boston, MA 10/18/06
   Cardiology Grand Rounds: "Imaging of Post-Infarct LV Remodeling with MMP Targeted Tracers"
69. Yale University, New Haven, CT, 5/15/06
   Medicine Research Seminar: "Role of MicroSPECT/CT for Targeted Molecular Imaging"
70. Yale University, New Haven, CT, 2/16/06
   Medical Grand Rounds: "Multi-Modality Non-Invasive Evaluation of Post-MI LV Remodeling: From Bench to Bedside"
71. University of Ottawa Heart Institute, Ottawa, Canada 11/21/05
   Frontiers in Heart Failure Research Distinguished Visitors Seminar Series

Lecture: "Role of targeted molecular imaging for prediction of post-MI remodeling"

72. Yale University 11/18/05
Cardiology Grand Rounds: "Imaging of Post-Infarct LV Remodeling with MMP Targeted Tracers"
73. Yale University VBT/IPCT Joint Retreat, 11/5/05
Invited Lecture: "Application of microSPECT/CT for imaging of angiogenesis and arteriogenesis"
74. University of Virginia, Charlottesville, VA, 10/21/05
Invited Lecture: "Imaging of Post-Infarct LV Remodeling with MMP Targeted Tracers"
75. Joint Summit on Markers in Cardiology, Louisville, KY, 10/20/05
Jewish Hospital Heart and Lung Institute
Invited Lecture: "Molecular Imaging: Applications in Diagnostic Cardiology"
76. Brigham and Women's Hospital, Boston, MA, 10/18/05
Radiology Grand Rounds: "Imaging of Post-Infarct LV Remodeling with MMP Targeted Tracers"
Invited Lecture: "Evaluation of LV Function"
77. Molecular Imaging Program Stanford (MIPS), Palo Alto, CA, 9/12/05
Invited Lecture: "Targeted imaging of ischemia-induced angiogenesis and post-MI remodeling"
78. Brigham and Women's Hospitial, Boston, MA, 2/10/05
Invited Lecture: "Targeted imaging of angiogenesis"
79. Yale University VBT Seminar Series, 5/17/04
Invited Lecture: "Imaging of post-infarction remodeling with MMP targeted tracers"
80. Yale University Dean's Workshop, Bioimaging: MRI as a template 5/7/04
Invited Lecture: "Cardiac MR Imaging"
81. Yale VBT/IPCT Joint Retreat, 12/6/03
"Targeted radiotracer imaging of angiogenesis"
82. Dartmouth-Hitchcock Medical Center, Hanover, NH, 4/17/03
Cardiology Grand Rounds: "Imaging of Myocardial Angiogenesis"
83. Cleveland Clinic, Cleveland Ohio, 2/19/03
Cardiology Grand Rounds: "Targeted Imaging of Myocardial Angiogenesis"
84. Medical University of South Carolina, Charleston, SC, 10/03/02
Cardiology Grand Rounds: "Targeted imaging of myocardial Angiogenesis"
85. Wayne State Medical School, Detroit Michigan, 12/9/99
Invited Lecture: "Non-invasive evaluation of myocardial metabolism"
Invited Lecture: "Novel approaches for evaluation of regional LV strain"
86. Carle Foundation Hospital, 2/27/98, Urbana, IL,
Invited lecture, "Noninvasive Detection of CAD"
87. University of Utah, 12/11/96, Salt Lake City, UT
Invited lecture, "New approaches for the noninvasive assessment of myocardial ischemia"
88. Heart Imaging Center, 5/23/95, Rumson NJ
Invited lecture, "Cardiac SPECT Imaging"
89. St. Luke's-Roosevelt Hospital Center, Columbia University, N.Y.
Third Annual Cardiac SPECT Symposium & Workshop,
90. Newport RI, 10/29/94,
"New Tc99m Compounds", "Workshop, Tl-201 Perfusion Imaging"

91. Emory University, Georgia, 5/94, Atlanta, GA,
Invited lecture, "Quantitative Thallium and Technetium Myocardial SPECT"

Bibliography:

A. **Peer-reviewed original articles:**

1. **Sinusas AJ,** Hardin NJ, Clements JP, Wackers FJ: Pathoanatomic correlates of regional left ventricular wall motion assessed by equilibrium angioradiography: A post-mortem correlation. Am J Cardiol, 1984, 54:975-981.
2. **Sinusas AJ,** Beller GA, Smith WH, Vinson E, Brookeman V, Watson DD: Quantitative Planar Imaging with Technetium-99m Labeled Methoxy-Isobutyl Isonitrile: Comparison of uptake patterns with Thallium-201. J Nucl Med, 1989, 30:1456-1464.
3. **Sinusas AJ,** Watson DD, Cannon JM, Beller GA: Effect of Ischemia on Myocardial Uptake of Tc-99m Labeled Methoxy-isobutyl Isonitrile and Thallium-201. J Am Coll Cardiol, 1989, 14:1785-93.
4. **Sinusas AJ,** Trautman KA, Bergin JD, Watson DD, Ruiz M, Smith WH, Beller GA: Quantification of "Area at Risk" During Coronary Occlusion and Degree of Myocardial Salvage After Reperfusion with Technetium-99m Methoxy Isobutyl Isonitrile. Circulation, 1990, 82:1424-1437.
5. Edwards NC, **Sinusas AJ,** Bergin JD, Watson DD, Ruiz M, Beller GA: Influence of Subendocardial Ischemia on Transmural Myocardial Function. Am J. Physiol, 1992, 262:H568-H576
6. **Sinusas AJ,** Shi QX, Vitols PJ, Fetterman RC, Maniawski P, Zaret BL, Wackers FJ: Impact of regional ventricular function geometry and dobutamine stress on quantitative Tc -99m-Sestamibi defect size. Circulation, 1993, 88:2224-2234
7. Haronian HJ, Remetz RS, **Sinusas AJ,** Baron JM, Miller HI, Cleman MW, Zaret BL, Wackers FJTh: Myocardial risk area defined by technetium 99m-Sestamibi imaging during presentaeous transluminal coronary angioplasty in comparison to coronary angiography. J Am Coll Cardiol, 1993, 22:1033-43
8. Jain D, Wackers FJTh, Mattera J, McMahan M, **Sinusas AJ,** Zaret BL: Biokinetics of ^{99m}Tc-tetrofosmin a new myocardial perfusion imaging agent: implications for a one day imaging protocol. J Nucl Med, 1993, 34:1254-59
9. **Sinusas AJ,** Shi QX, Saltzberg MT, Vitols PJ, Jain D, Wackers FJTh, Zaret BL: Tc-99m tetrofosmin to assess myocardial blood flow: Experimental validation in an intact canine model of ischemia. J Nucl Med, 1994, 35:664-671
10. Constable RT, Rath KM, **Sinusas AJ,** Gore JC: Development and evaluation of tracking algorithms for cardiac wall motion analysis using phase velocity MR imaging. Mag Res Med, 1994, 32:33-42
11. Raiker K, **Sinusas AJ**, Wackers, FJ, Zaret BL. One-year prognosis of patients with normal planar or single-photon emission computed tomographic technetium 99m-labeled sestamibi exercise imaging J Nucl Cardiol, 1994, 1:449-56
12. **Sinusas AJ**, Bergin JD, Edwards NC, Watson DD, Ruiz M, Smith WH, Beller GA: Redistribution of ^{99m}Tc-Sestamibi and ^{201}Tl in presence of a severe coronary artery stenosis. Circulation, 1994, 89:2332-2341
13. Haines DE, Verow AF, **Sinusas AJ,** Whayne JG, DiMarco JP: Intracoronary ethanol ablation in swine: Characterization of myocardial injury in target and remote vascular beds. J Cardiovasc Electrophysiol, 1994, 5:41-49
14. Haronian HL, **Sinusas AJ,** Remetz MS, Brennan JL, Cabin HS, Zaret BL, Wackers FJTh: Effects of altered left ventricular geometry on quantitative technetium 99m sestamibi defect size in humans: Perfusion imaging during coronary angioplasty. J Nucl Card 1:150-8, 1994

15. Shi QX, **Sinusas AJ,** Dione DP, Singer MJ, Young LH, Heller EN, Rinker BD, Wackers FJTh, Zaret BL: Technetium-99m nitroimidazole (BMS181321) a positive imaging agent for detection of myocardial ischemia. J Nucl Med, 1995, 36:1078-1086
16. Ng CK, **Sinusas AJ,** Zaret BL, Soufer R. Kinetic analysis of technetium-99m labeled nitromidazole (BMS181321) as a tracer of myocardial hypoxia. Circulation, 1995, 92:1261-1268
17. Liu YH, **Sinusas AJ**, Shi CQX, Shen MYH, Dione D, Heller EH, Wackers FJTh. Quantitation of tc99m-sestamibi SPECT based upon mean counts improves accuracy for assessment of relative blood flow: experimental validation in a canine model. J Nucl Cardiol, 1996, 3:312-20
18. Meyer FG, Constable RT, **Sinusas AJ,** Duncan JS. Tracking myocardial deformation using spatially-constrained velocities. IEEE Transactions on Medical Imaging, 1996, 15:453-465
19. McNulty PH, **Sinusas AJ,** Shi CQX, Dione D, Young LH, Cline GC, Shulman GI. Glucose metabolism distal to a critical coronary stenosis in a canine model of low flow myocardial ischemia. J Clin Invest, 1996, 98:62-69
20. Sieblink HMJ, Natale D, **Sinusas AJ**, Wackers FJTh. Quantitative comparison of single-isotope and dual-isotope stress-rest single-photn emission computed tomographic imaging for reversibility of defects. J Nucl Cardiol, 1996, 3:483-93
21. Naruse H, Daher E, **Sinusas AJ**, Jain D, Natale D, Mattera J, Makuch R, Wackers FJTh. Quantitative Comparison of Planar and SPECT Normal Data Files of Thallium-201, Tc99m Sestamibi, Tc99m Tetrofosmin and Tc99m Furifosmin. J Nucl Med, 1996, 37:1783-1788
22. Young LH, Renfu Y, Russel R, Hu X, Caplan M, Ren J, Shulman GI, **Sinusas AJ**. Low Flow Ischemia Leads to Translocation of Canine Heart GLUT-4 and GLUT-1 Glucose Transporters to the Sarcolemma In Vivo. Circulation, 1997, 95:415-422
23. Kocheril AG, Bokhari SAJ, Batsford WP, **Sinusas AJ**. Long QTc in Torsades de Pointes in Human Immunodeficiency Virus Disease. PACE, 1997, 20:2810-2816
24. Heller EN, DeMan P, Liu Y-H, Dione DP, Zubal IG, Wackers FJTh, **Sinusas AJ**. Extra-cardiac activity complicates quantitative cardiac SPECT imaging using a simultaneous transmission-emission approach. J Nucl Med, 1997, 38:1882-1890
25. Wu JC, Yun JJ, Heller EN, Dione DP, DeMan P, Liu Y-H, Zaret BL, Wackers FJTh, **Sinusas AJ** Limitation of Dobutamine for Enhancing Flow Heterogeneity in the Presence of Single Coronary Stenosis: Implications for Technetium-99m Sestamibi Imaging J Nucl Med 1998, 39:417-425
26. Liu YH, Rangarajan A, Gagnon D, Therrien M, **Sinusas AJ**, Wackers FJTh, Zubal IG. A novel geometry for SPECT imaging associated with EM-type blind deconvolution method. IEEE Transactions of Nuclear Science, 1998, 45:2095-2101
27. Duncan J, Shi P, Constable RT, **Sinusas AJ**. Physical and geometrical meodeling from image-based recovery of left ventricular deformation. Progress in Biophysics and Molecular Biology, 1998, 69:333-351
28. Mattera JA, Arain SA, **Sinusas AJ**, Finta L, Wackers FJTh. Exercise testing with myocardial perfusion imaging in patients with normal baseline electrocardiograms: Cost savings using a step-wise diagnostic strategy. J Nucl Cardiol, 1998, 5:498-506
29. Russell RR, Renfu Y, Caplan MJ, Hu X, Ren J, Shulman GI, **Sinusas AJ**, Young LH. Additive effects of hyperinsulinemia and ischemia on myocardial GLUT1 and GLUT4 translocation in vivo. Circulation, 1998, 98:2180-2186

30. Liu YH, **Sinusas AJ**, DeMan P, Zaret BL, Wackers FJTh. Quantification of single photon emission computerized tomographic myocardial perfusion images: Methodology and validation of the Yale-CQ method. J Nucl Cardiol, 1999, 6:190-204
31. Shen MYH, Liu Y, **Sinusas AJ**, Fetterman R, Bruni W, Drozhinin OE, Zaret BL, Wackers FJTh. Quantification of regional myocardial wall thickening on electrocardiogram-gated SPECT imaging. J Nucl Cardiol 6:583-95 1999
32. Shi P, **Sinusas AJ**, Constable RT, Duncan JS. Volumetric deformation analysis using mechanics-based data fusion: Applications in cardiac motion recovery. International J Computer Vision 35:87-107, 1999
33. Wu JC, Yun JJ, Dione DP, Heller EN, Deckelbaum LI, **Sinusas AJ**. Severe regional ischemia alters coronary flow reserve in the remote perfusion area. J Nucl Cardiol 7:43-52 2000
34. Daher E, Dione DP, Heller EN, Holahan J, DeMan P, Shen M, Hu J, **Sinusas AJ**. Acute ischemic dysfunction alters coronary flow reserve in remote non-ischemic regions: Potential mechanical etiology identified in an acute canine model. J Nucl Cardiol 7:112-22, 2000
35. Shi P, **Sinusas AJ**, Constable RT, Ritman E, Duncan JS: Point-tracked quantificative analysis of left ventricular motion from 3D image sequences, IEEE Transactions on Medical Imaging 19:36-50, 2000
36. Vallejo E, Dione DP, Bruni WL, Constable RT, Borek PP, Soares JP, Carr JG, Condos SG, Wackers FJTh, **Sinusas AJ**. Reproducibility and accuracy of gated SPECT for determination of left ventricular volumes and ejection fraction: Experimental validation using magnetic resonance imaging.. J Nucl Med 41:874-882 2000
37. Vallejo E, Dione DP, **Sinusas AJ,** Wackers FJTh. Assessment of left ventricular ejection fraction with quantitative gated SPECT: Accuracy and correlation with first-pass radionuclide angiography. J Nucl Cardiol 7:461-70 2000
38. Heller EN, Staib LH, Dione DP, Constable RT, Shi CQX, Duncan JS, **Sinusas AJ**. A new method for quantification of spatial and temporal parameters of endocardial motion: Evaluation of experimental infarction using magnetic resonance imaging. Can J Cardiol 17: 309-18 2001
39. Papademetris X, **Sinusas AJ,** Dione DP, Duncan JS. Estimation of 3D left ventricular deformation from echocardiography. Med Image Analysis 5:17-28 2001
40. **Sinusas AJ**, Papademetris X, Constable RT, Dione DP, Slade MD, Shi P, Duncan JS. Quantification of 3-D regional myocardial deformation: Shape-based analysis of magnetic resonance images. Am J Physiol: Heart and Circ Physiol 281:H698-H714 2001
41. Shi CQ, Young LH, Daher E, DiBella EVR, Dione DP, Liu Y-H, Heller EN, Zoghbi S, Arrighi JA, Wackers FJTh, Soufer R, **Sinusas AJ**. Correlation of myocardial para-123I-Iodophenyl-pentadecanoic acid retention with 18F-Fluorodeoxyglucose accumulation during experimental low flow ischemia. J Nucl Med 43:421-431 2002
42. Liu YH, Lam PT, **Sinusas AJ**, Wackers FJ. Differential effect of 180 degrees and 360 degrees acquisition orbits on the accuracy of SPECT imaging: quantitative evaluation in phantoms. J Nucl Med 43:1115-24, 2002
43. Papademetris X, **Sinusas AJ,** Dione DP, Constable RT, Duncan JS. Estimation of 3-d left ventricular deformation from medical images using biomechanical models. IEEE Transactions on Medical Imaging, 21: 786 -799 2002
44. Zhu Q, Piao D, Sadeghi MM, **Sinusas AJ**. Simultaneous optical coherence tomography imaging and beta particle detection. Optical Letters 28:1704-1706 2003

45. Meoli DF, Sadeghi MM, Krassilnikova S, Bourke BN, Giordano FJ, Dione DP, Su H, Edwards DS, Liu S, Harris TD, Madri J, Zaret BL, **Sinusas AJ**. Non-invasive imaging of myocardial angiogenesis following experimental myocardial infarction. J Clin Invest 113:1684-1691, 2004
46. Sadeghi MM, Krassilnikova S, Zhang J, Gharaei AA, Fassaei HR, Esmailzadeh L, Kooshkabadi A, Edwards, DS, Yalamanchili P, Harris TD, **Sinusas AJ**, Zaret BL, Bender JR. Detection of injury-induced vascular remodeling by targeting activated αvβ3 integrin in vivo. Circulation 110:84-90, 2004
47. Sadeghi MM, Schechner JS, Krasilnikova S, Gharaei AA, Kirkiles-Smith N, **Sinusas AJ**, Zaret BL, Bender JR. Vascular Cell Adhesion Molecule-1-targeted Detection of Endothelial Activation in Human Microvasculature. Transplantation Proceedings. 36:1585-91, 2004
48. Liu Y, **Sinusas AJ**, Khaimov D, Gebuza BI, Wackers FJTh. New hybrid count and geometry-based method for quantification of left ventricular volumes and ejection fraction from ECG-gated SPECT: methodology and validation. J Nucl Cardiol 12:55-65, 2005
49. Hua J, Dobrucki LW, Sadeghi MM, Zhang J, Bourke BN, Cavaliere P, Song J, Chow C, Jahanshad N, van Royen N, Buschmann I, Madri JA, Mendizabal M, **Sinusas AJ**. Noninvasive imaging of angiogenesis with a ^{99m}Tc-labeled peptide targeted at αvβ3 integrin after murine hindlimb ischemia. Circulation. 111:3255-3260, 2005
50. Piao D, Sadeghi M, Zhang J, Chen Y, **Sinusas AJ**, Zhu Q. A hybrid positron detection and optical coherence tomography system: Design, calibration and experimental validation with rabbit atherosclerotic models. J Biomed Opt, 10(4):044010 (July/August), 2005
51. Di Bella EVR, Parker DL, **Sinusas AJ**. On the Dark Rim Artifact in Dynamic Contrast MRI Myocardial Perfusion Studies. Magnetic Resonance in Medicine. 54:1295–1299, 2005
52. Su H, Spinale FG, Dobrucki LW, Hua J, Chow C, Sweterlitsch S, Bourke BN, Cavaliere P, Hu X, Azure M, Yalamanachili P, Liu R, Cheesman EH, Simon R, Edwards DS, **Sinusas AJ**. Non-invasive Targeted Imaging of Matrix Metalloproteinase Activation in a Murine Model of Post-Infarct Remodeling. Circulation, 112:3157-3167, 2005
53. Zhang J, Krassilnikova S, Gharaei AA, Fassaei HR, Esmailzadeh L, Asadi A, Edwards DS, Harris TD, Azure M, Tellides G, **Sinusas AJ**, Zaret BL, Bender JR, Sadeghi MM. Alphavbeta3-Targeted detection of arteriopathy in transplanted human coronary arteries: an autoradiographic study. The FASEB Journal (express article 10.1096/fj.05-4130fje) Published online September 8, 2005
54. Lindsey ML, Escobar GP, Dobrucki WL, Goshorn DK, Mingoia JT, McClister DM, Jr., Su H, Gannon J, MacGillivray C, Lee RT, **Sinusas AJ**, Spinale FJ. Matrix Metalloproteinase-9 Gene Deletion Facilitates Angiogenesis Following Myocardial Infarction. Am J Physiol, Am J Physiol:Heart & Circ Phys 290:232-9, 2006
55. Goyal A, Wang Y, Su H, Dobrucki LW, Brennan M, Fong P, Dardik A, Tellides G, **Sinusas AJ**, Pober JS, Saltzman WM, Breuer CK. Development of model system for preliminary evaluation of tissue-engineered vascular conduits. J Ped Surg 41:787-791, 2006
56. Yu W, Yan P, **Sinusas AJ**, Thiele K, Duncan JS. Towards pointwise motion tracking in echocardiographic image sequences – Comparing the reliability of different features for speckle tracking. Med Image Analysis 10(3):317-330, 2006
57. He Y, Luo Y, Tang SB, Rajantie I, Salven P, Heil M, Zhang R, Luo D, Li X, Chi H, Yu J, **Sinusas AJ**, Sessa WC, Alitalo K, Min W. Critical function of Bmx/Etk in ischemia-mediated arteriogenesis and angiogenesis. J Clin Invest 116:2344-55, 2006

58. Li J, Coven DL, Miller EJ, Hu X, Young ME, Carling D, **Sinusas AJ**, Young LH. Activation of AMPK α- and γ-Isoform Complexes in the Intact Ischemic Rat Heart. Am J Physiol:Heart & Circ Phys 291:H1927-34,2006
59. Liu Y, Fernando GP, **Sinusas AJ**. A New Method for Hot-spot Quantification of Hybrid SPECT/CT Cardiac Images: Methodology and Phantom Validation. IEEE Transactions in Nuclear Sciences 53:2814-21, 2006
60. Luo D, Luo Y,He Y, Zhang H, Zhang R, Li X, Dobrucki WL, **Sinusas AJ**, Sessa WC, Min W. Differential Functions of Tumor Necrosis Factor Receptor 1 and 2 Signaling in Ischemia-Mediated Arteriogenesis and Angiogenesis. Am J Pathol 169:1886-1898, 2006
61. Yan P, **Sinusas AJ**, Duncan JS. Boundary element method-based regularization for recovering of LV deformation. Med Image Anal. 2007 May 22 [in press, Epub ahead of print]
62. Lopez-Soler RI, Brennan MP, Goyal A, Wang Y, Fong P, Tellides G, **Sinusas A**, Dardik A, Breuer C. Development of a mouse model for evaluation of small diameter vascular grafts. J Surg Res. 139:1-6, 2007
63. Yan P, Jia CX, **Sinusas A**, Thiele K, O'Donnell M, Duncan JS. LV segmentation through the analysis of radio frequency ultrasonic images. Inf Process Med Imaging. 20:233-44, 2007
64. Roh JD, Nelson GN, Brennan MP, Mirensky TL, Yi T, Hazlett TF, Tellides G, **Sinusas AJ**, Pober JS, Saltzman WM, Kyriakides TR, Breuer CK. Small-diameter biodegradable scaffolds for functional vascular tissue engineering in the mouse model. Biomaterials. 29(10):1454-63, 2008
65. Kalinowski L, Dobrucki LW, Meoli DF, Dione DP, Sadeghi MM, Madri JA, **Sinusas AJ**. Targeted imaging of hypoxia-induced integrin activation in myocardium early after infarction. J Appl Physiol. 104(5):1504-12, 2008
66. Joshi A, Qian X, Dione D, Bulsara K, Breuer C, **Sinusas AJ**, Papademetris X. Effective visualization of complex vascular structures using a non-parametric vessel detection method. IEEE Trans Vis Comput Graph, Nov-Dec:14(6):1603-10, 2008.
67. Zhang J, Nie L, Razavian M, Ahmed M, Dobrucki LW, Asadi A, Edwards DS, Azure M, **Sinusas AJ**, Sadeghi MM. Molecular imaging of activated matrix metalloproteinases in vascular remodeling. Circulation, 118(19):1953-60, 2008.
68. Qian X, Brennan MP, Dione DP, Dobrucki WL, Jackowski MP, Breuer CK, **Sinusas AJ**, Papademetris X. A Non-Parametric Vessel Detection Method for Complex Vascular Structures. Medical Image Analysis, 13(1):49-61, 2009.
69. Brennan MP, **Sinusas AJ**, Horvath TL, Collins JG, Harding MJ. Correlation Between Body Weight Changes and Postoperative Pain in Rats Treated With Meloxicam or Buprenorphine. Lab. Anim. (NY). 38(3):87-93, 2009.
70. Dobrucki LW, Dione DP, Kalinowski L, Dione D, Mendizabal M, Yu J, Papademetris X, Sessa WC, **Sinusas AJ**. Serial noninvasive targeted imaging of peripheral angiogenesis: Validation and application of a semiautomated quantitative approach. J Nucl Med 50:1356-1363, 2009
71. Mekkaoui C, Jadbabaie J, Dione DP, Meoli DF, Purushothaman K, Belardinelli L, **Sinusas AJ**. Effects of Adenosine and a Selective A2A Adenosine Receptor Agonist on Hemodynamic and ^{201}Tl and ^{99m}Tc-SestaMIBI Biodistribution and Kinetics. JACC Cardiovasc Imaging 2:1198-208, 2009

72. Zhu Y, Papademetris X, **Sinusas AJ**, Duncan JS. A Dynamical Shape Prior for LV Segmentation from RT3D Echocardiography. Med Image Comput Comput Assist Interv. 2009;5761:206-213
73. Dobrucki LW, Tsutsumi Y, Kalinowski L, Dean J, Gavin M, Sen S, Mendizabal M, **Sinusas AJ**, Aikawa R. Analysis of angiogenesis induced by local IGF-1 expression after myocardial infarction using microSPECT-CT imaging. J Mol Cell Cardiol. 48(6):1071-9, 2009
74. Dobrucki LW, Meoli DF, Hu J, Sadeghi MM, **Sinusas AJ**. Regional Hypoxia Correlates with the Uptake of a Radiolabeled Targeted Marker of Angiogenesis in Rat Model of Myocardial Hypertrophy and Ischemic Injury. J Physiol & Pharm 60(Suppl 4):117-123, 2009
75. Razavian M, Zhang J, Nie L, Tavakoli S, Razavian N, Dobrucki LW, **Sinusas AJ**, Edwards DS, Azure M, Sadeghi MM. Molecular imaging of matrix metalloproteinase activation to predict murine aneurysm expansion in vivo. J Nucl Med. 51(7):1107-15, 2010 PMID: 20554725
76. Zhu Y, Papademetris X, **Sinusas AJ**, Duncan JS. A coupled deformable model for tracking myocardial borders from real-time echocardiography using an incompressibility constraint. Med Image Anal. 14(3):429-48. 2010 PMID: 20350833
77. Spinale FG, Mukherjee R, Zavadzkas JA, Koval CN, Bouges S, Stroud RE, Dobrucki LW, **Sinusas AJ**. Cardiac restricted overexpression of membrane type-1 matrix metalloproteinases causes adverse myocardial remodeling following myocardial infarction. J Biol Chem 285:30316-27, 2010 PMID: 20643648
78. Pearlman PC, Tagare HD, **Sinusas AJ**, Duncan JS. 3D radio frequency ultrasound cardiac segmentation using a linear predictor. Med Image Comput Comput Assist Interv. 2010;13(Pt 1):502-9. PMID: 20879268
79. Suh JW, Scheinost D, Dione DP, Dobrucki LW, **Sinusas AJ**, Papademetris X. A non-rigid registration method for serial lower extremity hybrid SPECT/CT imaging. Med Image Anal 15:96-111, 2011 PMID: 20869902
80. Tavakoli S, Razavian M, Zhang J, Nie L, Marfatia R, Dobrucki LW, **Sinusas AJ**, Robinson S, Edwards DS, Sadeghi MM. Matrix metalloproteinase activation predicts amelioration of remodeling after dietary modification in injured arteries. Arterioscler Thromb Vasc Biol. 31(1):102-9, 2011 PMID: 20947820
81. Liu YH, Sahul Z, Weyman CA, Dione DP, Dobrucki WL, Mekkaoui C, Brennan MP, Ryder WJ, **Sinusas AJ**. Accuracy and Reproducibility of Absolute Quantification of Myocardial Focal Tracer Uptake from Molecularly Targeted SPECT/CT: A Canine Validation. J Nucl Med. 52(3):453-60, 2011 PMID: 21321271
82. Sahul ZH, Mukherjee R, Song J, McAteer J, Stroud RE, Dione DP, Staib L, Papademetris X, Dobrucki LW, Duncan JS, Spinale FG, **Sinusas AJ**. Targeted imaging of the spatial and temporal variation of matrix metalloproteinase activity in a porcine model of postinfarct remodeling: relationship to myocardial dysfunction. Circ Cardiovasc Imaging. 2011 Jul;4(4):381-91. PMID: 21505092
83. Hibino N, Villalona G, Pietris N, Duncan DR, Schoffner A, Roh JD, Yi T, Dobrucki LW, Mejias D, Sawh-Martinez R, Harrington JK, **Sinusas A**, Krause DS, Kyriakides T, Saltzman WM, Pober JS, Shin'oka T, Breuer CK. Tissue-engineered vascular grafts form neovessels that arise from regeneration of the adjacent blood vessel. FASEB J. 2011 Aug;25(8):2731-9. PMID: 21566209
84. Buxton DB, Antman M, Danthi N, Dilsizian V, Fayad ZA, Garcia MJ, Jaff MR, Klimas M, Libby P, Nahrendorf M, **Sinusas AJ**, Wickline SA, Wu JC, Bonow RO, Weissleder R.

Report of the National Heart, Lung and Blood Institute working group on the translation of cardiovascular molecular imaging. Circulation. 2011 May 17;123(19):2157-63. PMID: 21576680.

85. Zhang Z, Dione DP, Brown PB, Shapiro EM, **Sinusas AJ**, Sampath S. Assessment of early diastolic strain-velocity temporal relationships using spatial modulation of magnetization with polarity alternating velocity encoding (SPAMM-PAV). Magn Reson Med. 2011 Dec;66(6):1627-38. PMID: 21630348.
86. Cardiovascular Council Board of Directors. Cardiovascular nuclear imaging: balancing proven clinical value and potential radiation risk. J Nucl Med. 2011 Jul:52(7):1162-4. PMID: 21724985.
87. **Sinusas AJ**, Thomas JD, Mills G. The future of molecular imaging. JACC Cardiovasc Imaging. 2011 Jul;4(7):799-806. PMID: 21757172.
88. Pearlman PC, Tagare HD, Lin BA, **Sinusas AJ**, Duncan JS. Segmentation of 3D RF echocardiography using a multiframe spatio-temporal predictor. Inf Process Med Imaging. 2011;22:37-48. PMID: 21761644.
89. Criscione JM, Dobrucki LW, Zhuang ZW, Papademetris X, Simons M, **Sinusas AJ**, Fahmy TM. Development and application of a multimodal contrast agent for SPECT/CT hybrid imaging. Bioconjug Chem. 2011 Sep 21;22(9):1748-92. PMID: 21851119.
90. Razavian M, Marfatia R, Mongue-Din H, Tavakoli S, **Sinusas AJ**, Zhang J, Nie L, Sadeghi MM. Integrin-targeted imaging of inflammation in vascular remodeling. Arterioscler Thromb Vasc Biol. 2011 Dec;31(12):2820-6. PMID: 21940943.
91. Razavian M, Tavakoli S, Zhang J, Nie L, Dobrucki LW, **Sinusas AJ**, Azure M, Robinson S, Sadeghi MM. Atherosclerosis plaque heterogeneity and response to therapy detected by in vivo molecular imaging of matrix metalloproteinase activation. J Nucl Med. 2011 Nov;52(11):1795-802. PMID: 21969358.
92. Jiang Y, Zhuang ZW, **Sinusas AJ**, Staib LH, Papademetris X. Vessel connectivity using Murray's hypothesis. Med Image Comput Comput Assist Interv. 2011;14(Pt 3):528-36. PMID: 22003740.
93. Pearlman PC, Tagare HD, Lin BA, **Sinusas AJ**, Duncan JS. Segmentation of 3D radio frequency echocardiography using a spatio-temporal predictor. Med Image Anal. 2011 Oct. 14. PMID: 22018842.
94. Hedhli N, Dobrucki LW, Kalinowski A, Zhuang ZW, Wu X, Russell RR 3rd, **Sinusas AJ**, Russell KS. Endothelial Derived Neuregulin is an Important Mediator of Ischemic Induced Angiogenesis and Arteriogenesis. Cardiovasc Res. 2012 Mar 1:93(3):516-24 PMID: 22003740.
95. Liu H, Hu H, **Sinusas AJ**, Shi P. An H(∞) approach for elasticity properties reconstruction. Med Phys. 2012 Jan:39(1):475-81. PMID:22225318.
96. Suh JW, Kwon OK, Scheinost D, **Sinusas AJ**, Cline GW and Papademetris X. CT-PET weighted image fusion for separately scanned whole body rat. Medical physics. 2012; 39(1):533-42. Epub 2012/01/10. PMID: 22225323; PMCID: PMC3266828
97. Zhang Z, Friedman D, Dione DP, Lin BA, Duncan JS, **Sinusas AJ**, Sampath S. Assessment of left ventricular 2D flow pathlines during early diastole using spatial modulation of magnetization with polarity alternating velocity encoding: A study in normal volunteers and canine animals with myocardial infarction. Magn Reson Med. 2012 Oct 8. doi: 10.1002/mrm.24517. PMID: 23044637

98. Huang X, Dione DP, Compas CB, Papademetris X, Lin BA, Sinusas AJ, Duncan JS. A dynamical appearance model based on multiscale sparse representation: segmentation of the left ventricle from 4D echocardiography. Med Image Comput Comput Assist Interv. 2012;15(Pt 3):58-65. PMID:23286114
99. Pellikka PA, Douglas PS, Miller JG, Abraham TP, Baumann R, Buxton DB, Byrd BF 3rd, Chen P, Cook NL, Gardin JM, Hansen G, Houle HC, Husson S, Kaul S, Klein AL, Lang RM, Leong-Poi H, Lopez H, Mahmoud TM, Maslak S, McCulloch ML, Metz S, Nagueh SF, Pearlman AS, Pibarot P, Picard MH, Porter TR, Prater D, Rodriguez R, Sarano ME, Scherrer-Crosbie M, Shirali GS, Sinusas A, Slosky JJ, Sugeng L, Tatpati A, Villanueva FS, von Ramm OT, Weissman NJ, Zamani S. American Society of Echocardiography Cardiovascular Technology and Research Summit: A Roadmap for 2020. J Am Soc Echocardiogr. 2013 Apr;26(4):325-338. doi: 10.1016/j.echo.2013.02.003. PMID: 23537771
100. Jaba IM, Zhuang ZW, Li N, Jiang Y, Martin KA, Sinusas AJ, Papademetris X, Simons M, Sessa WC, Young LH, Tirziu D. NO triggers RGS4 degradation to coordinate angiogenesis and cardiomyocyte growth. J Clin Invest. 2013 Mar 1. doi:pii: 65112. 10.1172/JCI65112. [Epub ahead of print] PMID: 23454748

B. Case Reports, Technical Notes, Full Manuscripts Published as Proceeding, and Letters:

1. Duncan J, Shi P, Amini A, Constable RT, Staib L, Dione D, Shi QX, Heller E, Singer M, Chakraborty A, Robinson G, Gore J, **Sinusas AJ**: Towards reliable noninvasive measurement of myocardial function from 4D images. Proceedings of Medical Imaging, 1994, Newport Beach SPIE
2. Shi P, Amini A, Robinson G, **Sinusas AJ,** Constable ET, Duncan J: Shape-based 4D left ventricular myocardial functional analysis. Proceedings IEEE Workshop on Biomedical Image Analysis. June 24-25, 1994, Seattle, Washington, pg 88-97
3. Duncan JS, Shi P, Amini AA, Constable RT, **Sinusas AJ**. Shape-based tracking and analysis of myocardial function from 4D images, AAAI Spring Symposium: Applications of Computer Vision in Medical Image Processing, Stanford University, March 1994, pg 165-168
4. Liu YH, **Sinusas AJ**, Shen MYH, Dione DP, Duncan JS, Wackers FJTh: An automated approach for quantification of relative regional myocardial blood flow, using SPECT Tc99m-sestamibi: Preliminary validation in a canine model. In: Proceedings of the 16th Annual International Conference of the IEEE Engineering in Medicine and Biology Society Baltimore, MD, 1994, pg 636-638
5. Shi P, Robinson GP, Chakraborty A, Staib LH, Constable RT, **Sinusas AJ,** Duncan JS. A unified framework to assess myocardial function form 4D images, Lecture Notes in Computer Science: First International Confewrence on Computer Vision, Virtual Reality, and Robotics in Medicine, Ayache, N. (ed.), Springer-Verlag, Nice France, April 1995, pg 327-337
6. Shi P, Robinson GP, Constable RT, **Sinusas AJ**, Duncan JS. A model-based integrated approach to track myocardial deformation using displacement and velocity constraints, Fifth International Conference on Computer Vision, IEEE Computer Society Press, Cambridge, Massachusetts, June 1995

7. Meyer FG, Constable RT, **Sinusas AJ**, Duncan JS. Tracking myocardial deformation using spatially-constrained velocities. XIVth International Conference on Information Processing in Medical Imaging, Kluwer, 1995, pages 177-188
8. Staib LH, **Sinusas A**. Cardiac SPECT restoration using MR-based support constraints. Proceedings International Conference Imaging Processing, 1995, pages 480-483
9. Liu YH, **Sinusas AJ**, Wackers FJTh. Validation of a new SPECT quantification method using computer simulation. Nuclear Science Symposium and Medical Imaging Conference Record. San Francisco, 1995, Vol 3, pages 1506-1509
10. Liu YH, DeMan P, **Sinusas AJ**, Natale D, Wackers FJTh. The Yale-CQ method for cardiac SPECT quantification: Phantom validation and patient application. Proceedings 18th Annual International Conference IEEE EMBS, Amsterdam, The Netherlands, paper #123, 1996
11. Liu YH, Rangarajan A, Gagnon D, Therrien M, **Sinusas AJ**, Wackers FJTh, Zubal G. New method for SPECT imaging and pre-reconstruction restoration. Proceedings 15th International Conference on Information Processing in Medical Imaging June, 1997, pg 531-536
12. Dione DP, Shi P, Smith W, DeMan P, Soares J, Duncan J, **Sinusas A**. Three-Dimensional Regional Left Ventricular Deformation from Digital Sonomicrometry. In: Proceedings of the 19th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Chicago IL, 1997, pg 848-851
13. Meoli D, Mazhari R, Dione D, Omens J, McCulloch A, **Sinusas A**. Three-dimensional digital sonomicrometry: Comparison with Biplane Radiography. Proceedings of the IEEE 24th Annual Northeast Bioengineering Conference; Hershey, PA, 1998, pg 64-67
14. Papademetris X, Shi P, Dione DP, **Sinusas AJ**, Duncan JS. Recovery of soft tissue object deformation using biomechanical models. Proceedings Information Processing in Medical Imaging (IPMI), Springer Lecture Notes in Computer Science, Visegrad, Hungary, June 1613:352-356, 1999
15. Papademetris X, **Sinusas AJ**, Dione DP, Duncan JS. 3D cardiac deformation from ultrasound images. Proceedings Medical Image Computing and Computer Aided Intervention (MICCAI), Cambridge UK, September 1679:420-429, 1999
16. Papademetris X, Onat ET, **Sinusas AJ**, Dione DP, Constable RT, Duncan JS. The active elastic model. Information Processing in Medical Imaging. 17th International Conference, Proceedings IPMI Berlin, Germany 2082:36-49 2001
17. **Sinusas AJ**, Wackers FJTh. Quantitative gated SPECT. J Nucl Med. 42(3):528-9, 2001
18. Yu W, Lin N, Yan P, Purushothaman K, **Sinusas AJ**, Thiele K, Duncan JS: Motion Analysis of 3D Ultrasound Texture Patterns. FIMH 2003, Functional Imaging and Modeling of the Heart, Second International Workshop, Lyon, France, June, Proceedings. Lecture Notes in Computer Science 2674, pg252-261, 2003
19. Lin N, Papademetris X, **Sinusas AJ**, Duncan JS: Analysis of Left Ventricular Motion Using a General Robust Point Matching Algorithm. MICCAI 2003: Medical Image Computing and Computer-Assisted Intervention - 6th International Conference, Montréal, Canada, November, Proceedings, Part I. Lecture Notes in Computer Science 2878, pg556-563, 2003
20. Wong LN, Shi P, Liu HF, **Sinusas AJ**. Joint Analysis of Heart Geometry and Kinematics with Spatiotemporal Active Region Model, IEEE International Conference of the Engineering in Biology and Medicine Society (EMBC), Cancun, Mexico, September, 2003, pg762-765

21. Wong LN, Liu HF, **Sinusas AJ**, Shi P. Spatio-temporal active region model for simultaneous segmentation and motion estimation of the whole heart, IEEE workshop on Variational, Geometrical and Level Set Methods in Computer Vision (VLSM), Nice, France, October, 2003, pg193-200
22. Liu Y, **Sinusas AJ**, Wackers FJTh, Lam PT. Cardiac SPECT: 360° circular acquisition may resolve defects of 180° data. (Letter) J Nucl Med 44:995-996, 2003
23. Shi P, Liu H, **Sinusas AJ**: Robust Filtering Strategies for Soft Tissue Young's Modulus Characterization. Proceedings of the IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI), Arlington, VA, April 2004, pg768-771
24. Wong LN, Liu HF, **Sinusas AJ**, Shi P. Simultaneous recovery of left ventricular shape and motion using meshfree particle framework, IEEE International Symposium on Biomedical Imaging: Nano to Macro (ISBI), Arlington, Virginia, April 2004, pg1263-1266
25. Wong CL, Liu HF, Wong LN, **Sinusas AJ**, Shi P. Meshfree cardiac motion analysis framework using composite material model and total lagrangian formulation, IEEE International Symposium on Biomedical Imaging: Nano to Macro (ISBI), Arlington, Virginia, April 2004, pg1263-1266
26. Yu W, Yan P, **Sinusas A**, Thiele K, Duncan JS. Pointwise motion tracking in echocardiographic images. IEEE Computer Vision and Pattern Recognition, Proceedings, Washington, DC, June 2004, pg 676-683
27. Dobrucki WL, **Sinusas AJ**. Book review: Molecular Nuclear Medicine. The challenge of genomics and proteomics to clinical Practice. J Nucl Card 2004
28. Li S, Dobrucki WL, **Sinusas AJ**, Liu YH. A new method for SPECT quantification of targeted radiotracers uptake in the myocardium. Proceeding of Medical Image Computing and Computer-Assisted Intervention (MICCAI), LNCS 3750: 684-691, 2005
29. Papademetris X, Dione DP, Dobrucki LW, Staib LH, **Sinusas AJ**. Articulated Rigid Registration for Serial Lower-Limb Mouse Imaging. Proceedings of Medical Image Computing and Computer-Assisted Intervention, MICCAI LNCS 3750: 919-926, 2005
30. Jackowski M, Papademetris X, Dobrucki LW, **Sinusas AJ**, Staib LH. Characterizing vascular connectivity from microCT images. Proceedings of Medical Image Computing and Computer-Assisted Intervention, MICCAI, LNCS 3750: 701-708, 2005
31. Yan P, Lin N, **Sinusas AJ**, Duncan JS. A Boundary Element-Based Approach to Analysis of LV Deformation. Proceedings of Medical Image Computing and Computer-Assisted Intervention, MICCAI, LNCS 3750, 8(Pt 1):778-85, 2005
32. Tong S, **Sinusas A**, Shi P. Continuous-discrete filtering for cardiac kinematics estimation under spatio-temporal biomechanical constrains," International Conference on Pattern Recognition (ICPR), 2006, pp. 167-170.
33. Tong S, **Sinusas A**, Shi P. Sampled-data H∞ filtering for robust kinematics estimation: Applications to biomechanics-based cardiac image analysis. International Conference on Image Processing (ICIP), 2006, pp. 2525-2528.
34. **Sinusas AJ**. Cardiovascular molecular imaging. J Nucl Med. 48(4):26N-7N, 2007
35. Zhu Y, Papademetris X, **Sinusas A**, Duncan JS. Segmentation of myocardial volumes from real-time 3D echocardiography using an incompressibility constraint. Med Image Comput Comput Assist Interv Int Conf Med Image Comput Comput Assist Interv.10(Pt 1):44-51, 2007

36. Qian X, Brennan MP, Dione DP, Dobrucki LW, Jackowski MP, Breuer CK, **Sinusas AJ**, Papademetris X. Detection of Complex Vascular Structures using Polar Neighborhood Intensity Profile. In MMBIA, October 2007
37. **Sinusas AJ**. Cardiovascular molecular imaging: promoting utilization and outreach. J Nucl Med. 49(6):60N-3N, 2008
38. Liu YH, Sahul Z, Weyman CA, Ryder WJ, Dione D, Dobrucki LW, Mekkaoui C, Brennan MP, Hu X, Hawley C, **Sinusas AJ**. Hotspot quantification of myocardial focal tracer uptake from molecular targeted SPECT/CT images: canine validation. Proceedings of the SPIE 6915:69150N, pgs 1-8, 2008.
39. Ryder WJ, Brennan MP, **Sinusas AJ**, Liu YH. Iterative reconstruction of multi-pinhole SPECT. Proceedings of the SPIE 1613:69132M, pgs 1-10, 2008
40. Zhu Y, Papademetris, X, **Sinusas AJ**, Duncan JS. Bidirectional segmentation of three-dimensional cardiac MR images using a subject-specific dynamical model. Medical Image Computing & Computer-Assisted Intervention: MICCAI. 11(Pt 2):450-7, 2008
41. Zhu Y, Papademetris X, **Sinusas A**, Duncan JS. Segmentation of Left Ventricle From 3D Cardiac MR Image Sequences Using A Subject-Specific Dynamical Model. Proc IEEE Comput Soc Conf Comput Vis Pattern Recognit. 2008:1-8, 2008
42. Suh J, Scheinost D, Dione DP, Dobrucki LW, **Sinusas AJ**, Papademetris X. A Non-rigid Registration Method for Serial microCT Mouse Hindlimb Images. Proceedings MICCAI 2009 (in press)
43. Suh JW, Scheinost D, Qian X, **Sinusas AJ**, Breuer CK, Papademetris X. Serial non-rigid vascular registration using weighted normalized mutual information. Proc IEEE Int Symp Biomed Imaging. 2010 Apr 14;2010:25. PMID: 21479163.
44. Jiang Y, Zhuang Z, **Sinusas AJ**, Papademetris X. Vascular Tree Reconstruction by Minimizing A Physiological Functional Cost. Conf Comput Vis Pattern Recognit Workshops. 2010 Jun 13:178-785. PMID: 21755061.
45. Compas, C.B., Lin, B.A., Sampath, S., Jia, C., Wei, Q., **Sinusas, A.J.** & Duncan, J.S. (2011). Multi-frame radial basis functions to combine shape and speckle tracking for cardiac deformation analysis in echocardiography. Proceedings of Functional Imaging and Modeling of the Heart 2011, Lecture Notes in Computer Science 6666:113-120.
46. Pearlman, P.C., Tagare, H.D., Lin, B.A., **Sinusas, A.J.** & Duncan, J.S. (2011). Segmentation of 3D RF echocardiography using a multiframe spatio-temporal predictor. Proceedings of Information Processing in Medical Imaging 2011, Lecture Notes in Computer Science 6801:37-48.
47. Compas C. B., Lin B. A., Sampath S., Jia C. X., Wei Q., **Sinusas A. J.**, and Duncan J. S. Combining shape and speckle tracking for deformation analysis in echocardiography using radial basis functions, IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI), 1322–1325, 2011.
48. Compas C. B., Lin B. A., Sampath S., Huang L., Wei Q., **Sinusas A. J.**, and Duncan J. S.. Comparing Shape Tracking, Speckle Tracking, and a Combined Method for Deformation Analysis in Echocardiography, Healthcare Informatics, Imaging, and Systems Biology (HISB), San Jose, pp. 120-125, 2011.
49. Huang X., Lin B. A., Compas C. B., **Sinusas A. J.**, Staib L. H., and Duncan J. S.. Segmentation of left ventricles from echocardiographic sequences via sparse appearance representation. IEEE Workshop on Mathematical Methods in Biomedical Image Analysis (MMBIA), pages 305-312, 2012.

