STAMFORD HOSPITAL | The Regional Center for Health

Affiliate Columbia University-College of Physicians & Surgeons
Member NewYork-Presbyterian Healthcare System
A Planetree Hospital

30 Shelburne Road
P.O. Box 9317
Stamford CT 06904-9317
203.276.1000

www.stamhealth.org

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CONNECTICUT OFFICE OF
HEALTH CARE ACCESS

November 6, 2007

VIA FACSMILE AND U.S. MAIL
Cristine A. Vogel, Commissioner
Office of Health Care Access
410 Capitol Avenue
MS #13HCA
P.O. Box 340308
Hartford, CT 06134-0308

Re: **The Stamford Hospital**
Replacement of MRI on Main Hospital Campus

Dear Commissioner Vogel:

Pursuant to recent discussions with the Office of Health Care Access ("OHCA"), this letter is being sent to request a waiver of the Letter of Intent requirement under C.G.S. §19a-639(b)(2) so that The Stamford Hospital ("TSH" or the "Hospital") may submit promptly a Certificate of Need ("CON") Application to acquire a replacement MRI unit for its main hospital campus. The total estimated capital expenditure of $2,506,831 on this project is for (i) purchase of a new 1.5 Tesla Signa HDx MRI (the "New Unit"), (ii) minor renovation costs associated with the equipment replacement and (iii) lease of a temporary mobile MRI while the New Unit is being installed. This capital program is of an emergent nature so that access to high quality MRI services for TSH patients can be maintained.

Background

Currently, TSH has only one MRI on its main hospital campus. This unit (the "Old Unit") is a refurbished 1991 Signa 1.5T Horizon MRI that TSH acquired from GE Medical Systems in 1998 for $399,000 after application of a $500,000 trade-in allowance. At that time, TSH traded in a 1.5T Signa 5X MRI built in 1994 (the "1994 Unit") for which it had obtained a CON under Docket No. 93-528R. The decision to replace the 1994 Unit in 1998 was apparently driven by TSH's need to maintain continuing MRI service while the area housing the 1994 Unit was demolished to allow for construction of the main campus Wittingham Pavillion. *See* OHCA Docket No. 98-503.

Senior administration and radiology department staff at TSH, none of whom were affiliated with TSH in 1998, only recently learned that the Old Unit was purchased below the former statutory threshold amount of $400,000 and, thereby, without CON approval as was permitted under the regulatory framework at the time. This knowledge was gained through

paperwork obtained from GE as it had been previously assumed by TSH officials that the Old Unit was the MRI approved and purchased under OHCA Docket No. 93-528R. Accordingly, replacement of the Old Unit with the New Unit was expected to be accomplished by obtaining a CON waiver under C.G.S. §19a-639c.

The Emergency Situation

As noted above, the Old Unit is the lone MRI operating at the Hospital. This results in it being the only MRI that can serve hospital inpatients who cannot access the other 1.5 Tesla MRIs available at TSH's Tully Health Center and Darien Imaging Center outpatient locations. The Old Unit is also the only MRI available to patients treated in TSH's Emergency Department and, when the Old Unit is not servicing these patient populations, it also supplements the MRI services available to the Hospital's outpatients. The Old Unit operates 24-hours per day, 7-days a week, and in Fiscal Year 2007 it performed 7,338 scans (an average of 24 scans per weekday and 10 per weekend day).

MRI services are crucial to the Hospital's diagnostic imaging capabilities in general and its designation as a stroke center in particular. The age of the Old Unit, its constant use, ongoing maintenance requirements, and the scarcity of replacement parts, has greatly increased the risk that a malfunction in this equipment could result it in being placed out of service for an extended period of time. The quality of images from the Old Unit is also less than optimal and there is a continued risk that further degradation in image quality could occur rapidly. If such events were to occur, quality of care for patients accessing the main Hospital campus would be severely compromised. In order to prevent this situation from occurring, TSH has worked out an arrangement with GE whereby the New Unit could be delivered and installed by no later than December 31, 2007.