50. Huang X., Dione D. P., Compas C. B., Papademetris X., Lin B., **Sinusas A. J.,** and Duncan J. S.. A Dynamical Appearance Model Based on Multiscale Sparse Representation: Segmentation of the Left Ventricle from 4D Echocardiography. In Medical Image Computing and Computer-Assisted Intervention (MICCAI), 2012. (in press).
51. Compas C.B., Wong E.Y., Huang X., Sampath S., Lin B.A., Papademetris X., Thiele K., Dione D.P., **Sinusas A.J.,** O'Donnell M., and Duncan J.S.. A Combined Shape Tracking and Speckle Tracking Approach for 4D Deformation Analysis in Echocardiography. In IEEE International Symposium on Biomedical Imaging (ISBI), pages 458-461, 2012.

C. Editorials, Reviews, Book Chapters:

1. **Sinusas AJ,** Beller GA, Watson DD: Cardiac Imaging with Technetium-99m Labeled Isonitriles. J Thoracic Imaging, 5:20-30 1990
2. Beller GA, **Sinusas AJ.** Animal Studies of the Physiologic Properties of Technetium-99m Isonitriles: Initial Uptake as a Function of Perfusion and Viability. Am. J. Cardiology, 66:5E-8E 1990
3. Beller GA, **Sinusas AJ**, Watson DD. Assessment of myocardial perfusion and viability with technetium-99m methoxyisobutyl isonitrile. Transactions of the American Clinical & Climatological Association 1990, 102:41-51
4. **Sinusas AJ:** Cardiac Imaging with Technetium-99m labeled perfusion agents. 1992 Year Book of Nuclear Medicine, Chicago, IL XV-XLVI
5. Wackers FJTh, Maniawski P, **Sinusas AJ**: Evaluation of left ventricular wall function by ECG-gated Tc-99m-Sestamibi imaging. Nuclear Cardiology: State of the Art and Future Direction Editors: Beller GA, Zaret BL, Mosby, 1993
6. **Sinusas AJ,** Zaret BL: Are conventional imaging strategies employed following myocardial infarction equally appropriate in the thrombolytic era? Am J Cardiac Imaging, 1993, 7:9-10
7. **Sinusas AJ,** Wackers FJTh: Assessing myocardial reperfusion with Tc-99m labeled myocardial perfusion agents: Basic concepts in clinical applications. Am J of Cardiac Imaging, 1993, 7:24-38
8. **Sinusas AJ.** Does myocardial fatty acid metabolism predict subsequent mechanical dysfunction associated with cardiomyopathy? (editorial) J Nucl Cardiol, 1994 1:218-220
9. **Sinusas AJ,** Zaret BL: Heart: Coronary Artery Disease Principles of Nuclear Medicine, Editors: Wagner HN, Szaboz Z, W B Saunders, Philadelphia, 1995, pages 789-819
10. **Sinusas AJ.** Assessment of reperfusion after acute myocardial infarction: Is there a role for acute technetium 99m-teboroxime imaging. J Nucl Cardiol 1996, 3:82-85
11. **Sinusas AJ.** New Approaches to Myocardial Imaging with Hypoxia Markers. New Developments in Nuclear Imaging, Editors: Verani M, Iskandrian A. Futura Publishing Co., Inc., Armonk N.Y. 1998, pg 203-218
12. **Sinusas AJ.** Experimental evaluation of radiotracers: Role of intact biological models. J Nucl Cardiol, 1998, 5:167-83
13. **Sinusas AJ.** Role of intact biological models for evaluation of radiotracers. Nuclear Cardiology: State-of-the-Art and Future Directions, Second Edition, Editors: Zaret BL, Beller GA., Mosby-Year Book, Inc., Philadelphia, PA 1998 pg 37-55
14. Gerson MC, Leppo JA, Corbett JR, Dae MW, Glover DK, Johnson G, Johnson LL, Nishimura T, Okada RD, **Sinusas AJ**, Soufer R. Wintergreen panel summaries - Panel II - New tracers and new approaches. [Editorial Material] Journal of Nuclear Cardiology, 1999 6:103-112.

15. Port SC, Berman DS, Garcia EV, Port SC, **Sinusas AJ**, Wackers FJTh, Bacharach SL, Barteman TM, Borges-Neto S, DePuey EG, Hachamovitch R, Johnson LL, Van Train KF, Watson D, Weinstein H. Imaging guidelines for nuclear cardiology procedures. Part 2. Journal of Nuclear Cardiology. 6:G49-G84 1999
16. **Sinusas AJ**. The Potential for Myocardial Imaging with Hypoxia Markers. Seminars in Nuclear Medicine: Current Status of Cardiovascular Nuclear Medicine – II. Guest Editors: Wexler JP, Travin MI. W. B. Saunders Co., Philadelphia, PA. 29:330-338 1999
17. Young LH. Russell RR 3rd. Yin R. Caplan MJ. Ren J, Bergeron R. Shulman GI. **Sinusas** AJ. Regulation of myocardial glucose uptake and transport during ischemia and energetic stress. American Journal of Cardiology. 83:25H-30H, 1999
18. **Sinusas AJ**. Technetium 99m N-NOET: although not equivalent to thallium-201, it still offers new opportunities. [editorial] J Nucl Cardiol 7:185-88, 2000
19. Kailasnath P, **Sinusas AJ**. Technetium-99m-labeled myocardial perfusion agents: Are they better than thallium-201? Cardiology in Review 9:160-172, 2001
20. Kailasnath P, **Sinusas AJ**. Comparison of thallium-201 with technetium-99m-labeled myocardial perfusion agents: technical, physiological, and clinical issues. J Nucl Cardiol 8:482-498, 2001
21. Gullberg GT, DiBella EVR, **Sinusas AJ**. Estimation of coronary flow reserve: Can SPECT compete with other modalities? J Nucl Cardiol 5:620-5, 2001
22. **Sinusas AJ**, Kailasnath P. Does contrast echocardiography provide new insight regarding regulation of microcirculatory flow and stress perfusion imaging? [editorial] J Nucl Cardiol 8:707-10, 2001
23. Papademetris X, **Sinusas AJ**, Duncan JS. Computational platforms for integrated cardiac image analysis. Measurement of Cardiac Deformations from MRI: Physical and Mathematical Models. Editors: Amini AA, Prince JL. Kluwer Academic Publishers, Dordrecht, The Netherlands. Chapter 11, pages 289-313, 2001
24. **Sinusas AJ**, Wackers FJTh. Myocardial perfusion imaging in the assessment of therapeutic interventions. Nuclear Cardiology Imaging: Principles and Applications, Third Edition, Editors: Iskandrian AE, Verani MS., Chapter 16, pages 311-322, 2002
25. **Sinusas AJ**. New Molecular Approaches for Imaging of Angiogenesis and Hypoxia. Clinical Nuclear Cardiology: State-of-the-Art and Future Directions. Third Edition Editors: Zaret BL, Beller GA. Elsevier, Chapter 39, pages 631-648, 2004
26. **Sinusas AJ**. Role of intact biological models for evaluation of radiotracers. Clinical Nuclear Cardiology: State-of-the-Art and Future Directions. Third Edition Editors: Zaret BL, Beller GA. Elsevier, Chapter 3, pages 25-47, 2004
27. Sinusas AJ. Imaging of angiogenesis. J Nucl Cardiol. 11(5):617-33, 2004
28. Dobrucki LW. **Sinusas AJ**. Cardiovascular molecular imaging. Seminars in Nuclear Medicine. 35:73-81, 2005
29. Dobrucki LW, **Sinusas AJ**. Molecular Cardiovascular Imaging. Current Cardiology Reports, 7:130–135, 2005
30. Dobrucki LW, **Sinusas AJ**. Molecular Imaging: A New Approach to Nuclear Cardiology. Quarterly Journal of Nuclear Medicine 49:106-15, 2005
31. **Sinusas AJ**. What is the role of molecular imaging in the management of cardiac disorders? J Nucl Med 47:33N-35, 2006
32. Dobrucki LW, **Sinusas AJ**. Imaging angiogenesis. Curr Opin Biotechnol. 18:90-6, 2007

33. Chung G, **Sinusas AJ**. Imaging of matrix metalloproteinase activation and left ventricular remodeling. Curr Cardiol Rep. 9:136-42, 2007
34. Dobrucki LW, **Sinusas AJ**. Imaging of Angiogenesis. Chapter 22. *Cardiovascular Molecular Imaging*, Gropler RJ, Glover DK, **Sinusas AJ**, Taegtmeyer H. (Eds), Informa Healthcare, New York, NY, 2007
35. Dobrucki LW, **Sinusas AJ**. Imaging of Angiogenesis. Chapter 26. Part V: Emerging Role of Molecular Imaging, *Cardiac PET and PET/CT Imaging*, DiCarli MF, Lipton MJ. (Eds), Springer, New York, NY, 2007
36. Sahul Z, **Sinusas AJ**. Imaging of Remodeling. *Nuclear Cardiac Imaging*. Iskandrian A, Garcia E (Eds). Oxford University Press (2008)
37. **Sinusas AJ**. Targeted imaging offers advantages over physiological imaging for evaluation of angiogenic therapy. J Am Coll Cardiol, Imaging 1:511-4, 2008
38. **Sinusas, AJ**. Cardiovascular MI Symposium. J Nucl Med. 50(3):19N, 2009
39. **Sinusas A**, Bengel F, Nahrendorf M, Epstein F, Wu J, Villanueva F, Fayad Z, Gropler R. Multimodality Cardiovascular Molecular Imaging, Part I. Circ Cardiovasc. Imaging. 1:224-256, 2008
40. Nahrendorf M, Sosnovik D, French B, Swirski F, Bengel F, Sadeghi M, Lindner J, Wu J, Kraitchman D, Fayad Z, **Sinusas AJ**. Multimodality Cardiovascular Molecular Imaging, Part II. Circ Cardiovasc. Imaging. 2:56-70, 2009
41. Morrison, AR, **Sinusas AJ**. New Molecular Imaging Targets to Characterize Myocardial Biology. Cardiol. Clin. 27(2):329-44, 2009.
42. **Sinusas AJ**. Future Prospects of Cardiac Imaging, Chapter 6. *Cardiovascular Imaging*. Yi-Hwa Liu, PhD and Frans J. Th. Wackers, MD (Eds), Manson Publishing, London, UK (in press 2009)
43. Dobrucki LW, **Sinusas AJ**. PET and SPECT in cardiovascular molecular imaging. Nat Rev Cardiol. 7(1):38-47, 2010
44. Morrison AR, **Sinusas AJ**. Advances in radionuclide molecular imaging in myocardial biology. J Nucl Cardiol. . [Epub ahead of print]
45. **Sinusas AJ**. Molecular imaging in nuclear cardiology: translating research concepts into clinical applications. Q J Nucl Med Mol Imaging. 2010 Apr;54(2):230-40. (Review)
46. Dobrucki LW, de Muinck ED, Lindner JR, **Sinusas AJ.** Approaches to multimodality imaging of angiogenesis. J Nucl Med. 51(Suppl 1):66S-79S. (Review) PMID: 20457795
47. Kramer CM, **Sinusas AJ,** Sosnovik DE, French BA, Bengel FM. Multimodality imaging of myocardial injury and remodeling. J Nucl Med. 51(Suppl 1):107S-121S. 2010 (Review). PMID: 20395347
48. **Sinusas AJ**. Multimodality cardiovascular molecular imaging: an overview. J Nucl Med. 51 (Suppl 1):1S-2S. 2010 (Review). PMID: 20395344
49. Criscione JM, **Sinusas AJ**, Fahmy TM. Multimodaltiy/fusion imaging toward imaging of structure and function. Chapter In *Stem Cell Labeling for Delivery and Tracking Using Noninvasive Imaging*. Edited by Kraitchman DL, and Wu J. CRC Press, London, UK, September 2011 (**ISBN:** 978-1-4398075-1-4)
50. Stacy MR, Maxfield MW, **Sinusas AJ**. Targeted molecular imaging of angiogenesis in PET and SPECT: a review. Yale J Biol Med. 2012 Mar:85(1):75-86. PMID:22461745.

D. Books:

1. Gropler RJ, Glover DK, **Sinusas AJ**, Taegtmeyer H. (Eds), *Cardiovascular Molecular Imaging*, Informa Healthcare, New York, NY (2007)

Abstract Presentations - Original Research

National Meetings of; (1) American College of Cardiology,
(2) American Heart Association,
(3) Society of Nuclear Medicine,
(4) American Society of Nuclear Cardiology
(5) International Society of Magnetic Resonance in Medicine
(6) Academy of Molecular Imaging

1990-2012: >200 scientific abstracts
(first author - 29 abstracts; second author - 25 abstracts; senior author - 66 abstracts)

Patents

1. U.S. Patent Application, entitled "Hybrid OCT/Scintigraphy Intravascular Device", Inventors: Albert J. Sinusas, Quing Zhu, Mehran Sadeghi. European patent EP1534128
2. U.S. Patent Application, entitled "A Stochastic Approach for Quantification of "Hot-Spot" Cardiac Imaging", Inventors: YiHwa Liu, Albert J. Sinusas, Frans J. Th. Wackers (patent pending).
3. International Patent Application, entitled "Integrin-targeted imaging of inflammation in vascular remodeling", PCT/US12/37546 Inventors: Mehran M. Sadeghi, Albert J. Sinusas, (patent pending).
4. U.S. Patent Application, entitled "Evaluation of presence of and vulnerability to atrial fibrillation and other indications using matrix metalloproteinase-based imaging", Inventors: Albert J. Sinusas, Joseph Akar, Richard Cesati (patent pending).
5. Provisional U.S. Patent Application, entitled "Compositions and applications of nanoconfined probes for enhanced non-invasive imaging", filed 11/24/2012 Inventors: Tarek Fahmy, Dongin Kim, Donald P. Dione, Albert J. Sinusas (patent pending).
6. Provisional U.S. Patent Application, entitled "Integrated RF and B-mode deformation analysis for 4D stress echocardiography", filed 3/6/2013 Inventors: James S. Duncan, Matthew O'Donnell, Colin Compas, Albert J. Sinusas, Lawrence Staib, Xiaojie Huang, Donald Dione (patent pending).

DOCUMENTATION OF NON-PROFIT STATUS

Internal Revenue Service

District
Director

Department of the Treasury
P.O. Box 9107
JFK Federal Bldg., Boston, Mass. 02203

Yale-New Haven Hospital Inc.
789 Howard Avenue
New Haven, Ct. 06504

Person to Contact: Daniel T. Valenzano

Telephone Number: (617) 223-1442

Refer Reply to: EO:Processing Unit

Date: JUL 10 1979

Name of Organization: Same

Gentlemen:

This is in reply to your recent letter requesting a copy of an exemption letter for the above-named organization.

Due to our records retention program, a copy of the original letter is not available.

[x] However, records in this office show that a determination letter was issued in November 1966 ruling that the organization was exempt from Federal Income Tax under Section (now) 501(C)(3) of the Internal Revenue Code of 1954.

[ ] However, records in this office show that the organization is exempt under Section (now) _____ of the Internal Revenue Code as part of a group ruling issued to _____

[x] Further, the organization is not a private foundation because it is an organization described under Section 170(b)(1)(a)(vi) and 509(a)(1).

This ruling remains in effect as long as there are no changes in the character, purposes, or method of operation of the organization.

I trust the foregoing information will serve your purpose.

If you have any questions, you may contact the person whose name ar telephone number are shown in the heading of this letter.

Sincerely yours,

H B Mirabile

District Director

IRS Department of the Treasury
Internal Revenue Service

OGDEN UT 84201-0038

In reply refer to: 0441981549
Nov. 01, 2010 LTR 4168C E0
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YALE NEW HAVEN HOSPITAL
% LAURIE CAHILL
20 YORK ST
NEW HAVEN CT 06510-3220

025077

Employer Identification Number: 06-0646652
Person to Contact: Mr. Ludlow
Toll Free Telephone Number: 1-877-829-5500

Dear Taxpayer:

This is in response to your Oct. 21, 2010, request for information regarding your tax-exempt status.

Our records indicate that you were recognized as exempt under section 501(c)(3) of the Internal Revenue Code in a determination letter issued in November 1966.

Our records also indicate that you are not a private foundation within the meaning of section 509(a) of the Code because you are described in section(s) 509(a)(1) and 170(b)(1)(A)(iii).

Donors may deduct contributions to you as provided in section 170 of the Code. Bequests, legacies, devises, transfers, or gifts to you or for your use are deductible for Federal estate and gift tax purposes if they meet the applicable provisions of sections 2055, 2106, and 2522 of the Code.

Please refer to our website www.irs.gov/eo for information regarding filing requirements. Specifically, section 6033(j) of the Code provides that failure to file an annual information return for three consecutive years results in revocation of tax-exempt status as of the filing due date of the third return for organizations required to file.

If you have any questions, please call us at the telephone number shown in the heading of this letter.

Sincerely yours,

Rita A. Leete

Rita A. Leete
Accounts Management II

IRS Department of the Treasury
Internal Revenue Service

OGDEN UT 84201-0038

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% LAURIE CAHILL
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060646652

YALE NEW HAVEN HOSPITAL
% LAURIE CAHILL
20 YORK ST
NEW HAVEN CT 06510-3220

INTERNAL REVENUE SERVICE

OGDEN UT 84201-0038

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STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH LICENSE

STATE OF CONNECTICUT

Department of Public Health

LICENSE

License No. 0044

General Hospital

In accordance with the provisions of the General Statutes of Connecticut Section 19a-493: Yale-New Haven Hospital, Inc. of New Haven, CT d/b/a Yale-New Haven Hospital, Inc. is hereby licensed to maintain and operate a General Hospital.

Yale-New Haven Hospital, Inc. is located at 20 York Street, New Haven, CT 06504.

The maximum number of beds shall not exceed at any time:
134 Bassinets
1407 General Hospital Beds

This license expires **September 30, 2013** and may be revoked for cause at any time.
Dated at Hartford, Connecticut, October 1, 2011.

SATELLITES

Hill Regional Career High School, 140 Legion Avenue, New Haven, CT
Branford High School Based Health Center, 185 East Main Street, Branford, CT
Walsh Middle School, 185 Damascus Road, Branford, CT
James Hillhouse High School Based Health Center, 480 Sherman Parkway, New Haven, CT
Weller Building, 425 George Street, New Haven, CT
Yale-New Haven Psychiatric Hospital, 184 Liberty Street, New Haven, CT
Yale-New Haven Shoreline Medical Center, 111 Goose Lane, Guilford, CT
Pediatric Dentistry Center, 860 Howard Avenue, New Haven, CT
YNHASC Temple Surgical Center, 60 Temple Street, New Haven, CT
YNHASC Women's Surgical Center, 40 Temple Street, New Haven, CT
Mauro-Sheridan School Based Health Center, 191 Fountain Street, New Haven, CT
Yale-New Haven Hospital Dental Center, 2560 Dixwell Avenue, Hamden, CT
Murphy School Based Health Center, 14 Brushy Plain Road, Branford, CT
P.T. Barnum Pediatric Center, 226 Mill Hill Avenue, Bridgeport, CT
Yale-New Haven Hospital-Saint Raphael Campus, 1450 Chapel Street, New Haven, CT
Adolescent Day Hospital, 646 George Street, New Haven, CT
Psychiatric Day Hospital, 1294 Chapel Street, New Haven, CT
Children's Psychiatric Day Hospital, 1450 Chapel Street, New Haven, CT
Elder Care Clinic, Atwater Clinic, 26 Atwater Street, New Haven, CT
Elder Care Clinic/Tower One, 18 Tower Lane, New Haven, CT
Elder Care Clinic/Casa Otonal, 135 Sylvan Avenue, New Haven, CT
Elder Care Clinic/Edith Johnson Tower, 114 Bristol Street, New Haven, CT
Evening Chemical Dependency Program, 1294 Chapel Street, New Haven, CT
Elder Care Clinic/Surfside, 200 Oak Street, West Haven, CT
Troup Magnet Academy School-Based Health Center, New Haven, CT
Adult PHP, 110 Sherman Avenue, Hamden, CT
Wheat, 674 Washington Avenue, West Haven, CT
Barnard Environmental Studies Magnet School, 170 Derby Avenue, New Haven, CT
Center for Women's Health/Midwifery & Chapel Pediatrics, 2 Ivy Brook Road, Suite 111, Shelton, CT
"Smiles 2 Go" Dental Mobile Van, 60 Commerce Street, East Haven, CT
Project Eldercare, 2080 Whitney Avenue, Suite 150, Hamden, CT
Chapel Pediatrics, 2080 Whitney Avenue, Suite 150, Hamden, CT
Shoreline Child and Adolescent Mental Health Services, 21 Business Park Drive, Branford, CT

License Revised to Reflect:
* Hospital of Saint Raphael merged with Yale-New Haven Hospital, Inc. effective 9/12/12

Jewel Mullen, MD, MPH, MPA
Commissioner

SIEMENS SYMBIA T QUOTE

SIEMENS

Siemens Medical Solutions USA, Inc.
51 Valley Stream Parkway, Malvern, PA 19355
Fax: (781) 203-6025

SIEMENS REPRESENTATIVE
John Hubbard - (603) 801-4879

Customer Number: 0000011518

Date: 12/30/2009

YALE NEW HAVEN HOSPITAL
20 YORK ST
NEW HAVEN, CT 06510

Siemens Medical Solutions USA, Inc. is pleased to submit the following quotation for the products and services described herein at the stated prices and terms, subject to your acceptance of the terms and conditions on the face and back hereof, and on any attachment hereto.

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Proposal valid for 45 days

Pricing contingent upon a 4 year POS service agreement.

Price is valid thru December 30, 2009 and contingent upon a POS service contract

This agreement to be governed by the signed & agreed to Terms & Conditions, dated 10/24/08, and the Compliance Addendum, dated 11/11/08.

Accepted and Agreed to by:

Siemens Medical Solutions USA, Inc.

By (sign): _____
Name: John Hubbard
Title: Product Sales Executive
Date: 12/31/09

YALE NEW HAVEN HOSPITAL

By (sign): _____
Name: KEITH J. MURPHY
Title: MGR CORP CONTRACTS
Date: 12-31-09

All pages of the signed proposal must be returned to Siemens to process the order - Thank you.

SIEMENS

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51 Valley Stream Parkway, Malvern, PA 19355
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Quote Nr:	**1-7N77-1343 Rev. 1**
Terms of Payment:	00% Down, 90% Delivery, 10% Installation Free On Board: Destination
Purchasing Agreement:	NOVATION (UHC, VHA, Provista) NOVATION (UHC, VHA, Provista) terms and conditions apply to Quote Nr 1-7N77-1343

Symbia T Series

All items listed below are included for this system: *(See Detailed Technical Specifications at end of Proposal.)*

Qty	Part No.	Item Description
1	10275007	**Symbia T** The Symbia T is built on TruePoint SPECT•CT technology, for the seamless integration of two equal modalities. The True Integration of state-of-the-art SPECT and high quality dual slice CT gives this system full functionality for all SPECT-only or SPECT•CT applications in Oncology, Neurology, and routine Cardiology. True Clarity from the ultra fast dual slice spiral CT maximizes confidence in precise Attenuation Correction and Anatomical Mapping and Diagnostic CT within a SPECT/CT study. The True Efficiency of the single patient bed and gantry, together with work flow improvements, achieves high throughput in all modes.
1	08719218	**Room Prep Kit Symbia T/T2 (US/CA)** Room preparation kit for U.S. sites with two components to bring power from wall to Symbia T or Symbia T2 Input power box with 50 amp fuse Junction box
1	10275012	**Symbia T Series Processing Wrkplc** The Symbia T Series Processing Wrkplc is a high performance, syngo-based workstation for reconstruction and review of Symbia TruePoint SPECT•CT data. This workplace provides a flexible user interface that automates a wide range of processing and display capabilities. Standard functionality includes quality control, advanced SPECT/CT reconstruction, advanced image fusion, volumetric analysis for tumor imaging, image manipulation tools, and organ-based NM processing.
1	10118559	**Monitor, 19" LCD DICOM** The 19" DICOM Calibrated LCD monitor is designed to meet the demanding requirements of medical imaging. The display features high contrast even under high ambient light conditions that can be encountered in nuclear medicine viewing environments. The gamma curve is exactly matched to CIE/DICOM recommendation, enhancing the ability to display both color and gray scale images. Light output stability is ensured by continuous backlight control throughout the display's lifetime.
1	07835742	**Dual Monitor Option** The Dual Monitor Software Option enables e.soft workstations to utilize 2 LCD monitors thereby expanding your clinical flexibility and efficiency when running multiple workflows. This option allows you to optimally compare an old and a new study on the same patient, or to simply process more than one patient at the same time. This option is only supported for LCD monitors.
1	10118559	**Monitor, 19" LCD DICOM** The 19" DICOM Calibrated LCD monitor is designed to meet the demanding requirements of medical imaging. The display features high contrast even under high ambient light conditions that can be encountered in nuclear medicine viewing environments. The gamma curve is exactly matched to CIE/DICOM recommendation, enhancing the ability to display both color and gray scale images. Light output stability is ensured by continuous backlight control throughout the display's lifetime.
1	08419207	**English MI WP Lang Kit** The language kit includes: e.soft Getting Started Manual, e.soft User Notes and customer letter.

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Qty	Part No.	Item Description
1	10521208	**Symbia T SW Upgrade** Software option to bring the Symbia T Acquisition Workplace to the same level of functionality as the Symbia T Processing Workplace. Includes: Organ-based NM Processing, Advanced Image Fusion, and Volumetric Analysis
1	10183459	**SPECT/CT 1/2 Time Imaging** SPECT/CT 1/2 Time Imaging provides shortened Planar acquisition time with syngo MI Workflows optimized for oncology.
2	07833283	**Symbia 3/8" Hi-Res. Det. /Tub Asm.**
1	08418407	**Hand Controller Symbia_SPECT_CT** All motorized motions of the patient bed, gantry and detectors are controlled from the ergonomically designed hand controller which can be plugged into either side of the gantry.
1	10183566	**Internal ECG for Symbia** Symbia Internal ECG gate provides ECG triggering to nuclear subsystem for nuclear cardiology examinations. In addition, for Symbia T2, T6, and T16 cameras the internal ECG gate provides ECG triggering to the CT subsystem for CT applications that require ECG gating. The ECG gate is built into the Symbia patient bed and is controlled by the Symbia acquisition station. The leads connect near the head of the patient bed and travel with patient, never interfering with scanning. ECG waveform is displayed on the touch-screen PPM.
2	07835494	**Low_Energy_Hi_Res Collimator Symbia** Low energy (140 keV), high resolution, parallel hole collimator · AUTOFORM Technology · 148,000 hexagonal holes · Sensitivity: 202 cpm/microCurie · Geometric Resolution: 6.4 mm · Weight: 70 lbs (31.8 kg) Includes drawer for collimator cart
2	07835452	**Medium Energy Collimator Symbia** Medium energy (300 keV), parallel hole collimator · 14,000 hexagonal holes · Sensitivity: 310 cpm/microCurie · Geometric Resolution 10.8 mm · Weight: 161 lbs (73.2 kg) Includes drawer for collimator cart
1	10273911	**Productivity Package** Productivity package includes the integrated collimator changer, the automatic collimator exchanger, and the automatic quality control option. Integrated Collimator Changer Innovative collimator exchange system that is mounted beneath the patient bed. Saves time and effort when changing the most frequently used collimators. Holds two sets of low or medium energy collimators. Automatic Collimator Exchange Fully automated changing of collimators within the integrated collimator changer. Collimator removal or exchange is initiated with the touch of one button on the patient positioning monitor. Automatic Quality Control Option Gd-153 line and Co-57 point sources housed in the patient bed will be extended at customer scheduled times to perform daily, weekly, and monthly quality control procedures without manual intervention.
1	10413528	**AQC Web Based Training**
1	10182856	**Detector Support with Caudal Tilt** Caudal and cephalic tilt on Detector 2 allows for precise positioning of static and dynamic acquisitions.
1	08719374	**English Symbia T Lang Kit**
1	07830909	**Remote Diagnostic Services** Remote Diagnostic Services. A broadband connection is required for full remote diagnostic functionality and optimal system uptime.
1	10097270	**MI University** Molecular Imaging University (MI-U) is a comprehensive resource for clinical educational materials in PET/CT and SPECT/CT (www.mi-university.com). MI University demonstrates the benefit of hybrid imaging and where it influences patient management. The license is valid for 1 year and includes the rights to set up accounts for other users that are related to the customer facility.
1	10119031	**UPS for SPECT Camera Systems** Uninterruptible power supply option that provides 10 minutes of back up power to the SPECT gantry enabling the proper shut down in the event of a power loss. Also provides noise filtering and transient suppression. Specifications:5.0 KVA Input configuration: 200-240 VAC, 50/60 Hz, L6-30P Output configuration: 208 VAC, L6-30R

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Qty	Part No.	Item Description
1	05245316	**UPS for e.soft/c.cam (60 Hz)** Uninterruptable power supply option that provides 10 minutes of back up power enabling the proper shut down of the system in the event of a power loss.
1	MI_SPEC_FLWUP_32	**MI_SYMB_FOLLOWUP**
1	MI_SPEC_CTCRSTR	**CT Cross Trainer (Printed Self Study)**
1	MI_SPECT_PM	**MI SPECT Project Management**
1	MI_SPEC_INITIAL_32	**Initial onsite training 32 hrs**
1	MI_SPEC_INT_BCLST	**Basic SymbiaT Class**
2	07835445	**High Energy Collimator Symbia.** High energy (364 keV), parallel hole collimator · 8,000 hexagonal holes · Sensitivity: 147 cpm/microCurie · Geometric Resolution 13.2 mm · Weight: 321 lbs (149.9 kg) Includes drawer for collimator cart
1	08717873	**Symbia Collimator Cart** The collimator cart combines manual collimator insertion with fully automatic collimator clamping and allows collimator exchange to occur without removing the bed. The cart is designed to hold two sets of collimators (or one set of collimators and one pinhole collimator)
1	10412858	**Symbia T Series US Installation** Mechanical installation of the Symbia T Series camera system including complete system assembly and alignment, system startup, calibrations, and performance verification to factory specifications.
1	10273917	**AutoQC Source Registration Kit** Source registration kit for Symbia Automatic Quality Control option.
1	10273914	**AutoQC source kit** Gd-153 line and Co-57 point source for the automatic quality control option.

System Total: $465,000

FINANCING: The equipment listed above may be financed through Siemens. Ask us about our full range of financial products that can be tailored to meet your business and cash flow requirements. For further information, please contact your local Sales Representative.

ACCESSORIES: Don't forget to ask us about our line of OEM imaging accessories to complete your purchase. All accessories can be purchased or financed as part of this order. To purchase accessories directly or to receive our accessories catalog, please call us directly at 1-888-222-9944 ext. 7 or contact your local Sales Representative.

COMPLIANCE: Compliance with legal and internal regulations is an integral part of all business processes at Siemens. Possible infringements can be reported to our Helpdesk "Tell us" function at www.siemens.com/tell-us.

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Siemens Medical Solutions USA, Inc. General Terms and Conditions

1. GENERAL

1.1 Contract Terms. These terms and conditions constitute an integral part of any contract between the Seller identified on the first page hereof to sell products ("Products") and Purchaser and shall govern the sale of the Products. Seller shall not be bound by, and specifically objects to, any terms, conditions or other provisions which are different from or in addition to the provisions of this Agreement (whether or not it would materially alter this Agreement) which is proffered by Purchaser in any purchase order, receipt, acceptance, confirmation, correspondence or otherwise (even if provided to Seller concurrently with this Agreement), unless Seller specifically agrees to any such provision in a writing signed by Seller. Neither Seller's lack of objection to any such terms, nor delivery of the Products or provision of any services hereunder, shall constitute the agreement of Seller to any such terms. Purchaser acknowledges that this is a commercial and not a consumer transaction.

1.2 Acceptance. Purchaser shall be deemed to have assented to, and waived any objection to, this Agreement upon the earliest to occur of any of the following: Purchaser's completion or execution of this Agreement; Purchaser's acceptance of all or any part of the Products subject to this Agreement; Purchaser's issuance of a purchase order for any Products identified on Seller's quotation or proposal; or delivery of the Products to the common carrier for shipment pursuant hereto.

1.3 Refurbished/Used Products. For Products identified on the Agreement as used or refurbished Products, these Products have been previously owned and used. When delivered to Purchaser, the Products may have received mechanical, electrical and/or cosmetic reconditioning, as needed, and will comply with the manufacturer's specifications. Since pre-owned Products may be offered simultaneously to several customers, the sale of such Products to Purchaser cannot be guaranteed and is subject to continuing availability at the time Purchaser accepts Seller's offer to sell the Products. If the Products are no longer available, Seller will use its best efforts to identify other products in its inventory that may be suitable for purchase by Purchaser, and if substitute products are not acceptable to Purchaser, then Seller will cancel the order and refund to Purchaser any deposits previously paid. The warranty period for any used or refurbished Products will be separately stated on the quotation.

1.4 Third Party Products. If this Agreement includes the sale of third party products not manufactured by Seller, then Purchaser agrees and acknowledges that (a) Purchaser has made the selection of these products on its own, (b) the products are being acquired by Seller solely at the request of and for the benefit of Purchaser, in order to eliminate the need for Purchaser to issue a separate purchase order to the manufacturer of the products, (c) no representation, warranty or guarantee has been made by Seller with respect to the products, (d) the obligation of Purchaser to pay Seller for the products is absolute and unconditional, (f) Purchaser will assert no claim whatsoever against the Seller with respect to the products, and will look solely to the manufacturer regarding any such claims, (g) Purchaser will indemnify and hold Seller harmless from and against any and all claims, regardless of the form of action, related to, resulting from or caused by the products or any work or service provided by the manufacturer of the products or any other party, (h) use of the products may be subject to the Purchaser's agreement to comply with any software licensing terms imposed by the manufacturer, as well as any applicable laws, rule and regulations; and (i) the manufacturer, and not Seller, is solely responsible for any required installation, testing, validation, tracking, product recall, warranty service, maintenance, support, and complaint handling, as well as any other applicable FDA regulatory requirements.

2. PRICES

2.1 Quotations. Unless otherwise agreed to in writing or set forth in the quotation, all prices quoted by Seller are based on U.S. dollars, and include standard and customary packaging. F.O.B. terms are set forth in Section 6.2 hereof. Domestic prices apply only to purchasers located in, and who will use the Products in, the U.S. International prices apply to all purchasers located outside of, or who will use or ship or facilitate shipment of the Products outside of, the U.S. Unless otherwise stated, the quotation shall only be valid for forty-five (45) days from the date of the quotation.

2.2 Delay in Acceptance of Delivery. Should the agreed delivery date be postponed by Purchaser, Seller shall have the right to deliver to storage at Purchaser's risk and expense, and payments due upon delivery shall become due when Seller is ready to deliver.

2.3 Escalation. Unless otherwise agreed to in writing, except as to goods to be delivered within six (6) months of Seller's acceptance of Purchaser's order, Seller reserves the right to increase its prices to those in effect at the time of shipment.

3. TAXES

3.1 Any sales, use or manufacturer's tax which may be imposed upon the sale or use of Products, or any property tax levied after readiness to ship, or any excise tax, license or similar fee required under this transaction, shall be in addition to the quoted prices and shall be paid by Purchaser. Notwithstanding the foregoing, Seller agrees to honor any valid exemption certificate provided by Purchaser.

4. TERMS OF PAYMENT

4.1 Payments; Due Date. Unless otherwise set forth in the quotation, Seller's payment terms are as follows: an initial deposit of 10% of the purchase price for each Product is due upon submission of the purchase order, an additional 80% of the purchase price is due upon delivery of each Product, and the final 10% of the purchase price is due upon completion of installation or when the Products are available for first patient use, whichever occurs first. Unless otherwise agreed, all payments other than the initial deposit are due net thirty (30) days from the date of invoice. Seller shall have no obligation to complete installation until the payment due upon delivery of the Product is received. All amounts payable pursuant to this Agreement are denominated in United States dollars, and Purchaser shall pay all such amount in lawful money of the United States. Partial shipments shall be billed as made, and payments for such shipments will be made in accordance with the foregoing payment terms. In the event that Purchaser makes any payments hereunder by credit card, Seller has the right to charge the Purchaser any credit card fees imposed on the Seller by the financial institution.

4.2 Late Payment. A service charge of 1½% per month, not to exceed the maximum rate allowed by law, shall be made on any portion of Purchaser's outstanding balance which is not paid within thirty (30) days after invoice date, which charge shall be determined and compounded on a daily basis from the due date until the date paid. Payment of such service charge shall not excuse or cure Purchaser's breach or default for late payment. In addition, in the event that Purchaser fails to make any payment to Seller within this thirty (30) day period, including but not limited to any payment under any service contract, promissory note or other agreement with Seller, then Seller shall have no obligation to continue performance under any agreement with Purchaser.

4.3 Payment of Lesser Amount. If Purchaser pays, or Seller otherwise receives, a lesser amount than the full amount provided for under this Agreement, such payment or receipt shall not constitute or be construed other than as on account of the earliest amount due Seller. Seller may accept any check or payment in any amount without prejudice to Seller's right to recover the balance of the amount due or to pursue any other right or remedy. No endorsement or statement on any check or payment or in any letter accompanying a check or payment or elsewhere shall constitute or be construed as an accord or satisfaction.

4.4 Where Payment Due Upon Installation or Completion. Should any terms of payment provide for either full or partial payment upon installation or completion of installation or thereafter, and the installation or completion is delayed for any reason for which Seller is not responsible, then the Products shall be deemed installed upon delivery and, if no other terms were agreed upon in writing signed by the parties, the balance of payments shall be due no later than thirty (30) days from delivery regardless of the actual installation date.

4.5 Default;Termination. Each of the following shall constitute an event of default under this Agreement: (i) a failure by Purchaser to make any payment due Seller within ten (10) days of receipt of notice of non-payment from Seller; (ii) a failure by Purchaser to perform any other obligation under this Agreement within thirty (30) days of receipt of notice from Seller; (iii) a default by Purchaser or any affiliate of Purchaser under any other obligation to or agreement with Seller, Siemens Financial Services, Inc. or Siemens Medical Solutions Health Services Corporation, or any assignee of the foregoing (including, but not limited to, a promissory note, lease, rental agreement, license agreement or purchase contract); or (iv) the commencement of any insolvency, bankruptcy or similar proceedings by or against the Purchaser (including any assignment by Purchaser for the benefit of creditors). Upon the occurrence of any event of default, at Seller's election: (a) the entire amount of any indebtedness and obligation due Seller under this Agreement and interest thereon shall become immediately due and payable without notice, demand, or period of grace; (b) Seller may suspend the performance of any of Seller's obligations hereunder, including, but not limited to, obligations relating to delivery, installation and warranty services; (c) Purchaser shall put Seller in possession of the Products upon demand; (d) Seller may enter any premises where the Products are located and take possession of the Products without notice or demand and without legal proceedings; (e) at the request of Seller, Purchaser shall

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assemble the Products and make them available to Seller at a place designated by Seller which is reasonable and convenient to all parties; (f) Seller may sell or otherwise dispose of all or any part of the Products and apply the proceeds thereof against any indebtedness or obligation of Purchaser under this Agreement (Purchaser agrees that a period of 10 days from the time notice is sent to Purchaser shall be a reasonable period of notification of sale or other disposition of the Products by or for Seller); (g) if this Agreement or any indebtedness or obligation of Purchaser under this Agreement is referred to an attorney for collection or realization, Purchaser shall pay to Seller all costs of collection and realization (including, without limitation, a reasonable sum for attorneys' fees, expenses of title search, all court costs and other legal expenses) incurred thereby; and (h) Purchaser shall pay any deficiency remaining after collection of or realization by Seller on the Products. In addition, Seller may terminate this Agreement upon written notice to Purchaser in the event that Purchaser is not approved for credit or upon the occurrence of any material adverse change in the financial condition or business operations of Purchaser.

4.6 Financing. Notwithstanding any arrangement that Purchaser may make for the financing of the purchase price of the Products, the parties agree that any such financing arrangement shall have no effect on the Purchaser's payment obligations under this Agreement, including but not limited to Sections 4.1 and 4.2 above.

5. EXPORT TERMS

5.1 Unless other arrangements have been made, payment on export orders shall be made by irrevocable confirmed letter of credit, payable in U.S. dollars against Seller's invoice and standard shipping documents. Such letter of credit shall be in an amount equal to the full purchase price of the Products and shall be established in a U.S. bank acceptable to Seller. Purchaser shall procure all necessary permits and licenses for shipment and compliance with any governmental regulations concerning control of final destination of Products.

5.2 Purchaser shall not, directly or indirectly, violate any U.S. law, regulation or treaty, or any other international treaty or agreement, relating to the export or reexport of any Product or associated technical data, to which the U.S. adheres or with which the U.S. complies. Purchaser shall defend, indemnify and hold Seller harmless from any claim, damage, liability or expense (including but not limited to reasonable attorney's fees) arising out of or in connection with any violation of the preceding sentence. If Purchaser purchases a Product at the domestic price and exports such Product, or transfers such Product to a third party for export, outside of the U.S., Purchaser shall pay to Seller the difference between the domestic price and the international retail price of such Product pursuant to the payment terms set forth herein. Purchaser shall deliver to Seller, upon Seller's request, written assurance regarding compliance with this section in form and content acceptable to Seller.

6. DELIVERY, RISK OF LOSS

6.1 Delivery Date. Delivery and completion schedules are approximate only and are based on conditions at the time of acceptance of Purchaser's order by Seller. Seller shall make every reasonable effort to meet the delivery date(s) quoted or acknowledged, but shall not be liable for any failure to meet such date(s). Partial shipments may be made.

6.2 Risk of Loss; Title Transfer. Unless otherwise agreed to in writing, the following shall apply:

(a) For Products that do not require installation by Seller or its authorized agent or subcontractor, and for options and add-on products purchased subsequent to delivery and installation of Products purchased under this Agreement, delivery shall be complete upon transfer of possession to common carrier, F.O.B. Shipping Point, whereupon title to and all risk of loss, damage to or destruction of the Products shall pass to Purchaser.

(b) For Products that require installation by Seller or its authorized agent or subcontractor, delivery shall be complete upon delivery of the Products to Purchaser's designated site, F.O.B. Destination; title to and all risk of loss, damage to or destruction of such Products shall pass to Purchaser upon completion of the installation by Seller or its authorized agent or subcontractor.

(c) All freight charges and other transportation, packing and insurance costs, license fees, custom duties and other similar charges shall be the sole responsibility of the Purchaser unless included in the purchase price or otherwise agreed to in writing by Seller. In the event of any loss or damage to any of the Products during shipment, Seller and Purchaser shall cooperate in making a claim against the carrier.

7. SECURITY INTEREST/FILING

7.1 From the F.O.B. point, Seller shall have a purchase money security interest in the Products (and all accessories and replacements thereto and all proceeds thereof) until payment in full by Purchaser and satisfaction of all other obligations of Purchaser hereunder. Purchaser hereby (i) authorizes Seller to file (and Purchaser shall promptly execute, if requested by Seller) and (ii) irrevocably appoints Seller its agent and attorney-in-fact to execute in the name of Purchaser and file, with such authorities and at such locations as Seller may deem appropriate, any Uniform Commercial Code financing statements with respect to the Products and/or this Agreement. Purchaser also agrees that an original or a photocopy of this Agreement (including any addenda, attachments and amendments hereto) may be filed by Seller as a Uniform Commercial Code financing statement. Purchaser further represents and covenants that (a) it will keep the Products in good order and repair until the purchase price has been paid in full, (b) it will promptly pay all taxes and assessments upon the Products or the use thereof, (c) it will not attempt to transfer any interest in the Products until the purchase price has been paid in full, and (d) it is solvent and financially capable of paying the full purchase price for the Products.

8. CHANGES, CANCELLATION, AND RETURN

8.1 Orders accepted by Seller are not subject to change except upon written agreement.

8.2 Orders accepted by Seller are noncancellable by Purchaser except upon Seller's written consent and payment by Purchaser of a cancellation charge equal to 10% of the price of the affected Products, plus any shipping, insurance, inspection and refurbishment charges; the cost of providing any training, education, site evaluation or other services; and any return, cancellation or restocking fees with respect to any Third Party Products ordered by Seller on behalf of Purchaser. Seller may retain any payments received from Purchaser up to the amount of the cancellation charge. In no event can an order be cancelled by Purchaser or Products be returned to Seller after shipment has been made.

8.3 Seller shall have the right to change the manufacture and/or design of its Products if, in the judgment of Seller, such change does not alter the general function of the Products.

9. FORCE MAJEURE

9.1 Seller will make every effort to complete shipment, and installation where indicated, but shall not be liable for any loss or damage for delay in delivery, inability to install or any other failure to perform due to causes beyond its reasonable control including, but not limited to, acts of government or compliance with any governmental rules or regulations, acts of God or the public, war, civil commotion, blockades, embargoes, calamities, floods, fires, earthquakes, explosions, storms, strikes, lockouts, labor disputes, or unavailability of labor, raw materials, power or supplies. Should such a delay occur, Seller may reasonably extend delivery or production schedules or, at its option, cancel the order in whole or part without liability other than to return any unearned deposit or prepayment.

10. WARRANTY

10.1 Seller warrants that the Products manufactured by Seller and sold hereunder shall be free from defects in material or workmanship under normal use and service for the warranty period. The final assembled Products shall be new although they may include certain used, reworked or refurbished parts and components (e.g., circuit boards) that comply with performance and reliability specifications and controls. Seller's obligation under this warranty is limited, at Seller's option, to the repair or replacement of the Product or any part thereof. Unless otherwise set forth in the Product Warranty attached hereto and incorporated herein by reference, the warranty period shall commence upon the earlier of the date that the Products have been installed in accordance with 12.6 hereof, which date shall be confirmed in writing by Seller, or first patient use, and shall continue for 12 consecutive months. Seller makes no warranty for any Products made by persons other than Seller or its affiliates, and Purchaser's sole warranty therefor, if any, is the original manufacturer's warranty, which Seller agrees to pass on to Purchaser, as applicable. The warranty provided by Seller under this Section 10 extends only to the original Purchaser, unless the Purchaser obtains the Seller's prior written consent with respect to any sale or other transfer of the Equipment during the term of the warranty.

10.2 No warranty extended by Seller shall apply to any Products which have been damaged by fire, accident, misuse, abuse, negligence, improper application or alteration or by a force majeure occurrence as described in Section 9 hereof or by the Purchaser's failure to operate the Products in accordance with the manufacturer's instructions or to maintain the recommended operating environment and line conditions; which are defective due to unauthorized attempts to repair, relocate, maintain, service, add to or modify the Products by the Purchaser or any third party or due to the attachment and/or use of non-Seller supplied equipment , parts or software, without Seller's prior written approval; which failed due to causes from within non-Seller supplied equipment, parts or software; which have been damaged from the use of operating supplies or consumable parts not approved by Seller. In addition, no warranty extended by Seller shall apply to any transducer or probe failure due to events such as cracking from high impact drops, cable rupture from rolling equipment over the cable, or delamination from cleaning

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with inappropriate solutions. Seller's obligation under this warranty is limited to the repair or replacement, at Seller's option, of defective parts. Seller may effectuate such repair at Purchaser's facility, and Purchaser shall furnish Seller safe and sufficient access for such repair. Repair or replacement may be with parts or products that are new, used or refurbished. Repairs or replacements shall not interrupt, extend or prolong the term of the warranty. Purchaser shall, upon Seller's request, return the noncomplying Product or part to Seller with all transportation charges prepaid, but shall not return any Product or part to Seller without Seller's prior written authorization. Purchaser shall pay Seller its normal charges for service and parts for any inspection, repair or replacement that is not, in Seller's sole judgment, required by noncompliance with the warranty set forth in Section 10.1. Seller's warranty does not apply to consumable materials, disposables, supplies, accessories and collateral equipment, except as specifically stated in writing or as otherwise set forth in the Product Warranty attached hereto and incorporated herein by reference, nor to products or parts thereof supplied by Purchaser.

10.3 This warranty is made on condition that immediate written notice of any noncompliance be given to Seller and Seller's inspection reveals that the Purchaser's claim is valid under the terms of the warranty (i.e., that the noncompliance is due to traceable defects in original materials and/or workmanship).

10.4 Purchaser shall provide Seller with full and free access to the Products, network cabling and communication equipment as is reasonably necessary for Seller to provide warranty service. This access includes establishing and maintaining connectivity to the Products via VPN IPsec Tunneling (non-client) Peer-to-Peer connection, modem line, internet connection, broadband internet connection or other secure remote access reasonably required by Seller, in order for Seller to provide warranty service, including remote diagnostics, monitoring and repair services.

10.5 Warranty service will be provided without charge during Seller's regular working hours (8:30-5:00), Monday through Friday, except Seller's recognized holidays. If Purchaser requires that service be performed other than during these times, such service can be made available at an additional charge, at Seller's then current rates. The obligations of Seller described in this section are Seller's only obligations and Purchaser's sole and exclusive remedy for a breach of product warranty.

10.6 SELLER MAKES NO WARRANTY OTHER THAN THE ONE SET FORTH HEREIN AND IN THE ATTACHED PRODUCT WARRANTY COVERING THE APPLICABLE PRODUCT CATEGORY. SUCH WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSES, AND SUCH CONSTITUTES THE ONLY WARRANTY MADE WITH RESPECT TO THE PRODUCTS AND ANY DEFECT, DEFICIENCY OR NONCONFORMITY IN ANY PRODUCT, SERVICE OR OTHER ITEM FURNISHED UNDER THIS AGREEMENT.

10.7 In the event of any inconsistencies between the terms of this Section 10 and the terms of the attached Product Warranty, the terms of the attached Product Warranty shall prevail.

11. LIMITATION OF LIABILITY

11.1 In no event shall Seller's liability hereunder exceed the actual loss or damage sustained by Purchaser, up to the purchase price of the Products.

11.2 SELLER SHALL NOT BE LIABLE FOR ANY LOSS OF USE, REVENUE OR ANTICIPATED PROFITS, COST OF SUBSTITUTE PRODUCTS OR SERVICES, LOSS OF STORED, TRANSMITTED OR RECORDED DATA, OR FOR ANY INDIRECT, INCIDENTAL, UNFORESEEN, SPECIAL, PUNITIVE OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THIS AGREEMENT OR THE SALE OR USE OF THE PRODUCTS. This provision does not affect third party claims for personal injury arising as a result of Seller's negligence or product defect. **THE FOREGOING IS A SEPARATE, ESSENTIAL TERM OF THIS AGREEMENT AND SHALL BE EFFECTIVE UPON THE FAILURE OF ANY REMEDY, EXCLUSIVE OR NOT.**

12. INSTALLATION - ADDITIONAL CHARGES

12.1 General. Unless otherwise expressly stipulated in writing, the Products covered hereby shall be installed by and at the expense of Seller except that Seller shall not provide rigging or site preparation services unless otherwise agreed to in writing by Seller for an additional charge. Seller will not install accessory items such as cabinets, illuminators, darkroom equipment or processors for X-Ray and CT equipment, unless otherwise agreed to in writing by Seller.

12.2 Installation by Seller. If Seller specifies it will install the Products, the following applies: subject to fulfillment of the obligations set forth in 12.4 below, Seller shall install the Products covered hereby and connect same to the requisite safety switches and power lines to be installed by Purchaser. Except as otherwise specified below, if such installation and connection are performed by Seller's technical personnel, prices shown include the cost thereof, provided that the installation and connection can be performed within the Continental United States or Puerto Rico and during normal business hours. Any overtime charges or other special expenses shall be additional charges to the prices shown.

12.3 Trade Unions. In the event that a trade union, or unions, or other local labor conditions prevent Seller from performing the above work with its own employees or contractors, then Purchaser shall either make all required arrangements with the trade union, or unions, to permit Seller's completion of said work or shall provide the personnel, at Purchaser's sole cost and expense. Moreover, any additional cost incurred by Seller and related to such labor disputes shall be paid by the Purchaser and Seller's obligations under such circumstances will be limited to providing engineering supervision of installation and connection of Seller equipment to existing wiring.

12.4 Purchaser's Obligations. Purchaser shall, at its expense, provide all proper and necessary labor and materials for plumbing service, carpentry work, conduit wiring, and other preparations required for such installation and connection. All such labor and materials shall be completed and available at the time of delivery of the Products by Seller. Additionally, the Purchaser shall provide free access to the premises of installation and, if necessary, safe and secure space thereon for storage of Products and equipment prior to installation by Seller. Purchaser shall be responsible, at its sole cost and expense, for obtaining all permits, licenses and approvals required by any federal, sate or local authorities in connection with the installation and operation of the Products, including but not limited to any certificate of need and zoning variances. Purchaser shall provide a suitable environment for the Products and shall ensure, at its sole cost and expense, that its premises are free of asbestos, hazardous conditions and any concealed, unknown or dangerous conditions and that all site requirements are met. Seller shall delay its work until Purchaser has completed the removal of the asbestos or other hazardous materials or has taken any other precautions and completed any other work required by applicable regulations. Purchaser shall reimburse Seller for any increased costs and expenses incurred by Seller that are the result of or are caused by any such delay. In the event that Seller is requested to supervise the installation of the Products, it remains the Purchaser's responsibility to comply with local regulations. Seller is not an architect and all drawings furnished by Seller are not construction drawings.

12.5 Regulatory Reporting. In the event that any regulatory activity is performed by other than Seller authorized personnel, Purchaser shall be responsible for fulfilling any and all reporting requirements.

12.6 Completion of Installation. Installation shall be complete upon the conclusion of final calibration and checkout under Seller's standard procedures to verify that the Products meet applicable written performance specifications. Notwithstanding the foregoing, first use of the Products by Purchaser, its agents or employees for any purpose after delivery shall constitute completion of installation.

13. PATENT, TRADEMARK AND OTHER INFRINGEMENT CLAIMS

13.1 Infringement by Seller. Seller warrants that the Products manufactured by Seller and sold hereunder do not infringe any U.S. patent or copyright. If Purchaser receives a claim that any such Product, or parts thereof, infringe upon the rights of others under any U.S. patent or copyright, Purchaser shall notify Seller immediately in writing. As to all infringement claims relating to Products or parts manufactured by Seller or one of its affiliates:

(a) Purchaser shall give Seller information, assistance and exclusive authority to evaluate, defend and settle such claims.

(b) Seller shall then, at its own expense, defend or settle such claims, procure for the Purchaser the right to use the Products, or remove or modify them to avoid infringement. If none of these alternatives is available on terms reasonable to Seller, then Purchaser shall return the Products to Seller and Seller shall refund to Purchaser the purchase price paid by the Purchaser less reasonable depreciation for Purchaser's use of the Products. The foregoing states Seller's entire obligation and liability, and the Purchaser's sole remedy, for claims of infringement.

13.2 Infringement by Purchaser. If some or all of the Products sold hereunder are made by Seller pursuant to drawings or specifications furnished by the Purchaser, or if Purchaser modifies or combines, operates or uses the Products other than as specified by Seller or with any product, data, software, apparatus or program not provided or approved by Seller, then the indemnity obligation of Seller under Section 13.1 shall be null and void and should a claim be made that such Products infringe the rights of any third party under patent, trademark or otherwise, then Purchaser shall indemnify and hold Seller harmless against any liability or expense, including reasonable attorneys' fees, incurred by Seller in connection therewith.

14. DESIGNS AND TRADE SECRETS; LICENSE; CONFIDENTIALITY

14.1 Any drawings, data, designs, software programs or other technical

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information supplied by Seller to Purchaser in connection with the sale of the Products are not included in the sale of the Products to Purchaser, shall remain Seller's property and shall at all times be held in confidence by Purchaser. Such information shall not be reproduced or disclosed to others without Seller's prior written consent.
14.2 For all goods purchased hereunder which utilize software for their operation, such "Applications Software" shall be licensed to Purchaser under the terms of Seller's Software License Schedule as attached hereto.
14.3 Diagnostic/Maintenance Software is not included under 14.2 above, is available only as a special option under a separate Diagnostic Materials License Agreement and may be subject to a separate licensing fee.
14.4 Seller and Purchaser shall maintain the confidentiality of any information provided or disclosed to the other party relating to the business, customers and/or patients of the disclosing party, as well as this Agreement and its terms (including the pricing and other financial terms under which the Purchaser will be purchasing the Products hereunder). Each party shall use reasonable care to protect the confidentiality of the information disclosed, but no less than the degree of care it would use to protect its own confidential information, and shall only disclose the other party's confidential information to its employees and agents having a need to know this information. The obligations of confidentiality set forth herein shall not apply to any information in the public domain at the time of disclosure or that is required to be disclosed by court order or by law.

15. ENGINEERING CHANGES
15.1 Seller makes no representation that engineering changes which may be announced in the future will be suitable for use on, or in connection with, the Products.

16. ASSIGNMENT
16.1 Neither party may assign any rights or obligations under this Agreement without the written consent of the other and any attempt to do so shall be void, except that Seller may assign this Agreement without consent to any subsidiary or affiliated company, and may delegate to authorized subcontractors or service suppliers any work to be performed under this Agreement so long as Seller remains liable for the performance of its obligations under this Agreement. This Agreement shall inure to and be binding upon the parties and their respective successors, permitted assigns and legal representatives. Seller shall have no obligations under this Agreement to any assignee of Purchaser that is not approved by Seller in advance.

17. DAMAGES, COSTS AND FEES
17.1 In the event that any dispute or difference is brought arising from or relating to this Agreement or the breach, termination or validity thereof, the prevailing party shall NOT be entitled to recover from the other party any punitive damages. The prevailing party shall be entitled to recover from the other party all reasonable attorneys' fees incurred, together with such other expenses, costs and disbursements as may be allowed by law.

18. MODIFICATION
18.1 This Agreement may not be changed, modified or amended except in writing signed by duly authorized representatives of the parties.

19. GOVERNING LAW; WAIVER OF JURY TRIAL
19.1 This Agreement shall be governed by the laws of the Commonwealth of Pennsylvania.

19.2 EACH OF THE PARTIES EXPRESSLY WAIVES ALL RIGHTS TO A JURY TRIAL IN CONNECTION WITH ANY DISPUTE UNDER THIS AGREEMENT.

20. COST REPORTING
20.1 Purchaser agrees that it will fully and accurately account for and report in all cost reports and otherwise fully and accurately disclose to federal and state health care program payors and fully and accurately reflect where and as appropriate to the applicable reimbursement methodology, all services and other items, including any and all discounts, received from Seller under this Agreement, in compliance with all applicable laws, rules and regulations, including but not limited to the Social Security Act and implementing regulations relating to Medicare, Medicaid and other federal and state health care reimbursement programs

21. INTEGRATION
21.1 These terms and conditions, including any attachments or other documents incorporated by reference herein, constitute the entire agreement and the complete and exclusive statement of agreement with respect to the subject matter hereof, and supersede any and all prior agreements, understandings and communications between the parties with respect to the Products.

22. SEVERABILITY; HEADINGS
22.1 No provision of this Agreement which may be deemed unenforceable will in any way invalidate any other portion or provision of this Agreement. Section headings are for convenience only and will have no substantive effect.

23. WAIVER
23.1 No failure and no delay in exercising, on the part of any party, any right under this Agreement will operate as a waiver thereof, nor will any single or partial exercise of any right preclude the further exercise of any other right.

24. NOTICES
24.1 Any notice or other communication under this Agreement shall be deemed properly given if given in writing and delivered in person or mailed, properly addressed and stamped with the required postage, to the intended recipient at its address specified on the face hereof. Either party may from time to time change such address by giving the other party notice of such change in accordance with this section.

25. RIGHTS CUMULATIVE
25.1 The rights and remedies afforded to Seller under this Agreement are in addition to, and do not in anyway limit, any other rights or remedies afforded to Seller by any other agreement, by law or otherwise.

26. END USER CERTIFICATION
26.1 Purchaser represents, warrants and covenants that it is acquiring the Products for its own end use and not for reselling, leasing or transferring to a third party (except for lease-back financings).

01/09 Rev.

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Software License Schedule to the Siemens Medical Solutions USA, Inc. General Terms and Conditions

1. DEFINITIONS: The following definitions apply to this Schedule:
"Agreement" shall mean the attached (i) Quotation for Products and/or Services including the Terms and Conditions of Sale and applicable schedules; and/or (ii) Software License Agreement describing the software licensed herein and the specific system for which the license is issued.
"Licensor" shall mean Siemens Medical Solutions USA, Inc.
"Licensee" shall mean the end-user to whom Licensor provides Software or Documentation for its internal use under the Agreement.
"Software" shall mean the software described in the attached Agreement, including the following as contained therein: (i) software programs consisting of a series of statements or instructions to be used directly or indirectly in a programmable controller or computer to bring about a certain result and (ii) databases consisting of systemized collections of data to be used or referenced directly or indirectly by a programmed controller or computer. Notwithstanding the foregoing, "Software" does not include "firmware" as such term is conventionally understood. Diagnostic/Maintenance Software also is not included within the scope of the Software licensed under this Schedule, and is available only as a special option under a separate Diagnostic Materials License Agreement and may be subject to a separate licensing fee.
"Documentation" shall mean the documents and other supporting materials which are intended to support the use of an associated product, including (but not limited to) instructions, descriptions, flow charts, logic diagrams and listings of the Software, in text or graphic form, on machine readable or printed media.
"Designated Unit" shall mean a single control unit or computer identified on the first page of the Agreement, on which Software licensed hereunder may be used by Licensee.
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Revised 03/15/05

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MI Warranty Information

Product	Period of Warranty[1]	Coverage	
MI-SPECT System or MI-PET System (not including radioactive sources and consumables)	12 month	Full Warranty (parts & labor including ALL CT tubes)	
Following parts will include warranty as listed below:			
Dura Akron Q CT tubes	Prorated to a maximum of 120,000 scan-seconds or 12 months whichever occurs first	Prorated credit given to customer against replacement cost	credit percentage = (120,000 – scan-seconds used) / 120,000*100
All other Dura CT tubes	Prorated to a maximum of 130,000 scan-seconds or 12 months whichever occurs first	Prorated credit given to customer against replacement cost	credit percentage = (130,000 – scan-seconds used) / 130,000*100
Straton CT tubes	12 month		
Post-Warranty (after expiration of system warranty) – Replacement parts only:			
Spare Parts	6 month	Parts only	
Straton CT tubes	Prorated to a maximum of 160,000 scan-seconds or 12 months whichever occurs first	Prorated credit given to customer against replacement cost	credit percentage = (160,000 – scan-seconds used) / 160,000*100
Radioactive Sources	Not covered		
Consumables	Not covered		

Note: Optional extended warranty coverage can be obtained by purchase of a service agreement.

[1] Period of warranty commences from the date of first use or completion of installation, whichever occurs first. In the event the completion of installation is delayed for reasons beyond Siemens' control, the stated Warranty period shall commence 60 days after delivery of equipment.

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Detailed Technical Specifications

Symbia T Series

Part No. / Product	Description
10275007 **Symbia T**	The Symbia T system consist of the following integrated TruePoint SPECT•CT features. **Gantry** Variable Angle, open design with 70 cm patient opening. The two High Definition Digital SPECT detectors can be configured at 76° or 90° for cardiac applications and at 180° for all other whole body and general protocols. Optional cephalic and caudal tilt of one detector allows for optimum detector positioning of static and dynamic acquisitions. The UFC (Ultra Fast Ceramic) multislice spiral CT detector rotates at 75 RPM (0.8 Sec per revolution). The contemporary design of the gantry incorporates Siemens-typical design elements like translucent cover materials and a fresh stripe décor. The unobstructed gantry base permits planar imaging of seated and standing patients and patients on wheelchairs, or on standard imaging tables, stretchers and gurneys. The gantry supports circular orbits and non-circular orbits using autocontour. Autocontour, with infrared real-time body contouring, is a standard component which minimizes patient to collimator distance to 1.2 cm (0.45 inches) in Whole Body and SPECT non-circular orbit acquisition modes. A fully integrated source holder is provided for quick and convenient quality control. **Patient Bed** The patient-oriented design of the imaging bed consists of 35.6 cm (14 inch) wide and 15 mm (0.6 inch) thin, carbon fiber pallet, supporting patient weights up to 227 kg (500 lbs). Minimum bed height is 53 cm (21 inches) for easy patient access. Programmable table positions for wheelchairs and gurneys minimize the transport efforts of patients and staff. Integrated rulers on each side of the patient bed, allow for quick whole body set up. The bed also provides automatic, uninterrupted table feed for multi-rotation continuous CT volume scanning The patient bed can easily removed for rail-free access of sitting/standing patients, wheelchairs, imaging tables, stretchers and gurneys. **User Interface** All motorized motions of the patient bed, gantry and detectors are controlled from the ergonomically designed hand controller which can be plugged into either side of the gantry. The Patient Positioning Monitor (PPM) is a touch screen flat panel display monitor which can be rotated for a wide range user access and visibility. It is used for the following functions: Patient Positioning with window and persistence adjustment - Acquisition Parameter display (elapsed time, time remaining, view number and count rate etc.) - Camera Information (detector and bed positions) -Gantry Control (Reconfiguration, Collimator Change, Offset Zoom, and Adjusting the CT acquisition limits.) **syngo MI Workplace.Symbia A** The *syngo*-based high performance workstation provides a standardized multi-modality graphical user interface, keyboard and mouse. SPECT and CT acquisition and processing are integrated in a single syngo MI Workplace. Workflows for a wide variety of clinical applications include the entire sequence from SPECT and CT acquisition parameters, image reconstruction and processing protocols, to archiving and printing. The syngo MI workplace has: - Single 2.6 GHz Core 2 Duo CPU - 2 GB RAM - 4x73 GB Hard Drives - Workflow based architecture - Integrated DVD-R Writer SPECT Acquisition

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Part No. / Product	Description
(Continued) **10275007** **Symbia T**	- Planar static and dynamic - Whole Body - SPECT, gated, non-gated or both - Dynamic SPECT - Whole Body SPECT **CT Acquisition** - Topogram, scanning perspectives: anterior-posterior (ap), posterior-anterior (pa), lateral (lat) - Spiral CT, continuous volume scanning technique with uninterrupted table feed in the multi-rotation mode - Sequential CT, incremental, slice-by-slice imaging mode with no table movement during data acquisition **CT examination and evaluation functions:** **CARE Dose 4D:** This software feature provides automatic, real-time x-ray dose management for all scan modes. The minimal x-ray dose level needed to obtain optimal image quality is determined from extensive computer analysis of the Topogram image and also from the data collected during every slice scanned, on a real time basis. This dual stage automatic approach ensures optimal image quality at the lowest possible x-ray dose. With this method of dose control, the initial or starting tube current for every axial slice position is determined from the Topogram image. Then, during the data acquisition for each axial slice, the x-ray attenuation values are closely monitored and the tube current is adjusted, on a real time basis, to optimize the x-ray dose level for the specific organs and anatomy in the x-ray path. Several clinical benefits are achieved with CARE Dose 4D: - Significant x-ray dose reduction (up to 66 %) possible for all body regions scanned compared with standard sequence or spiral scanning; - Consistent, optimal image quality with the x-ray dose level unique for every patient and for every anatomical region; - Thinner axial slices and/or longer scan ranges possible because of reduced tube loading; - Ultra-low dose examinations for pediatric patients. **SureView™ – Multislice Image Reconstruction System** - Excellent Image Quality and no slice broadening at any pitch – IQ is kept constant for all scan speeds, independent of the selected range and scan time. - Up to 20% dose savings in spiral mode. **Asynchronous Recon:** Asynchronous Recon allows for multiple image reconstructions and reformats, parallel to scanning. With this feature, up to eight reconstruction job requests can be loaded into a scan protocol. Immediately upon completion of the scan acquisition, these reconstruction jobs are automatically executed in the background without delaying the start of next patient examination. **Image reconstruction:** Reconstruction using raw data zoom with the possibility of freely selecting the image center either before scanning (prospectively) or retrospectively. **Image display:** CT value scale for window setting -1024 to +3071 HU. For very dense objects the CT value scale can be extended from -10240 to +30710 HU. **Multiplanar Reconstruction (MPR)** Real-time MPR for real-time reconstruction of secondary slices. Slice orientation: coronal, sagittal, irregular as well as multi-planar with SIR and Oblique. Cutlines can be determined using the reference tomogram or in sagittal reformatted images (SRI). 512 x 512 reconstruction matrix. **Syngo 3D SSD** Used to display and analyze complex anatomies – e.g. skull, pelvis, and hips – for the purpose of planning surgical

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Part No. / Product	Description
(Continued) **10275007** **Symbia T**	interventions. **Workflow Features** - Combine Acquisition, Processing and Display in a single workflow - Automatic Data Propagation from Acquisition through Hardcopy - Workflows are highly automated - Each step (activity) of a workflow is highly automated - Workflows can be modified or customized by the user - Automatic Data Distribution upon completion of each workflow - Automatic Printing - Automatic Networking to DICOM Workstations - Automatic Archiving Workflows in progress can be saved to disk and retrieved for processing at a later time - Workflows are network resources - A single workflow can be processed on multiple workstations simultaneously - Workflows can start or link to other workflows **Quality Control (Quality Control Activity) Features** - Sinogram, Linogram, and Summed Image - Cine with reference line - Automatic and Manual Motion Correction - Static X / Y / Copy / Paste - Dynamic X / Y / Copy / Paste - Gated Histogram Review - Tomo X / Copy / Paste - Dynamic Tomo Repeat X / Copy / Paste - Dynamic Tomo X / Copy / Paste / Repeat Rejection **General Reconstruction (TOMO Reconstruction Activity)** - Process up to 5 series simultaneously - Multi-Isotope support (6 per series) - Standard Tomography and Dynamic Tomography reconstructions - Separate reconstruction parameters per series / isotope - 3D Elliptical Masking - Filtered Backprojection, OSEM 2D - Reconstructions - 3D Reconstruction Zoom - Trial Mode Reconstruction - Interactive Filter Tool Interactive Masking / Centering - Chang's Attenuation Correction **3D Reorientation** - Free angle reorientation of reconstructed series - Process up to 4 series simultaneously - Process 1 series to create 3 different series, each in a different plane **Image Fusion** - Automatic adjustment based on pixel size - Volume translation and rotation operations - Manual, interactive volume manipulations - Manually enter desired translation and rotation parameters - Adjustable alpha blending display

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Part No. / Product	Description
(Continued) **10275007** **Symbia T**	- Selectable viewing angles - Choice of output matrix size (64, 128, or 256) - Landmark registration technique **Cardiac Processing (Autocardiac Activity) Features** - Process up to 4 series simultaneously - Mixed Non-Gated and Gated Series - Separate reconstruction parameters per series / isotope 3D Elliptical Masking - Filtered Backprojection, Iterative-W, OSEM 2D - Coincidence Reconstruction - True 3D Reconstruction Zoom - Trial Mode Reconstruction - Interactive Filter Tool - Interactive Masking / Centering **Advanced SPECT/CT Reconstruction** - Flash 3D 3D OSEM reconstruction algorithm using 3D collimator modeling to increase image quality, while maintaining the exact shape of organs and lesions, with decreased noise and enhanced resolution. - Attenuation Correction Creates very precise coefficient maps from the high quality CT data to correct for attenuation from the patients body to increase reading accuracy. - Scatter Correction Uses patient specific scatter projection estimates form a generalized dual-or triple energy window method to compensate for scatter during the iterative reconstruction process to further improve image quality. **Customizable Displays** **Hardcopy and Print Preview of all results**
10275012 **Symbia T Series** **Processing Wrkplc**	**System Features** **Hardware** - Dual 3.0 GHz Xeon CPUs - 2 GB RAM - 73 GB SAS Disk Drive for software - 147 GB SAS Disk Drive for patient data - 1333 MHz Front side bus - Integrated DVD-R Writer - 3 Button Mouse - Enhanced Keyboard **Quality Control (Quality Control Activity) Features** - Sinogram, Linogram, and Summed Image - Cine with reference line - Automatic and Manual Motion Correction - Static X / Y / Copy / Paste - Dynamic X / Y / Copy / Paste - Gated Histogram Review - Tomo X / Copy / Paste - Dynamic Tomo Repeat X / Copy / Paste - Dynamic Tomo X / Copy / Paste / Repeat Rejection

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Part No. / Product	Description
(Continued) **10275012** **Symbia T Series** **Processing Wrkplc**	**General Reconstruction (TOMO Reconstruction Activity)** - Process up to 5 series simultaneously - Multi-Isotope support (6 per series) - Standard Tomography and Dynamic Tomography reconstructions - Separate reconstruction parameters per series / isotope - 3D Elliptical Masking - Filtered Back-projection and OSEM 2D - Reconstructions - 3D Reconstruction Zoom - Trial Mode Reconstruction - Interactive Filter Tool Interactive Masking / Centering - Chang's Attenuation Correction **Cardiac Processing (Autocardiac Activity) Features** - Process up to 4 series simultaneously - Mixed Non-Gated and Gated Series - Separate reconstruction parameters per series / isotope 3D Elliptical Masking - Filtered Backprojection, Iterative-W, and OSEM 2D - Coincidence Reconstruction - True 3D Reconstruction Zoom - Trial Mode Reconstruction - Interactive Filter Tool - Interactive Masking / Centering **Advanced SPECT/CT Reconstruction** - Flash 3D 3D OSEM reconstruction algorithm using 3D collimator modeling to increase image quality, while maintaining the exact shape of organs and lesions, with decreased noise and enhanced resolution. - Attenuation Correction Creates very precise coefficient maps from the high quality CT data to correct for attenuation from the patients body to increase reading accuracy. - Scatter Correction Uses patient specific scatter projection estimates form a generalized dual-or triple energy window method to compensate for scatter during the iterative reconstruction process to further improve image quality. **Advanced Image Fusion** - Advanced Image Fusion includes the 3D Package, Image Fusion, and Automatic Image Fusion. Images from NM, PET, CT, MR, and AX are supported. **3D Package** Navigate through volume data and to create surface shaded and maximum intensity projection images. The package contains the following features: - Surface Shaded Display - Maximum Intensity Projection (MIP) - MPR user defined Thickness - Interactive 3D volume rotation - Interactive 3 slice display - Oblique cuts at any angle within the volume - Storage of fused results as DICOM secondary capture images - Region of interest punch tool - Curved cuts along any user defined pathway - Storage of 3D results Image Fusion Package

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Part No. / Product	Description
(Continued) **10275012** **Symbia T Series Processing Wrkplc**	Functionality for spatial alignment, superimposition, and visualization of image data from one patient where image data has been generated by different modalities. Supports optimal diagnosis by fusing the morphological with the functional information. - Easy-to-use visual alignment with 6 degrees of freedom (3X translation, 3X rotation) - Landmark based registration with convenient landmark editor for point-based registration using anatomical landmarks - Storage of transformation matrix after registration for later retrieval - Side by side visualization with correlated pointer and simultaneous scrolling - 2D alpha blending in monochrome or pseudo-color with adjustable balance between the two superimposed data sets. **Automatic Image Fusion** Automatic image registration enhancements to the Image Fusion Package. Surface Matching and Mutual Information algorithms allow for mix of image registration between anatomic modalities and functional modalities. **Volumetric Analysis for Tumor Imaging** - Viewing of SPECT and CT DICOM images including image fusion display for registered series. - Common display tools such as correlated cursors, quantitative color bar and interactive pixel value. - Default CT image windows. - 3D Volume of interest image masking. - Display of CT Maximum Intensity Projections (MIP). - Generation and display of SPECT whole body and static Maximum Intensity Projections. - 3D Reorientation of volume data. - Region of Interest (ROI) analysis and visualization - Volume of Interest (VOI) analysis and visualization - DICOM Attribute Edit Dialog **Image Manipulation Tools** - Series Filter - Series Arithmetic - Series Reformat - Series ROI & Curve **Organ-Based NM Processing** **Cardiac Planar Gated Blood Pool** - Left and Right Ventricular EF Analysis - Regional EF Analysis - Automated Image Filtering - Automatic or Manual ROI determination - Functional Image Creation - Curve Analysis - Filling and Emptying Rate Analysis **Shunt Analysis** - Automatic Composite Creation - Curve Smoothing and Fitting Options - Integral Calculation for Patient and Shunt Curve - Shunt Qp/Qs via Area Method - Shunt Qp/Qs via Height Method **Lung Analysis** - Total or Segmented analysis

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Part No. / Product	Description
(Continued) **10275012** **Symbia T Series Processing Wrkplc**	- Perfusion Quantitation - L/R Lung Comparison - Geometric Mean Calculation - Single Lung Processing **Thyroid Analysis** - Automatic or Manual ROI determination - Uptake, Countrate, Area and Volume Calculations - Single Lobe Processing - 6 and 24 Hour Uptake **Renal Analysis** - Automatic or Manual ROI Determination - Gates GFR - Oberhausen ERPF - Itoh ERPF - Oriuchi MAG3 - MAG3 without Blood Sample - Transplant - Captopril Comparison - Curve Analysis - R/L Ratio - Bubeck (TER) Processing **Gastric Emptying Analysis** - Automatic or Manual ROI Determination - Dual Isotope / energy window support - Geometric Mean Calculation - Curve Fitting Routines - Liquid / Solid Processing - Emptying Calculations **Hepatobiliary** - Automatic or Manual ROI Determination - EF Calculations - Dynamic and Static Methods supported - User Defined Interval EF Processing **Brain Analysis** - ROI Quantitation and Ratio Analysis - Bloodflow Analysis - Patlok Plot & Cerebral Bloodflow - Lassen Method - IMP - IMP-ARG - NIMS **Customizable Displays** **Hardcopy and Print Preview of all Results**
10118559 **Monitor, 19" LCD DICOM**	Additional features include: - 19" TFT panel

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Part No. / Product	Description
(Continued) **10118559** **Monitor, 19" LCD DICOM**	- minimum of 170 degree horizontal and vertical viewing angle - Optimal picture resolution of 1280 x 1024 - Contrast ratio 450:1 - Maximum luminance 280 cd/m2 - Anti-glare panel surface
10118559 **Monitor, 19" LCD DICOM**	Additional features include: - 19" TFT panel - minimum of 170 degree horizontal and vertical viewing angle - Optimal picture resolution of 1280 x 1024 - Contrast ratio 450:1 - Maximum luminance 280 cd/m2 - Anti-glare panel surface
10183459 **SPECT/CT 1/2 Time Imaging**	The SPECT/CT ½ Time Imaging package is based upon a statistical, adaptive de-noising and de-blurring process for planar images and longitudinal whole body bone scans. It can be used to shorten the acquisition time of planar images without loss in image quality. Alternatively, current acquisition times can be maintained to produce better looking images.
07833283 **Symbia 3/8" Hi-Res. Det. /Tub Asm.**	The Symbia® utilizes an energy independent HD High Definition Digital Detector (two are required), each with a true rectangular FOV of 38.7 x 53.3 cm (15.25" x 21"). Each detector has 59 Photomultiplier tubes: - 53 7.6 cm (3") diameter - 6 5.1 cm (2") diameter - 3/8 inch (0.95 cm) NaI (Tl) crystal - 59.1 x 44.5 cm (23 x 17.4 inch) The HD Detectors include: - OptiMath light interface for balanced performance between energy and spatial resolution. - One 10-bit high speed flash ADC per PMT. PMTs are bonded with a patented process for maximum light transmission - VariSEL (Variable PMT Selection) which is a unique energy independent method for tube selection used for event positioning that ensures high resolution for all multi-energy and multi-peak applications. - Dynamic Digital Integration which optimizes the integration time on an event by event basis as count rate demands, dramatically improving high count rate capability. - TriplePUR provides individual PMT pile-up correction for improved performance at high count rates. - Digital Light Pipe for energy independence which maintains clinical performance at all energies, important for multi-peak isotopes such as Tl-201, Ga-67 or dual isotope studies, and for off-peak imaging. The Digital Light Pipe obviates the need for count skimming on-line flood corrections for each photopeak. Six user-accessible energy windows are available. - LIPC, location independent position calculator, used to maintain consistent spatial resolution across the entire true rectangular field of view. - ZLC Energy and Linearity Correction, which corrects crystal variations for optimal uniformity and linearity

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Part No. / Product	Description
(Continued) **07833283** **Symbia 3/8" Hi-Res. Det. /Tub Asm.**	at all energies without the need for user re-calibration. - DIGITRAC PMT Gain Control, which uses a single source of either Co-57 or Tc-99m to tune each detector for all energy ranges. - Uptime Optimized Serviceability, from the Digital Acquisition Controller, which is capable of testing individual systems down to the PMT and preamplifier, the most specific component resolution in the industry.
07830909 **Remote Diagnostic Services**	A broadband connection is required for full remote diagnostic functionality and optimal system uptime. The Remote Diagnostic Services option allows for remote access to your networked workstations. This service includes all the necessary hardware, software and configuration required to access your equipment remotely for the purposes of remote diagnostics. Features include: -Image Transfer -Access to automatic Virus Protection updates -Error log retrieval -Remote Workflow revisions -Remote configuration -License management -Remote workstation control via netmeeting
10097270 **MI University**	Molecular Imaging University (MI-U) is the ultimate training resource for the interpreting physician, the referring physician and the technologist working with Siemens PET/CT and SPECT/CT systems. MI University is exclusively offered to customers of Siemens Molecular Imaging.
05245316 **UPS for e.soft/c.cam (60 Hz)**	Specifications: 1.4 KVA Input configuration: 120 VAC, 5-15P Output configuration: 120.VAC, (6) 5-15R
MI_SPEC_FLWUP_32 **MI_SYMB_FOLLOWUP**	Up to (32) hours of follow-up on-site clinical education training, scheduled consecutively (Monday – Friday) during standard business hours for a maximum of (4) imaging professionals. Uptime Clinical Education phone support is provided during the warranty period for specified posted hours. **This educational offering must be completed (12) months from install end date. If training is not completed within the applicable time period, Siemens obligation to provide the training will expire without refund.**
MI_SPEC_CTCRSTR **CT Cross Trainer (Printed Self Study)**	CT Cross Trainer printed self study materials for (1) imaging professional. These materials will provide the user with basic CT knowledge by testing the participant periodically. Successful completion of the self study program will provide the participant with CE credits. CT Cross Trainer printed self study materials for (1) imaging professional. These materials will provide the user with basic CT knowledge by testing the participant periodically. Successful completion of the self study program will provide the participant with CE credits. **This educational offering must be completed (12) months from install end date. If training is not completed within the applicable time period, Siemens obligation to provide the training will expire without refund.**
MI_SPECT_PM **MI SPECT Project Management**	A Siemens Project Manager (PM) will be the single point of contact for the implementation of your Siemen's equipment. The assigned PM will work with the customer's facilities management, architect or building contractor to assist you in ensuring that your site is ready for installation. Your PM will provide initial and final drawings and will coordinate the scheduling of the equipment, installation, and rigging, as well as the initiation of on-site clinical education.
MI_SPEC_INITIAL_32 **Initial onsite training 32 hrs**	Up to (32) hours of on-site clinical education training, scheduled consecutively (Monday – Friday) during standard business hours for a maximum of (4) imaging professionals. Training will cover agenda items on the ASRT approved checklist. Uptime Clinical Education phone support is provided during the warranty period for specified

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Part No. / Product	Description
(Continued) **MI_SPEC_INITIAL_32** **Initial onsite training 32 hrs**	posted hours. **This educational offering must be completed (12) months from install end date. If training is not completed within the applicable time period, Siemens obligation to provide the training will expire without refund.**
MI_SPEC_INT_BCLST **Basic SymbiaT Class**	Tuition for (1) imaging professional to attend a Siemens Classroom Course at Siemens Training Center. The objectives of this class are to introduce the user interface of the common *syngo* platform and instructions on building protocols, demonstration of software functions, and hands-on sessions. This class includes lunch, economy airfare, and lodging for (1) imaging professional. All arrangements must be arranged through Siemens designated travel agency. **This educational offering must be completed (12) months from install end date. If training is not completed within the applicable time period, Siemens obligation to provide the training will expire without refund.**
10273914 **AutoQC source kit**	The useful life of the 370 MBq (10 mCi) Gd-153 line, used for daily extrinsic floods and monthly multi-head registration procedures, is 2 years. The useful life of the 1.85 MBq (50 µCi) Co-57 point, used for intrinsic floods, is 1 year. Sources that have been replaced are returned to the source vendor for disposal. Return shipment costs are not included in the purchase price.