In the interest of maintaining high quality of care for its patients, TSH believes it is vital that the New Unit be installed on this expedited timetable. Installation of the New Unit will immediately improve MRI services in terms of faster scan times, more robust clinical applications and the improved image quality that a new MRI magnet and updated software will provide. The installation of the New Unit will also allow TSH to comply with a City of Stamford ordinance which prohibits MRIs and similar pieces of equipment from being cooled using the municipal water supply. The Old Unit is incapable of meeting this ordinance and is only able to operate subject to a grandfathering provision that allows certain older equipment to operate until it is replaced.

It is for all of the above reasons that TSH cannot wait for the 60-day Letter of Intent period to lapse before submitting its CON Application. We thank OHCA for its prompt consideration of this important matter and respectfully ask that this emergency application be granted and that the CON Application be forwarded to the attention of outside counsel, who is copied on this letter, at your earliest possible convenience. An original CON Determination form (and three copies) for the temporary mobile unit that TSH proposes to use while the fixed site MRI is being replaced is also enclosed with this letter. Please call me at (203) 276-7505 should you have any questions.

Sincerely,

David L. Smith
Senior Vice President
Strategy and Market Development

cc: Stephen M. Cowherd, Jeffers & Ireland (w/enc.)

State of Connecticut
Office of Health Care Access
CON Determination Form
Form 2020

All persons who are requesting a determination from OHCA as to whether a CON is required for their proposed project must complete this Form 2020. The completed form should be submitted to the Commissioner of the Office of Health Care Access, 410 Capitol Avenue, MS#13HCA, P.O. Box 340308, Hartford, Connecticut 06134-0308.

SECTION I. PETITIONER INFORMATION

If this proposal has more than two Petitioners, please attach a separate sheet, supplying the same information for each Petitioner in the format presented in the following table.

	Petitioner	Petitioner
Full Legal Name	The Stamford Hospital	
Doing Business As	The Stamford Hospital	
Name of Parent Corporation	Stamford Health System	
Petitioner's Mailing Address, if Post Office (PO) Box, include a street mailing address for Certified Mail	30 Shelburne Road, P.O. Box 9317, Stamford, CT 06904	
What is the Petitioner's Status: P for profit and NP for Nonprofit	NP	
Contact Person, including Title/Position: This Individual will be the Petitioner's Designee to receive all correspondence in this matter.	David L. Smith Senior Vice President	Stephen M. Cowherd, Jeffers & Ireland

Contact Person's Mailing Address, if PO Box, include a street mailing address for Certified Mail	30 Shelburne Road, P.O. Box 9317, Stamford, CT 06904	55 Walls Drive, Fairfield, CT 06824
Contact Person's Telephone Number	203-276-7505	203-259-7900
Contact Person's Fax Number	203-276-5529	203-259-1070
Contact Person's e-mail Address	dsmith@stamhealth.org	scowherd @jeffire.com

SECTION II. GENERAL PROPOSAL INFORMATION

a. Proposal/Project Title: Temporary Mobile MRI at The Stamford Hospital

b. Location of proposal, identifying Street Address, Town and Zip Code:
30 Shelburne Road, Stamford, CT 06904

c. List each town this project is intended to serve:
The population to be served is the same as the current TSH Primary, Secondary and Extended service areas which are as follows: Primary – Stamford and Darien, Secondary – New Canaan, Greenwich, Old Greenwich, Riverside, Cos Cob, Norwalk, Wilton, and Westport and Extended – Fairfield, Southport, Ridgefield, Weston, Bedford, NY, Bedford Hills, NY, Katonah, NY, Mt. Kisco, NY, Port Chester, NY, Pound Ridge, NY, Rye, NY and South Salem, NY.

d. Estimated starting date for the project: On or about November 19, 2007

e. Type of Entity: (Please check *E* for Existing and *P* for Proposed in the boxes that apply)

E	P		E	P		E	P	
☒	☐	Acute Care Hospital	☐	☐	Imaging Center	☐	☐	Cancer Center
☐	☐	Behavioral Health Provider	☐	☐	Ambulatory Surgery Center	☐	☐	Primary Care Clinic
☐	☐	Hospital Affiliate	☐	☐	Other (specify):_____			

SECTION III. EXPENDITURE INFORMATION

a. Estimated Total Project Cost: $130,000**

b. Please provide the following breakdown as appropriate: (may not represent the aggregate shown above)