Pages 22 and 23 were blank.

TURNER HEALTHCARE QUOTE

Turner ≡ Healthcare

11/30/2011

NP 2-640 Symbia Project Estimate

Cut and Patch, Relocate Millwork, D/F/HW	$	23,732.00
Relocate Lav	$	2,191.00
Straight Time Electrical	$	9,580.00
Flooring Patch	$	1,778.00
Window Replacement for Neg Air	$	8,000.00
Final Cleaning	$	3,000.00
Premium Time	$	5,000.00
General Conditions	$	5,897.00
Insurance	$	685.00
Contractor Compensation	$	1,137.00
Total	**$**	**61,000.00**

Facilities Design & Construction
Project No:
Location: NP 2-640
Proj.Name: Renovate Symbia T room - Relocate Control Switch
Estimate Date: 01/19/12

Recommended Budget Allocation	81,270

WORK DESCRIPTION		TOTAL COST			
		LABOR $	MATER $	CONTR $	TOTAL $
Division: 2 -	DEMOLITION				
Division: 3 -	CONCRETE				
Division: 4 -	MASONRY				
Division: 5 -	METALS				
Division: 6 -	WOOD & PLASTICS				
Division: 7 -	THERMAL & MOISTURE PROTECTION				
Division: 8 -	DOORS & WINDOWS				
Division: 9 / Section: 09260 -	FINISHES /GYPSUM DRYWALL				
Section: 09310 -	CERAMIC TILE FLOOR				
Section: 09510 -	ACOUSTICAL CEILING				
Section: 09658 -	RESILIENT FLOORING				
Section: 09680 -	CARPET				
Section: 09910 -	PAINTING				
Subtotal Division 9					
Division: 10 -	SPECIALTIES				
Division: 11 -	EQUIPMENT				
Division: 12 -	FURNISHINGS				
Division: 13 -	SPECIAL CONSTRUCTION				
Division: 14 -	CONVEYING SYSTEMS				
Division: 15 / Section: 15100 -	MECHANICAL/PIPE & FITTINGS				
Section: 15400 -	PLUMBING FIXTURES				
Section: 15410 -	FIRE PROTECTION				
Section: 15700 -	HVAC SYSTEM				
Subtotal Division 15					
Division: 16 / Section 16100 -	ELECTRICAL /WIRING DEVICES				
Section: 16500 -	LIGHTING				
Section: 16800 -	SPECIAL SYSTEM				
Subtotal Division 16					
TOTAL					

GE DISCOVERY 570c QUOTE

GE Healthcare

QUOTATION

Quotation Number: P8-C53877 V 10

Yale - New Haven Hospital	Attn: Ms Wendy Bruni	Date: 12-15-2009
20 York St	20 York St	
New Haven CT 06510	New Haven CT 06510	

This Agreement is by and between the Customer and the GE Healthcare entity (referred to herein as "GE Healthcare"), each as identified in this Quotation. GE Healthcare agrees to provide and Customer agrees to pay for the Products and/or Services set forth in this Agreement, in accordance with the terms and conditions set forth in the Governing Agreement identified below. If a Governing Agreement is not identified below on this page, this Agreement shall be governed by the following terms and conditions:

1) This GE Healthcare Quotation (together with any applicable schedules referred to herein) that identifies the Product and/or Service offerings purchased or licensed by Customer;

2) The attached (i) GE Healthcare Warranty documentation; (ii) GE Healthcare Additional Terms and Conditions documentation; and (iii) GE Healthcare Statement of Service Deliverables documentation, as applicable; and

3) The attached GE Healthcare Standard Terms and Conditions Sales and Service.

In the event of conflict among the foregoing items, the order of precedence is as numbered above.

This Agreement constitutes the complete and final agreement of the parties relating to the Products and/or Services identified in the Quotation. No agreement or understanding, oral or written, in any way purporting to modify these terms and conditions or the Quotation, whether contained in Customer's purchase order or shipping release forms, or elsewhere, shall be binding unless hereafter made in writing and signed by each party's authorized representative.

By signing below, each party certifies that it has not made any handwritten modifications. Manual changes or mark-ups on this Quotation (except signatures in the signature blocks and an indication in the form of payment section below) will be void.

- Terms of Delivery: FOB Destination
- Quotation Expiration Date: 12-18-2009
- Billing Terms: 10% down / 70% delivery / 20% installation or first patient use
- Payment Terms: UPON RECEIPT
- Governing Agreement: None

Each party has caused this agreement to be signed by an authorized representative on the date set forth below. Please submit purchase orders to GE Healthcare
3200 N. Grandview Blvd., Mail Code WT-897, Waukesha, WI 53188

GE HEALTHCARE _____
Emily Kloeblen Date
Sales Representative

CUSTOMER

_____
Authorized Customer Date

_____
Print Name and Title

_____
PO #

INDICATE FORM OF PAYMENT:

(If there is potential to finance with a lease transaction, GE HFS or otherwise, select lease.)

____Cash * ____ Lease ____HFS Loan

If financing please provide name of finance company below*:

_____

*Selecting Cash or not identifying GE HFS as the finance company declines option for GE HFS financing.

GE Healthcare

QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
1		**Discovery NM/CT 570c**
1	S8000RD	Discovery NM/CT 570c Integrated

Discovery NM/CT 570c ushers in the first generation of volume SPECT/CT technology, bringing a distinct set of new capabilities beyond those offered by conventional SPECT or SPECT/CT scanners and opening the doors to new and advanced procedure possibilities in non-invasive cardiac imaging.

The Discovery NM/CT 570c Integrated System is comprised of the following subsystems:

NM Detector & Gantry: High-resolution, solid-state SPECT detector technology

- Multiple arrays of direct conversion 2.46x2.46mm semiconductor CZT detector
- Multi-pinhole collimation enabling high sensitivity, simultaneous acquisition of all views and reduced penetration
- Detectors shielded for 40-200 keV energy range
- Simultaneous acquisition of all views without motion during scanning
- Improved energy resolution and scatter rejection
- QC source holder enabling fast and accurate QC and calibrations
- Open gantry design facilitates patient setup and free access
- Real-Time gantry status display on acquisition console
- Intuitive Icon-Based handset mounted on the gantry
- Guided Patient Positioning tools for accurate patient positioning

CT Detector & Gantry

- Exclusive V-Res (TM) Detector technology
- Breakthrough diode technology providing true 64-channel acquisition and a platform for future growth.
- 40mm anatomical coverage per rotation with 0.625mm slices.
- Enhanced features for coronary angiography including: ECG waveform display on the console, cardiac optimized bowtie filters for dose reduction and cardiac specific image filters.
- Complete workflow solutions to support the acquisition of 64 sub-mm slices per rotation including Xtream XT Workflow Platform
- Proprietary Volume Reconstruction delivering industry leading z-axis resolution.
- Vari-Speed, GE's exclusive variable speed capability for enhanced coronary angiography
- Performix Pro X-ray tube and generator technology delivering 100kW, 800mA
- OptiDose management features: new bowtie filters optimized for coronary angiography and pediatric body exams, fully 3-Dose modulation
- Neuro 3D Filter

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
		Imaging Table • Flexible, 500lb (227kg) patient weight capacity • full cradle extension & 2000mm scannable range Ventricam Positioning Camera/Monitor - A miniature video camera attached to an LCD screen; monitors patients position relative to the detectors during setup and during the scan. Ventricare Patient Leg support - Ergonomic leg support mounted on top of patient table, designed to increase patient comfort, reduces movement & joint strain VentriCare patient Supine Arm support - Ergonomic arm support mounted on top of patient table, designed to increase patient comfort, reduces movement & joint strain Xeleris 2 - Functional Imaging Workstation for NM, PET, NM/CT & PET/CT-Desktop Configuration: • Intely Core2 Quad Processor Q9300 • 6MB onboard L2 cache • Intel X38 chipset with 1333 MHz front side bus • Dual-channel 4x512MB PC2-6400 DDR2 800 • RAID 0 2x80GB SATA II Hard Drive • Database capability: 60GB or 10000 studies (whichever comes first) • Windowsy XP Professional • Integrated ethernet adapter • PCI-E graphics Interface • CD-RW / DVD-RW Multi Drive • CD-RW / DVD-RW Multi Drive • Xeleris 2 Applications Software • 19" Color LCD Processing Monitor • Emory Cardiac Toolbox Software • 1 year subscription top Emory Reporting Option
2	M81511FB	AW VolumeShare2 System with 2 Monitors, VolumeViewer3.1 and 4GB RAM AW VolumeShare2 with Two Flat Panel Monitors and 4GB of RAM AW VolumeShare2 provides 3D visualization and analysis with exceptional stability, quality and flexibility for powerful multi-modality image management, review, comparison and processing. It features innovative 64 bit technology and 2 dual core processors for exceptional performance and large thin slice data set handling. In addition, AW VolumeShare2 features dramatic user

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description

interface enhancements that makes processing routine cases easy and complex cases simpler.

The AW software family improves diagnostic/treatment workflow and enhances clinician-patient communication. AW VolumeShare2 software includes:

- Volume Viewer 3.1: GE 3D software package that includes Volume Rendering, Volume Analysis, Navigator and other 3D visualization and analysis tools
- Advanced X-ray Analysis: Accommodates routine and special procedures, providing tools specifically for the review of DICOM x-ray images.
- 2D image viewer that displays RT, CT, MR, CR X-Ray (Angio and R&F), Digital X-Ray (DX), MG, NM, PET, U/S, Secondary Capture, Secondary Capture Color DICOM Image Objects
- Filmer: Multimedia export tool that creates standard or free-format electronic films in DICOM SR that can be saved, networked or printed to a DICOM, DICOM color or a supported postscript printer. Electronic films can also be exported out of the DICOM environment in a variety of multimedia formats (HTML, PDF, JPEG, PNG, MPEG, AVI, QuickTimey VR).

AW VolumeShare 2 ships with:

- Post-processing software platform, Patient List, database, and DICOM networking
- Volume Viewer 3.1(VA, VR, Navigator)
- 2D Viewer
- Filmer
- Data Export
- Advanced X-ray Analysis
- Two 19" flat panel monitors
- HP xw8400 Workstation:
  - 2 Intel Xeon Dual Core Processors @ 3.0GHz clock speed, 4MB shared L2 cache
  - 4GB DDR-2 RAM (expandable to 12GB)
  - 2 x 146 GB: SAS 15,000rpm hard disks (292 GB can be used for image storage)
  - 1 x 73 GB: SAS 15,000rpm hard disk for OS and system files
  - Internal DVD-ROM drive with CD burner (40x read/write) for DICOM media interchange and writing of DataExport electronic films
  - 10/100/1000 base-T network interface
  - USB Optical 3-button mouse
  - 3 inch floppy drive for service use and preset archive capability

DOES NOT INCLUDE AUTOBONE XPRESS SOFTWARE OR ANY OTHER ADVANCED APPLICATIONS NOT LISTED

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QUOTATION

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Qty	Catalog No.	Description
1	B7877EN	ENGLISH KYBD&LABEL'G KIT English Keyboard for CT systems (CT750 HD)
1	B7864JA	VCTproduct cables - standard length set (40 Ft) Standard length cable set for VCT and VCT Select system
1	B7864PZ	Uninterruptible Power Supply for LightSpeed CT750 HD & VCT Series products Un-Interruptible Power Supply Un-interruptible Power Supply for CT750 HD, and LightSpeed VCT systems. Un-interruptible power supply: supply's power to CT console allowing the user to power down system in the event of source power loss; thus preventing the loss of scan data previously acquired before source power loss. This UPS also: -Provides continuous protection to all of the system's major electronics subsystems -Protects the tube from power outages because it continues to provide power for tube cooling. -Minimizes system restart time by continuing to power the thermal control of the DAS and detector. -Provides enhanced ease of patient removal from the system by keeping the table powered.
1	P5064RR	DVCT SNAPSHOT PULSE OPT. Snapshot(TM) Pulse for Discovery VCT SnapShot Pulse is a new cardiac scanning techniques that reduces patient dose up to 70% and improves cardiac workflow, with uncompromised image quality. The Discovery VCT system uniquely designed to make it all possible - as a result of these key CT scanner attributes: • The 40-mm high resolution V-Res detector with micro voxel technology. • Prospective real-time patient heart-rate controlled ECG gating. • Real-time system controls to precisely control table movement and pulse the X-ray on and off. SnapShot Pulse uses prospectively triggered axial acquisitions synchronized by the patient heart rate, in which X-rays are turned on only during the required heart phase and turned off completely at all other times. In essence, the technique captures a complete picture of the heart using a series of three to four snap shots taken at precise patient table positions and precisely timed to correspond to a specific phase of the cardiac cycle, enabling a dose reduction of up to 70% relative to conventional cardiac CT acquisitions. SnapShot Pulse helps improve workflow by reducing the size of image set to be reconstructed, reviewed and post processed. A typical SnapShot Pulse series consists of 280 - 400 images, compared with up to 3,000 images in a typical helical cardiac scan series. Since these's a

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Qty	Catalog No.	Description
		smaller number of images to reconstruct, SnapShot Pulse takes less time, yet delivers the same amount of information as a helical cardiac exam. This Option requires Discovery VCT with 5-Beat option and Snapshot Imaging (Helical cardiac acquisition).
1	S8006KW	Xeleris 2 Dual Monitor Upgrade X2 DUAL MON UPGRADE XELERIS 19" LCD Dual Monitor Upgrade Requires an existing H3700MP 19" LCD monitor Additional Black 19 inch LCD Color Monitor for Xeleris 2 Desktop systems only and license for Dual Monitor Optimized Xeleris Applications.This small footprint LCD color monitor from NEC includes US and European power cabling only (Japan Power cable sold separately is not included
1	S8006LN	Sony MOD with SCSI Card 4.1 Gbyte, 5.25 Inch Re-Writable Sony Magneto Optical Drive for Xeleris 2 Workstations. Includes H3700MD SCSI Card for XW6200 Hardware only.
2	H2600SW	4D-MSPECT for Xeleris/eNTEGRA - 1st or 2nd License 4D-MSPECT 4D-MSPECT is an application developed at the University of Michigan Medical Center in Ann Arbor, Michigan. It is a comprehensive cardiac SPECT display and quantification program for gated and ungated SPECT perfusion studies.
1	S8005WF	MultiMedial Creator for Xeleris 1.1 - Multi Pack MultiMedia Creator for Xeleris 1.1 - A powerful tool for the creation and distribution of Xeleris results pages in full color and motion. Text and vocal descriptions may be added to the selected images and the overall report can be viewed and edited prior to distribution. Once created, reports may be distributed on CD, Email or Network easily from within the application.
2	H3900PE	SYNCTOOL FOR ECTB VL SyncTool, cardiac imaging tool for Emory Cardiac Toolbox, to analyze which heart failure patients will benefit from cardiac resynchronization therapy (CRT). This software application provides cardiologists with an objective and timely measure of left ventricular (LV) dyssynchrony. Once the gated SPECT (G-SPECT) image study is completed, results are available in less than one minute. SyncTool works on Syntermed's Emory Cardiac Toolbox (ECTb) included in Xeleris 2.1 for optimum accuracy and efficiency.
1	H3900NW	Alcyone List Mode License

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
		Alcyone List Mode License An upgrade to Myovation software on Xeleris 2 workstations to include List Mode for Alcyone cameras
1	E4503LL	2 KVA Online Double Conversion UPS - 120V Input/Output 2 KVA Online Double Conversion UPS - 120V Input/Output The 2 KVA Online Double Conversion UPS - 120V Input/Output provides reliable, clean, consistent voltage power for diagnostic imaging systems. The use of uninterruptible power enables the system imaging to be completed after the loss of supply power, and allows for saving of valuable data and orderly system shutdown. The Online Double Conversion UPS eliminates all power anomalies such as noise, transients, overvoltage, and undervoltage, which could damage the imaging system's sensitive computer components. Tested for use with GE Nuclear Medicine, Mammography and Ultrasound. Customer is responsible for rigging and arranging for installation by a certified electrician. ITEM IS NON-RETURNABLE AND NON-REFUNDABLE. Warranty Code: O
1	W0009HC	3.5 day TiP HQ Class CT Cardiac Imaging - Full Service TiP HQ Class CT Cardiac Imaging - Full Service 3.5 day CT course held in the Milwaukee area. Includes travel and modest living expenses. This course covers anatomy, patient preparation, scanning, data reconstruction, and post processing. This training program must be scheduled and completed within 12 months after the date of product delivery.
1	W0100CT	6 Day CT TiP Onsite System Training 6 Day CT TiP Onsite System Training CT Onsite Training for a new CT system • One 4 day onsite visit to coincide with system start-up. • One 2 day onsite follow-up visit 6-8 weeks post system start up. During the first visit, the applications specialist will work with the medical and technical staff on system operation and patient procedures. The training produces the best results when a dedicated core group of 2-4 CT technologists complete the session with a modified patient schedule. It is suggested that key physicians are available to participate in the protocol implementation and image quality review sessions. By the end of this visit, the core group should be able to perform the routine patient procedures. The 2 day revisit is suggested after the staff has run the system for 6-8 weeks, however this is flexible based on the site needs. The training will focus on the intermediate and advanced

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Qty	Catalog No.	Description
		functions of the system or special needs of the customer. The training produces the best results when the same dedicated core group of 2-4 CT technologists from the initial visit complete the session with a modified patient schedule. This training program must be scheduled and completed within 12 months after the date of product delivery.
1	W0110CT	TiP Applications VCT Cardiac Training TiP Applications VCT Cardiac Training TiP Applications VCT Cardiac Training includes: • 4 onsite days covered in one site visit • 10 hrs. TVA This training program must be scheduled and completed within 36 months after the date of product delivery. Onsite training and TVA are delivered Monday through Friday between 8AM and 5PM. T&L expenses are included.
1	W0201NM	TiP NM Onsite Training for Infinia or Millennium System TiP NM Onsite Training for Infinia or Millennium System 6 Days of TiP Onsite Camera and Workstation Training (4 Day Startup; 2 Day follow-up). Onsite training is delivered Monday through Friday between 8AM and 5PM. T&L expenses are included. This training program must be scheduled and completed within 12 months after the date of product delivery.
1	W0972NM	NM TiP Virtual Assist 10 Hrs NM TiP Virtual Assist 10 Hrs 10 hours of remote NM training using TiP virtual Assist. Requires broadband connection with customer upload speed of at least 400 kbps. This training program must be scheduled and completed within 24 months after the date of product delivery.
1		**CT Accessories**
1	E8007NG	Medrad Stellant DX Dual Flow Injector - Ceiling Mount (Short Post) Medrad Stellant DX Dual-Flow Ceiling Mount Injection System with Short Post. Requires E8007NZ Mounting Plate be added to the order....E
1	E8007PJ	OCS III MOUNTING PLATE OCS III MOUNTING PLATE

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
1	E8007RP	Ivy 3150-B Cardiac Trigger Monitor w/Cable Collector

Ivy 3150-B Cardiac Trigger Monitor w/Synchronized Output for R-Wave Synchronization Applications

Features/Benefits

- Impedance Measurement: Measures impedance between the patient's skin and each individual ECG electrode.
- Automatic Operation: After patient cables are connected and the monitor is receiving an ECG signal, the monitor finds the peak of the R-wave and generates synchronization pulses
- Bright TFT active matrix 6.5 in. color LCD with a wide viewing angle and large heart rate characters enhance visibility of patient data.
- Polarity lock reduces the number of false triggers when tall T waves or deep S waves occur
- Synchronized trigger output produces a trigger pulse starting at the peak of each R-wave - R to R accuracy
- Color trigger mark indicates timing of each trigger pulse with respect to the ECG
- System Interlock function indicates proper connection with the imaging device
- Integrated USB Drive - allows user to store and retrieve ECG events for retrospective analysis.
- Built-in recorder produces hard copy support documentation. A marker identifies the synchronized timing for later review.
- The ECG monitor will operate in one of two mutually exclusive modes:
  - Ethernet mode: Monitor has software to support real-time and buffered waveform data transfer to the CT console via Ethernet
  - USB Mode
- The mode of operation is selected via hardware switch located on the monitor rear panel
- Auto-notch selects the correct ECG notch filter. This reduces interference on the ECG signal

Specifications (Mechanical)

- Height: 6.70 in. (17.2 cm)
- Width: 9.25 in. (23.5 cm)
- Depth: 9.21 in. (23.4 cm)
- Weight: 6.5 lbs. (2.9 kg)

Basic Accessory Kit Includes:

- Patient Cable (3 lead, low noise)
- Set of 3 radio translucent lead wires
- ECG Adult Electrodes (box of 30)

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
		Starter Kit includes everything in the Basic Accessory Kit plus: • Roll stand with mounting plate • Hospital-grade cord set (12 ft.)
1	E4502AE	125A Main Disconnect Panel (US) CT Main Disconnect Panel - 125 Amp This 125-amp main disconnect panel serves as the main power disconnect between the CT system and the facility 400-480V power source. It provides short circuit, overload, under voltage release, automatic restart, and emergency shut down for the CT system. It also reduces install ation time and cost by providing a single-point power connection eliminating the need to mount and wire a number of individual components, and its standardized design and testing assures high product quality and system reliability. On systems where the optional 12.5 KVA partial system UPS is ordered (E4502KT), the main disconnect panel also provides mandated emer gency power off control via a UPS output disconnect function included in the panel design. It also provides a standardized plat form for future UPS or other GE-engineered modifications or upgrades. This panel is compatible with GEHC LightSpeed Pro 16, Pro 32, LightSpeed VCT and RT CT systems. Customer is responsible for rigging and arranging for installation by a licensed electrician. This ITEM IS NON-RETURNABLE AND NON-REFUNDABLE. Warranty Code: Y
1	E8016AN	Slicker - VCT 2000 Systems (2-pc Set) Slicker - CT HD750 and VCT w/GT 2000 Table (2 Piece Set) Protective table cover and cushion set for the CT VCT 2000 systems. This two-piece, sealed slicker cushion set have comfort pads enclosed inside the slicker cover and extender cover. Durable, clear PVC plastic covers facilitate faster, more thorough cleanup of blood and fluids. Also help to increase system uptime by protecting table from spills and particulate contaminants, easy to install and comfortable for patients. Thermo-sealed seams and flaps prevent contaminate buildup in hard to clean areas. Includes table cushion, extender cushion and catheter bag holder. Warranty Code: H
1		**NonProducts**
1		Rigging
1		Flood Source
1		**AW VolumeShare4 and Applications**
2	M80171LS	AW Floating License Manager AW Floating License Manager

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
		AW Floating license manager is the license server software that manager AW floating licenses at your facility. You will need ONE license server per facility to manage licenses. The software will be loaded on hardware provided and maintained by your IT department (Note: Not Applicable with AW Server purchase). The hardware should meet the following minimum specifications: • P4 1.5GHz Processor • 512 MB RAM • 100MB free hard disk space (5GB recommended for license metering log files) Operating System specifications: • Windows 2000 Professional, Server, 2003 Server or XP Professional Included with this order is the AW Floating license manager software package.
2	M81531VM	AW VOLUMESHARE 4-SW UPGRA AW VolumeShare 4 Software Only Upgrade with Purchase of a Advanced Application
1	M81551TC	Integrated Registration PET/SPECT Fusion Single (and additional) Floating License Inetgrated Registration - PET/SPECT Fusion Single Floating License A Single Floating License provides one Concurrent user license for an application that can be installed on AW Floating License manager at your facility. This license can be used by any AW in your facility that is "Concurrency Enabled" and is configured to use floating licenses. Requires: • AW Floating License Manager to be installed at your facility. • AW's "Concurrency Enabled" to access this floating license.
2	M81521PN	Productivity Package for AW VolumeShare 4 - HP xw8600 Systems AW VolumeShare4 Productivity Package with 12GB of Additional RAM. Requires HP xw8600 Hardware AW VolumeShare4 with Productivity Package Represents: • More Capacity to Load Multiple Large Dataset with at least 12GB of RAM. • Instantaneous Display of Exams with AutoLaunch. • Instantaneous Access to the Segmented Vessel Volume with Preprocessing. Productivity Package makes full use of the 64 bit Technology as well as the Dual Screen xw8400 Hardware of the AW workstation. It Runs 12 to 16 GB of RAM giving the Ability to Load simultaneously up to 15,300 Images.

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
		AutoLaunch Loads Automatically Multiple Cases as soon as they are Transferred to the AW. A Single Click in the AutoLaunch Window Raises Instantly in the Case in Volume Viewer. Interaction with the Data is Immediately Possible as they are Preloaded and Ready to Use. AutoLaunch is compatible with CT, MR and PET Single Volume Protocols of Volume Viewer. One-Touch Links provide the Ability to Automatically Launch the best Protocol for each Exam based upon DICOM Image Acquisition Elements. An Intuitive User Interface in the Protocol Launcher provided an Easy Configuration of One Touch Links by Clicking the Hand Icon. When combined with Optional AutoBone Xpress, the Productivity Package will also Provide the Automatic Preprocessing of the Bone Removal. Raising CTA Exams Located in the AutoLaunch Window will give Instantaneous Access to the Vessel Volume Resulting from the 0-Click Bone Removal. There is No More Waiting Time between the Exam Selection and the Ability to interact in 3D with the Segmented Vascular Volume.
2	B79821ES	CardEP Single (and Additional) Floating License CardEP Single Floating License CardEP Single Floating License provides one concurrent user license for CardEP application that can be installed on AW Floating License manager at your facility. This license can be used by any AW in your facility that is "Concurrency Enabled" and is configured to use floating licenses. Requires: • AW Floating License Manager to be installed at your facility. • Atleast one prior purchase of CardEP Floating License Ready or conversion of an existing node locked license to CardEP Floating License Ready. • AW's "Concurrency Enabled" to access this floating license. Included with this order is the CardEP Single Floating license. For AW VolumeShare 2
2	B79821TC	CardIQ Function Xpress Single (and Additional) Floating License CardIQ Function Xpress Single Floating License CardIQ Function Xpress Single Floating License provides one concurent user license for CardIQ Function Xpress application that can be installed on AW Floating License manager at your facility. This license con be used by any AW in your facility that is "Concurrency Enabled" and is configured to use floating licenses. Requires: • AW Floating License Manager to be installed at your facility. • Atleast one prior purchase of CardIQ Function Xpress Floating License Ready or conversion of an existing node locked license to Floating License Ready.

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
		• AW's "Concurrency Enabled" to access this floating license. Included with this order is the CardIQ Function Xpress Single Floating License. For AW VolumeShare 2
2	B79821SH	CardIQ Xpress 2.0 Elite Singe (and Additional) Floating License CardIQ Xpress 2.0 Elite Single Floating License CardIQ Xpress 2.0 Elite Single Floating License provides one concurent user license for CardIQ Xpress 2.0 Elite application that can be installed on AW Floating License manager at your facility. This license can be used by any AW in your facility that is "Concurrency Enabled" and is configured to use floating licenses. Requires: • AW Floating License Manager to be installed at your facility. • Atleast one prior purchase of CardIQ Xpress 2.0 Elite Floating License Ready or conversion of an existing node locked license to Floating License Ready. • AW's "Concurrency Enabled" to access this floating license. Included with this order is the CardIQ Xpress 2.0 Elite Single Floating License. For AW VolumeShare2 or higher
2	B79971FK	Smartscore 4.0 Single (and Additional) Floating License Smartscore 4.0 Single Floating License. Smartscore 4.0 Single Floating License provides one concurent user license for Smartscore 4.0 application that can be installed on AW Floating License manager at your facility. This license can be used by any AW in your facility that is "Concurrency Enabled" and is configured to use floating licenses. Requires: • AW Floating License Manager to be installed at your facility. • Atleast one prior purchase of Smartscore 4.0 Floating License Ready or conversion of an existing node locked license to Floating License Ready. • AW's "Concurrency Enabled" to access this floating license. Included with this order is the Smartscore 4.0 Single Floating License. For AW VolumeShare2 or higher
2	B77151BD	VESSELIQ & AB XPRESS SFL VesselIQ Xpress & AutoBone Xpress Single Floating VesselIQ Xpress Software if for AW VolumeShare2 or higher is running on AW

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
		VesselIQ Xpress provides an optimized non-invasive application to analyze vascular anatomy and pathology and aid in determining treatment plans from a set of CTA images. This software supports the physician in: • Assessment of aneurysms with or without thrombus (false lumen) for size and volume measurements with the capability to track the size and volume over time, stenosis analysis, pre/post stent and surgical planning and directional vessel tortuosity visualization. • Automatic tools for the segmentation of bony structures in the brain and neck and other vascular areas for accurate identification of the vessels, single or double click vessel analysis. • Sizing the vessel, analyzing calcified and non-calcified plaque to determine the densities of plaque within a vessel, measure areas of abnormalities within a vessel (like stenosis, plaque, thrombus, dissection or leakage). • Semi-automated detection and segmentation of thrombus for subsequent measurements within the application. • Dedicated anatomy based protocols for improved workflow. • Compare a patient's previous exam to their current exam in order to measure and track any changes over time of their vascular structures. • After review of the exams, there are multiple ways to film, archive and capture information for future review. System Requirements: • AW VolumeShare2 or higher Note: All software are Non-Transferable to other hardware and are Non-Returnable.
2	P51801BT	CardIQ Fusion PET Single (and Additional) Floating License CardIQ Fusion PET Single Floating License. CardIQ Fusion PET Single Floating License provides one concurrent user license for CardIQ Fusion PET application that can be installed on AW Floating License manager at your facillity. This license can be used by any AW in your facility that is "Concurrency Enabled" and is configured to use floating licenses. Requires: • AW Floating License Manager to be installed at your facility. • Atleast one prior purchase of CardIQ Fusion PET Floating License Ready or conversion of an existing node locked license to CardIQ Fusion PET Floating License Ready. • AW's "Concurrency Enabled" to access this floating license. Included with this order is the CardIQ Fusion PET Single Floating license.

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QUOTATION

Quotation Number: P8-C53877 V 10

Qty	Catalog No.	Description
2	H25801BT	CardIQ Fusion SPECT Single (and Additional) Floating License CardIQ Fusion SPECT Single Floating License. CardIQ Fusion SPECT Single Floating License provides one concurrent user license for CardIQ Fusion SPECT application that can be installed on AW Floating License manager at your facillity. This license can be used by any AW in your facility that is "Concurrency Enabled" and is configured to use floating licenses. Requires: • AW Floating License Manager to be installed at your facility. • Atleast one prior purchase of CardIQ Fusion SPECT Floating License Ready or conversion of an existing node locked license to CardIQ Fusion SPECT Floating License Ready. • AW's "Concurrency Enabled" to access this floating license. Included with this order is the CardIQ Fusion SPECT Single Floating license.

Quote Summary:

Total Quote Net Selling Price **$1,354,443.44**

(Quoted prices do not reflect state and local taxes if applicable. Total Net Selling Price Includes Trade In allowance, if applicable.)

GE Healthcare

Standard Terms and Conditions Sales and Service

References herein to "products" and "services" mean the products (including equipment and software) and services purchased by Customer as identified on the applicable GE Healthcare Quotation.

1. **Contract Formation**. GE Healthcare's Quotation is subject to withdrawal at any time before acceptance. Customer accepts by signing and returning the Quotation or by sending a purchase order in response to the Quotation. Upon Customer's acceptance, GE Healthcare's Quotation and the related terms and conditions referred to in the Quotation (as modified to the extent applicable by any strategic purchasing agreement Customer may have in effect at the time with GE Healthcare) shall constitute the entire agreement relating to the products and services covered by the Quotation. The parties agree that they have not relied on any oral or written terms, conditions, representations or warranties outside those expressly stated or incorporated by reference in this agreement in making their decisions to enter into this agreement. No agreement or understanding, oral or written, in any way purporting to modify these terms and conditions or the Quotation, whether contained in Customer's purchase order or shipping release forms, or elsewhere, shall be binding on GE Healthcare unless hereafter made in writing and signed by GE Healthcare's authorized representative. Customer is hereby notified of GE Healthcare's objection to any terms inconsistent with this Quotation and to any other terms proposed by Customer in accepting this Quotation. Neither GE Healthcare's subsequent lack of objection to any such terms, nor the delivery of the products or services, shall constitute an agreement by GE Healthcare to any such terms.

2. **Confidentiality.** GE Healthcare will treat patient information as confidential and comply with applicable privacy laws. Each party will treat the terms of this agreement and the other party's written, proprietary business information as confidential if marked as confidential or proprietary. Customer will treat GE Healthcare (and GE Healthcare's third party vendors') software and technical information as confidential information whether or not marked as confidential and shall not use or disclose to any third parties any such confidential information except as specifically permitted in this agreement or as required by law (with reasonable prior notice to GE Healthcare). The receiving party shall have no obligations with respect to any information which (i) is or becomes within the public domain through no act of the receiving party in breach of this agreement, (ii) was in the possession of the receiving party prior to its disclosure or transfer and the receiving party can so prove, (iii) is independently developed by the receiving party and the receiving party can so prove, or (iv) is received from another source without any restriction on use or disclosure.

3. **Warranties.** GE Healthcare warrants that its services will be performed by trained individuals in a professional, workman-like manner. GE Healthcare will promptly re-perform any non-conforming services for no charge as long as Customer provides reasonably prompt written notice to GE Healthcare. Product warranties (if applicable) are set forth in the GE Healthcare warranty forms delivered with this agreement. The foregoing service remedy, together with any remedy provided in the applicable GE Healthcare product warranty forms delivered with this agreement, are Customer's sole and exclusive remedies (and GE Healthcare's sole and exclusive liability) for warranty claims. These exclusive remedies shall not have failed of their essential purpose (as that term is used in the Uniform Commercial Code) as long as GE Healthcare remains willing to repair or replace defective warranted products or re-perform any non-conforming services for no charge, as applicable, within a commercially reasonable time after being notified of Customer's warranty claim. NO OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, QUIET ENJOYMENT, SYSTEM INTEGRATION AND DATA ACCURACY, WILL APPLY. GE Healthcare may use refurbished parts in new products as long as it uses the same quality control procedures and warranties as for new products. Any part for which GE Healthcare has supplied a replacement shall become GE Healthcare property.

4. **Software License.** GE Healthcare grants to Customer a non-exclusive, non-transferable license to use for internal business only the GE Healthcare software, third-party software and associated documentation provided hereunder by GE Healthcare to Customer, subject to the license scope and other restrictions set forth in this agreement. Customer may permit its employees, agents and independent contractors to use the software and associated documentation consistent with this agreement; provided, however, that Customer shall be responsible for any acts of its employees, agents and/or independent contractors which are inconsistent with this agreement. Customer may only use any third-party software provided by GE Healthcare together with the GE Healthcare software and will comply with all third-party software license terms included in any click or shrink wrap license or of which GE Healthcare otherwise makes Customer aware. Without GE Healthcare's prior written consent, Customer may not: (i) copy, sublicense, distribute, rent, lease, loan, resell, modify or translate the software or create derivative works based thereon; (ii) directly or indirectly decompile, disassemble, reverse engineer or otherwise attempt to learn the source code, structure, algorithms or ideas underlying the software; (iii) provide service bureau, time share or subscription services based on the software; or (iv) remove, obscure or modify any markings, labels or any notice of the proprietary rights, including copyright, patent and trademark notices of GE Healthcare or its licensors. Customer may make one copy of the software solely for backup purposes. GE Healthcare and its licensors, as applicable, retain all ownership and intellectual property rights to the software and documentation. If Customer acquires any rights to the software or documentation, Customer hereby assigns all of those rights to GE Healthcare or its licensors, as applicable. No license rights are granted (whether by implied license or otherwise), to Customer, except as specifically provided in this section. If Customer is a U.S. Government

agency, Customer acknowledges that the software licensed under this agreement is a commercial item that has been developed at private expense and not under a Government contract. The Government's rights relating to the software are limited to those rights applicable to Customers as set forth herein and is binding on Government users in accordance with Federal Acquisition Regulation 48 C.F.R. Section 12.212 for non-defense agencies and/or Defense FAR Supplement 48 C.F.R. Section 227.7202-1 for defense agencies.

5. **Indemnification.** GE Healthcare will defend, indemnify and hold harmless Customer from any third party claims brought against Customer for infringement of intellectual property rights arising from Customer's use of the GE Healthcare manufactured equipment and/or GE Healthcare proprietary software purchased or licensed by Customer from GE Healthcare in accordance with their specifications and within the license scope granted in this agreement. If any such claim materially interferes with Customer's use of the GE Healthcare manufactured equipment and/or GE Healthcare proprietary software, GE Healthcare shall, at its option: (i) substitute functionally equivalent non-infringing products; (ii) modify the GE Healthcare product so that it no longer infringes but remains functionally equivalent; (iii) obtain for Customer at GE Healthcare's expense the right to continue to use the infringing GE Healthcare product; or (iv) if the foregoing are not commercially reasonable, refund to Customer the purchase price, as depreciated (based on five year's straight-line depreciation), for the GE Healthcare product that gave rise to the claim. Any such claims against Customer arising from Customer's use of the GE Healthcare manufactured equipment and/or proprietary software after GE Healthcare has notified Customer to discontinue use of such equipment and/or software and offered one of the remedies set forth in clauses (i) through (iv) above are the sole responsibility of Customer. This section represents Customer's sole and exclusive remedy (and GE Healthcare's sole and exclusive liability) regarding any claim of infringement associated with the GE Healthcare manufactured equipment and/or proprietary software and/or any use thereof. The above indemnification obligation is conditional upon Customer providing GE Healthcare prompt written notice of the third party infringement claim after receipt of notice of such claim, allowing GE Healthcare to control the defense and disposition of such claim, and reasonably cooperating with GE Healthcare in the defense. Notwithstanding any other provision in this agreement to the contrary, GE Healthcare shall not have any obligation to Customer hereunder: (a) for damages sought by a third party claimant based on or resulting from the amount of revenues or profits earned or other value obtained by the use of such GE Healthcare product, or the amount of use of such GE Healthcare product; or (b) for infringement claims based on or resulting from: (i) the use of such GE Healthcare product in combination with any computer software, tools, hardware, equipment, or any other materials, or any part thereof, or services, not furnished by GE Healthcare or authorized by GE Healthcare in its documentation; (ii) the use of such GE Healthcare product in a manner or environment, or for any purpose, for which GE Healthcare did not design or license it, or in violation of GE Healthcare's instructions on use; or (iii) any modification of such GE Healthcare product by Customer or any third party. GE Healthcare shall not be responsible for any compromise made by Customer or its agents without GE Healthcare's consent. This indemnification obligation is expressly limited to the product purchased or licensed by Customer from GE Healthcare.

6. **Termination; Compliance.** If either party materially breaches this agreement and the other party seeks to terminate on the basis of that breach, such other party shall notify the breaching party in writing, setting out the breach, and the breaching party will have 60 days following such notice to remedy the breach. If the breaching party fails to remedy the breach during that period, the other party may, subject to the terms of Sections 3, 5 and 23.3, by written notice terminate this agreement. All orders are subject to (i) GE Healthcare's on-going credit review and approval and (ii) GE Healthcare's on-going determination that Customer and the proposed order or related service agreement comply with all applicable laws and regulations, including those relating to workplace safety, FDA matters, Federal Healthcare Program Anti-kickback compliance, export/import control and money laundering prevention. Customer acknowledges that the products are or may be subject to regulation by the FDA and other federal or state agencies. Customer shall not use or permit the products to be used in any manner that does not comply with applicable FDA or other regulations or for any non-medical, entertainment, or amusement purposes. Further, Customer represents that it is purchasing the products for its own use consistent with the terms of this agreement and that it does not intend to re-sell the products to any other party or to export the products outside the country to which GE Healthcare delivers the products. If GE Healthcare determines in good faith at any time that there are legal or regulatory compliance and/or material credit issues with the order or related service agreement, GE Healthcare may terminate this agreement (including warranty services hereunder) immediately upon written notice to Customer.

7. **Data Access.** Customer shall permit GE Healthcare to connect to the products, or to otherwise access performance data related to the products, to gather and use products and resource usage data in various ways such as product development, quality initiatives, benchmarking and reporting services. The data collected by GE Healthcare will be used, during and after the term of this agreement, in accordance with all applicable laws and regulations and in a manner that will maintain confidentiality.

8. **Force Majeure.** Neither party is liable for delays or failures in performance (other than payment obligations) under this agreement due to a cause beyond its reasonable control. In the event of such delay, the time for performance shall be extended as reasonably necessary to enable performance.

9. **Record Retention.** If Section 1861(v)(1)(I) of the Social Security Act applies to this agreement, subsections (i) and (ii) of such Section are made a part hereof. If applicable, GE Healthcare will retain and make available, and insert the requisite clause in each applicable subcontract requiring its subcontractors to retain and make available, the contracts, books, documents and records to the persons, upon the requests, and for the periods of time as required by such subsections.

10. **Cost Reporting.** Customer will (i) fully and accurately account for, and report in any applicable cost reports or otherwise fully disclose to government program payors and accurately reflect where and as appropriate to the applicable reimbursement methodology, and (ii) provide information upon request by federal or state agencies concerning, all services and other items, including any discounts, received from GE Healthcare under this agreement in compliance with all applicable laws, including the federal Social Security Act and implementing regulations relating to Medicare, Medicaid, and other federal and state health care programs.

11. **Customer Responsibilities.** In order for GE Healthcare to perform its obligations under this agreement (including warranty obligations), Customer agrees to:

- Provide and maintain a suitable, safe and hazard-free location and environment for the GE Healthcare products and services in material compliance with any written requirements provided by GE Healthcare, perform GE Healthcare recommended routine maintenance and operator adjustments, ensure that any non-GE Healthcare provided service is performed by, and GE Healthcare products are used by, qualified personnel in accordance with applicable user documentation.
- Provide GE Healthcare prompt and unencumbered access to the products, network cabling and communication equipment as necessary to perform services. This access includes providing and maintaining connectivity to the products (modem line, internet connection, vpn persistent access, broadband internet connection, or other secure remote access reasonably requested by GE Healthcare) to permit GE Healthcare to perform support services and meet service levels, including remote diagnostic, monitoring and repair services. GE Healthcare may separately charge Customer for a scheduled service call where Customer does not provide such access and GE Healthcare is therefore required to schedule an additional service call.
- Provide a secure area reasonably near the products for GE Healthcare's proprietary service materials. Customer shall not have any right, title or interest in or to these materials or any license or other right to access, use, or decompile these materials. Customer agrees to use reasonable efforts to protect this GE Healthcare property against damage, loss or unauthorized access or use.
- Promptly place service calls in accordance with any reasonable GE Healthcare protocols provided to Customer and designate a Customer representative and alternate as GE Healthcare's support contacts with the necessary skills to assist GE Healthcare in the diagnosis of service problems.
- Establish and maintain security, virus protection, backup and disaster recovery plans for any data, images, software or equipment (GE Healthcare's services do not include recovery of lost data or images). This responsibility includes maintaining secure network and network security components, firewalls and security-related hardware or software, preventing unauthorized access to the product and preventing interception of communications between GE Healthcare's service center and the product.
- Obtain and maintain all licenses, permits, and other approvals necessary for installation, use, disposal, and recycling (each as applicable) of products provided under this agreement. During the term of this agreement, Customer will take all necessary and legally required precautions for the health and safety of GE Healthcare personnel who will perform any service at the Customer site, including, but not limited to, (i) instructing any GE Healthcare personnel who will be present at the Customer site about Customer's safety procedures and practices, (ii) providing GE Healthcare with current written information identifying all known existing hazardous materials (including wastes) on or near the Customer site that could affect the GE Healthcare personnel, (iii) taking all necessary and/or legally required actions to properly store, remove and/or remediate any safety conditions and hazardous materials so that GE Healthcare may safely perform its services, and (iv) maintaining a workplace and operating environment in accordance with Federal, State and/or local requirements. GE Healthcare shall have no obligation to perform services until Customer has complied with each of the items identified above.

Unless expressly provided otherwise, Customer is separately responsible for: (a) the repair, replacement or removal of any disposables, consumables, supplies, accessories or collateral equipment; (b) the provision of or payment for any applicable rigging or facility cost; and (c) any service necessitated by (i) Customer's or its representative's designs, specifications, or instructions, (ii) anything external to the products, including any causes or events beyond GE Healthcare's reasonable control, (iii) product misuse, (iv) combining any component of the products with any incompatible equipment or software, or (v) Customer's relocation, additions, or changes to the products, unless GE Healthcare has consented in writing to such relocations, additions or changes.

12. **Terms of Payment.** The payment terms for the product(s) and/or service(s) are stated in the GE Healthcare Quotation or additional terms and conditions, as applicable. For any products requiring final assembly or installation by GE Healthcare, if such assembly or installation is delayed by more than 30 days after delivery of the products for any reason for which Customer is responsible, GE Healthcare may, at its option, bill Customer for and Customer will pay GE Healthcare any remaining payments due under this agreement. If Customer has a good faith dispute regarding payment for a particular product (or subsystem thereof) or service, such dispute shall not entitle Customer to withhold payment for any other product (or subsystem thereof) or service purchased from GE Healthcare. GE Healthcare may revoke credit extended to Customer because of Customer's failure to pay for any products or services when due or for any other reason deemed good or sufficient by GE Healthcare, and in such event all subsequent shipments and services shall be paid for on receipt. Customer grants GE Healthcare a purchase money security interest in all items of equipment listed in the GE Healthcare Quotation until full payment is received, and Customer agrees to perform all acts and execute all documents as may be necessary to perfect GE Healthcare's security interest. Prices for upgrades and revisions assume that Customer returns the replaced component and transfers title to GE Healthcare at no charge to GE Healthcare.

13. **Late Payment.** Failure to make timely payment is a material breach of this agreement, for which (in addition to other available remedies) GE Healthcare may suspend performance under any or all GE Healthcare agreements until all past due amounts are brought current. If GE Healthcare so suspends, GE Healthcare will not be responsible for the completion of planned maintenance due to be performed during the suspension period and any product downtime will not be included in the calculation of any uptime commitment. Interest shall accrue on past-due amounts at a rate equal to the lesser of 1.5% per month or the maximum rate permitted by applicable law. Customer will reimburse GE Healthcare for reasonable costs (including attorneys' fees) relating to collection of past due amounts. Any credits that may be due to Customer under an agreement may be applied first to any outstanding balance. If, after product delivery, Customer does not make any payments for the products within 45 days after such payments are due, GE Healthcare may, upon 10 days prior written notice to Customer, either (a) enter upon Customer's site and remove the products or (b) temporarily disable the products so that they are not operational.

14. **Taxes.** Prices do not include sales, use, gross receipts, excise, valued-added, services, or any similar transaction or consumption taxes ("Taxes"). Customer acknowledges and agrees it shall be responsible for the payment of any such Taxes to GE Healthcare unless it otherwise timely provides GE Healthcare with a valid exemption certificate or direct pay permit. In the event GE Healthcare is assessed Taxes, interest and penalty by any taxing authority, Customer agrees to reimburse GE Healthcare for any such Taxes, including any interest or penalty assessed thereon. Each party is responsible for any personal property or real estate taxes on property that the party owns or leases, for franchise and privilege taxes on its business, and for taxes based on its net income or gross receipts.

15. **Customer Training.** Unless otherwise stated in the catalog description, training must be completed within 12 months after (i) the date of product delivery for training purchased with products and (ii) the start date for services for training purchased with services. If training is not completed within the applicable time period, GE Healthcare's obligation to provide the training will expire without refund.

16. **Assignment; Use of Subcontractors.** Neither party may assign any of its rights or obligations under this agreement without the prior written consent of the other party, which consent shall not be unreasonably withheld; provided, however, that either party may transfer and assign this agreement without the other party's consent to any person or entity (except to a GE Healthcare competitor) that is an affiliate of such party or that acquires substantially all of the stock or assets of such party's applicable business if any such assignees agree, in writing, to be bound by the terms of this agreement. Subject to such limitation, this agreement shall be binding upon and inure to the benefit of the parties hereto and their respective successors and permitted assigns. GE Healthcare may hire subcontractors to perform work under this agreement; provided, however, that GE Healthcare will at all times remain responsible for the performance of its obligations and duties under this agreement.

17. **Medical Diagnosis and Treatment.** Customer hereby acknowledges and agrees that all clinical and medical treatment and diagnostic decisions are the responsibility of Customer and its professional healthcare providers.

18. **Amendment; Waiver; Survival.** This agreement may be amended only in writing signed by both parties. Any failure to enforce any provision of this agreement is not a waiver of that provision or of either party's right to later enforce each and every provision. The terms of this agreement that by their nature are intended to survive its expiration (such as the confidentiality provisions included herein) will continue in full force and effect after its expiration. Software license provisions applicable to perpetual software licenses fully paid for prior to termination shall survive termination of this agreement.

19. **Governing Law; Disputes; Limitation of Liability.** The law of the state where the product is installed or the service is provided will govern any dispute between the parties. EACH PARTY EXPRESSLY WAIVES ALL RIGHTS TO A JURY TRIAL IN CONNECTION WITH ANY DISPUTE ARISING UNDER THIS AGREEMENT. Other than collection matters and actions seeking injunctive relief in a court of competent jurisdiction to prevent or cease a violation of intellectual property rights related to the products or services, disputes arising under or relating to this agreement will be submitted to the American Arbitration Association ("AAA") office located closest to the largest metropolitan area of the state where the product is installed or the service is provided for binding arbitration in accordance with the AAA's then-current Commercial Arbitration Rules. The cost of the arbitration, including the fees and expenses of the arbitrator, will be shared equally, with each party paying its own attorneys' fees. The arbitrator will have the authority to award damages only to the extent otherwise available under this agreement. GE HEALTHCARE'S (AND ITS REPRESENTATIVES') LIABILITY UNDER THIS AGREEMENT, REGARDLESS OF THE FORM OF ACTION, SHALL NOT EXCEED: (A) FOR PRODUCTS OR SERVICES OTHER THAN SERVICES UNDER AN ANNUAL SERVICE CONTRACT, THE PRICE FOR THE PRODUCT OR SERVICE THAT IS THE BASIS FOR THE CLAIM; OR (B) FOR ANNUAL SERVICE CONTRACTS, THE ANNUAL CONTRACT PRICE FOR THE SERVICE THAT IS THE BASIS FOR THE CLAIM. NEITHER CUSTOMER NOR GE HEALTHCARE (NOR THEIR RESPECTIVE REPRESENTATIVES) SHALL BE LIABLE TO THE OTHER PARTY UNDER THIS AGREEMENT (OR OTHERWISE IN CONNECTION WITH THE PRODUCTS AND SERVICES) FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL OR CONSEQUENTIAL DAMAGES, OR FOR LOSS OF PROFITS, REVENUE, TIME, OPPORTUNITY OR DATA, WHETHER IN AN ACTION IN CONTRACT, TORT, PRODUCT LIABILITY, STATUTE, EQUITY OR OTHERWISE. The limitation of liability and exclusion of damages shall apply even if the limited remedies fail of their essential purpose.

20. **Leases.** If Customer is acquiring use of products through an equipment lease (a "Lease") with an equipment lessor (a "Lessor"), certain provisions of this agreement will be modified as follows: (i) payment (the applicable Lessor or Customer, as agreed by the parties, will pay GE Healthcare the purchase price for the products per the terms of the applicable GE Healthcare Quotation, including any applicable GE Healthcare additional terms and conditions, or such other terms and conditions as shall be agreed to in writing by GE Healthcare and the Lessor); (ii) title transfer (GE Healthcare will convey title to the equipment portion of the products to the applicable Lessor per the terms of the applicable GE Healthcare Quotation, including any applicable GE Healthcare additional terms and conditions, or such other terms and conditions as shall be agreed to in writing by GE Healthcare and the Lessor); (iii) acceptance (as between Customer and the applicable Lessor, the terms of product acceptance shall be governed by the applicable Lease and other documentation entered into between Customer and such Lessor; as between GE Healthcare and such Lessor, the terms of product acceptance shall be governed by the terms of the applicable GE Healthcare Quotation, including any applicable GE Healthcare additional terms and conditions, or such other terms and conditions as may be agreed to in writing by GE Healthcare); (iv) warranties (subject to the last sentence of this section, all warranties hereunder shall extend to and be enforceable by Customer); and (v) software licenses (Customer shall be an authorized end-user under any software licenses under this agreement in connection with the products, subject to the applicable license terms and conditions). Notwithstanding this section, if the applicable Lessor does not comply with the terms of this agreement relating to items (i) and (iii) above, Customer continues to be responsible for the payment and acceptance obligations hereunder. As between the applicable Lessor and Customer, the applicable Lease terms may modify the manner in which warranties hereunder are enforceable by Customer, provided that GE Healthcare shall not be bound by any Lease terms that would modify GE Healthcare's warranty obligations unless GE Healthcare has agreed in writing to such modifications.

21. **Independent Contractor**. GE Healthcare and Customer are independent contractors and nothing contained in this agreement is intended nor shall it be construed as creating a fiduciary relationship, partnership, joint venture or agency relationship between GE Healthcare and Customer, nor is anything contained in this agreement intended to be construed as creating or requiring any ongoing or continuing relationship or commitment between GE Healthcare and Customer, except as otherwise agreed in writing by the parties.

22. **Severability.** The provisions of this agreement are severable from each other. If any provision of this agreement is held to be invalid or unenforceable, it shall be revised to reflect as closely as possible its originally intended meaning, and the validity or enforceability of any other provisions in this agreement will not be affected.

23. **Products.** The following provisions shall apply only to the purchase or licensing of products:

23.1 Delivery: When feasible, GE Healthcare reserves the right to make delivery in installments. All such installments shall be separately invoiced and paid for when due, without regard to subsequent deliveries. Delivery dates are approximate. If Customer fails to schedule a delivery date with GE Healthcare within 6 months after order entry, GE Healthcare may cancel Customer's order upon written notice to Customer.

23.2 Transportation, Title and Risk of Loss: Unless otherwise indicated in the GE Healthcare Quotation, shipping terms are FOB Destination. Title and risk of loss to equipment passes to Customer upon delivery to Customer's designated delivery location. Software is licensed (and not sold) to Customer.

23.3 Installation: GE Healthcare's installation services provided or identified in its Quotation will be performed in accordance with applicable GE Healthcare installation guides and project plans and otherwise subject to the following additional provisions. Customer agrees to review the applicable installation guides and project plans and perform its obligations set forth in those materials.

- Customer will prepare the location for the installation consistent with GE Healthcare's written specifications and applicable law. Customer will install necessary system cable and assemble any necessary equipment or hardware not provided by GE Healthcare, unless agreed otherwise in writing by the parties. For products that will be operated on or in connection with Customer supplied hardware or software, Customer is responsible for ensuring that its hardware and software conform with GE Healthcare's minimum hardware and software requirements as made available to Customer. Unless GE Healthcare has agreed in writing to maintain responsibility for an applicable service, Customer will be responsible for enabling the connectivity and interoperability between its Customer supplied hardware or software or other systems or devices and the GE Healthcare product, including, without limitation, procuring and installing any modifications, interfaces or upgrades consistent with GE Healthcare's written specifications.
- Unless Customer has elected to purchase network preparation and certification services from GE Healthcare as set forth in the GE Healthcare Quotation, Customer is solely responsible for ensuring that Customer's network is adequate for the proper operation and performance of the products and that it otherwise meets GE Healthcare's network configuration requirements (including requirements for preparation of Customer's site, remote interconnections and Internet Protocol address assignments) provided by GE Healthcare to Customer.
- If local labor conditions make it impractical to, or GE Healthcare is directed not to, use GE Healthcare's regular employees for the installation, all work will be performed by Customer's laborers or outside labor at Customer's expense; provided that GE Healthcare will, at Customer's request, furnish supervision for proper installation.
- GE Healthcare will provide Customer with the product(s) in the configuration as listed in the Quotation. The configuration is based upon information furnished to GE Healthcare by Customer. Customer is responsible for modifications, if any, to the configuration due to inaccuracies or incompleteness of the information furnished to GE Healthcare by Customer, changes in Customer's needs or requirements, or for other reasons attributable to Customer.
- For products that GE Healthcare is obligated to install under the terms of this agreement, if GE Healthcare delivers the product but fails to perform its installation obligations, then in such event Customer shall nevertheless be obligated to pay GE Healthcare an amount equal to the product purchase price less the fair market value of the applicable installation services, taking into account the type of product and level of installation required ("Installation Service FMV"). An independent third party shall determine the Installation Service FMV pursuant to the dispute resolution provisions of Section 19. Subject to the terms of Section 19 and notwithstanding any other provision of this agreement to the contrary, the deduction of the Installation Service FMV shall be Customer's sole and exclusive remedy (and GE Healthcare's sole and exclusive liability) in the event GE Healthcare fails to perform its installation obligations under this agreement.

23.4 Acceptance: Unless expressly provided otherwise in this agreement or in the applicable GE Healthcare installation guide or standard project plan, Customer shall be deemed to have accepted a product delivered by GE Healthcare under this agreement on the earlier of: (i) if GE Healthcare installs the product, 5 days after GE Healthcare notifies Customer that it has completed assembly and the product is operating substantially in accordance with GE Healthcare's published performance specifications; (ii) if GE Healthcare does not install the product, 5 days after delivery of the product to Customer; or (iii) the date Customer first uses the product for patient use.

23.5 Returns: Customer shall not have any right to return products for a refund after delivery except for products shipped in error that are different from the products listed in the applicable GE Healthcare Quotation.

GE Healthcare

Additional Terms and Conditions For Diagnostic Imaging Products

These Additional Terms and Conditions incorporate GE Healthcare's Standard Terms and Conditions Sales and Services and will apply to the purchase and use of GE Healthcare diagnostic imaging products in the X-Ray, Mammography, CT, MR, PET, PET Cyclotron/Chemistry, and Nuclear modalities. Certain provisions apply only to pre-owned GoldSeal Preferred products in these modalities and other provisions apply only to construction work GE Healthcare has agreed in writing to provide.

Cancellation and Payments. If Customer cancels an order without GE Healthcare's prior written consent within 90 days before the scheduled delivery date, Customer will pay a cancellation charge of 15% of the price of the products ordered. GE Healthcare will retain as a credit any payments received up to the amount of the cancellation charge. If Customer cancels an order for products requiring site evaluation services by GE Healthcare or its representatives, Customer will also pay GE Healthcare reasonable charges for such services performed prior to cancellation. If applicable for the order, Customer will pay all progress payments (other than the final payment) prior to final product calibration, and GE Healthcare may, at its option, delay final calibration until required progress payments are received.

Order Changes. GE Healthcare will accept order changes up to 5 weeks prior to scheduled delivery or, for orders placed less than 5 weeks before the delivery date, up to 3 business days after its receipt of the order. GE Healthcare reserves the right to refuse late change requests. Product delivery may be delayed by late change requests.

Site Preparation. If applicable, Customer will be responsible, at its expense, for preparing the site where the products will be installed in accordance with GE Healthcare's site preparation requirements. Site preparation requirements vary by product and are described in the applicable GE Healthcare product pre-installation manual and other materials provided by GE Healthcare. Site preparation includes, but is not limited to, compliance with all necessary electrical, lighting, heating, air conditioning, plumbing, radiation shielding, fire protection, ceiling and wall structures/supports, architectural/seismic preparations, magnetic and radio frequency shielding, and other environmental requirements, as applicable for the specific product.

For MR systems, Customer will provide a site and surroundings suitable for installation and operation of an MR system producing strong magnetic and electric fields, and Customer will be required to provide a water chiller meeting GE Healthcare specifications.

For PET or PET Cyclotron/Chemistry systems, Customer will provide a site and surroundings suitable for installation and operation of such a system using and/or producing radiation. Further, Customer will be responsible for obtaining all required federal, state, and local licenses and permits for radioactive sealed sources and radioisotopes used with such system. If permitted under applicable licensing requirements, GE Healthcare representatives will work under Customer's license and supervision when handling any radioactive substance for which a license is required, or Customer will provide such handling itself under an appropriate license. Customer will provide all radioactive sources and radioisotopes for calibration and performance checks of such system.

Site Evaluation Assistance. If applicable, upon Customer's request, GE Healthcare will provide reasonable assistance in evaluating and reviewing Customer's site preparation plans, drawings and materials to facilitate compliance with GE Healthcare's site planning requirements. Site evaluation assistance available from GE Healthcare varies by product and will be coordinated through GE Healthcare's assigned installation specialists. GE Healthcare's site evaluation services rely on and are subject to the completeness and accuracy of information provided by Customer, its representatives and contractors, and conditions prevailing at the time of such site evaluation services. Such site evaluation services are intended only to assist Customer in fulfilling its responsibility to ensure that the site complies with GE Healthcare's applicable site preparation requirements.

Installation and Certification. If applicable, GE Healthcare will provide product assembly, installation, interconnection, calibration and checkout services, as required, at no additional charge, except for items excluded herein. Upon completion of assembly and installation and prior to turnover of the products to Customer for clinical use, as applicable, GE Healthcare will perform prescribed tests using its own performance specifications, instruments and procedures to verify that the products meet GE Healthcare's applicable performance specifications. GE Healthcare will not provide rigging or site preparation services in connection with product installation, unless otherwise agreed in writing by GE Healthcare for an additional charge. GE Healthcare will not install accessory items such as illuminators, pass boxes, cabinets, darkroom equipment or processors for X-Ray and CT products, unless otherwise agreed in writing by GE Healthcare.

Customer will provide any licenses, permits and approvals needed for installation and use of the products, including, but not limited to, licensing, compounding, packing, holding and reporting requirements of the FDA, NRC, state certificate of need or equivalent approvals, state radiation control authorities and state pharmacy and medical boards, and any state or local architectural/seismic submissions and approvals, as applicable. GE Healthcare will file any required Federal and State reports relating to its installation activities. GE Healthcare will not install, test, certify or provide its own software license or warranty for products that are not listed in its on-line catalog or price pages at the time of sale (such products are normally identified by NL or NW series numbers), unless otherwise agreed in writing by GE Healthcare.

Applications Training. At Customer's request and for an additional charge, GE Healthcare will provide training for Customer personnel through GE Healthcare's Learning Solutions TiP "Training in Partnership" program. Customer may select training at GE Healthcare's then-current standard rates and in accordance with its then-current training program offerings and terms.

Use in Manufacturing. The products and/or their components may have been operated intermittently under normal conditions and/or used in staging similar types of products for a limited time period at GE Healthcare's manufacturing facility to (i) verify that products and components perform reliably in accordance with their specifications or (ii) facilitate engineering testing of other components and software. Further, the products and/or components may have undergone design maturity testing at GE Healthcare's manufacturing facility to validate the reliability of new or modified product design and manufacturing processes. Such tests are conducted on a small percentage of newly manufactured products and simulate normal operation within a product's technical specifications for a limited time period. Use of products or components for the purposes described above does not impair their useful life or affect their warranty.

Remote Access. If applicable, Customer is responsible for providing and maintaining an appropriate telephone line or Broadband connection at the site that GE Healthcare may use to provide remote diagnostic service for the products. Eligible products include an uptime commitment during the warranty period, provided Customer maintains a Broadband connection in accordance with GE Healthcare specifications and allows GE Healthcare to remotely monitor performance of the products via this connection. GE Healthcare will provide details of this uptime commitment for eligible products.

Mobile Systems. For products that are approved by GE Healthcare for use as transportable, relocatable and mobile systems, GE Healthcare will deliver the system to Customer's van manufacturer and furnish final assembly services to place the system in Customer's van. At the time of order, Customer must notify GE Healthcare of the van manufacturer to which the system is to be shipped. It is Customer's responsibility to make arrangements with the van manufacturer for delivery of the van and to comply with any additional planning requirements of the van manufacturer. For MR systems, GE Healthcare's product tests will be performed when assembly in the van is completed and MR system operation will be re-checked when the van is delivered to Customer.

GoldSeal Preferred Products. For products designated as GoldSeal Preferred products (identified by catalog numbers beginning with L, NL193-199, and NL528), the products have been previously owned and used; they are not new. When delivered to Customer, the products may have received mechanical, electrical and/or cosmetic reconditioning, as necessary, and will meet their original specifications. GE Healthcare will deliver pre-owned mobile, transportable and relocatable MR and CT systems to Customer's site at no additional charge. Since pre-owned products may be offered simultaneously to several customers, their sale to Customer is subject to their continued availability at the time Customer offers to purchase the products. If the products are no longer available, (i) GE Healthcare will attempt to identify other pre-owned products in its inventory that meet Customer's needs and (ii) if substitute products are not acceptable to Customer, GE Healthcare will cancel the order and refund any deposit Customer has paid for such products.

Third Party Products and Services. If GE Healthcare has agreed to provide any third party products and/or services (other than GE Healthcare accessories and supplies) to Customer as part of the Quotation, including but not limited to any Commitment Account/Non-Inventory items, (i) GE Healthcare is acquiring such products and/or services on Customer's behalf and not as a supplier of such products and/or services; (ii) GE Healthcare makes no warranties of any kind, express or implied, with respect to such products and/or services (warranties, if any, on such products and/or services will be provided by the manufacturer or service provider, as applicable); (iii) Customer is solely responsible for ensuring that the acquisition and use of such products and/or services is in compliance with applicable laws and regulations, including applicable FDA regulations; and (iv) Customer is solely responsible for any and all claims resulting from or related to the acquisition or use of such products and/or services.

iCenter and iLinq. If specified in the Quotation, GE Healthcare will provide iCenter and/or iLinq information management services at no additional charge during the term of the applicable product warranty, subject to then-applicable terms and conditions for such services.

Site Access Control. Customer is responsible for controlling access to the products and for all operations and protocols using the products at the site, and Customer will comply with all applicable laws and regulations related to site access control.

For MR systems, Customer acknowledges that such systems utilize magnets of high field strength and radio frequency electromagnetic fields. The magnetic fields of such systems attract ferro-magnetic articles and are capable of rapidly accelerating such articles toward the magnet, creating corresponding physical danger to persons in the vicinity and possible damage to such systems. In addition, the magnetic and radio frequency fields of such systems may adversely affect the operation of pacemakers, equipment containing magnetic reed switches, and aneurysm or surgical clips.

For PET or PET Cyclotron/Chemistry systems, Customer acknowledges that such systems utilize radioactive materials. As with all systems utilizing radioactive materials, hazards exist creating possible physical danger to persons in the vicinity.

Radioactive Materials. For nuclear, PET and/or PET Cyclotron/Chemistry systems that require the use of radioactive sources included with the order, Customer is solely responsible for obtaining any NRC and other government licenses required to use such sources. If Customer does not provide GE Healthcare with satisfactory evidence that Customer has obtained all required licenses at the time of order entry, GE Healthcare may, at its option, remove such sources from the order and create a second order for such sources. GE Healthcare will then ship the other products ordered and bill Customer for the amount due for delivery of products under the original order, less the amount attributable to such sources. GE Healthcare will ship such sources to Customer only after Customer provides GE Healthcare with satisfactory evidence that Customer has obtained all required licenses for such sources and GE Healthcare will bill Customer for the amount due for such sources upon shipment. Customer shall pay for and accept delivery of the other products and such sources per the above procedures.

In addition, Customer will provide all radioactive sources and radioisotopes for calibration and performance checks of such system. For PET Cyclotron/Chemistry systems, GE Healthcare will provide 4.12 grams of ^{18}O water per installed ^{18}F target to perform GE Healthcare's standard on-site acceptance testing, and Customer is responsible for the expense of any additional testing requirements for such systems.

Magnet Maintenance and Cryogens. The price of MR systems includes all cryogens necessary for final assembly and testing of the MR system. Cryogen loss attributable to power loss or water chiller failure for the MR system's shield cooler or condenser system during installation is Customer's responsibility, and Customer will be billed for cryogen replacement in 250 liter (minimum dewar size) increments plus

the associated cryogen transfill labor at GE Healthcare's standard hourly billed service rates. After final assembly, Customer will be responsible to supply and install all cryogens, unless cryogen loss is caused by a defect in material or workmanship within the scope of GE Healthcare's applicable MR system warranty. Following final assembly, GE Healthcare will offer magnet maintenance and cryogen service under a separate agreement. The typical helium level upon final assembly as measured using the supplied helium meter is approximately 70%.

Provided cryogen boil-off rates have not been adversely affected by actions of Customer, its representatives or contractors, or any third party not authorized by GE Healthcare, GE Healthcare will provide a super-conductive magnet which, at the expiration of the warranty period, has cryogen boil-off rates not exceeding those stated in GE Healthcare's applicable magnet specifications. GE Healthcare has no responsibility to Customer for cryogen boil-off rates subsequent to expiration or termination of the applicable MR system warranty.

End Of Life Disposal. For PET and PET Cyclotron/Chemistry systems, at the end of the system's useful life, Customer is responsible for disposing of the system in accordance with applicable federal, state and local laws and regulations. Upon request, GE Healthcare will provide consulting concerning the disposal of such systems to help promote compliance with regulations and environmentally responsible disposal.

PET Cyclotron/Chemistry Special Terms. For PET Cyclotron/Chemistry systems, any target or gas processing system purchased with the system must be installed with the original system prior to system checkout. Installation after this time will require a separate quotation by GE Healthcare and is billable to Customer at GE Healthcare's then-current installation rates. Further, any system storage fees associated with this order are solely the responsibility of Customer. PET Cyclotron/Chemistry systems are sold for use in generating radiotracers for diagnostic imaging applications only. GE Healthcare does not sell or intend such systems or any part(s) thereof for use in radiation therapy.

Software License. Except as modified by license terms provided for specific software, GE Healthcare grants Customer a non-exclusive, non-transferable license to use the software (i) for Customer's internal business use and (ii) only on the specific equipment for which GE Healthcare provided Customer the software at the identified location (or, for mobile systems, in the specific vehicle) identified in the Quotation. Customer may make one copy of the software in machine-readable form solely for backup purposes, in accordance with Customer's standard back-up policies, provided Customer reproduces on such copy the copyright notice and any other proprietary legends that were on the original copy.

GE Healthcare also grants Customer a non-exclusive, non-transferable license to use the copy of the documentation ("documentation" means GE Healthcare provided user manuals, on-line help functions and user instructions regarding the operation, installation or maintenance of the software) identified in the Quotation and having a white cover or label and/or a notice that identifies it as "operating documentation", and use the tools or instruments identified in the Quotation and provided with the equipment in a container having a white cover or label and/or a notice that identifies them as "operating tools", for the sole purpose of using the software and equipment for their intended purposes.

Customer may transfer authorized copies of the software, operating documentation and operating tools to a party that purchases or otherwise acquires the equipment and accepts the terms of this license and any other applicable license terms, except that GE Healthcare's prior written consent is required for transfers of software and documentation that are (i) not a part of the base system standard operating software or documentation for the equipment and (ii) generally provided by GE Healthcare to its customers for a separate fee or charge. Advanced service software is subject to a separate fee and eligibility criteria and licensed under a separate agreement with GE Healthcare.

Affiliate Billing. If Customer's order includes products manufactured by more than one GE Healthcare affiliated company, each affiliated company may invoice Customer separately for the portion of the total price under the Quotation attributable to its products, under the same payment terms specified in the Quotation. There shall be no additional fees or charges to Customer for such separate invoicing.

GE Healthcare-Supplied Parts. GE Healthcare products are designed to provide optimum performance with GE Healthcare-supplied parts. Accordingly, GE Healthcare can make no assurances that product performance will not be affected by the use of non-GE Healthcare-supplied parts. In some instances, use of non-GE Healthcare-supplied parts may affect product performance or functionality.

To enhance user awareness when non-GE Healthcare-supplied tubes are in use, certain products that use x-ray or image intensifier tubes have been designed to recognize GE Healthcare-supplied tubes and report to the user the presence of a non-GE Healthcare-supplied tube. This will permit the user to make any adjustments to product use that the user deems appropriate. Use of the products with non-GE Healthcare-supplied tubes/other parts is always at the user's discretion. GE Healthcare assumes no liability for the use of non-GE-Healthcare supplied tubes/other parts and disclaims any responsibility for any effect such tubes/other parts may have on product performance.

Broadband Connectivity. GE Healthcare will provide Customer with expanded warranty protection for eligible diagnostic imaging systems covered by the Quotation, as identified in the Quotation ("Eligible Systems"), in consideration of Customer's commitment to provide a broadband network connection to enable GE Healthcare to better provide warranty service for the Eligible Systems during the warranty period. The following provisions will apply only to Eligible Systems and only during the warranty period:

To be eligible for this expanded warranty protection, Customer must: (i) establish (if not previously established) and maintain a broadband network connection at Customer's site that connects to the Eligible System, which broadband connection meets GE Healthcare's minimum specifications, (ii) provide GE Healthcare with access to the Eligible System through Customer's broadband network connection and maintain security for Customer's broadband network connection in accordance with appropriate industry best practices, (iii) provide necessary support to maintain such broadband network connection, including designation of a primary Customer contact person, (iv) provide GE Healthcare with at least 2 business days advance notice of any planned changes to Customer's network that may impact such broadband connection and with notice of any unplanned changes (e.g., power outages, computer viruses, system crashes) to Customer's network that may impact such broadband connection within 2 business days after the occurrence of the unplanned changes, (v) reasonably cooperate with GE Healthcare in maintaining such broadband connection during all such planned and unplanned changes, and (vi) use reasonable efforts to ensure that Customer's connection to the Internet and LAN systems operate at a maximum of 75% of capacity and have an uptime rate of at least 98%.

If Customer performs these responsibilities, GE Healthcare will provide Customer, at no additional charge and in addition to other remedies available under GE Healthcare's warranty, an uptime commitment of 97% (95% for all covered nuclear imaging systems and all covered X-ray systems except digital mammography, digital radiographic and vascular X-ray systems), and uptime remedies, as described below:

(i) "Uptime Commitment" means GE Healthcare's commitment on Eligible System uptime during the warranty period, as defined below.

(ii) "Uptime Remedy" is, in addition to the other remedies specified in the warranty, Customer's sole and exclusive remedy if GE Healthcare fails to meet any Uptime Commitment over a 26-week measurement period during the warranty period. Should the Eligible System fail to achieve the Uptime Commitment as calculated by the Uptime Commitment Calculation, GE Healthcare will provide an extension of Customer's service agreement with GE Healthcare for the Eligible System (or, if Customer has not entered into a service agreement with GE Healthcare, the warranty period for the Eligible System) at no additional charge, as follows:

% < Uptime Commitment	Extension
0	0 weeks
0.1 - 3.0	1 week
3.1 - 8.0	2 weeks
8.1 - 13.0	4 weeks
> 13.0	6 weeks

(iii) "Uptime Commitment Calculation" means the calculation used to determine achievement of the Uptime Commitment, as follows:

The basis for each measurement period is GE Healthcare's standard warranty service coverage hours of A hours per day, B days per week for 26 weeks, less C hours spent on PMs (planned maintenance) during that interval:

Hours1 = A hours per day X B days per week X 26 weeks.

Hours2 = Hours1 - C hours for planned maintenance

Required in-service hours at Customer's % commitment:

Hours3 = Hours2 X Customer's %.

(iv) An Eligible System will be considered inoperable and out of service under the Uptime Commitment if, due to GE Healthcare's design, manufacturing, material, or service or maintenance performance failure, the Eligible System is unavailable for scanning patients and diagnosing images on the Eligible System display console or operator's console. Peripheral equipment such as remote consoles, magnetic tape drives, hard copy devices, and multi-format and laser cameras are excluded from the terms of the Uptime Commitment. Repair and adjustments required for anything other than Eligible System failure, and damage or inoperability due to any cause other than GE Healthcare's design, manufacturing, material, or service or maintenance performance failure, will be excluded from the Uptime Commitment Calculation, including without limitation damage through misuse, operator error, inadequate environmental or air conditioning protection, power failure, and acts of God. PM time will not be included in the calculation of downtime. If GE Healthcare's responding representative agrees the Eligible System is inoperable due to GE Healthcare's design, manufacturing, material, or service or maintenance performance failure, the Eligible System will be considered out of service from the time the request for service was received by GE Healthcare until the Eligible System is again turned over to Customer for operation. If Customer fails to give GE Healthcare immediate and unencumbered access to the Eligible System or continues to obtain scans after notifying GE Healthcare of any Eligible System failure, the Eligible System will be considered to be in service.

Construction Special Terms. The following special terms apply to certain site preparation design and construction services ("work") provided with the products, if applicable. These terms supersede any conflicting terms set forth above for the work. These terms apply only to the work; they do not apply to the products or any other services. Except to the extent the work satisfies Customer's site preparation responsibilities for the products, Customer remains responsible for such responsibilities in accordance with the terms set forth above.

- Time for Performance and Delays. The work will be commenced as soon as practical after the contract including the work has been formed and GE Healthcare's credit approval of Customer for such contract. The schedule for GE Healthcare's performance of the work is based on a workweek of five 8-hour days, Monday through Friday, exclusive of GE Healthcare observed holidays. Unless stated otherwise, all work will be performed on the 1st shift (usually between 7 a.m. and 5 p.m.). GE Healthcare is not liable for delays in performance of the work due to causes beyond its reasonable control, and its time for performance of the work will be extended for a period equal to the time lost by reason of such delays. In addition, Customer shall pay GE Healthcare for the reasonable and allocable increased costs, if any, resulting from such delays.
- Substantial Completion. Substantial completion of the work occurs when the work is completed to the extent it is available for reasonable use or occupancy (e.g., the work and work site are ready for installation of the products).
- Changes and Extra Work. Customer may request in writing changes in the work. If those changes affect the price or time required for performance of the work, GE Healthcare will so advise Customer in writing. The contract for the work shall be modified by written amendment signed by GE Healthcare's and Customer's authorized representatives to reflect those changes and any resulting changes in price and/or time required for performance of the work.
- Alternate Contractors. If Customer requests that all or a part of the work be performed by contractor(s) other than the contractor(s) selected by GE Healthcare, Customer will pay to GE Healthcare, in addition to the price for the work, all additional costs incurred by GE Healthcare resulting from its compliance with such request.
- Site Rules. While performing the work, GE Healthcare will observe Customer's reasonable regulations and rules in effect at the work site, provided GE Healthcare is reasonably notified of such rules and regulations. GE Healthcare will keep the work site and adjoining premises reasonably clear of its work rubbish.

- Work Warranties. GE Healthcare will require its work contractor(s) to issue directly to Customer their standard warranty for the portion of the work provided by such contractor(s) without any recourse or liability to GE Healthcare. GE Healthcare does not warrant the work, including but not limited to the labor, services or materials forming all or a part of the work; GE Healthcare provides such items AS IS.
- Liens. GE Healthcare will, upon receipt of final payment for the work, submit to Customer a waiver of lien rights or a similar instrument as may be permitted under the laws of the state where the work is performed.
- Drawings. All drawings, specifications, designs, bills of material, calculations, operating instructions and other documents (originals and copies) submitted by GE Healthcare in connection with the work are confidential and remain GE Healthcare's exclusive property and shall not be used by Customer without GE Healthcare's prior written authorization. Customer may retain copies of these documents as a source of information for maintenance and modification to the work.
- Title and Risk of Loss. Title to a completed portion of work passes to Customer the earlier of its incorporation into the construction or upon GE Healthcare's receipt of payment for such portion of the work. GE Healthcare remains responsible for transportation and risk of loss for the work until it reaches substantial completion, after which those responsibilities pass to Customer. If Customer occupies a portion of the work before its substantial completion, risk of loss for that portion of the work passes to Customer upon such occupancy.
- Substitution. GE Healthcare may, at its option, make substitutions in the work if such substitutions would reduce any delay caused by unavailability of specified work materials or equipment and provided that the substituted work materials or equipment are of at least equal quality to that specified.
- Hazardous Materials. If asbestos or other hazardous materials are known or suspected to be within the work site and other ancillary areas that GE Healthcare representatives or contractors may occupy during the performance of the work, Customer will immediately advise GE Healthcare of that condition in writing. Customer will complete its inspection and testing for those materials, and the removal of or implementation of any special precautions to the extent required by applicable regulations governing those materials prior to the on-site work commencement date designated in GE Healthcare's construction schedule for the work, if any.

  If asbestos or other hazardous materials are suspected or discovered at the work site or in areas that GE Healthcare or GE Healthcare's contractor(s) occupy during the course of performance of the work, the discovering party shall immediately advise the other party of that condition and all work in the effected areas shall cease. Customer shall test the suspected materials for asbestos or other hazardous materials and provide GE Healthcare with copies of the test results before GE Healthcare or its contractor(s) are required to resume any portion of the work in the affected areas.

  If the asbestos or other hazardous materials must be removed or special precautions must be taken, Customer, at its expense, will immediately remove the asbestos or other hazardous materials or take all precautions required by applicable regulations governing those materials. GE Healthcare will delay the work at the work site until Customer has completed removal of the asbestos or other hazardous materials or has taken any other precautions required by applicable regulations. GE Healthcare's time for performance of the work will be extended for a period equal to the time lost by reason of such delay. In addition, Customer will pay GE Healthcare for the reasonable and allocable increased costs resulting from such delay.
- Concealed Conditions. If concealed or unknown conditions are encountered in the performance of the work, the parties shall equitably adjust the work price and GE Healthcare's time for performance of the work.
- Suspension/Termination. Customer may request a suspension of the work by notifying GE Healthcare in writing in advance of the requested suspension date and indicating the suspension period. GE Healthcare will advise Customer of any estimated increase in price and GE Healthcare's time for performance of the work resulting from such suspension. Customer shall pay GE Healthcare for the reasonable and allocable increased costs resulting from such suspension and GE Healthcare's time for performance of the work will be extended for a period equal to the time lost by reason of such suspension.