Medical Equipment Purchases	
Major Medical Equipment Purchases	
Non-Medical Equipment Purchases*	
Land/Building/Asset Purchases	
Construction/Renovation	
Other (Non-Construction) Specify:	
Total Capital Expenditure	
Medical Equipment - Fair Market Value of Leases	
Major Medical Equipment - Fair Market Value of Leases	$130,000
Non-Medical Equipment - Fair Market Value of Leases*	
Fair Market Value of Space –Capital Leases Only	
Total Capital Cost	**$130,000**
Total Project Cost	**$130,000**
Capitalized Financing Costs (Informational Purpose Only)	

* Provide an itemized list of all non-medical equipment to be purchase and leased.

This is a maximum amount that includes a contingency for construction/delivery delays regarding the fixed MRI Unit the Hospital will install.

Major Medical and/or Imaging Equipment Acquisition:

Equipment Type	Name	Model	Number of Units	Cost per unit
Mobile MRI System	GE	1.5 T	1	62,000 per month

Note: Provide copy of the vendor contract or quotation for the medical equipment.

c. Check each applicable financing method or funding source to be used for the proposal:

☐ Petitioner's Equity ☐ Capital Lease ☐ Conventional Loan

☐ Charitable Contributions ☒ Operating Lease ☐ CHEFA Financing

☐ Funded Depreciation ☐ Grant Funding ☐ Other (specify): _____

SECTION IV. PROPOSAL DESCRIPTION

Please provide a description of the proposed project, highlighting each of its important aspects, on at least one, but not more than two separate 8.5" X 11" sheets of paper. At a minimum each of the following elements need to be addressed, if applicable.

1. Identify the types of services currently provided. If applicable, provide a copy of each Department of Public Health license held by the Petitioner.
2. Identify the types of services that are being proposed and what DPH licensure categories will be sought, if applicable?
3. Identify the current population served and the target population to be served.
4. Identify the entity that will be providing the service(s).
5. Identify the entity that will be responsible for the billing of the service(s) relating to this proposal.
6. Identify the entity that owns/leases or will own/lease the physical space of the proposed equipment/service.
7. If there is more than one entity involved in this proposal, please provide copies of any and all existing or proposed contracts or written agreements entered between the two entities that relate to the proposal.
8. Provide a list that identifies the name of each petitioning or affiliate entity involved with this proposal.
9. Provide a copy of the chart of organization for each individual petitioning entity or affiliate and a corporate chart of organization, if applicable.
10. Provide a narrative that addresses the relationship of each petitioning or affiliate entity with the other entities involved with this proposal.
11. Who are the current payers of this service and identify any anticipated payer changes when the proposed project becomes operational?

PROJECT DESCRIPTION

The Stamford Hospital ("TSH") is submitting this CON Determination so that a mobile MRI unit (the "Mobile Unit") may provide temporary service at its main hospital campus while it replaces its current fixed site 1.5 Tesla MRI (the "Old Unit") with a new 1.5 T Singa HDx MRI (the "New Unit"). *See* Letter from Kathleen Silard of TSH to OHCA dated November 2, 2007 which accompanies this submission and describes the emergent reasons for installing the New Unit as soon as possible.

As set forth in the November 2 letter, TSH only has one MRI unit operating at its main hospital campus. This is the Old Unit, which was originally manufactured in 1991 and was bought refurbished in 1998. The age, suboptimal image quality, maintenance requirements, scarcity of spare parts and intense utilization of the Old Unit (7,338 scans were performed on the equipment in FY 2007), has raised serious concerns at TSH that a malfunction in the equipment may be imminent and that it should be immediately replaced. If MRI services at its main hospital campus were interrupted for any significant period of time, TSH would be unable to offer this important form of diagnostic imaging to inpatients and patients accessing the Emergency Department, which is a Level II trauma center, for stroke and other soft tissue injuries. Accordingly, TSH is planning to replace the Old Unit with the New Unit on an expedited basis to maintain quality of care.