  If the length of such suspension exceeds an aggregate total of 60 calendar days, then GE Healthcare may, at its option and at any time thereafter prior to resumption of its performance of the work, either require full or partial payment for the work in advance or terminate its contract obligations related to the work and recover the termination charges described below.

  If GE Healthcare's contract obligations related to the work are terminated by either party, Customer shall pay GE Healthcare for all work performed and for any expenses related to its performance of the work incurred by GE Healthcare up to the date of or as a result of such termination, including reasonable profit on the work performed.

GE Healthcare

Warranty Statement (United States)

WARRANTY SCOPE

These warranties cover the following GE Healthcare products:

- Magnetic Resonance
- Computed Tomography
- Mammography
- Positron Emission Tomography (including scanners, cyclotrons & chemistry labs)
- Centricity® products (excluding Group Management, Practice Management & EMR, unless sold with a Centricity Business Solutions product)
- Nuclear
- X-ray
- Surgical Navigation Systems
- Cardiology
- Ultrasound
- Bone Mineral Densitometry
- Physiological Monitoring
- Small Animal Imaging
- C-Arms
- Anesthesia Delivery
- Respiratory Care
- Gold Seal Preferred
- Phototherapy and other infant care accessories
- Microenvironments, including Giraffe®, Care Plus®, Ohio® Infant Warmer Systems and Panda™ Baby Warmers

This warranty statement incorporates GE Healthcare's Standard Terms and Conditions Sales and Service.

Term Usage. "Warranted Product" is a collective term which includes both the above-listed manufactured equipment and licensed software purchased by and/or licensed to (as applicable) Customer under the relevant GE Healthcare quotation. Where an item of equipment has software code embedded in it, the code will only be considered licensed software under this warranty statement if the applicable GE Healthcare quotation provides a separate part number for that software.

Equipment Warranty. Except as indicated otherwise below, GE Healthcare warrants for 1 year from the Warranty Commencement Date (as defined below) that (i) the equipment will be free from defects in title, material and workmanship under normal use and service and (ii) except for equipment manufactured in compliance with Customer's designs or specifications, the equipment will perform substantially in accordance with GE Healthcare's written technical specifications for the equipment (as such specifications exist on the date the equipment is shipped) (the "Equipment Specifications"). This warranty covers both parts and labor and is available only to end-users that purchase the equipment from GE Healthcare or its authorized distributors. Customers purchasing through an authorized distributor must contact GE Healthcare promptly following such purchase to enable this warranty.

Software Warranty. Except as indicated otherwise below, GE Healthcare warrants for 90 days from the Warranty Commencement Date that (i) the licensed software will perform substantially in accordance with the applicable Documentation (as defined herein), (ii) it has not inserted any Disabling Code (as defined herein) into the licensed software and (iii) it will use reasonable commercial efforts consistent with industry standards to scan for and remove any software viruses before installation of the applicable Warranted Product. Except as indicated otherwise below, GE Healthcare warrants that it has the right to license or sublicense the licensed software to Customer for the purposes and subject to the terms and conditions set forth in GE Healthcare's Standard Terms and Conditions – Sales and Service. As used in this warranty statement, (i) "Disabling Code" means computer code that is designed to delete, interfere with, or disable the normal operation of the Warranted Product; provided, however, that code included in the licensed software that prevents use outside of the license scope purchased for the software will not be deemed to be Disabling Code and (ii) "Documentation" means the GE Healthcare user manuals, on-line help functions, technical specifications and user instructions regarding the operation, installation and use of the software as made available by GE Healthcare to Customer.

Pre-owned Equipment. GE Healthcare's Gold Seal Preferred Products (certain pre-owned GE Healthcare equipment) and GE Healthcare's certified pre-owned Bone Mineral Densitometry Products are provided with GE Healthcare's standard warranties carrying the same duration as the new equipment warranty, but in no event exceeding 1 year (unless otherwise provided in writing by GE Healthcare). Except as expressly provided in this paragraph or in the applicable GE Healthcare quotation, used and/or pre-owned equipment is not warranted by GE Healthcare.

Supplies and Accessories. GE Healthcare's warranty for its supplies and accessories (sometimes identified by catalog numbers starting with the letter "E") that are shipped with Warranted Products is included in a separate warranty statement, which is available upon request. GE Healthcare X-ray and Image Intensifier Tubes and Maxiray X-ray Tubes are covered by a separate warranty statement, which is available upon request. Supplies and accessories for Datex-Ohmeda, Inc. Anesthesia, Respiratory Care and monitors carry a warranty of (a) 12 months for reusable products and (b) the earlier of first use or expiration date for disposable products.

Third-Party Software and Equipment. This warranty statement does not cover Third-Party Software and Equipment (as defined herein) delivered with the Warranted Products (commonly identified by NL or NW series numbers in GE Healthcare's quotation). "Third-Party Software and Equipment" means any non-GE Healthcare software or equipment (i) delivered to Customer in the third-party manufacturer/supplier's packaging and with its labeling or (ii) for which GE Healthcare expressly indicates (either in the GE Healthcare quotation or in the product documentation) that the software or equipment is provided with the third-party manufacturer/supplier's warranty in lieu of a GE Healthcare warranty. Such products are covered by the third-party manufacturer/supplier's warranties, to the extent available. Anesthesia monitor mounting solutions Third-Party Software and Equipment purchased directly from GE Healthcare will not be treated as Third-Party Software or Equipment.

WARRANTY COMMENCEMENT

Unless expressly provided otherwise in this warranty statement or the applicable GE Healthcare quotation, the warranty period begins (the "Warranty Commencement Date") on on the earlier of: (i) if GE Healthcare installs the product, 5 days after GE Healthcare notifies Customer that it has completed assembly and the product is operating substantially in accordance with GE Healthcare's published performance specifications; (ii) if GE Healthcare does not install the product, 5 days after delivery of the product to Customer; (iii) the date Customer first uses the product for patient use; or (iv) if GE Healthcare is contractually required to install the product, the 30th day following shipment to the end-user Customer if installation is delayed for reasons beyond GE Healthcare's reasonable control. The warranty period for any Warranted Product or component furnished to correct a warranty failure will be the unexpired term of the warranty applicable to the repaired or replaced Warranted Product.

REMEDIES

If Customer promptly notifies GE Healthcare of Customer's warranty claim during the warranty period and makes the Warranted Product available for service, GE Healthcare will, at its option (i) with respect to equipment, either repair, adjust or replace (with new or exchange replacement parts) the non-conforming Warranted Product or components of the Warranted Product and (ii) with respect to GE Healthcare's licensed software, either correct the non-conformity or replace the applicable licensed software. Warranty service will be performed without charge from 8:00 a.m. to 5:00 p.m. (local site time), Monday-Friday, excluding GE Healthcare holidays, and outside those hours at GE Healthcare's then prevailing service rates and subject to the availability of personnel. For certain Warranted Products, GE Healthcare will perform warranty service only at an authorized service center or, in some instances, via a secure, remote connection to a GE Healthcare online center. With respect to GE Healthcare's warranty for the services it provides to Customer, Customer's exclusive remedy is set forth in GE Healthcare's Standard Terms and Conditions Sales and Service.

LIMITATIONS

GE Healthcare shall not have any obligation to Customer hereunder if the warranty claim results from or arises out of: (i) the use of the Warranted Product in combination with any software, tools, hardware, equipment, supplies, accesories or any other materials or services not furnished by GE Healthcare or recommended in writing by GE Healthcare; (ii) the use of the Warranted Product in a manner or environment, or for any purpose, for which GE Healthcare did not design or license it, or in violation of GE Healthcare's recommendations or instructions on use; or (iii) any alteration, modification or enhancement of the Warranted Product by Customer or any third party not authorized or approved in writing by GE Healthcare. In addition, this warranty does not cover the Warranted Product to the extent it is used in any country other than the country to which GE Healthcare ships the Warranted Product (unless GE Healthcare expressly agrees otherwise in writing). GE Healthcare does not guarantee that licensed software will operate without error or interruption.

In addition, these warranties do not cover: (i) any defect or deficiency (including failure to conform to Equipment Specifications and/or Documentation, as applicable) that results, in whole or in part, from any improper storage or handling, failure to maintain the Warranted Products in the manner described in any applicable instructions or specifications, inadequate back-up or virus protection or any cause external to the Warranted Products or beyond GE Healthcare's reasonable control, including, but not limited to, power failure and failure to keep Customer's site clean and free of dust, sand and other particles or debris; (ii) the payment or reimbursement of any facility costs arising from repair or replacement of the Warranted Products; (iii) any adjustment, such as alignment, calibration, or other normal preventative maintenance required of Customer; (iv) expendable supply items; and (v) stockpiling of replacement parts. For network and antenna installations not provided by GE Healthcare or its authorized agent(s), network and antenna system troubleshooting will be billable at GE Healthcare's standard service rates.

For MR systems, these warranties do not cover (i) any defect or deficiency that results, in whole or in part, from failure of any water chiller system supplied by Customer, (ii) service to any water chiller systems supplied by Customer and (iii) for MR systems with LHe/LN or shield cooler configured superconducting magnets (except for MR Systems with LCC magnets), any cryogen supply, cryogenic service or service to the magnet, cryostat, coldhead, shield cooler compressor or superconductive or resistive shim coils unless the need for such supply or service is caused by a defect in material or workmanship covered by these warranties (GE Healthcare's MR Magnet Maintenance and Cryogen Service Agreement is available to provide supplemental coverage during the warranty period). For Proteus XR/a, Definium and Precision 500D x-ray systems, these warranties do not cover collimator bulbs.

EXCEPTIONS TO GE HEALTHCARE STANDARD WARRANTIES DESCRIBED ABOVE

CT Partial System Equipment Upgrades*: Six months
MR Partial System Equipment Upgrades*: Six months
X-ray Partial System Equipment Upgrades*; High Voltage Rectifiers and TV Camera Pick-Up Tubes: Six months
PET Partial System Equipment Upgrades* (Scanners, Cyclotrons and Chemistry Labs): Six months
Nuclear Partial System Equipment Upgrades*: Six months
GE OEC New or Exchange Service/Maintenance Parts: 90 days
HealthNet Lan, Advantage Review — Remote Products: 90 days
GE Ultrasound Exchange Probes and Transducers, Ultrasound Water Path attachment Kit: 90 days
GE Ultrasound Service Replacement Parts: 30 days
LOGIQBook and Other Handheld/Compact Ultrasound Products: Standard warranty includes (i) repair services at GE Healthcare service facilities, (ii) three business day turnaround repair time for systems shipped via overnight delivery (where available), measured from the date of shipment (GE Healthcare is not responsible for delays in overnight shipment), (iii) technical support via telephone from 7:00 am to 7:00 pm Central Time, Monday-Friday, excluding GE Healthcare holidays, (iv) field support/service is available for an additional charge, (v) loaner systems service, for an additional charge and (vi) preventative maintenance for an additional charge. For an additional charge, GE Healthcare will also provide the following enhanced warranty features as part of the system warranty: (i) coverage for system damage due to accidental dropping or mishandling, with a maximum of two replacement systems during the term of the warranty and (ii) loaner systems or probe replacement service available for next day delivery (if overnight delivery service is available).
Ultrasound Partial System Equipment Upgrades*: 90 days (Customer will not be credited the value of this warranty against pre-existing warranties or service agreements).
Dash, Solar 8000M, 8000i & Tram: Additional two years of parts only coverage, excluding displays (United States only)
DINAMAP ProCare Vital Signs Monitors: Two years
DINAMAP Pro 100-400V2 Series Monitors: Three years
Enterprise Access: One year parts, 90 days labor
MAC 1600: Three years
MAC 1200: Three years (United States only)
Batteries: Ninety days, except (i) for LOGIQBook batteries, which are warranted for 12 months and (ii) for Nickel cadmium or lead acid batteries for X-ray and mammography systems (which will carry a 60-month warranty prorated as shown below). For Nickel cadmium or lead acid batteries for X-ray and mammography systems, warranty service will be performed without charge from 8:00 a.m. to 5:00 p.m. (local site time), Monday-Friday, excluding GE Healthcare holidays, and outside those hours at GE Healthcare's then prevailing service rates and subject to the availability of personnel only during the first twelve months of the 60-month warranty period. For X-ray and mammography systems, if nickel cadmium or lead acid batteries need replacement during their applicable warranty period, Customer will pay the price of the replacement battery in effect on its delivery date less a Pro Rata Credit Allowance (as defined herein). The Pro Rata Credit Allowance for batteries that fail less than 12 months after the warranty begins is 100%. The Pro Rata Credit Allowance for batteries that fail more than 12 months after the warranty begins is:

1 - (# of Mos. After Warranty Commencement /60) x 100%

For the purpose of Pro Rata Credit Allowance, a fraction of a month less than 15 days will be disregarded, and a fraction of a month equal to or greater than 15 days will be regarded as a full month.
QS Perinatal System: Equipment delivered with Centricity Perinatal System is "Third-Party Equipment".
Care Plus® Incubator: Three years parts, one year labor
Ohio® Infant Warmer Systems and Panda™ Warmers: Lifetime parts warranty on heater cal rod
BiliBlanket® Plus High Output Phototherapy System: Two years on Light Box and 18 months on Fiberoptic Pad
Microenvironment and Phototherapy expendable components, this includes but is not limited to patient probes, probe covers and light bulbs: 30 days
GE OEC refurbished c-arms: 6 months after installation
Oximeters: 36 months from installation, or 39 months from GE Healthcare invoice, whichever occurs sooner
Tec 7 Vaporizers: Three years
Tec 6 Plus Vaporizers: Two years

*** NOTE: For partial system equipment upgrades, the warranty applies only to the upgraded components**

GE Healthcare

Additional Terms and Conditions For Accessories and Supplies

These Additional Terms and Conditions incorporate GE Healthcare's Standard Terms and Conditions Sales and Service and will apply to the purchase and use of GE Healthcare accessories and supplies ("Products").

PRODUCT RETURNS

a. Products may be returned if wrong, defective or outdated Products are received or if Products are damaged during shipment. For full instructions please refer to the return policy documentation available online at www.gehealthcare.com or by calling 1-800-558-5102.
b. Return Material Authorization must be obtained within 30 calendar days of shipment.
c. Sterile and environmentally controlled Products cannot be returned unless the Product is defective. Please refer to the Product labeling for these classifications.
d. Return shipments must be received within 21 calendar days of authorization to receive credit, if applicable.
e. Other returns GE Healthcare agrees to accept that are not due to any fault of GE Healthcare (as referenced in a. above) are subject to a minimum 15% restocking fee.
f. Credit is based upon the condition of the Product and other restrictions may apply.

WARRANTIES AND DISCLAIMER

a. Scope of Warranties

Product Warranties: GE Healthcare warrants to Customer that Products will (1) be free from defects in title, material and workmanship under normal use and service and (2) conform to the Product descriptions and specifications contained in GE Healthcare's Accessories and/or Supplies catalogs as in effect on the date the Products are shipped to Customer. If GE Healthcare's catalogs do not contain descriptions or specifications for a Product, the manufacturer's applicable descriptions and specifications as in effect on the date the Product is shipped to Customer will apply.

Patent and Copyright Warranty: GE Healthcare warrants to Customer that when they are delivered, the Products will not be subject to any valid patent or copyright infringement claim.

b. Duration of Warranties

The GE Healthcare catalog and/or website includes "Service/Warranty Codes" for each Product. The Service/Warranty Code provides a reference to the attached Service/Warranty Code Descriptions, which identify the installation, warranty, applications and post-warranty service, if any, provided for each Product. The warranty period for all warranted Products is limited in time as shown below:

- All Products with Service/Warranty Code T ..... 100 Years
- All Products with Service/Warranty Code V ..... 25 Years
- All Products with Service/Warranty Codes X ..... 15 Years
- All Products with Service/Warranty Codes F ..... 3 Years
- All Products with Service/Warranty Codes D, J, N, O, R or Z ..... 2 Years
- All Products with Service/Warranty Codes A, B, C, E, G, L, P, Q, S or Y ..... 1 Year
- All Products with Service/Warranty Code H ..... 6 Months
- All Products with Service/Warranty Code K ..... 3 Months
- All Products with Service/Warranty Code M ..... 1 Month
- All Products with Service/Warranty Code W ..... Out of Box Failure Only

The warranty period begins on the date the Products are delivered to Customer. But, if GE Healthcare or its subcontractor installs the Products, the warranty period begins on the earlier of (1) five days after the date GE Healthcare or its subcontractor notifies Customer that installation has been completed and the Products are operating in accordance with the applicable Product descriptions or specifications, or (2) the date Customer first uses the Products. If such installation is delayed for thirty days or more from the date of delivery for a reason beyond GE Healthcare's reasonable control, the warranty period will begin on the thirtieth day after the date of delivery.

c. Warranty Exclusions

The warranties do not cover:

1. Any defect or deficiency (including failure to conform to Product descriptions or specifications) which results, in whole or in part, from (a) any alteration, improper storage, handling, use or maintenance, or any extraordinary use, repair or service of the Products, by anyone other than GE Healthcare or its authorized representatives, (b) failure to strictly comply with any written recommendations, instructions, or warnings provided by GE Healthcare or the manufacturer, (c) using or combining the Products with any item or data except as specified in the Product specifications or using or combining the Products with any item or data that does not properly and unambiguously exchange data with the Products in accordance with the Products' specifications, (d) any of Customer's designs, specifications or instructions, (e) any failure to use the Products in accordance with their specifications, including upper and lower date limits, (f) any failure of the Products other than GE Healthcare-manufactured Products to use or process correctly dates, or (g) any cause external to the Products as furnished by GE Healthcare or beyond its reasonable control;
2. Products not listed in GE Healthcare's Accessories and/or Supplies catalogs at the time of sale, and all Service Manuals (Non-listed Products and Service Manuals are provided AS IS).
3. Use of any Product on or in connection with a machine for which it was not designed, and any defect or deficiency (including failure to conform to Product descriptions or specifications) which results, in whole or in part, from machine defects;
4. Customer combining the Product with any item of others or with any incompatible items of GE Healthcare's or Customer's failure to acquire or install upgrades, or take other actions, which GE Healthcare may recommend so that Products properly function.
5. The payment or reimbursement of any facility costs arising from repair or replacement of the Products or parts; and
6. Products installed outside the United States.

d. Exclusive Warranty Remedies

Product Warranties: If Customer promptly notifies GE Healthcare of its warranty claim and makes the Product available for service, GE Healthcare will provide the warranty service indicated in the applicable Service/Warranty Code description.

Patent and Copyright Warranty: GE Healthcare will defend or settle any suit against Customer to the extent it is based on an infringement claim, which would be a breach of the Patent and Copyright warranty. If the infringement claim is valid, GE Healthcare will pay all damages and costs awarded against Customer due to the breach. In addition, GE Healthcare will (at its option) obtain a license for Customer to continue using the infringing Product, provide a non-infringing replacement, alter the Product so that it is non-infringing, or remove the infringing Product and refund that price (less reasonable depreciation) and any return transportation costs paid by Customer.

The statements above and the warranty service identified in the applicable Service/Warranty Code descriptions are Customer's exclusive remedies and GE Healthcare's sole liability for any warranty claims.

SOFTWARE

If GE Healthcare provides computer software in connection with the sale of a Product, GE Healthcare will arrange for Customer to be granted a non-exclusive license or sublicense to use the software with the Product. By acceptance of the software, Customer agrees to the applicable terms and conditions of the license or sublicense and agrees to execute, prior to delivery of the software or upon request, an agreement containing such terms and conditions. A copy of such terms and conditions is available at any time upon request to GE Healthcare.

SERVICE/WARRANTY CODES

a. All Service/Warranty Codes

The terms and conditions of GE Healthcare's Product Warranties apply to all warranty claims.

Basic Service Premise for Products – GE Healthcare Field Engineers will take the first call for service and either provide direct support or arrange for support from the manufacturer or its dealers as indicated by the individual Service/Warranty Code.

If the Service/Warranty Code calls for Product return for repair or in-warranty exchange, Customer must return the Product as GE Healthcare directs.

GE Healthcare provides warranty service from 8:00 AM to 5:00 PM local time Monday-Friday EXCLUDING GE HEALTHCARE HOLIDAYS. If a Service/Warranty Code provides for warranty service to be performed on Customer's site, such service is available outside the above hours at GE Healthcare's prevailing service rates and subject to the availability of personnel.

b. Service/Warranty Code Descriptions

A GE Healthcare directly, or through a sub-contractor, provides the following:

- Installation.
- Parts.
- On-site warranty service to repair, adjust or replace (at GE Healthcare's option and using new or exchange replacement parts) non-conforming products or parts.
- Applications training in some cases (with additional charge).
- Post-warranty service, at prevailing hourly billed service ("HBS") rates and, in some cases, under GE Healthcare service contracts.

B GE Healthcare directly provides the following through GE Healthcare's Global Parts Operation (GPO):

- New or exchange replacement parts at no charge to correct non-conforming products or parts during the warranty period.
- New or exchange replacement parts at GE Healthcare's normal prices for post-warranty repairs.

Note: Installation, applications training and on-site service is the Customer's responsibility. However, GE Healthcare's Field Engineers may be available at prevailing HBS rates. Contact GE CARES for availability.

C GE Healthcare arranges for the third-party Product Manufacturer or its dealers to provide the following:

- Installation (in some cases with an additional charge).
- Parts.
- On-site warranty service to repair, adjust, or replace (at the manufacturer's or dealer's option and using new or exchange replacement parts) non-conforming products or parts.
- Applications training in some cases (some with additional charge).
- Post-warranty service at prevailing service rates.

D GE Healthcare refers to the Product Manufacturer warranty, which provides the following:

- Basic functional troubleshooting (no technical labor) with supplier phone support.
- Repair or replacement (at the manufacturer's or dealer's option) of defective products or parts.

Note: The battery for Service/Warranty Code **D** has a 1-year warranty. For detailed warranty information, please refer to the Product Manufacturer's warranty certificate.

E GE Healthcare directly, or through a sub-contractor, provides:

- Installation (in some cases with an additional charge).
- Basic functional troubleshooting (no technical labor) with supplier phone support.
- Coordination of unit exchange or loaner program for in-factory service.

GE Healthcare arranges for the third-party Product Manufacturer or its dealers to provide in-factory service:

- At no charge during the warranty period.
- At manufacturers or dealer's prevailing service rates outside of the warranty period. Products must be returned to the manufacturer or dealer, at GE Healthcare's expense during warranty and Customer's expense after warranty, for repair.

F GE Healthcare refers to the Product Manufacturer warranty, which provides the following:

- Basic functional troubleshooting (no technical labor) with supplier phone support.
- Replacement of non-conforming products or parts, which Customer returns to the manufacturer or dealer during the warranty period.

Note: For detailed warranty information, please refer to the Product Manufacturer's warranty certificate.

G, J, O and Q GE Healthcare refers to the Product Manufacturer warranty, which provides the following:

- Start up and commissioning.
- Basic functional troubleshooting (no technical labor) with supplier phone support 24/7.
- Warranty service to repair, adjust, or replace (at the manufacturer's or dealer's option) non-conforming products or parts (excluding installation, time and material).

Note: The UPS battery for Service/Warranty Code **G** has a 9-year pro-rated warranty to cover non-conforming material. Start up and commissioning for Service/Warranty Code **O** applies only to 10 KVA and above. The UPS battery for Service/Warranty Codes **O** and **Q** has a 1-year warranty to replace the product. For detailed warranty information, please refer to the Product Manufacturer's warranty certificate. Warranty service for Service/Warranty Codes **G** and **O** is provided On-site. For detailed warranty information, please refer to the Product Manufacturer's warranty certificate

H, K, L and M GE Healthcare directly provides the following:

– Exchange of non-conforming products, which Customer returns to GE Healthcare during the warranty period.

Note: Installation, parts, applications training, and on-site service is the Customer's responsibility.

N, R and S GE Healthcare refers to the Product Manufacturer warranty, which provides the following:

– Installation.
– Preventative Maintenance.
– Parts & Labor.

Note: Post-warranty service, at manufacturer's prevailing HBS rates, and in some cases, under GE Healthcare service contracts. The battery for Service/Warranty Code R has a 1-year warranty. For detailed warranty information, please refer to the Product Manufacturer's warranty certificate.

P GE Healthcare directly provides the following:

– Replacement of non-conforming components.

Note: Installation, parts, applications training, and on-site service is the Customer's responsibility.

T, V and X GE Healthcare directly provides the following:

– Replacement of Product only; GE Healthcare will not replace patient records.
– Product is warranted only for image legibility.

Note: Installation, parts, applications training, and on-site service is the Customer's responsibility.

W GE Healthcare directly provides the following:

– Replacement of Product only for Out of Box failure.

Note: Installation, parts, applications training, and on-site service is the Customer's responsibility.

Y and Z GE Healthcare refers to the Product Manufacturer warranty, which provides the following:

– Basic functional troubleshooting (no technical labor) with supplier phone support.
– Replacement of non-conforming components.

Note: All electrical components (excluding the UPS) for Service/Warranty Code Z have a 1-year warranty. For detailed warranty information, please refer to the Product Manufacturer's warranty certificate.

c. **Additional Product or Service Information**

FOR ADDITIONAL PRODUCT OR SERVICE INFORMATION OR ASSISTANCE, please contact the Customer Service Rep (in the U.S. call 1-800-558-5102; in Canada call 1-800-668-0732).

ALL REQUESTS FOR SERVICE ON PRODUCTS should be directed through GE CARES (from the U.S. call 1-800-437-1171).

GE Healthcare

Warranty Statement
X-Ray and Image Intensifier Tubes
(United States and Canada)

WARRANTY SCOPE

These warranties cover each GE Healthcare X-ray or image intensifier tube ("Tube") listed in the GE Healthcare Quotation. This warranty statement incorporates GE Healthcare's Standard Terms and Conditions Sales and Services.

GE Healthcare warrants that, starting with the Warranty Commencement Date and for the Warranty Period (as defined below): (i) the Tube will be free from defects in title, material and workmanship under normal use and service and (ii) except for Tubes manufactured in compliance with Customer's designs or specifications, the Tube will perform substantially in accordance with GE Healthcare's written technical specifications for the Tube (as such specifications exist on the date the Tube is shipped) ("Tube Specifications"). This warranty statement defines GE Healthcare's warranty obligations for both parts and labor and is available only to end-users that purchase Tubes from GE Healthcare or its authorized distributors. The Warranty Period for all warranties, except the warranty of title and the Patent and Copyright Warranty, is limited in time as shown below.

WARRANTY COMMENCEMENT DATE AND WARRANTY PERIODS

Determining Warranty Periods For Tubes

The Warranty Period start date ("Warranty Commencement Date") for Tubes supplied as part of a new system installation will be the system installation date. The Warranty Commencement Date for replacement Tubes is determined by (i) the date GE Healthcare installs the Tube or (ii) if the date of installation is unknown, then the date of GE Healthcare's invoice to Customer or GE Healthcare's authorized distributor, as applicable, and in all cases not later than six (6) months following shipment of the Tube by GE Healthcare. The Warranty Periods are determined as follows:

- Customer Receives A New Tube As Part Of A New System Installation: For Tubes furnished to Customer as part of a new system installation, the Warranty Period for the replacement Tube will be the full term of the warranty, as shown in the chart below.
- Customer Pays A Portion Of The Cost For The New Tube (Pro Rata Calculation Table Applies): For Tubes purchased by Customer with A PRO-RATA ALLOWANCE, the Warranty Period for the new Tube will be the full term of the warranty, as shown in the chart below.
- Customer Pays The Entire Cost For The New Tube: For Tubes purchased by Customer with NO PRO-RATA ALLOWANCE, the Warranty Period for the new Tube will be the full term of the warranty, as shown in the chart below.
- GE Healthcare Pays The Entire Cost For The New Tube: For Tubes furnished to Customer under terms of the FULL WARRANTY PERIOD, as described in the chart, the Warranty Period for the new Tube will be the unexpired term of the warranty applicable to the last Tube for which Customer paid all or a portion of the cost of that Tube. (Note that the Warranty Period is not "reset" for Tubes supplied when GE Healthcare pays the entire cost for the replacement Tube)
- GE Healthcare Supplied Tubes Under A GE Healthcare Tube Contract: For Tubes furnished to Customer under terms of a GE Healthcare Tube contract, refer to the Tube contract terms for discussion of any warranty provisions for the Tube. (Note that in general, at Tube contract termination, GE Healthcare provides no warranty of any kind on the Tube(s) remaining in the system)

REMEDIES

If, within 10 days after Tube failure, Customer notifies GE Healthcare of Customer's warranty claim during the Warranty Period, provides GE Healthcare with the information shown below, and makes the Tube available for service, GE Healthcare will, at its option, either repair, adjust or replace (with new or exchange replacement parts) the non-conforming Tube or parts of the Tube. Customer must provide GE Healthcare in writing (i) GE Healthcare's serial number of the Tube, (ii) the location and GE Healthcare's serial number of the system on which the Tube was installed, (iii) the date the Tube failed, (iv) the date the Tube was removed from service, and (v) the exposure counter reading when the Tube was removed. Warranty service will be performed as detailed below (with some types of service for a charge and other types of service on a no charge basis, as listed below) during GE Healthcare's standard service coverage hours of 8:00 a.m. to 5:00 p.m. (local site time), Monday-Friday, excluding GE Healthcare holidays ("Standard Coverage Hours"), and outside of Standard Coverage Hours at GE Healthcare's then-prevailing service rates (except as otherwise stated herein) and subject to the availability of personnel.

Customer must: (i) use the Tube in accordance with GE Healthcare service instructions and recommendations for the Tube and the system on which it is installed (including warm up and calibration procedures); (ii) perform preventive and corrective maintenance of the Tube utilizing maintenance procedures in accordance with GE Healthcare service instructions and recommendations and using GE Healthcare replacement parts or replacements parts of equivalent quality; and (iii) keep and make available to GE Healthcare, upon request records documenting the above maintenance.

Customer's failure to (i) properly use the Tube, (ii) perform the maintenance described above, (iii) maintain the information required above, (iv) provide the above information or any other information required by this warranty within the designated time periods, or (v) permit GE Healthcare, to verify such information during GE Healthcare's normal working hours will invalidate this warranty.

Determining Tube Charge For Replacement Tubes

Customer will pay the price of the replacement Tube in effect on its delivery date less the applicable Pro Rata Warranty Allowance (if applicable) described in the table that follows. For the purpose of the Pro Rata Warranty Allowance, a fraction of a month less than 15 days will be disregarded, and a fraction of a month equal to or greater than 15 days will be regarded as a full month.

Non-CT Tubes (Radiographic, Radiographic & Fluoroscopic, Vascular, and Mammographic)

For Non-CT Tubes, warranty service does not include installation of the replacement Tube in Customer's system, but upon Customer's request, GE Healthcare, will install the Tube at GE Healthcare's then-prevailing service rates. If a replacement Tube is not installed by GE Healthcare, Customer must, not later than 10 days after its installation date, provide GE Healthcare, in writing (i) GE Healthcare's serial number of the replacement Tube, (ii) the location and GE Healthcare's serial number of the system on which the replacement Tube has been installed, (iii) the date of installation, and (iv) the exposure counter reading on the installation date.

CT Tubes Replaced During Full Warranty Period

Determining Labor Charges For Tubes Replaced During Full Warranty Period: No service charges for the installation of the replacement Tube will be billed to Customer for CT Tubes replaced during the Full Warranty Period when those Tubes are replaced during Standard Coverage Hours.

- GE Healthcare Pays The Entire Cost For The CT Tube: For CT Tubes furnished to Customer under terms of the FULL WARRANTY PERIOD as described in the chart, there is no charge to Customer for GE Healthcare installation costs for installation during Standard Coverage Hours. For services performed outside the Standard Coverage Hours, the service will be provided at GE Healthcare's prevailing service rates at the time of service, less a credit for the comparable service had it been rendered during the Standard Coverage Hours, so that Customer will pay the net difference. No refund or payment will be issued to Customer or other parties who choose to utilize either in-house or third party service providers for installation of the replacement Tube.

CT Tubes Replaced During Pro Rata Warranty Period

Determining Labor Charges For CT Tubes Replaced During Pro Rata Warranty Period: Customer will pay GE Healthcare a service charge for the installation of the replacement CT Tube in effect on the date the service is rendered, less the applicable Pro Rata Labor Allowance. (Note that the Pro Rata Labor Allowance may be applied only to charges by GE Healthcare for GE Healthcare supplied labor). No refund or payment will be issued to Customer or other parties who choose to utilize either in-house or third party service providers for installation of the replacement Tube. GE Healthcare will make a credit allowance at the billing rate for services performed for installation during Standard Coverage Hours. For services performed outside of Standard Coverage Hours, the service will be performed at GE Healthcare's prevailing service rates at the time of service, less a credit for the comparable service had it been rendered during Standard Coverage Hours, so that Customer will pay the net difference.

- Customer Pays A Portion Of The Cost For The Replacement Tube: For Tubes furnished to Customer with A PRO-RATA WARRANTY ALLOWANCE to correct the warranty failure, the labor allowance multiplier will be calculated at the same pro-rata rate as is applicable to the part that is being replaced or repaired. That allowance will be applied to the prevailing service rates at time of service. Customer will pay the service charge less the Pro-Rata Labor Allowance amount.

LIMITATIONS

GE Healthcare shall not have any obligation to Customer hereunder if the warranty claim results from or arises out of: (i) the use of the Tube in combination with any hardware, equipment, supplies, accessories or any other materials or services not furnished by GE Healthcare or recommended in writing by GE Healthcare; (ii) the use of the Tube in a manner or environment, or for any purpose, for which GE Healthcare did not design or manufacture it, or in violation of GE Healthcare's recommendations or instructions on use; or (iii) any alteration, modification or enhancement of the Tube by Customer or any third party not authorized or approved in writing by GE Healthcare. In addition, this warranty does not cover the Tube to the extent it is used in any country other than the country to which GE Healthcare ships the Tube (unless GE Healthcare expressly agrees otherwise in writing).

In addition, these warranties do not cover: (i) any defect or deficiency (including failure to conform to Tube Specifications that results, in whole or in part, from any improper storage or handling, failure to maintain the Tubes in the manner described in any applicable instructions or specifications or any cause external to the Tubes or beyond GE Healthcare's reasonable control, including, but not limited to, power failure and failure to keep Customer's site clean and free of dust, sand and other particles or debris; (ii) any adjustment, such as alignment, calibration, or other normal preventative maintenance required of Customer; (iii) expendable supply items; and (iv) stockpiling of replacement parts.

WARRANTY PERIODS

TUBE TYPE OR SYSTEM DESCRIPTION (a)	FULL WARRANTY PERIOD (b)	PRO RATA WARRANTY PERIOD (c)
Radiographic	30 days	24 months
Radiographic & Fluoroscopic	30 days	24 months
Vascular	30 days	24 months
Mammographic	30 days (d)	12 months
MX150 Vascular	12 months (e)	N/A
Performix 160A (MX160)	12 months (e)	N/A
MX120 Fluoroscopic	30 days	18 months
CT Max	4,000 slices	40,000 slices or 12 months
CT 8800/9000 Metal	4,000 slices	40,000 slices or 12 months
CT 8800/9000 Graphite	4,000 slices	40,000 slices or 12 months
GE CGR Graphite	4,000 slices	40,000 slices or 12 months
GE Technicare CT	4,000 slices	40,000 slices or 12 months
CT Pace/Sytec 2000-4000	5,000 slices	80,000 slices or 12 months
CT SRi/Synergy	6,000 slices	80,000 slices or 12 months
CT 9800 Graphite	5,000 slices	80,000 slices or 12 months
HiLight Advantage	5,000 slices	80,000 slices or 12 months
Pegasus on CT/e	5,000 slices	50,000 slices or 12 months
Pegasus on CT/e Dual	30 days	50,000 slices or 12 months
ProSpeed/Sytec 6000-8000	9,000 slices	110,000 slices or 12 months
HiSpeed Advantage on HiSpeed Advantage and CT/I	9,000 slices	140,000 slices or 12 months
Solarix on LX/I, FX/I, DX/I	10,000 slices	100,000 slices or 12 months
Solarix 350 on BrightSpeed Select 4, 8 or 16 (Lite)	500 exams (f)	6,000 exams or 12 months
Solarix 630 on HiSpeed ZX/I	10,000 slices	100,000 slices or 12 months
Solarix 630 on NX/I Pro	30 days	12 months or 15,000 amp-seconds
Performix-ADV on CT/I	12 months or 100,000 slices, whichever occurs first (g)	N/A
Performix-ADV QX/I	12 months or 30,000 amp-seconds, whichever occurs first (g)	N/A
Performix Ultra on LightSpeed 16, LightSpeed Ultra, LightSpeed Plus, LightSpeed QX/I, HiSpeed QX/I, Discovery LS, Discovery ST	12 months or 70,000 amp-seconds, whichever occurs first (g)	N/A
Performix Ultra on BrightSpeed 16 (Elite), BrightSpeed 8 (Edge), BrightSpeed 4 (Excel)	12 months or 6,000 patient exams, whichever occurs first (g)	N/A
Performix Pro80 (D3634T) on LightSpeed Pro 16, LightSpeed RT	12 months or 70,000 amp-seconds, whichever occurs first (g)	N/A
Performix Pro VCT100 (D3194T) on LightSpeed Pro16	12 months or 70,000 amp-seconds, whichever occurs first (g)	N/A
Performix Pro VCT100 (D3194T) on LightSpeed VCT, LightSpeed VCT Select, LightSpeed RT16, LightSpeed Xtra, Discovery VCT	12 months or 6,000 patient exams, whichever occurs first (g)	N/A
Image Intensifier	30 days	24 months

COMMENTS

(a) For actual catalog numbers, please contact your local GE Healthcare representative.
(b) Initial period of time or amount of use after warranty begins during which a full 100% warranty is provided for a Tube that fails.
(c) Maximum period of time or amount of use during which a Pro Rata Warranty Allowance is provided for a Tube that fails. The Pro Rata Warranty Allowance and the Pro Rata Labor Allowance are calculated as follows:

$$1 - \frac{\text{Number of months between date of Warranty commencement and date of failure}}{\text{Complete Warranty Time Period}} \times 100\%$$

OR

$$1 - \frac{\text{Slices Taken or Amp-Seconds}}{\text{Complete Pro Rata Warranty Slice Or Amp-Second Amount}} \times 100\%$$

The Pro Rata Warranty period ends at the expiration of the maximum time period or the maximum usage amount identified in column (c) above, whichever occurs first.
(d) Mammography tubes included with new systems have a full 12 month, non-prorated warranty. Mammography replacement tubes carry a 30 day full warranty/12 month prorated warranty.
(e) MX150 and MX160 Vascular tubes included with new systems have a full 36 month, non-prorated warranty. MX150 and MX160 Vascular replacement tubes carry a full 12 month, non-prorated warranty.
(f) Solarix 350 tubes included with new systems have 12-month full coverage. Solarix 350 on BSL replacement tubes have a 500 exam full warranty and a 12-month or 6000 patient exam prorated warranty per the table above.
(g) All Performix tubes included with new systems have 12-month full coverage. Performix replacement tubes carry a 12-month/specified usage warranty (varies by tube per above chart), whichever occurs first.

GE Healthcare

SOFTWARE SUPPORT SERVICES FOR GE HEALTHCARE SOFTWARE SYSTEMS

"You" or "your" means the individual or entity that has purchased the applicable software support services. "GE," "GE Healthcare," "we" and "our" refers the General Electric Company, by and through its GE Healthcare division.

Software Support Services. GE will provide to you the software support services as described in the applicable GE Healthcare service policy for the GE software product and the support period as specified in the applicable quotation for which you have paid the applicable fees. Software that is identified on the GE Healthcare quotation and either (i) is delivered to you in a third-party developer/supplier's packaging and with its labeling or (ii) for which GE Healthcare expressly indicates (either in the quotation or in the product documentation) that the software is provided with the third-party developer/supplier's software support services in lieu of GE Healthcare software support services is not covered under this Statement of Service Deliverables unless specifically stated otherwise in the applicable quotation.

Software Support Services Price Adjustments. GE Healthcare support services will automatically renew for another annual term upon payment of the applicable renewal support fees, unless either party provides sixty (60) days prior written notice of non-renewal. GE Healthcare may increase its charges for support and maintenance fees for each successive annual software renewal support term by providing no less than sixty (60) days advanced notice of such increase before the beginning of the support term for which the increase is to be in effect. In connection with any annual renewal of support services, GE Healthcare may increase its annual charges for maintenance and support by no more than CPI plus two percent (2%). CPI shall mean the U.S. City Average (December to December percent) for ALL Urban Consumers (CPI-U).

GE Healthcare

Additional Terms and Conditions For GE Healthcare Software Professional Services

"You" and "your" means the individual or entity that has purchased the applicable software licenses. "We," "our" and "GE Healthcare" refers to the General Electric Company, by and through its GE Healthcare division. These Additional Terms and Conditions contain the provisions that will apply to your purchase of GE Healthcare professional services which will be described on one or more statements of work. The term "deliverables" means those specific items to be delivered by GE Healthcare to you pursuant to a statement of work. A "statement of work" or "SOW" means the project work plan, program guide, quotation or other standard GE Healthcare document that describes the professional services, scope, schedule, dependencies, deliverables and any applicable special terms. The term "intellectual property" means, collectively and individually, as the context requires, all worldwide copyrights, patents, patent applications, trade secrets or other intellectual property rights associated with any ideas, know-how, concepts, techniques, inventions, processes, works in progress, work product or works of authorship.

Statement of Work.
GE Healthcare shall exercise commercially reasonable efforts to perform the professional services and to provide any deliverables which are described in the SOWs mutually agreed upon and signed by both parties and to do so according to any delivery schedule set forth in the SOW. GE Healthcare shall be responsible for the assignment of personnel to perform all services and may make any change in staffing it deems necessary provided that such change does not compromise the level of expertise required to complete the applicable SOW. Each SOW may include descriptions of the following: (i) professional services to be performed; (ii) deliverables; (iii) your additional responsibilities; (iv) project work scope, (v) estimated performance schedule and applicable milestones; (vi) your site and any site preparation requirements; (vii) network, hardware or other environmental or infrastructure requirements; and (viii) key assumptions. The terms and conditions of these Additional Terms and Conditions shall prevail over those of the SOW. Each SOW shall constitute a separate, distinct and independent work engagement and contractual obligation. If you purchase services to implement GE Healthcare software, GE Healthcare, with your reasonable assistance, will exercise commercially reasonable efforts to complete a project work plan within a period of time as mutually agreed upon by the parties. A SOW may only be modified by a written document signed by authorized representatives of both of us and must be made pursuant to mutually agreed change control procedures. Changes to a SOW may require a change in fees reflecting the change in scope and/or change in schedule of delivery of the professional services or deliverables and/or change in your responsibilities. Dates scheduled for services may be changed or cancelled only in accordance with the GE Healthcare Service Cancellation Policy. Cancellation or rescheduling fees as described in the policy will apply.

Ownership Rights.
GE Healthcare shall retain ownership of all deliverables (including any intellectual property embodied in the deliverables or related to them) and any intellectual property developed under a SOW or during the course of performing the services whether or not the services are performed by GE Healthcare alone or jointly with you or others. In addition, GE Healthcare shall own all improvements, enhancements and derivative works of any GE Healthcare intellectual property. You hereby assign, and will cause your employees and independent contractors to assign, to GE Healthcare all of your rights in and to such deliverables and intellectual property. GE Healthcare grants to you a nonexclusive, nontransferable, non-sublicensable license to use the deliverables solely for your internal business purposes and subject to the limitations described in these Additional Terms and Conditions and the relevant SOW. You agree to provide reasonable assistance to GE Healthcare in obtaining and enforcing GE Healthcare's rights to such deliverables and intellectual property. GE Healthcare will acquire no rights to any of your confidential information which may be included in any deliverable unless expressly agreed otherwise.

Project Managers.
Each of us shall designate a project manager, who will be responsible for day-to-day communications regarding the subject matter of the applicable SOW. The project managers will be responsible for monitoring the schedules and progress of work pursuant to the Agreement and/or SOW and will have the authority to act for the respective parties in all aspects of the engagement. The project managers for the parties will meet in person or via conference call as necessary. The responsibilities of the project managers include: (i) serve as the single point of contact for all departments in their organization participating in this project; (ii) administer the change control procedure; (iii) participate in project status meetings; (iv) obtain and provide information, data, decisions and approvals, within seven working days of the other party's request unless we mutually agree to an extended response time; (v) resolve deviations from project plans that may be caused by our respective organizations; (vi) help resolve project issues and escalate issues within our respective organizations, as necessary; (vii) monitor and report project status on a regular basis to respective organizations as appropriate; and (viii) provide and coordinate technical and specialist resources as necessary.

Post-Engagement Maintenance.
Post-engagement maintenance for any deliverables developed or modified under a SOW, to the extent made available by GE Healthcare, will be provided solely as described in the applicable SOW. You understand that post-engagement maintenance for deliverables may differ from the support GE Healthcare offers for its standard products. Unless expressly provided for in a SOW, no support or maintenance will be provided for deliverables.

Payment Terms.

Unless otherwise provided in the applicable quotation, professional services will be provided on a fixed fee basis at the rates as set forth in the applicable quotation. These fees shall be invoiced in blocks of hours upon the payment milestones as set forth below. Fixed fee means that the fees for the implementation services described in that part number within the scope defined in the applicable SOW shall be fixed in amount and shall not exceed the corresponding amount as set forth in the part number description in the applicable quotation, so long as the applicable services do not exceed the scope defined in the SOW. In the event the services do exceed the scope defined in the applicable SOW, additional professional services shall be invoiced on a time and materials basis at GE Healthcare's then current time and materials rates and these fees shall be invoiced on a monthly basis as incurred. Unless otherwise provided in the applicable quotation, professional fees provided on a fixed fee basis shall be payable as follows: 20% on signing of the applicable quotation, 20% on installation of the applicable software, 20% on training start date for the applicable software, 20% on go live (first clinical use of the applicable software) and 20% on acceptance of the applicable software (as defined in the GE Healthcare Standard Terms and Conditions). Actual, reasonable travel, living and incidental project related expenses incurred in the performance of any services, including, but not limited to, travel, meals, lodging, car rental, telecommunications and other out-of-pocket expenses are in addition to the prices and fees quoted and shall be invoiced separately as incurred.

GE Healthcare

Additional Terms and Conditions For GE Healthcare Software License

"You" and "your" means the individual or entity that has purchased the applicable software licenses. "We," "our" and "GE Healthcare" refers to the General Electric Company, by and through its GE Healthcare division. These Additional Terms and Conditions describe the provisions that will apply to your license of GE Healthcare software products. The term "software" means the GE Healthcare proprietary software and third party software and associated documentation provided by GE Healthcare to you pursuant to this agreement as identified in the applicable GE Healthcare quotation. The term "documentation" means GE Healthcare's user manuals, on-line help functions and user instructions, regarding the operation, installation and use of the software as made available by GE Healthcare to you. All references to "specifications" or "performance specifications" in the Standard Terms and Conditions, Sales and Service shall mean documentation when such terms are used in reference to GE Healthcare software products.

Scope of License Grant.
Entities over which you have control may use the software only by agreeing to be bound by this agreement and by paying any applicable license fees. Independent contractors that supply products comparable to the software shall be provided access to the software only if we have provided our prior written consent and subject to any applicable conditions required by us, including any conditions that we deem appropriate to protect confidential and proprietary information relating to our products. You shall reproduce on any such copy the copyright notice and any other proprietary legends that were on the original copy. To the extent permitted by applicable law, licensors of third party software shall be third party beneficiaries of this agreement with respect to products licensed to GE Healthcare by such licensors and sublicensed to you. In addition to the restrictions stated in the GE Healthcare Standard Terms and Conditions Sales and Service, you agree not to (i) display, transmit, sell, or otherwise transfer or make available the software to any other person or entity, unless expressly provided otherwise under this agreement; (ii) electronically transfer the software outside your intranet or network dedicated for the software, unless otherwise authorized in writing by GE Healthcare; (iii) reduce the software to a human-perceivable form; or (4) release the results of any testing or benchmarking of the software without the prior written consent of GE Healthcare.

Delivery.
"Delivery" means (a) with respect to any item of GE Healthcare software or documentation, the first to occur of: (i) communication to Customer through electronic means, that allows Customer to take possession of the first copy or product master, or (ii) delivery by GE Healthcare of the first copy or product master in person to Customer or to any common carrier or delivery service for transport to Customer, (b) with respect to any item of hardware or third party software, the delivery of the hardware or third party software by GE Healthcare or the supplier of the hardware or third party software to a common carrier for transport to the Customer or to any location specified in writing by or on behalf of the Customer, and (c) with respect to any services, the performance of such services by GE Healthcare.

Medical Diagnosis and Treatment.

You hereby acknowledge and agree that:

- the software does not make clinical, or other decisions and is not a substitute for competent, properly trained and knowledgeable staff who bring professional judgment and analysis to the information presented by the software.
- You are responsible for verifying the accuracy of all patient information and determining the data necessary for you and your users to make medical and diagnostic decisions, as well as for complying with all laws, regulations and licensing requirements applicable to your delivery of healthcare services.
- You are responsible for establishing and maintaining reasonable quality control procedures to ensure the accuracy of input to the software.
- You and your staff will consider all relevant information including information presented to you and them by the software and may give whatever weight you and your staff deem appropriate to the information produced by the software in the performance of your and their functions.
- any and all financial and management information produced by the software must be tested for reasonableness and accuracy before any actions are taken or reliance placed on it.
- you have reviewed and will communicate to users who use and access the software any software information, which may be provided to you by GE Healthcare from time to time.

Audit Rights.
Upon 45 days notice we may audit your use of the software. You agree to cooperate with our audit and to provide reasonable assistance and access to information. If the audit uncovers underpaid or unpaid fees owed to us, you agree to pay those fees and our costs incurred in conducting the audit within 30 days of written notification of the amounts owed. If you do not pay the amounts owed, we may terminate your license to use the applicable software. You agree to permit us to obtain certain reasonable information regarding the users and other use information regarding the software. All of such information shall be treated as confidential information and shall be used solely for the

purposes of technical support and auditing the use of the software and shall not be disclosed to any third party (other than third party vendors of software licensed to you under this agreement), without your consent.

Relief for Breach.
You agree that a violation of our license, confidentiality or intellectual property rights will cause irreparable harm to us for which the award of money damages are inadequate. You agree that in the event of any breach of this provision, we shall be entitled to seek injunctive relief in addition to immediately terminating the license granted herein and requiring that you cease use of and return the software, including all copies in any media, in addition to seeking any other legal or equitable remedies available to us. This paragraph shall survive the termination of this agreement.

License Metrics.
If referenced in your quotation, please see the following definitions of license metrics listed below or on your quotation in connection with your quotation to understand the scope of your license: "**Active Devices**" means the number of devices that are transmitting data to the applicable software. "**Annual ED Visits**" means the maximum number of patient visits to the emergency room(s) of the Site for which the applicable software is used for clinical documentation during each twelve month period of the license. "**Beds**" means the total number of beds that you are authorized by the applicable government authority to provide at the Site. "**Bedside Device Interfaces**" means the maximum number of bedside device interfaces for which the applicable software is permitted to be used at the Site. "**Clients**" means the maximum number of workstations permitted to use the applicable software. "**Concurrent Database Users**" means the maximum number of database users permitted to simultaneously access the applicable software at a given point in time. "**Concurrent Users**" means the maximum number of users permitted to simultaneously access the applicable software at a given point in time. "**Critical Care Beds**" means the maximum number of beds in a high acuity setting which the applicable software can be used for clinical documentation at the point of care at the Site. "**Designated Individual**" is defined as a particular individual who has been identified by name and user authorization ID, regardless of whether the individual is actively using the software at any given time; **Designated Individual** licenses are purchased for every individual authorized to use the software. "**Dispensaries**" means the maximum number of physical locations at which the outpatient prescriptions are dispensed permitted to use the applicable software. "**Enterprise**" means you and any entities controlled by you. "**Named Users**" means specified users identified by name or other identifier. "**ORs**" means the maximum number of Operating Rooms in which the software is used for clinical documentation at the Site. "**Other Provider**" means the maximum number of other providers (individuals other than Physicians designated by the software as a billable provider of health care services including nurse practitioners, physical therapists and other non-physician billable providers of healthcare services) authorized to use the software. "**PACU beds**" means the maximum number of beds in a high acuity setting for which the applicable software is used for post operative anesthesia documentation at the point of care at the Site. "**Physician**" means the maximum number of physicians (doctor of medicine, doctor of osteopathy, doctor of dental science and doctor of psychiatric medicine) authorized to use the applicable software. "**Prep Rooms**" means the maximum number of prep rooms in which the applicable software is used for clinical documentation at the Site. "**Prescriptions**" means the number of prescriptions dispensed by Customer Dispensaries during the applicable calendar year. "**Requests per Day**" means the number of laboratory orders requested per day. **Requests per Day** licenses are purchased for the maximum number of requests to be processed by the software each day. "**Site**" means the maximum number of your facility(ies) of the Size specified in the quotation at which you are authorized to use the software and which may be added to or changed only in accordance with these terms and conditions and upon the written consent of GE Healthcare. You shall be permitted to use the applicable software only for the **Size of Site** as indicated in the applicable quotation.

FINANCIAL ATTACHMENTS

Yale-New Haven Hospital
OHCA Financial Attachment I

SPECT-CT: Cardiology Description	FY 2011 Actual Results	FY 2012 Actual Results	FY 2013 Actual Results	FY 2014 Projected With CON	FY 2015 Projected With CON	FY 2016 Projected With CON
Net Patient Revenue						
Non- Government	$832,690	$968,759	$846,560	$867,724	$889,417	$911,652
Medicare	$468,899	$571,177	$499,672	$512,164	$524,968	$538,092
Medicaid and Other Medical Assistance	$56,871	$87,558	$77,008	$78,933	$80,906	$82,929
Other Government	$0	$0	$0	$0	$0	$0
Total Net Patient Revenue	**$1,358,459**	**$1,627,495**	**$1,423,240**	**$1,458,821**	**$1,495,291**	**$1,532,674**
Other Operating Revenue						
Revenue from Operations						
Salaries and Fringe Benefits	$548,711	$565,682	$482,499	$496,974	$511,884	$527,240
Professional / Contracted Services	$0	$0	$0	$0	$0	$0
Supplies and Drugs	$348,335	$382,720	$326,140	$335,924	$346,002	$356,382
Bad Debts	$0	$0	$0	$0	$0	$0
Other Operating Expense	$0	$0	$0	$0	$0	$0
Subtotal	**$897,046**	**$948,402**	**$808,639**	**$832,899**	**$857,886**	**$883,622**
Depreciation/Amortization	$0	$193,492	$193,492	$193,492	$193,492	$193,492
Interest Expense						
Lease Expense						
Total Operating Expense	**$897,046**	**$1,141,894**	**$1,002,131**	**$1,026,391**	**$1,051,377**	**$1,077,114**
Gain/(Loss) from Operations	$461,413	$485,601	$421,109	$432,430	$443,914	$455,560
Plus: Non-Operating Revenue						
Revenue Over/(Under) Expense						
Plus: Non-Operating Revenue						
Revenue Over/(Under) Expense						
SPECT CT Scans*	1832	2176	1856	1306	1305	1304

*Please note that the source of the volume and revenue data within all of the financial-related attachments is RIMS (software used by the YNHH Finance Department that captures billing and revenue). The data pulled from RIMS is slightly different than the data pulled from Imagecast used to populate the data listed in the tables within the CON narrative and cannot identify volume associated with a particular machine. However, the RIMS data listed in the financial attachments is more applicable with respect to financial matters. Thus, the Imagecast data was used to identify volumes by machine and type of scan within the CON narrative, and the RIMS data was used to complete the financial-related attachments.

Yale-New Haven Hospital
OHCA Financial Attachment I

SPECT-CT: Nuclear Medicine Description	FY 2011 Actual Results	FY 2012 Actual Results	FY 2013 Actual Results	FY 2014 Projected With CON	FY 2015 Projected With CON	FY 2016 Projected With CON
Net Patient Revenue						
Non- Government	$111,584	$111,938	$98,653	$101,119	$103,647	$106,238
Medicare	$56,277	$56,162	$45,665	$46,806	$47,976	$49,176
Medicaid and Other Medical Assistance	$25,114	$29,677	$25,627	$26,267	$26,924	$27,597
Other Government	$0	$0	$0	$0	$0	$0
Total Net Patient Revenue	**$192,974**	**$197,776**	**$169,944**	**$174,192**	**$178,547**	**$183,011**
Other Operating Revenue						
Revenue from Operations						
Salaries and Fringe Benefits	$59,306	$61,140	$49,711	$51,202	$52,739	$54,321
Professional / Contracted Services	$0	$0	$0	$0	$0	$0
Supplies and Drugs	$84,208	$243,510	$251,948	$259,506	$267,291	$275,310
Bad Debts	$0	$0	$0	$0	$0	$0
Other Operating Expense	$0	$0	$0	$0	$0	$0
Subtotal	**$143,514**	**$304,650**	**$301,659**	**$310,709**	**$320,030**	**$329,631**
Depreciation/Amortization	$0	$70,495	$70,495	$70,495	$70,495	$70,495
Interest Expense						
Lease Expense						
Total Operating Expense	**$143,514**	**$375,146**	**$372,154**	**$381,204**	**$390,525**	**$400,126**
Gain/(Loss) from Operations	$49,460	($177,369)	($202,210)	($207,011)	($211,978)	($217,115)
Plus: Non-Operating Revenue						
Revenue Over/(Under) Expense						
Plus: Non-Operating Revenue						
Revenue Over/(Under) Expense						
SPECT CT Scans*	348	340	308	308	308	308

*Please note that the source of the volume and revenue data within all of the financial-related attachments is RIMS (software used by the YNHH Finance Department that captures billing and revenue). The data pulled from RIMS is slightly different than the data pulled from Imagecast used to populate the data listed in the tables within the CON narrative and cannot identify volume associated with a particular machine. However, the RIMS data listed in the financial attachments is more applicable with respect to financial matters. Thus, the Imagecast data was used to identify volumes by machine and type of scan within the CON narrative, and the RIMS data was used to complete the financial-related attachments.

Nuclear Cardiology - Minimum Number of Units required

	2011	2012	2013	2014	2015	2016
Expenses from operations	$ 897,046	$ 1,141,894	$ 1,002,131	$ 1,026,391	$ 1,051,377	$ 1,077,114
Cases Needed to show incremental gain from operations	1,210	1,527	1,307	1,306	1,305	1,304
Average Revenue per case by year	$ 742	$ 748	$ 767	$ 786	$ 806	$ 826
Volume	1,832	2,176	1,856	1,856	1,856	1,856
Revenue	$ 1,358,459	$ 1,627,495	$ 1,423,240	$ 1,458,821	$ 1,495,291	$ 1,532,674

Nuclear Medicine - Minimum Number of Units required

	2011	2012	2013	2014	2015	2016
Expenses from operations	$ 143,514	$ 375,146	$ 372,154	$ 381,204	$ 390,525	$ 400,126
Cases Needed to show incremental gain from operations	259	645	674	674	674	673
Average Revenue per case by year	$ 555	$ 582	$ 552	$ 566	$ 580	$ 594
Volume	348	340	308	308	308	308
Revenue	$ 192,974	$ 197,776	$ 169,944	$ 174,192	$ 178,547	$ 183,011

Proposal for the Justification of Ownership of SPECT CT Camera at Yale-New Haven Hospital

	Expected Cost	Type	Years	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Construction																				
Construction & Renovation	$ 61,000																			
Construction Subtotal:	$ 61,000	Construction	15	-	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	4,067	61,000
				$ -	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 61,000
Other Non-Construction																				
Goodwill (does not depreciate)	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Imaging Equipment	1,354,443	Nuc Card Equip	7	-	193,492	193,492	193,492	193,492	193,492	193,492	193,492	-	-	-	-	-	-	-	-	1,354,443
Imaging Equipment	465,000	Nuc Med Equip	7	-	66,429	66,429	66,429	66,429	66,429	66,429	66,429	-	-	-	-	-	-	-	-	465,000
Other Non-Construction Subtotal:	$ 1,819,443			$ -	$ 259,920	$ 259,920	$ 259,920	$ 259,920	$ 259,920	$ 259,920	$ 259,920	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,819,443
Total	$ 1,880,443			$ -	$ 263,987	$ 263,987	$ 263,987	$ 263,987	$ 263,987	$ 263,987	$ 263,987	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 4,067	$ 1,880,443

Half Year Depreciation Convention
Assume purchase in the second half of FY 11

Table 3: Patient Population Mix

Patient Population Mix for Nuc Med & Nuc Cardiology CT Scans (based on number of patients)

II. Case Mix

Nuclear Cardiology Payor Mix

Payor	Current FY 2012	Year 1 FY 2013	Year 2 FY 2014	Year 3 FY 2015	Year 4 FY 2016
Medicare*	34.6%	34.6%	34.6%	34.6%	34.6%
Medicaid*	22.0%	22.0%	22.0%	22.0%	22.0%
CHAMPUS & TriCare	0.2%	0.2%	0.2%	0.2%	0.2%
Total Government	**56.8%**	**56.8%**	**56.8%**	**56.8%**	**56.8%**
Commercial Insurers*	41.0%	41.0%	41.0%	41.0%	41.0%
Uninsured	2.1%	2.1%	2.1%	2.1%	2.1%
Workers Compensation	0.1%	0.1%	0.1%	0.1%	0.1%
Total Non-Government	**43.2%**	**43.2%**	**43.2%**	**43.2%**	**43.2%**
Total Payer Mix	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

** Includes managed care activity*

Nuclear Medicine Payor Mix

Payor	Current FY 2012	Year 1 FY 2013	Year 2 FY 2014	Year 3 FY 2015	Year 4 FY 2016
Medicare*	32.9%	32.9%	32.9%	32.9%	32.9%
Medicaid*	11.7%	11.7%	11.7%	11.7%	11.7%
CHAMPUS & TriCare	0.6%	0.6%	0.6%	0.6%	0.6%
Total Government	**45.2%**	**45.2%**	**45.2%**	**45.2%**	**45.2%**
Commercial Insurers*	52.8%	52.8%	52.8%	52.8%	52.8%
Uninsured	1.5%	1.5%	1.5%	1.5%	1.5%
Workers Compensation	0.6%	0.6%	0.6%	0.6%	0.6%
Total Non-Government	**54.8%**	**54.8%**	**54.8%**	**54.8%**	**54.8%**
Total Payer Mix	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

** Includes managed care activity*

YALE-NEW HAVEN HOSPITAL

Acquisition of two SPECT/CT cameras to replace a SPECT camera in Nuclear Medicine and two gamma cameras in Nuclear Cardiology

Assumptions

Net Revenue Rate Increases	FY 2014	FY 2015	FY 2016
1) Government	-0.6 - 0.0%	0.0 - 1.0%	0.0 - 1.0%
2) Non-Government	5.0%	5.0%	5.0%

	FY 2014	FY 2015	FY 2016
EXPENSES			
A. Salaries and Fringe Benefits	3.1%	3.1%	3.1%
B. Non-Salary			
1) Medical and Surgical Supplies	3.5%	3.5%	3.5%
2) Pharmacy and Solutions	3.5%	3.5%	3.5%
3) Malpractice Insurance	4.0%	4.0%	4.0%
4) Professional and Contracted Services	2.5%	2.5%	2.5%
5) All Other Expenses	3 - 5%	3 - 5%	3 - 5%

	FY 2014	FY 2015	FY 2016
FTEs			
1) Total estimated FTEs	10,866.0	10,984.0	11,106.0

Note - The above increase projections reflect all changes relating to Medicare and Medicaid reimbursement regulations.

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

Office of Health Care Access

July 18, 2013

VIA FAX ONLY

Nancy Rosenthal
Senior Vice President-Health Systems Development
Yale-New Haven Hospital
20 York Street
New Haven, CT 06510

RE: Certificate of Need Application, Docket Number 13-31845-CON
Yale New Haven Hospital
Acquisition of Two SPECT-CT Scanners

Dear Ms. Rosenthal:

On June 18, 2013, the Office of Health Care Access ("OHCA") received your Certificate of Need ("CON") application filing on behalf of Yale-New Haven Hospital ("Applicant") proposing to acquire two Single Photon Emission Computed Tomography-Computed Tomography ("SPECT-CT") scanners, with an total associated cost of $1,880,443.

OHCA has reviewed the CON application and requests the following additional information pursuant to General Statutes §19a-639a(c).

1. Please revise and resubmit Financial Attachment 1 (pages 711 & 712), to include a column for each year (historical/actual & projected) for Yale New Haven Hospital. Please be sure to include any and all financial assumptions related to the Financial Attachment 1 (for each proposed SPECT-CT scanner).

In responding to the questions contained in this letter, please repeat each question before providing your response. Paginate and date your response, i.e., each page in its entirety. Information filed after the initial CON application submission (i.e. completeness response letter, prefile testimony, late file submissions and the like) must be numbered sequentially from the Applicant's document preceding it. Please begin your submission using Page 716 and reference "Docket Number: 13-31845-CON." Submit one (1) original and three (3) hard copies of your response. In addition, please submit a scanned copy of your response, in an Adobe format (.pdf) including all attachments on CD. If available, a copy of the response in MS Word should also be copied to the CD.

Pursuant to Section 19a-639a(c) of the Connecticut General Statutes, you must submit your response to this request for additional information not later than sixty days after the date that this request was transmitted. Therefore, please provide your written responses to OHCA no later than September 16, 2013, otherwise your application will be automatically considered withdrawn. If you have any questions concerning this letter, please feel free to contact me by email or at (860) 418-7012.

Sincerely,

Steven W. Lazarus
Associate Health Care Analyst

****
*** TX REPORT ***
****

TRANSMISSION OK

TX/RX NO	3584
RECIPIENT ADDRESS	912038634736
DESTINATION ID	
ST. TIME	07/18 13:41
TIME USE	00'34
PAGES SENT	3
RESULT	OK

STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC HEALTH
OFFICE OF HEALTH CARE ACCESS

FAX SHEET

TO: Nancy Rosenthal

FAX: (203) 863-4736

AGENCY:

FROM: Steven Lagarus

DATE: 7/18/13 TIME: 1:35 pm

NUMBER OF PAGES: 3
(including transmittal sheet

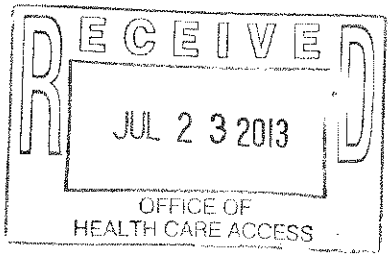
Comments: Please see the enclosed CL re: DN: 13-31845

PLEASE PHONE IF THERE ARE ANY TRANSMISSION PROBLEMS.

5Perryridge Road
Greenwich, CT 06830-4697
203-863-3908
Fax 203-863-4736

GREENWICH HOSPITAL
YALE NEW HAVEN HEALTH

FAX



Date:	July 23, 2013
To:	Mr. Steven Lazarus
Fax Number:	860-418-7053
From:	Nancy Rosenthal
Subject:	Docket Number 13-31845-CON Yale New Haven Hospital Acquisition of Two SPECT-CT Scanners

Number of pages including cover sheet: 7

YALE NEW HAVEN HEALTH

July 23, 2013

Mr. Steven Lazarus
Associate Health Care Analyst
Office of Health Care Access
410 Capitol Avenue
MS #13HCA
P.O. Box 340308
Hartford, CT 06106

Re: Docket Number: 13-31845-CON
Yale-New Haven Hospital
Acquisition of Two SPECT-CT Scanners

Dear Mr. Lazarus:

Enclosed please find the original, three (3) hard copies, and an electronic copy on CD of YNHH's response to OHCA's July 18, 2013 completeness questions with respect to the above referenced Certificate of Need application.

Please do not hesitate to contact me with any questions or concerns. I can be reached at (203) 863-3908. Thank you for your time and support of this project.

Sincerely,

Nancy Rosenthal

Nancy Rosenthal
Senior Vice President – Health Systems Development

Enclosures

789 Howard Avenue
New Haven, CT 06519

Yale-New Haven Hospital

Acquisition of a Two SPECT/CT Cameras to Replace a SPECT Camera in Nuclear Medicine and Two Gamma Cameras in Nuclear Cardiology

Docket Number: 13-31845-CON

Response to Completeness Questions

July 23, 2013

Yale-New Haven Hospital

Certificate of Need Application
Docket Number: 13-31845-CON

Acquisition of Two SPECT/CT Cameras to Replace a SPECT Camera in Nuclear Medicine and Two Gamma Cameras in Nuclear Cardiology

Response to Completeness Questions

1. Please revise and resubmit Financial Attachment 1 (pages 711 &712), to include a column for each year (historical/actual & projected) for Yale New Haven Hospital. Please be sure to include any and all financial assumptions related to the Financial Attachment 1 (for each proposed SPECT-CT scanner).

Please find attached a revised Financial Attachment 1, which includes a column for each year (historical/actual & projected) for Yale New Haven Hospital, and the financial assumptions.

Yale-New Haven Hospital
OHCA Financial Attachment I

SPECT-CT: Cardiology Description	FY 2011 Actual Results	Hospital FY 2011 Actual Results	FY 2012 Actual Results	Hospital FY 2012 Actual Results	FY 2013 Actual Results	Hospital FY 2013 Actual Results	FY 2014 Projected With CON	Hospital FY 2014 Projected With CON	FY 2015 Projected With CON	Hospital FY 2015 Projected With CON	FY 2016 Projected With CON	Hospital FY 2016 Projected With CON
Net Patient Revenue												
Non- Government	$ 833	$ 728,857	$ 969	$ 927,799	$ 847	$ 1,164,381	$ 858	$ 1,232,905	$ 889	$ 1,307,426	$ 912	$ 1,382,516
Medicare	469	481,753	571	521,852	500	800,034	512	822,600	525	847,546	536	881,356
Medicaid and Other Medical Assistance	57	225,122	88	300,719	77	341,015	79	354,430	81	373,522	83	392,278
Other Government	-	6,325	-	13,830	-	13,844	-	13,858	-	13,672	-	13,885
Total Net Patient Revenue	$ 1,358	$ 1,442,057	$ 1,627	$ 1,764,200	$ 1,423	$ 2,319,274	$ 1,459	$ 2,423,793	$ 1,495	$ 2,540,367	$ 1,533	$ 2,670,035
Other Operating Revenue	$ -	$ 46,640	$ -	$ -	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727
Revenue from Operations	$ 1,358	$ 1,488,697	$ 1,627	$ 1,764,200	$ 1,423	$ 2,380,001	$ 1,459	$ 2,484,520	$ 1,495	$ 2,601,094	$ 1,533	$ 2,730,762
Salaries and Fringe Benefits	$ 549	$ 690,313	$ 586	$ 770,717	$ 482	$ 1,053,715	$ 497	$ 1,159,684	$ 512	$ 1,182,497	$ 527	$ 1,223,396
Professional / Contracted Services	-	318,798	-	364,348	-	520,852	-	472,153	-	518,997	-	557,710
Supplies and Drugs	348	290,189	383	345,061	326	522,854	336	551,453	346	581,296	356	611,982
Bad Debts	-	26,390	-	36,129	-	35,046	-	36,097	-	37,180	-	38,295
Other Operating Expense	-	13,377	-	16,860	-	17,366	-	17,887	-	18,423	-	18,976
Subtotal	$ 897	$ 1,339,067	$ 946	$ 1,553,105	$ 809	$ 2,149,833	$ 833	$ 2,237,475	$ 858	$ 2,338,395	$ 884	$ 2,450,359
Depreciation/Amortization	$ -	$ 67,948	$ 193	$ 74,357	$ 193	$ 102,560	$ 193	$ 109,193	$ 193	$ 113,846	$ 193	$ 119,171
Interest Expense	-	16,867	-	17,759	-	42,420	-	44,111	-	43,490	-	47,848
Lease Expense	-	11,926	-	13,679	-	14,089	-	14,512	-	14,947	-	15,396
Total Operating Expense	$ 897	$ 1,435,808	$ 1,142	$ 1,658,900	$ 1,002	$ 2,308,902	$ 1,026	$ 2,405,291	$ 1,051	$ 2,510,778	$ 1,077	$ 2,632,774
Gain/(Loss) from Operations	$ 461	$ 52,889	$ 486	$ 105,300	$ 421	$ 71,099	$ 432	$ 79,229	$ 444	$ 90,316	$ 456	$ 97,988

Note :
The total hospital column does not contain results from the Spect CT PL.

Yale-New Haven Hospital
OHCA Financial Attachment I

SPECT-CT: Nuclear Medicine Description	FY 2011 Actual Results	Hospital FY 2011 Actual Results	FY 2012 Actual Results	Hospital FY 2012 Actual Results	FY 2013 Actual Results	Hospital FY 2013 Actual Results	FY 2014 Projected With CON	Hospital FY 2014 Projected With CON	FY 2015 Projected With CON	Hospital FY 2015 Projected With CON	FY 2016 Projected With CON	Hospital FY 2016 Projected With CON
Net Patient Revenue												
Non- Government	$ 112	$ 728,857	$ 112	$ 927,799	$ 99	$ 1,164,381	$ 101	$ 1,232,905	$ 104	$ 1,307,426	$ 106	$ 1,382,516
Medicare	56	461,753	56	521,852	46	800,034	47	822,600	48	847,546	49	861,356
Medicaid and Other Medical Assistance	25	225,122	30	300,719	26	341,015	26	354,490	27	371,522	28	392,278
Other Government	-	6,325	-	13,830	-	13,844	-	13,858	-	13,872	-	13,885
Total Net Patient Revenue	$ 193	$ 1,442,057	$ 198	$ 1,764,200	$ 170	$ 2,319,274	$ 174	$ 2,423,793	$ 179	$ 2,540,367	$ 183	$ 2,670,035
	-		-		-		-		-		-	
Other Operating Revenue	$ -	$ 46,640	$ -	$ -	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727
Revenue from Operations	$ 193	$ 1,488,697	$ 198	$ 1,764,200	$ 170	$ 2,380,001	$ 174	$ 2,484,520	$ 179	$ 2,601,094	$ 183	$ 2,730,762
Salaries and Fringe Benefits	$ 59	$ 690,313	$ 61	$ 770,717	$ 50	$ 1,053,715	$ 51	$ 1,159,864	$ 53	$ 1,182,497	$ 54	$ 1,223,386
Professional / Contracted Services	-	316,798	-	384,348	-	520,852	-	472,153	-	516,997	-	557,710
Supplies and Drugs	84	290,189	244	345,051	252	522,854	260	551,453	267	581,298	275	611,982
Bad Debts	-	26,290	-	36,129	-	35,046	-	36,097	-	37,180	-	38,295
Other Operating Expense	-	13,377	-	16,860	-	17,366	-	17,887	-	18,423	-	18,976
Subtotal	$ 144	$ 1,339,067	$ 305	$ 1,553,105	$ 302	$ 2,149,833	$ 311	$ 2,237,475	$ 320	$ 2,336,395	$ 330	$ 2,450,359
Depreciation/Amortization	$ -	$ 67,948	$ 70	$ 74,357	$ 70	$ 102,560	$ 70	$ 109,193	$ 70	$ 113,946	$ 70	$ 119,171
Interest Expense	-	16,867	-	17,759	-	42,420	-	44,111	-	43,490	-	47,848
Lease Expense	-	11,826	-	13,679	-	14,089	-	14,512	-	14,947	-	15,396
Total Operating Expense	$ 144	$ 1,435,808	$ 375	$ 1,658,900	$ 372	$ 2,308,902	$ 381	$ 2,405,291	$ 391	$ 2,510,778	$ 400	$ 2,632,774
Gain/(Loss) from Operations	$ 49	$ 52,889	$ (177)	$ 105,300	$ (202)	$ 71,099	$ (207)	$ 79,229	$ (212)	$ 90,316	$ (217)	$ 97,988

Note :
The total hospital column does not contain results from the Spect CT PL.

YALE-NEW HAVEN HOSPITAL

Acquisition of two SPECT/CT cameras to replace a SPECT camera in

Assumptions

	Net Revenue Rate Increases	FY 2014	FY 2015	FY 2016
1)	Government	-0.6 - 0.0%	0.0 - 1.0%	0.0 - 1.0%
2)	Non-Government	5.0%	5.0%	5.0%

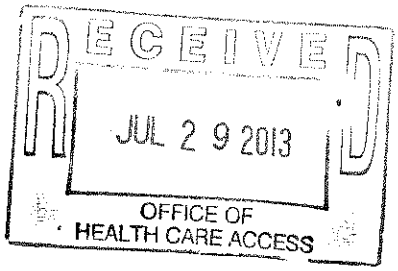
		FY 2014	FY 2015	FY 2016
	EXPENSES			
A.	**Salaries and Fringe Benefits**	3.1%	3.1%	3.1%
B.	**Non-Salary**			
1)	Medical and Surgical Supplies	3.5%	3.5%	3.5%
2)	Pharmacy and Solutions	3.5%	3.5%	3.5%
3)	Malpractice Insurance	4.0%	4.0%	4.0%
4)	Professional and Contracted Services	2.5%	2.5%	2.5%
5)	All Other Expenses	3 - 5%	3 - 5%	3 - 5%

		FY 2014	FY 2015	FY 2016
	FTEs			
1)	Total estimated FTEs	10,866.0	10,984.0	11,106.0

Note - The above increase projections reflect all changes relating to Medicare and Medicaid reimbursement regulations. The assumptions in the CON application are applicable to the hospital.

YALE NEW HAVEN HEALTH

July 23, 2013



Mr. Steven Lazarus
Associate Health Care Analyst
Office of Health Care Access
410 Capitol Avenue
MS #13HCA
P.O. Box 340308
Hartford, CT 06106

Re: Docket Number: 13-31845-CON
Yale-New Haven Hospital
Acquisition of Two SPECT-CT Scanners

Dear Mr. Lazarus:

Enclosed please find the original, three (3) hard copies, and an electronic copy on CD of YNHH's response to OHCA's July 18, 2013 completeness questions with respect to the above referenced Certificate of Need application.

Please do not hesitate to contact me with any questions or concerns. I can be reached at (203) 863-3908. Thank you for your time and support of this project.

Sincerely,

Nancy Rosenthal

Nancy Rosenthal
Senior Vice President – Health Systems Development

Enclosures

789 Howard Avenue
New Haven, CT 06519

Yale-New Haven Hospital

Acquisition of a Two SPECT/CT Cameras to Replace a SPECT Camera in Nuclear Medicine and Two Gamma Cameras in Nuclear Cardiology

Docket Number: 13-31845-CON

Response to Completeness Questions

July 23, 2013

Yale-New Haven Hospital

Certificate of Need Application
Docket Number: 13-31845-CON

Acquisition of Two SPECT/CT Cameras to Replace a SPECT Camera in Nuclear Medicine and Two Gamma Cameras in Nuclear Cardiology

Response to Completeness Questions

1. Please revise and resubmit Financial Attachment 1 (pages 711 &712), to include a column for each year (historical/actual & projected) for Yale New Haven Hospital. Please be sure to include any and all financial assumptions related to the Financial Attachment 1 (for each proposed SPECT-CT scanner).

Please find attached a revised Financial Attachment 1, which includes a column for each year (historical/actual & projected) for Yale New Haven Hospital, and the financial assumptions.

Yale-New Haven Hospital
OHCA Financial Attachment I

SPECT-CT: Cardiology Description	FY 2011 Actual Results	Hospital FY 2011 Actual Results	FY 2012 Actual Results	Hospital FY 2012 Actual Results	FY 2013 Actual Results	Hospital FY 2013 Actual Results	FY 2014 Projected With CON	Hospital FY 2014 Projected With CON	FY 2015 Projected With CON	Hospital FY 2015 Projected With CON	FY 2016 Projected With CON	Hospital FY 2016 Projected With CON
Net Patient Revenue												
Non- Government	$ 833	$ 728,857	$ 969	$ 927,799	$ 847	$ 1,164,381	$ 868	$ 1,232,905	$ 889	$ 1,307,426	$ 912	$ 1,382,516
Medicare	469	481,753	571	521,852	500	800,034	512	822,600	525	847,546	538	881,356
Medicaid and Other Medical Assistance	57	225,122	88	300,719	77	341,015	79	354,430	81	371,522	83	392,278
Other Government	-	6,325	-	13,830	-	13,844	-	13,858	-	13,872	-	13,885
Total Net Patient Revenue	$ 1,358	$ 1,442,057	$ 1,627	$ 1,764,200	$ 1,423	$ 2,319,274	$ 1,459	$ 2,423,793	$ 1,495	$ 2,540,367	$ 1,533	$ 2,670,035
Other Operating Revenue	$ -	$ 46,640	$ -	$ -	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727
Revenue from Operations	$ 1,358	$ 1,488,697	$ 1,627	$ 1,764,200	$ 1,423	$ 2,380,001	$ 1,459	$ 2,484,520	$ 1,495	$ 2,601,094	$ 1,533	$ 2,730,762
Salaries and Fringe Benefits	$ 549	$ 690,313	$ 566	$ 770,717	$ 482	$ 1,053,715	$ 497	$ 1,159,884	$ 512	$ 1,182,497	$ 527	$ 1,223,396
Professional / Contracted Services	-	318,798	-	384,348	-	520,852	-	472,153	-	518,997	-	557,710
Supplies and Drugs	348	290,189	383	345,051	326	522,854	336	551,453	346	581,298	356	611,982
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Subtotal	$ 897	$ 1,339,067	$ 948	$ 1,553,105	$ 809	$ 2,149,833	$ 833	$ 2,237,475	$ 858	$ 2,338,395	$ 884	$ 2,450,359
Depreciation/Amortization	$ -	$ 67,948	$ 193	$ 74,357	$ 193	$ 102,560	$ 193	$ 109,193	$ 193	$ 113,946	$ 193	$ 119,171
Interest Expense	-	16,867	-	17,759	-	42,420	-	44,111	-	43,490	-	47,848
Lease Expense	-	11,926	-	13,679	-	14,089	-	14,512	-	14,947	-	15,396
Total Operating Expense	$ 897	$ 1,435,808	$ 1,142	$ 1,658,900	$ 1,002	$ 2,308,902	$ 1,026	$ 2,405,291	$ 1,051	$ 2,510,778	$ 1,077	$ 2,632,774
Gain/(Loss) from Operations	$ 461	$ 52,889	$ 486	$ 105,300	$ 421	$ 71,099	$ 432	$ 79,229	$ 444	$ 90,316	$ 456	$ 97,988

Note :
The total hospital column does not contain results from the Spect CT PL.

Yale-New Haven Hospital
OHCA Financial Attachment I

SPECT-CT: Nuclear Medicine **Description**	**FY 2011 Actual Results**	Hospital **FY 2011 Actual Results**	**FY 2012 Actual Results**	Hospital **FY 2012 Actual Results**	**FY 2013 Actual Results**	Hospital **FY 2013 Actual Results**	**FY 2014 Projected With CON**	Hospital **FY 2014 Projected With CON**	**FY 2015 Projected With CON**	Hospital **FY 2015 Projected With CON**	**FY 2016 Projected With CON**	Hospital **FY 2016 Projected With CON**
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Non- Government	$ 112	$ 728,857	$ 112	$ 927,799	$ 99	$ 1,164,381	$ 101	$ 1,232,905	$ 104	$ 1,307,426	$ 106	$ 1,382,516
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	-		-		-		-		-		-	
Other Operating Revenue	$ -	$ 46,640	$ -	$ -	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727	$ -	$ 60,727
Revenue from Operations	$ 193	$ 1,488,697	$ 198	$ 1,764,200	$ 170	$ 2,380,001	$ 174	$ 2,484,520	$ 179	$ 2,601,094	$ 183	$ 2,730,762
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Subtotal	$ 144	$ 1,339,067	$ 305	$ 1,553,105	$ 302	$ 2,149,833	$ 311	$ 2,237,475	$ 320	$ 2,338,395	$ 330	$ 2,450,359
Depreciation/Amortization	$ -	$ 67,948	$ 70	$ 74,357	$ 70	$ 102,560	$ 70	$ 109,193	$ 70	$ 113,946	$ 70	$ 119,171
Interest Expense	-	16,867	-	17,759	-	42,420	-	44,111	-	43,490	-	47,848
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Gain/(Loss) from Operations	$ 49	$ 52,889	$ (177)	$ 105,300	$ (202)	$ 71,099	$ (207)	$ 79,229	$ (212)	$ 90,316	$ (217)	$ 97,988

Note :
The total hospital column does not contain results from the Spect CT PL.

YALE-NEW HAVEN HOSPITAL

Acquisition of two SPECT/CT cameras to replace a SPECT camera in

Assumptions

	Net Revenue Rate Increases	FY 2014	FY 2015	FY 2016
1)	Government	-0.6 - 0.0%	0.0 - 1.0%	0.0 - 1.0%
2)	Non-Government	5.0%	5.0%	5.0%

		FY 2014	FY 2015	FY 2016
	EXPENSES			
A.	Salaries and Fringe Benefits	3.1%	3.1%	3.1%
B.	Non-Salary			
1)	Medical and Surgical Supplies	3.5%	3.5%	3.5%
2)	Pharmacy and Solutions	3.5%	3.5%	3.5%
3)	Malpractice Insurance	4.0%	4.0%	4.0%
4)	Professional and Contracted Services	2.5%	2.5%	2.5%
5)	All Other Expenses	3 - 5%	3 - 5%	3 - 5%

		FY 2014	FY 2015	FY 2016
	FTEs			
1)	Total estimated FTEs	10,866.0	10,984.0	11,106.0

Note - The above increase projections reflect all changes relating to Medicare and Medicaid reimbursement regulations. The assumptions in the CON application are applicable to the hospital.