OHCA has previously recognized that temporary MRI services such as the Mobile Unit being proposed by TSH are necessary to bridge these services at a hospital while a fixed site MRI is being replaced. In those situations, OHCA has not required a separate CON for the leasing of temporary MRI units. *See, e.g.,* OHCA Docket No. 07-30926-WVR (granting the request of Lawrence & Memorial Hospital for a CON waiver to replace its fixed site MRI under C.G.S.§19a-639c and not requiring a CON for rental of a mobile MRI scanner during the interim period). The Mobile Unit is expected to provide temporary MRI services to TSH patients for approximately 1-2 months while the New Unit is being installed. Thereafter, the Mobile Unit will be returned to the vendor, Alliance Imaging, Inc. The capital cost of the Mobile Unit will be included in the overall project cost of the CON Application that TSH submits for the New Unit.

The Mobile Unit will serve the same patient population for MRI services that the Hospital serves currently and will not result in any payor or reimbursement changes. For all these reasons, TSH requests that OHCA determine that no CON is needed for the temporary Mobile Unit to become operational on the Hospital's main campus on or about November 19, 2007.

SECTION V. USE OF CON DETERMINATION FORM AS A LETTER OF INTENT

If the Petitioner's proposal requires a Certificate of Need, please check one of the following:

☒ OHCA may consider the form, and the information provided, as the Petitioner's Letter of Intent Form 2030 requesting initiation of the Certificate of Need process. OHCA will provide the Petitioner a CON application for the proposal.

☐ The Petitioner will submit a separate Letter of Intent Form 2030 to request the initiation of the Certificate of Need process.

SECTION VI. AFFIDAVIT

(Each Petitioner must submit a completed Affidavit.)

Petitioner: Stamford Hospital

Project Title: Temporary Mobile MRI at Stamford Hospital

I, Brian G. Grissler (Name), President & CEO (Position – CEO or CFO)

of Stamford Hospital (Organization Name) being duly sworn, depose and state that the information provided in this CON Determination form is true and accurate to the best of my knowledge, and that Stamford Hospital (Facility Name) complies with the appropriate and applicable criteria as set forth in the Sections 19a-630, 19a-637, 19a-638, 19a-639, 19a-486 and/or 4-181 of the Connecticut General Statutes.

Signature

11/8/07
Date

Subscribed and sworn to before me on November 5 2007

Lauren Mallozzi
Notary Public/Commissioner of Superior Court

LAUREN MALLOZZI
NOTARY PUBLIC
MY COMMISSION EXPIRES FEB. 28, 2008

My commission expires:

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STATE OF CONNECTICUT

OFFICE OF HEALTH CARE ACCESS

M. JODI RELL
GOVERNOR

CRISTINE A. VOGEL
COMMISSIONER

November 13, 2007

David L. Smith
Senior Vice President
30 Shelburne Road
P.O. Box 9317
Stamford, CT 06904

RE: Certificate of Need Application Forms; Docket Number 07-31059-CON
The Stamford Hospital
Emergency Certificate of Need for the Acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner

Dear Mr. Smith:

Enclosed are the application forms for The Stamford Hospital's Certificate of Need ("CON") proposal for the emergency CON for the acquisition of a 1.5 Tesla magnetic resonance imaging ("MRI") scanner at a total capital expenditure of $2,0506,831. According to the parameters stated in Section 19a-639 of the Connecticut General Statutes, the CON application may be filed between November 9, 2007, and January 8, 2008.

When submitting your CON application, please paginate and date each page contained in your submission. In addition, please submit one (1) original and five hard copies; as well as a scanned copy of the complete application, including all attachments, on CD or Diskette. OHCA requests that the electronic copy be in Adobe or MS Word format and that the Financial Attachment and other data as appropriate be in MS Excel format.

The OHCA analysts assigned to the CON application are Steven W. Lazarus and Alexis G. Fedorjaczenko. Please feel free to contact them at (860) 418-7001, if you have any questions.