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

Office of Health Care Access

September 12, 2013 FAX ONLY

Nancy Rosenthal
Senior Vice President-Health Systems Development
Yale-New Haven Hospital
20 York Street
New Haven, CT 06510

RE: Certificate of Need Application, Docket Number 13-31845-CON
Yale-New Haven Hospital
CON Application Deemed Complete

Dear Ms. Rosenthal:

This letter is to inform you that, pursuant to Section 19a-639a (d) of the Connecticut General Statutes, the Office of Health Care Access has deemed the above-referenced application complete as of September 5 2013.

If you have any questions regarding this matter, please feel free to contact me at (860) 418-7001.

Sincerely,

Steven W. Lazarus
Associate Health Care Analyst

****
*** TX REPORT ***
****

TRANSMISSION OK

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ST ATE OF CONNECTICUT
DEPAR TMENT OF PUBLIC HEALTH
OFFIC E OF HEALTH CARE ACCESS

FAX SHEET

TO: NANCY ROSE NTHAL

FAX: (203) 863-4736

AGENCY: YALE-NEW H AVENHOSPITAL

FROM: STEVEN LAZ ARUS

DATE: 9/12/13 **TIME:**

NUMBER OF PAGES: 2
(in luding transmittal sheet

Comments: DM: 13-3184 -CON Deemed Complete letter

PLEASE PHONE IF T IERE ARE ANY TRANSMISSION PROBLEMS.

Phone: (60) 418-7001 ***Fax: (860) 418-7053***

Greer, Leslie

From: Lazarus, Steven
Sent: Thursday, February 06, 2014 7:28 AM
To: Greer, Leslie
Cc: Martone, Kim; Riggott, Kaila; Hansted, Kevin
Subject: FW: Spect CT infomration for Yale New Haven Hospital
Attachments: Financial Response to Questions in January of 2014.xlsx; SPECT CT VOLUME -- Updated FY13 (Nuclear Cardio).docx; SPECT CT VOLUME -- Updated FY13 (Nuclear Medicine).docx; Cover Letter SPECTCT -- February 2014.docx

Leslie,

Please add to the record.

Thank you!

Steve

Steven W. Lazarus
Associate Health Care Analyst
Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134
Phone: 860-418-7012
Fax: 860-418-7053

From: Rosenthal, Nancy [mailto:Nancy.Rosenthal@greenwichhospital.org]
Sent: Wednesday, February 05, 2014 3:29 PM
To: Lazarus, Steven
Subject: Spect CT infomration for Yale New Haven Hospital

Steve,

Here is the information that was requested by your office regarding Docket Number: 13-31845-CON. There is a cover letter attached as well.

Hope you are staying safe and warm.

Nancy

Nancy Rosenthal
Senior Vice President-Health Systems Development

Greenwich Hospital
5 Perryridge Rd.
Greenwich, CT 06830
Phone:(203) 863-3908

Nancy.Rosenthal@greenwichhospital.org

www.greenwichhospital.org

Please consider the environment
before printing this email.

YALE NEW HAVEN HEALTH

February 5, 2014

Mr. Steven Lazarus
Associate Health Care Analyst
Office of Health Care Access
410 Capitol Avenue
MS #13HCA
P.O. Box 340308
Hartford, CT 06106

Re: Docket Number: 13-31845-CON
Yale-New Haven Hospital
Acquisition of Two SPECT-CT Scanners

Dear Mr. Lazarus:

Per your request, attached are the requested updated volume tables and financial attachments for the above referenced Certificate of Need application. These documents now include actual data for the complete FY13, and projections through FY16. As we discussed, the delay in getting this information to you in a timelier manner was due to the Hospital's adoption and implementation of the EPIC electronic medical record in February of 2013. We are still learning how this change impacts the way data is captured in the new system. We have worked closely with our finance department to present this data in the most appropriate manner despite the data issues caused by the new EMR. And we continue to work with EPIC to resolve these issues.

Please do not hesitate to contact me with any questions or concerns. I can be reached at (203) 863-3908. Thank you for your time and support of this project.

Sincerely,

Nancy Rosenthal
Senior Vice President – Health Systems Development

Enclosures

789 Howard Avenue
New Haven, CT 06519

Updated on January 24, 2014

Nuclear Cardiology - Minimum Number of Units required

	2011	2012	2013	2014	2015	2016
Expenses from operations	$ 897,046	$ 1,141,894	$ 1,012,481	$ 1,037,051	$ 1,062,358	$ 1,088,424
Cases Needed to show incremental gain from operations	1,210	1,527	1,320	1,289	1,294	1,300
Average Revenue per case by year	$ 742	$ 748	$ 767	$ 805	$ 821	$ 837
Volume	1,832	2,176	1,909	1,909	1,909	1,909
Revenue	$ 1,358,459	$ 1,627,495	$ 1,464,291	$ 1,493,577	$ 1,523,449	$ 1,553,918

Nuclear Medicine - Minimum Number of Units required

	2011	2012	2013	2014	2015	2016
Expenses from operations	$ 143,514	$ 375,146	$ 372,154	$ 381,204	$ 390,525	$ 400,126
Cases Needed to show incremental gain from operations	259	645	674	674	674	673
Average Revenue per case by year	$ 555	$ 582	$ 552	$ 566	$ 580	$ 594
Volume	348	340	282	290	299	308
Revenue	$ 192,974	$ 197,776	$ 152,975	$ 203,710	$ 209,821	$ 216,116

Nuclear Cardiology (updated with complete FY13 volume)

Table 2a: Historical, Current, and Projected SPECT and SPECT/CT Volume, by Equipment Unit[1]

	Actual Volume (Last 3 Completed FYs)			Actual Volume	Projected Volume (Next 3 Full Operational FYs)		
	FY10[2]	FY11	FY12	FY13[3]	FY14	FY15	FY16
CPIMG (total)	743	713	956	1158	1158	1158	1158
IP	189	123	356	272	272	272	272
OP	0	0	0	0	0	0	0
ED	554	590	600	886	886	886	886
NMC1 (total)	17	7	3	5	5	5	5
IP	10	3	0	1	1	1	1
OP	7	4	3	4	4	4	4
ED	0	0	0	0	0	0	0
NMC2 (total)	1185	1136	652	353	353	353	353
IP	580	572	272	137	137	137	137
OP	605	564	374	211	211	211	211
ED	0	0	6	5	5	5	5
NMC3 (total)[4]	50	209	415	300	300	300	300
IP	20	93	162	92	92	92	92
OP	30	116	252	205	205	205	205
ED	0	0	1	3	3	3	3
NMC4 (total)[5] SPECT/CT	N/A	N/A	599	845	845	845	845
IP	N/A	N/A	281	334	334	334	334
OP	N/A	N/A	317	505	505	505	505
ED	N/A	N/A	1	6	6	6	6
SMVDsti (total)[6]	96	56	22	N/A	0	0	0
IP	43	12	9	N/A	0	0	0
OP	53	44	13	N/A	0	0	0
ED	0	0	0	N/A	0	0	0
GE Vari (total)[7]	408	360	41	N/A	0	0	0
IP	101	107	6	N/A	0	0	0
OP	307	253	35	N/A	0	0	0
ED	0	0	0	N/A	0	0	0
Philips (total)[8]	219	N/A	N/A	N/A	0	0	0
IP	99	N/A	N/A	N/A	0	0	0
OP	120	N/A	N/A	N/A	0	0	0
ED	0	N/A	N/A	N/A	0	0	0
Total IP	1042	910	1086	836	836	836	836
Total OP	1122	981	994	925	925	925	925
Total ED	554	590	608	900	900	900	900
Grand Total	2718	2481	2688	2661	2661	2661	2661

[1] Source: Imagecast (software that provides volume by machine); and EPIC after January 2013.
[2] The YNHH fiscal year runs from October 1st to September 30th.
[3] This includes actual FY13 volume for the complete FY.
[4] This gamma camera was installed in July 2010 to replace the Phillips gamma camera.
[5] This is the GE Discovery 570c that was purchased in 2011 to replace two gamma cameras (a GE SMV Dsti and a GE Varicam with Hawkeye that were purchased in 2000 and 1999, respectively).
[6] This gamma camera was replaced by the GE Discovery 570c SPECT/CT in 2011.
[7] This gamma camera with hawkeye was replaced by the GE Discovery 570c SPECT/CT in 2011.
[8] This gamma camera was replaced by NMC3 in July 2010.

Nuclear Cardiology (updated with complete FY13 volume)

Table 2b: Historical, Current and Projected SPECT and SPECT/CT Volume by Type of Scan/Exam[9]

	Actual Volume (Last 3 Completed FYs)			Actual Volume*	Projected Volume (Next 3 Full Operational FYs)**		
	FY10[10]	FY11	FY12	FY13[11]	FY14	FY15	FY16
CPIMG (total)	743	713	956	1158	1158	1158	1158
Myocardial Perfusion	743	713	956	1158	1158	1158	1158
NMC1 (total)	17	7	3	5	5	5	5
Myocardial Perfusion	17	7	3	5	5	5	5
NMC2 (total)	1185	1142	652	353	353	353	353
Myocardial Perfusion	1185	1136	652	353	353	353	353
NMC3 (total)[12]	50	209	415	300	300	300	300
Myocardial Perfusion	50	209	415	300	300	300	300
NMC4[13] (total) SPECT/CT	N/A	N/A	599	845	845	845	845
Myocardial Perfusion	N/A	N/A	599	845	845	845	845
SMVDsti[14] (total)	96	56	22	N/A	0	0	0
Myocardial Perfusion	96	56	22	N/A	0	0	0
GE Vari (total)[15]	408	365	41	N/A	0	0	0
Myocardial Perfusion	408	360	41	N/A	0	0	0
Philips (total)[16]	219	N/A	N/A	N/A	0	0	0
Myocardial Perfusion	219	N/A	N/A	N/A	0	0	0
Total	2718	2481	2688	2661	2661	2661	2661

[9] Source: Imagecast (software that provides volume by machine); and EPIC after January 2013.
[10] The YNHH fiscal year runs from October 1st to September 30th.
[11] This includes actual FY13 volume for the complete FY.
[12] This gamma camera was installed in July 2010 to replace the Phillips gamma camera.
[13] This is the GE Discovery 570c that was purchased in 2011 to replace two gamma cameras (a GE SMV Dsti and a GE Varicam with Hawkeye that were purchased in 2000 and 1999, respectively).
[14] This gamma camera was replaced by the GE Discovery 570c SPECT/CT in 2011.
[15] This gamma camera with hawkeye was replaced by the GE Discovery 570c SPECT/CT in 2011.
[16] This gamma camera was replaced by NMC3 in July 2010.

Nuclear Medicine (updated with complete FY13 volume)

Table 2a: Historical, Current, and Projected SPECT and SPECT/CT Volume, by Equip. Unit[1]

	Actual Volume (Last 3 Completed FYs)			CFY Volume*	Projected Volume (Next 2 Full Operational FYs)**		
	FY10[2]	FY11	FY12	FY13[3]	FY14	FY15	FY16
NM2 (total)	58	41	29	18	18	18	18
IP	10	5	4	3	3	3	3
OP	48	36	25	15	15	15	15
NM3 (total)	195	184	142	37	53	53	53
IP	12	13	7	1	1	1	1
OP	183	171	135	36	52	52	52
NM4 (total)[4] SPECT/CT	19	126	123	204	220	220	220
IP	6	11	13	9	9	9	9
OP	13	115	110	195	211	211	211
NM6 (total)	315	381	260	78	106	106	106
IP	21	35	28	11	11	11	11
OP	294	346	232	67	95	95	95
SN1 (total)	54	31	53	34	40	40	40
IP	1	0	0	0	0	0	0
OP	53	31	53	34	40	40	40
Total IP	50	64	52	24	24	24	24
Total OP	591	699	555	347	413	413	413
Grand Total	641	763	607	371	437	437	437

Please note that YNHH transitioned to EPIC EMR in February of 2013. Certain codes (such as the NM Parathyroid Early Images) were not created in EPIC and this volume was not initially captured. As a result, volume appears to be down in FY13. We have been working with EPIC to resolve the issue, and the capture of some of this volume is accounted for in FY14, 15, 16.

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[1] Source: Imagecast (software that provides volume by machine); and Epic after January 2013.
[2] The YNHH fiscal year runs from October 1st to September 30th.
[3] This includes actual FY13 volume for the complete FY.
[4] This is the Siemen's Symbia T that was purchased in 2010 to replace a SPECT camera (a Philips Axis that was purchased in 1996) at the end of its useful life.

Nuclear Medicine (updated with complete FY13 volume)

Table 2b: Historical, Current and Projected SPECT and SPECT/CT Volume by Type of Scan/Exam[5]

	Actual Volume (Last 3 Completed FYs)			CFY Volume*	Projected Volume (Next 2 Full Operational FYs)**		
	FY10[6]	FY11	FY12	FY13[7]	FY14	FY15	FY16
NM2 (total)	58	41	29	18	18	18	18
Bone Scan	6	3	1	5	5	5	5
Brain Image	3	0	0	0	0	0	0
Liver/Spleen	20	13	5	1	1	1	1
Octreo	13	20	21	10	10	10	10
Parathyroid	13	2	1	0	0	0	0
Para. (Early)	2	1	0	0	0	0	0
General	1	2	0	1	1	1	1
WBC Abscess	0	0	1	1	1	1	1
NM3 (total)	195	184	142	37	53	53	53
Bone Scan	5	4	2	0	0	0	0
Brain Image	3	1	1	0	0	0	0
Liver/Spleen	32	17	8	1	1	1	1
Octreo	25	8	10	3	3	3	3
Parathyroid	55	65	53	10	10	10	10
Para. (Early)	39	68	56	8	24	24	24
Kidney	0	1	11	13	13	13	13
General	36	20	1	1	1	1	1
WBC Abscess	0	0	0	1	1	1	1
NM4 (total)[8]	19	126	123	204	220	220	220
Bone Scan	8	4	1	19	19	19	19
Brain Image	1	1	1	38	38	38	38
Liver/Spleen	0	0	15	14	14	14	14
Octreo	0	15	21	35	35	35	35
Parathyroid	0	40	31	68	68	68	68
Para. (Early)	0	36	32	8	24	24	24
Kidney	0	5	5	7	7	7	7
General	0	11	2	9	9	9	9
WBC Abscess	0	1	1	6	6	6	6
NM6 (total)	315	381	260	78	106	106	106
Bone Scan	8	2	2	3	3	3	3
Brain Image	23	34	31	35	35	35	35
Liver/Spleen	10	10	11	0	0	0	0
Octreo	3	0	0	1	1	1	1
Parathyroid	170	165	108	22	22	22	22
Para. (Early)	100	165	107	14	42	42	42
Kidney	0	0	1	2	2	2	2
General	1	5	0	0	0	0	0
WBC Abscess	0	0	0	1	1	1	1

[5] Source: Imagecast (software that provides volume by machine); and Epic after January 2013.
[6] The YNHH fiscal year runs from October 1st to September 30th.
[7] This includes actual FY13 volume for the complete FY.
[8] This is the Siemen's Symbia T that was purchased in 2010 to replace a SPECT camera (a Philips Axis that was purchased in 1996) at the end of its useful life.

	Actual Volume (Last 3 Completed FYs)			Actual Volume FY13	Projected Volume (Next 3 Full Operational FYs)		
SN1 (total)	54	31	53	34	40	40	40
Bone Scan	9	8	9	5	5	5	5
Liver/Spleen	7	9	8	2	2	2	2
Octreo	38	14	14	9	9	9	9
Parathyroid	0	0	11	15	15	15	15
Para. (Early)	0	0	11	3	9	9	9
Total	641	763	607	371	437	437	437

Please note that YNHH transitioned to EPIC EMR in February of 2013. Certain codes (such as the NM Parathyroid Early Images) were not created in EPIC and this volume was not initially captured. As a result, volume appears to be down in FY13. We have been working with EPIC to resolve the issue, and the capture of some of this volume is accounted for in FY14, 15, 16.

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

Office of Health Care Access

February 20, 2014

IN THE MATTER OF:

An Application for a Certificate of Need filed Pursuant to Section 19a-638, C.G.S. by:	Notice of Final Decision Office of Health Care Access Docket Number: 13-31845-CON
Yale-New Haven Hospital	**Acquisition of Two Single Photon Emission Tomography-Computed Tomography Cameras**

To:

Nancy Rosenthal
Senior Vice President-Health Systems Development
Yale-New Haven Hospital
20 York Street
New Haven, CT 06510

Dear Ms. Rosenthal:

This letter will serve as notice of the Final Decision of the Office of Health Care Access in the above matter, as provided by Section 19a-638, C.G.S. On February 20, 2014, the Final Decision was rendered as the finding and order of the Office of Health Care Access. A copy of the Final Decision is attached hereto for your information.

Kimberly R. Martone
Director of Operations

Enclosure
KRM:swl

Department of Public Health
Office of Health Care Access
Certificate of Need Application

Final Decision

Applicant: **Yale-New Haven Hospital**

Docket Number: **13-31845-CON**

Project Title: **Acquisition of Two Single Photon Emission Tomography-Computed Tomography Cameras**

Project Description: Yale-New Haven Hospital ("Hospital" or "Applicant") is seeking approval for the acquisition of two Single Photon Emission Computed Tomography-Computed Tomography ("SPECT-CT") cameras to replace a SPECT camera and two nuclear gamma cameras at the Hospital.

Procedural History: On June 18, 2013, the Office of Health Care Access ("OHCA") received the initial Certificate of Need ("CON") application from the Hospital for the above-referenced project. The Hospital published notice of its intent to file the CON Application in *The New Haven Register* on March 18, 19 and 20, 2013. The application was deemed complete on September 5, 2013. OHCA received no responses from the public concerning the Hospital's proposal and no hearing requests were received from the public per Connecticut General Statutes § 19a-639a(e). In rendering her decision, Deputy Commissioner Davis considered the entire record in this matter.

To the extent the findings of fact actually represent conclusions of law, they should be so considered, and vice versa. *SAS Inst., Inc., v. S & H Computer Systems, Inc.*, 605 F.Supp. 816 (Md. Tenn. 1985).

Findings of Fact and Conclusions of Law

1. The Hospital is a 1,541[1] bed not-for-profit acute care teaching hospital located at 20 York Street, New Haven, Connecticut. Exhibit A, pp. 15, 642.

2. In January 2010, the Hospital acquired a Siemens Symbia T SPECT-CT camera to replace its 14-year-old Philips Axis SPECT camera in the Nuclear Medicine Department. Exhibit A, pp. 15-17.

3. In September 2011, the Hospital acquired a GE Discovery 570C SPECT-CT camera to replace two of its gamma cameras, which were over ten years old, in the Nuclear Cardiology Department. Exhibit A, pp.17-18.

4. The SPECT camera and the two gamma cameras have been removed and disposed of by the Hospital. Exhibit A, pp. 17-18.

5. Under Report Number 12-31807-DTR, OHCA determined that the Hospital was required to file a CON application for the acquisition of the above-mentioned SPECT-CT cameras. OHCA CON Determination, Report Number 12-31807-DTR.

6. Based upon Determination Report Number 12-31807-DTR, the Hospital is seeking CON authorization for the two SPECT-CT cameras. Exhibit A, pp. 15-18.

7. A nuclear medicine scan is used to assess organ function and internal anatomy for diagnosis and treatment for a broad range of patients, including cardiac, oncology and neurology patients. Exhibit A, p. 16.

8. The SPECT-CT camera in the Hospital's Nuclear Medicine Department can perform several different types of scans, including two- (planar) and three-dimensional imaging, SPECT, and SPECT-CT. Exhibit A, p. 16.

9. The camera's 2-slice CT component can be used to conduct bone, brain, pediatric neuroblastoma, whole body, liver, parathyroid and white blood cell scans as well as scan for Parkinson's disease (which can only be performed on a SPECT-CT). Exhibit A, pp. 16-17.

10. The SPECT-CT produces a three-dimensional image similar to SPECT, but the CT component adds clarity to the scan via attenuation correction, which removes shadows and artifacts which frequently can appear on images. Exhibit A, p. 16.

11. Images may be distorted due, in part, to the density of body tissue, which may result in low quality scans that appear cloudy or obstructed, and could provide false positives. The accompanying low dose CT scan can eliminate much of the distortion associated with tissue density. Exhibit A, pp. 16-17.

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[1] Includes 134 bassinets

12. The SPECT-CT in the Nuclear Cardiology Department is used to perform stress perfusion exams, which are non-invasive tests that can detect heart disease. These tests are widely accepted and commonly used to stratify risk among patients prior to surgery and to evaluate the source of chest pain. Exhibit A, p. 18.

13. The Nuclear Cardiology SPECT-CT has a 64 slice CT component that can be used immediately after a SPECT scan to apply attenuation correction to remove shadows and artifacts distorted by overlying breast or adipose tissue that may appear as coronary defects. Use of the CT component allows for a high quality scan that can be interpreted with greater confidence, improved lesion detection, eliminate the need for unnecessary follow-up testing and decrease the risks of false positives. Exhibit A, pp. 17-19.

14. The CT component is also used to evaluate calcium scoring of the coronary arteries, providing physicians with additional information when interpreting perfusion scans and creating a more complete picture for treatment planning. Exhibit A, p. 18.

15. SPECT-CT scans can be performed with a lower dose of radioactive tracers and in less time than typical scans via a SPECT or gamma camera. Exhibit A, pp. 18-19, 22.

16. The SPECT-CT cameras cannot be used as standalone CT scanners for diagnostic imaging. Exhibit A, pp. 16, 18.

17. The Hospital's historical and projected SPECT-CT utilization in the Nuclear Medicine and Nuclear Cardiology Departments is as follows:

Table 1: Historical and Projected Utilization SPECT-CT Cameras

	Actual				Projected		
	FY2010	**FY2011**	**FY2012**	**FY2013**	**FY2014**	**FY2015**	**FY2016**
Nuclear Medicine	19	126	123	204	220	220	220
Nuclear Cardiology	n/a*	n/a*	599	845	845	845	845

Exhibit E.
*Although the SPECT-CT camera was acquired in 2010, the Hospital used only its planar imaging and SPECT functions until remodeling was completed in September 2012, when the Hospital became compliant with Occupational Safety and Health Administration regulations pertaining to accommodating the low-dose radiation associated with the CT component.

18. Based on its actual historical utilization, the Hospital has conservatively projected stable utilization volumes for FY2014 through FY2016.

19. The need for, and use of, SPECT-CT cameras, is supported by the following submissions:
    - *American Society of Nuclear Cardiology and Society of Nuclear Medicine Joint Position Statement: Attenuation Correction of Myocardial Perfusion SPECT Scintigraphy.* This article states that "incorporation of attenuation correction in addition to ECG gating with SPECT myocardial perfusion images will improve

image quality, interpretive certainty, and diagnostic accuracy. These combined results are anticipated to have a substantial impact on improving the effectiveness of care and lowering health care costs." Exhibit A, pp. 36, 460-461.

- *SPECT/CT.* This report notes the growing role of SPECT-CT in oncologic applications and its superiority over planar imaging or SPECT for benign and malignant skeletal diseases, thyroid or neuroendocrine cancer, parathyroid adenoma and sentinel lymph node mapping in the head, neck and pelvis. Exhibit A, pp. 36, 482-496.
- *SPECT/CT Imaging: Clinical Utility of an Emerging Technology.* This article explains the benefits of SPECT-CT and notes that "combining the functional imaging available with SPECT and the anatomic imaging of computed tomography has gained more acceptance and proved useful in many clinical situations [...] These attributes have proved useful in many cardiac, general nuclear medicine, oncologic, and neurologic applications in which SPECT results alone are inconclusive." Exhibit A, pp. 36-37, 497-514.
- *Clinical Applications of SPECT/CT; New Hybrid Nuclear Medicine Imaging System.* This article provides a summary of clinical applications such as thyroid cancer, adrenal tumors, neuroendocrine tumors, lymphoma, bone scintigraphy, cerebral masses and various cardiac images. Exhibit A, pp. 37, 516-576.

20. Since the two SPECT-CT cameras replaced an existing SPECT camera and existing gamma cameras, no impact on existing providers is expected. Exhibit A, p. 27.

21. The proposal's total capital expenditure is itemized as follows:

Table 2: Total Capital Expenditure -- Nuclear Medicine

Imaging Equipment (SPECT-CT Scanner)	$465,000
Construction/Renovation	$61,000
Total Capital Expenditure	**$526,000**

Exhibit A, p. 39.

Table 3: Total Capital Expenditure -- Nuclear Cardiology

Imaging Equipment (SPECT-CT Scanner)	$1,354,443
Total Capital Expenditure	**$1,354,443**

Exhibit A, pp. 39-40.

22. The SPECT-CT camera acquisitions were fully funded by the Hospital's equity. Exhibit A, p. 40.

23. As shown in **Tables 4** and **5**, the projected gains derived from Nuclear Cardiology more than offset the losses projected from Nuclear Medicine and result in a net gain for the overall proposal.

Table 4: Historical/Projected Incremental Revenues and Expenditures (Nuclear Medicine)

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Revenue from Operations	$192,974	$197,776	$152,974	$203,710	$209,821	$216,116
Total Operating Expenses*	$143,514	$375,146	$372,154	$381,204	$390,525	$400,126
Gain/(Loss) from Operations	**$49,460**	**($177,369)**	**($219,180)**	**($177,494)**	**($180,704)**	**($184,010)**

Note: figures are in thousands.
*Operating expenses include salaries/fringe benefits, supplies/drugs and depreciation/amortization.
Exhibit E.

Table 5: Historical/Projected Incremental Revenues & Expenditures (Nuclear Cardiology)

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Revenue from Operations	$1,358,459	$1,627,495	$1,464,291	$1,493,577	$1,523,449	$1,553,918
Total Operating Expenses*	$897,046	$948,402	$818,989	$843,559	$868,866	$894,932
Gain/(Loss) from Operations	**$461,413**	**$485,601**	**$451,810**	**$456,526**	**$461,091**	**$465,494**

Note: figures are in thousands.
*Operating expenses include salaries/fringe benefits, supplies/drugs and depreciation/amortization.
Exhibit E.

24. With the proposal, the Hospital projects operational gains of $79.2M in FY 2014, $90.3M in FY 2015 and $98.0M in FY 2016.

Table 6: Yale-New Haven Hospital Projected Revenues & Expenditures with CON

	FY 2014	FY 2015	FY 2016
Revenue from Operations	$2,484,520	$2,601,094	$2,730,762
Total Operating Expenses*	$2,405,291	$2,510,778	$2,632,774
Gain/(Loss) from Operations	**$79,229**	**$90,316**	**$97,988**

Note: figures are in thousands.
*Operating expenses include salaries/fringe benefits, professional/contracted services, supplies/drugs, bad debts, other operating expenses, depreciation/amortization, interest expense and lease expense.
Exhibit B, pp.718-719.

25. As shown in **Tables 7** and **8**, no change in the patient population mix is projected by the Hospital:

Table 7: Current and Projected Payer Mix (Nuclear Medicine)

Description	FY2012	FY2013	FY2014	FY2015	FY2016
Medicare*	32.9%	32.9%	32.9%	32.9%	32.9%
Medicaid*	11.7%	11.7%	11.7%	11.7%	11.7%
CHAMPUS & TriCare	0.6%	0.6%	0.6%	0.6%	0.6%
Total Government	**45.2%**	**45.2%**	**45.2%**	**45.2%**	**45.2%**
Commercial Insurers*	52.8%	52.8%	52.8%	52.8%	52.8%
Uninsured	1.5%	1.5%	1.5%	1.5%	1.5%
Workers Compensation	0.6%	0.6%	0.6%	0.6%	0.6%
Total Non-Government	**54.8%**	**54.8%**	**54.8%**	**54.8%**	**54.8%**
Total Payer Mix	**100%**	**100%**	**100%**	**100%**	**100%**

* Includes managed care activity.

Exhibit A, p. 41.

Table 8: Current and Projected Payer Mix (Nuclear Cardiology)

Description	FY2012	FY2013	FY2014	FY2015	FY2016
Medicare*	34.6%	34.6%	34.6%	34.6%	34.6%
Medicaid*	22.0%	22.0%	22.0%	22.0%	22.0%
CHAMPUS & TriCare	0.2%	0.2%	0.2%	0.2%	0.2%
Total Government	**56.8%**	**56.8%**	**56.8%**	**56.8%**	**56.8%**
Commercial Insurers*	41.0%	41.0%	41.0%	41.0%	41.0%
Uninsured	2.1%	2.1%	2.1%	2.1%	2.1%
Workers Compensation	0.1%	0.1%	0.1%	0.1%	0.1%
Total Non-Government	**43.2%**	**43.2%**	**43.2%**	**43.2%**	**43.2%**
Total Payer Mix	**100%**	**100%**	**100%**	**100%**	**100%**

* Includes managed care activity.
Exhibit A, p. 41.

29. OHCA is currently in the process of establishing its policies and standards as regulations. Therefore, OHCA has not made any findings as to this proposal's relationship to any regulations adopted by OHCA. (Conn .Gen. Stat. § 19a-639(a)(1))

30. This CON application is consistent with the overall goals of the State Health Care Facilities and Services Plan. (Conn. Gen. Stat. § 19a-639(a)(2))

31. The Applicant has established that there is a clear public need for its proposal. (Conn. Gen. Stat. § 19a-639(a)(3))

32. The Applicant has satisfactorily demonstrated that its proposal is financially feasible. (Conn. Gen. Stat. § 19a-639(a)(4))

33. The Applicant has satisfactorily demonstrated that its proposal would improve the accessibility and quality of health care delivery in the region and it has satisfactorily demonstrated a potential improvement in cost effectiveness. (Conn. Gen. Stat. § 19a-639(a)(5))

34. The Applicant has shown that there will be no change in access to the provision of health care services to the relevant populations and payer mix. (Conn. Gen. Stat. § 19a-639(a)(6))

35. The Applicant has satisfactorily identified the population to be served and has satisfactorily demonstrated that this population has a need as proposed. (Conn. Gen. Stat. § 19a-639(a)(7))

36. The Applicant's historical provision of treatment in the service area supports this proposal. (Conn. Gen. Stat. § 19a-639(a)(8))

37. The Applicant has satisfactorily demonstrated that the proposal will not result in an unnecessary duplication of existing services in the area. (Conn. Gen. Stat. § 19a-639(a)(9))

Discussion

CON applications are decided on a case by case basis and do not lend themselves to general applicability due to the uniqueness of the facts in each case. In rendering its decision, OHCA considers the factors set forth in General Statutes § 19a-639(a). The Applicant bears the burden of proof in this matter by a preponderance of the evidence. *Jones v. Connecticut Medical Examining Board, 309 Conn. 727 (2013).*

Yale-New Haven Hospital, a 1,541 bed not-for-profit acute care teaching hospital in New Haven, is seeking authorization for the acquisition of two SPECT-CT cameras, which were acquired to replace a SPECT camera and two gamma cameras. *FF1-3.* Under Determination Report Number 12-31807-DTR, OHCA determined that the acquisition of the two SPECT-CT cameras required CON approval, although the Hospital has been operating them without CON authorization since 2010/2011. *FF2-5.*

The Hospital's Nuclear Medicine Department uses the SPECT-CT camera to assess organ function and internal anatomy for diagnosing and treating cardiac, oncology and neurology patients, among others. *FF7.* The camera, which can perform two- and three-dimensional imaging, SPECT, and SPECT-CT, has a 2-slice CT component which is used to conduct bone, brain, pediatric neuroblastoma, whole body, liver, parathyroid and white blood cell scans as well as scan for Parkinson's disease. *FF8-9.* The SPECT-CT produces a three-dimensional image similar to SPECT, but its CT component eliminates distortion and adds clarity to the scan via attenuation correction. This CT capability removes shadows and artifacts which frequently appear on images, thus reducing low quality, cloudy or obstructive scans and the potential for false positives. *FF10-11.*

The SPECT-CT in the Nuclear Cardiology Department is used to perform stress perfusion exams that can detect heart disease, which are widely accepted and commonly used to stratify risk among patients prior to surgery and to evaluate the source of chest pain. *FF12.* The Nuclear Cardiology SPECT-CT has a 64 slice CT component that can be used immediately after a SPECT scan to apply attenuation correction to remove shadows and artifacts distorted by overlying breast or adipose tissue that may appear as coronary defects. The CT component is also used to evaluate calcium scoring of the coronary arteries, providing physicians with additional information when interpreting test results and creating a more complete picture for treatment planning. *FF13-14.* Its use allows for a high quality scan that can be interpreted with greater confidence and improved lesion detection, thus eliminating the need for unnecessary follow-up testing and decreasing the risks of false positives. *FF13.*

The Applicant provided numerous clinical studies and articles that support the need for, and use of, SPECT-CT cameras and which substantiate SPECT-CT's impact on the quality of care and its potential for lowering health care costs. *FF19.* Both SPECT-CTs replaced equipment that was more than ten years old. *FF2-3.* The quality of the scans produced by the SPECT-CT cameras are significantly superior to the outdated SPECT and gamma cameras they replaced, due in part to the ability of the CT component to provide attenuation correction. Moreover, these scans can be performed with a lower dose of radioactive tracers and in less time than typical scans via a

SPECT or gamma camera. *FF15.* Specifically, in order to perform a nuclear medicine scan, a small amount of radioactive isotope is first injected into a patient. This radioactive tracer is then detected by nuclear camera to create pictures of internal organs based on the distribution of the isotope. A nuclear medicine scan can be used to assess organ function and internal anatomy for diagnosis and treatment purposes, and can be useful in a broad range of patients, including but not limited to cardiac, oncology, and neurology patients. According to the Hospital, at times the image produced may be distorted, due in part to the density of tissue within the body. This may result in low quality scans that appear cloudy or obstructed and could produce false positive results. To correct these imperfections, a nuclear medicine scan that is performed with a SPECT camera may be accompanied by low dose CT, which provides attenuation correction. *Exhibit A, pp.16-17.*

The two SPECT-CT cameras replaced existing equipment and the Hospital stated that it is not aware of any providers in its service area that offer SPECT-CT nuclear imaging services. *FF20;Exhibit A, pp. 23, 27.* As such, there is no duplication of services in the service area and no impact on existing providers. The Hospital projects that there will be no change in the payer mix as a result of the acquisition. *FF25.* The Applicant has projected stable utilization for FY2014 and FY2016. *FF18.* Based on the actual historical utilization, the projections appear reasonable and achievable.

The total capital expenditure for the Nuclear Medicine Department SPECT-CT, $526,000, and the Nuclear Cardiology Department SPECT-CT, $1,354,443, was fully funded by the Hospital's equity. *FF21.* While there is an overall loss from operations projected for FY2014-2016 in the Nuclear Medicine Department, it is more than offset by projected gains from operations in the Nuclear Cardiology Department. Moreover, the Hospital projects operational gains of $79.2M, 90.3M and $98.0M, respectively, for FY2014-2016. *FF24.* Therefore, the Applicant has demonstrated that its proposal is financially feasible.

The Applicant has demonstrated clear public need for the acquisition of the two SPECT-CT cameras due to the overall clinically superior care it offers. Additionally, the Applicant has satisfactorily shown that access to care will be maintained, quality of care will be improved and the combined results of the quality improvements may have a potential impact on cost effectiveness. *FF19.*

Order

Based upon the foregoing Findings of Fact and Discussion, the Certificate of Need application of Yale-New Haven Hospital for the acquisition of two SPECT-CT cameras is hereby **approved.**

All of the foregoing constitutes the final order of the Office of Health Care Access in this matter.

By Order of the
Department of Public Health
Office of Health Care Access

3/20/14
Date

Lisa A. Davis, MBA, BSN, RN
Deputy Commissioner

* * * COMMUNICATION RESULT REPORT (FEB. 20. 2014 2:19PM) * * *

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STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC HEALTH
OFFICE OF HEALTH CARE ACCESS

FAX SHEET

TO: NANCY ROSENTHAL

FAX: (203) 863-4736

AGENCY:

FROM: STEVEN LAZARUS

DATE: 2/20/14 **Time:**

NUMBER OF PAGES: 11
(including transmittal sheet

Comments:

Please see the enclosed final decision in the matter of Docket Number 13-31845.

PLEASE PHONE IF THERE ARE ANY TRANSMISSION PROBLEMS.

Phone: (860) 418-7001 ***Fax: (860) 418-7053***

410 Capitol Ave., MS#13HCA
P.O.Box 340308
Hartford, CT 06134

STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC HEALTH

Jewel Mullen, M.D., M.P.H., M.P.A.
Commissioner

Dannel P. Malloy
Governor

Nancy Wyman
Lt. Governor

VIA CERTIFIED MAIL
RETURN RECEIPT REQUESTED

February 20, 2014

Nancy Rosenthal, Sr. Vice President
Health Systems Development
Yale-New Haven Hospital
20 York Street
New Haven, CT 06510

Re: Notice of Civil Penalty Pursuant to Conn. Gen. Stat. § 19a-653

Dear Ms. Rosenthal:

On June 18, 2013, the Department of Public Health, Office of Health Care Access, ("OHCA") received a Certificate of Need ("CON") application on behalf of Yale-New Haven Hospital seeking authorization to acquire two SPECT/CT cameras. After a review of the information provided by Yale-New Haven Hospital, OHCA determined that Yale-New Haven Hospital acquired a Siemens Symbia SPECT-CT camera in January 2010 and a GE Discovery 570C SPECT-CT camera in September 2011, both without CON authorization.

Connecticut General Statutes §19a-638(a)(9)[i] states that CON authorization is required for "[t]he acquisition of computed tomography scanners…by any person, physician, provider, short-term acute care general hospital…" Because the purchase of the two SPECT/CT cameras was an acquisition of computed tomography scanners, Yale-New Haven Hospital was required to file a CON application with OHCA specific to the acquisition. However, OHCA was not afforded an opportunity to review the CON application until recently since Yale-New Haven Hospital failed to file its CON application until June 18, 2013[ii].

Pursuant to Connecticut General Statutes § 19a-653, the Department of Public Health is authorized to impose a civil penalty against any person, health care facility or institution that willfully fails to seek CON approval for any of the activities described in Connecticut General Statutes § 19a-638.

Connecticut Department of Public Health

Phone: (860) 509-8000 • Fax: (860) 509-7184 • VP: (860) 899-1611
410 Capitol Avenue, P.O. Box 340308
Hartford, Connecticut 06134-0308
www.ct.gov/dph

This letter shall serve as formal notice under § 19a-653(b) that the Department of Public Health is imposing a civil penalty against Yale-New Haven Hospital as follows:

REFERENCE TO THE SECTIONS OF THE STATUTES INVOLVED

1. Connecticut General Statutes § 19a-638 related to the activities requiring a certificate of need; and
2. Connecticut General Statutes § 19a-653 related to the imposition of a civil penalty.

STATEMENT OF THE MATTER ASSERTED OR CHARGED

Yale-New Haven Hospital willfully failed to comply with Connecticut General Statutes § 19a-638 by acquiring two computed tomography scanners without submitting a CON application to OHCA for approval.

STATEMENT OF THE AMOUNT AND INITIAL DATE OF THE CIVIL PENALTY IMPOSED

$100.00 per calendar day starting on February 1, 2010 and ending on June 17, 2013 (the day prior to the date the CON application was filed with OHCA. The total amount of the civil penalty imposed is $180,000.

STATEMENT OF THE PARTY'S RIGHT TO A HEARING

Pursuant to Connecticut General Statutes § 19a-653(c), Yale-New Haven Hospital has fifteen (15) business days from the date of the mailing of this notice to make written application to the Department of Public Health to request a hearing to contest the imposition of the penalty. Therefore, such request for a hearing must be received by the Department of Public Health on or before the close of business on March 13, 2014. A failure to make a timely request for a hearing shall result in a final order for the imposition of the penalty.

Lisa A. Davis, MBA, BSN, RN
Deputy Commissioner

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[i] The revisions to Connecticut General Statutes §19a-638 became effective October 1, 2010. However, the previous version of §19a-638 also required CON authorization for the acquisition of computed tomography scanners.

[ii] Docket Number 13-31845-CON.

* * * COMMUNICATION RESULT REPORT (FEB. 20. 2014 2:47PM) * * *

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STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC HEALTH
OFFICE OF HEALTH CARE ACCESS

FAX SHEET

TO: NANCY ROSENTHAL

FAX: 1-203-863-4736

AGENCY: YALE-NEW HAVEN HOSPITAL

FROM: OHCA

DATE: 2/20/14 **Time:**

NUMBER OF PAGES: *(including transmittal sheet*

Comments:

Please see attached Notice of Civil Penalty for Yale-New Haven Hospital

PLEASE PHONE Barbara K. Olejarz IF THERE ARE ANY TRANSMISSION PROBLEMS.

Phone: (860) 418-7001 ***Fax: (860) 418-7053***

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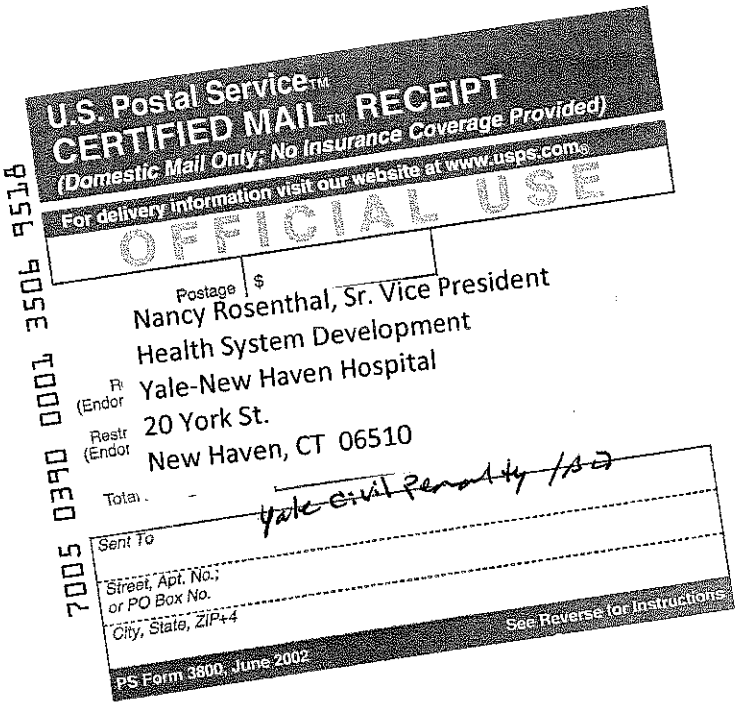
Hartford, CT 06134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Nancy Rosenthal, Sr. Vice President
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Yale civil penalty 150
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