Sincerely,

Kimberly Martone
Certificate of Need Supervisor
Enclosures

HOSPITAL AFFIDAVIT

Applicant: _____

Project Title: _____

I, _____, _____
(Name) (Position – CEO or CFO)

of _____ being duly sworn, depose and state that the (Hospital Name) information submitted in this Certificate of Need application is accurate and correct to the best of my knowledge. With respect to the financial impact related to this CON application, I hereby affirm that:

1. The proposal will have a capital expenditure in excess of $15,000,000.

   ☐ Yes ☐ No

2. The combined total expenses for the proposal's first three years of operation will exceed one percent of the actual operating expenses of the Hospital for the most recently completed fiscal year as filed with the Office of Health Care Access.

   ☐ Yes ☐ No

_____ _____
Signature Date

Subscribed and sworn to before me on_____

_____

Notary Public/Commissioner of Superior Court

My commission expires: _____

OFFICE OF HEALTH CARE ACCESS

REQUEST FOR NEW CERTIFICATE OF NEED

FILING FEE COMPUTATION SCHEDULE

APPLICANT: _____ PROJECT TITLE: _____ DATE: _____	FOR OHCA USE ONLY: DATE INITIAL 1. Check logged (Front desk) _____ _____ 2. Check rec'd (Clerical/Cert.) _____ _____ 3. Check correct (Superv.) _____ _____ 4. Check logged (Clerical/Cert).) _____ _____

SECTION A – NEW CERTIFICATE OF NEED APPLICATION	
1. Check statute reference as applicable to CON application (see statute for detail): _____ 19a-638.Additional function or service, change of ownership, service termination. **No Fee Required.** _____ 19a-639 Capital expenditure exceeding $3,000,000 or capital expenditure exceeding $3,000,000 fo major medical equipment, CT scanner, PET scanner, PET/CT scanner, MRI scanner, cineangiography equipment or linear accelerator. **Fee Required.** _____ 19a-638 and 19a-639. **Fee Required.** 2. Enter $0 on "Total Fee Due" line (SECTION B) if application is required pursuant to Section 19a-638 only, otherwise go on to line 3 of this section. 3. Enter $400 on "Total Fee Due" line (SECTION B) if application is for capital expenditure for major medical equipment, imaging equipment or linear accelerator less than $3,000,000 4. Section 19a-639 fee calculation (applicable if section 19a-639 capital expenditure for major medical equipment, imaging equipment or linear accelerator exceeding $3,000,000 or other capital expenditure exceeding $3,000,000 is checked above **OR** if both 19a-638 and 19a-639 are checked): a. Base fee: _____ $ 1,000.00 b. Additional Fee: (Capital Expenditure Assessment)_____ $_____.00 (To calculate: Total requested Capital Expenditure/Cost excluding capitalized financing costs multiplied times .0005 and round to nearest dollar.) ($_____ x .0005) c. Sum of base fee plus additional fee: (Lines A4a + A4b)_____ $_____.00 d. Enter the amount shown on line A4c. on "Total Fee Due" line (SECTION B).	
SECTION B TOTAL FEE DUE:_____	$_____.00

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

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

Please complete all questions. If any question is not relevant to your project, Not Applicable may be an acceptable response. Your Certificate of Need application will be eligible for submission no earlier than November 9, 2007, and may be submitted no later than January 8, 2008. The Analysts assigned to your application are Steven W. Lazarus and Alexis G. Fedorjaczenko and they may be reached at the Office of Health Care Access at (860) 418-7001.

Note: Due to the emergent nature of this application, Office of Health Care Access anticipates that The Stamford Hospital will complete and submit the enclosed application no later than November 21, 2007.

Docket Number:	07-31059-CON
Applicant Name:	The Stamford Hospital
Contact Person:	David L. Smith
Contact Title:	Senior Vice President, Strategy and Market Development The Stamford Hospital
Contact Address:	30 Shelburne Road P.O. Box 9317 Stamford, CT 06904
Project Location:	Stamford
Project Name:	Emergency Certificate of Need for the Acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner
Type proposal:	Section 19a-639, C.G.S.
Est. Capital Expenditure:	$2,506,831

1. Expansion of Existing or New Service

What services are currently offered at your facility that the proposed expansion or new service will augment or replace? Please list.

Augment:

Replace:

2. State Health Plan

No questions at this time.

3. Applicant's Long Range Plan

Is this application consistent with your long-range plan?

☐ Yes ☐ No

If "No" is checked, please provide an explanation.

4. Clear Public Need

A. Explain how it was determined there was a need for the proposal in the proposed service area.

B. Please discuss the emergent nature of the proposed application (i.e. excessive down time, lack of available part s for the existing scanner, etc.).

C. Provide the primary and secondary service area towns for The Stamford Hospital's ("TSH") MRI service.

D. Provide the following information for TSH's existing MRI scanners at all locations:

Facility Name & Location	MRI Description (i.e. Tesla, Open, Fixed, etc.)	First Year of Operation	CON Docket Number

E. Provide the units of service (i.e. procedure, scan, visit, etc.) for the past three fiscal years for each MRI scanner operated by TSH by location.

F. Provide the projected units of service (i.e. procedure, scans, visits, etc.) for each of the MRI scanners operated by TSH for the first three years of operation of the proposed MRI scanner. **Include the derivation/calculation.**

G. Please discuss the capacity for each of TSH's existing MRI scanner.

H. Provide the hours of operation of all existing *and* proposed MRI scanners operated by TSH.

I. What will be the effect of your proposal on existing providers (i.e. patient volume, financial stability, quality of care, etc.)?

J. Provide the information as outlined in the following table concerning the existing providers' (in the Applicant's PSA and SSA) current operations:

Description of Service[1]	Provider Name and Location	Hours and Days of Operation[2]	Current Utilization[3]

[1] If proposal concerns imaging equipment, provide a description of the equipment used by the Provider, if known. For MRI scanners, include Tesla strength, and whether or not the scanner is considered to be "open" or "closed".
[2] Specify days of the week and start and end time for each day.
[3] Number of scans performed on specified scanner by Provider for the most recent 12 month period, if known.

K. Will your proposal remedy any of the following barriers to access? Please provide an explanation.

☐ Cultural ☐ Transportation

☐ Geographic ☐ Economic

☐ None of the above ☐ Other (Identify) _____

If you checked other than None of the above, please provide an explanation.

L. Provide copies of any of the following plans, studies or reports related to your proposal:

- ☐ Epidemiological studies
- ☐ Public information reports
- ☐ Needs assessments
- ☐ Market share analysis
- ☐ Other (Identify)
- ☐ None, *Explain* why no reports, studies or market share analysis was undertaken related to the proposal:

5. Quality Measures

A. Check off all the Standard of Practice Guidelines that will be utilized by the Applicant for the proposed service. Please submit the most recent copy of each report related to the proposal:

- ☐ American College of Cardiology
- ☐ National Association of Child Bearing Centers
- ☐ Report of the Inter-Council for Radiation Oncology
- ☐ National Committee for Quality Assurance
- ☐ American College of Obstetricians & Gynecologists
- ☐ American College of Radiology
- ☐ Public Health Code & Federal Corollary
- ☐ American College of Surgeons
- ☐ Substance Abuse Society and Mental Health Services Administration
- ☐ Other, Specify:

B. Describe in detail how the Applicant plans to meet the each of the guidelines checked off above.

C. Submit a list of **all** key professional and administrative personnel, including the Applicant's Chief Executive Officer (CEO) and Chief Financial Officer (CFO), Medical Director, physicians, nurses, therapists, counselors, etc., related to the proposal and a copy of their Curriculum Vitae.

***Note**: For physicians, please provide a list of hospitals where the physicians have admitting privileges.*

D. Provide a copy of the most recent inspection reports and/or certificate for your facility:

- ☐ DPH
- ☐ Fire Marshall Report
- ☐ AAAHC
- ☐ Other:
- ☐ JCAHO
- ☐ Other States Health Dept. Reports
- ☐ (New Out-of-State Providers)
- ☐ AAAASF

Note: Above referenced acronyms are defined below. [1]

E. Provide a copy of the following (as applicable):

- ☐ A copy of the related Quality Assurance plan
- ☐ Protocols for service (new service only)

6. Improvements to Productivity and Containment of Costs

In the past year has your facility undertaken any of the following activities to improve productivity and contain costs?

- ☐ Energy conservation
- ☐ Application of technology (e.g., computer systems, robotics, telecommunication systems, etc.)
- ☐ None of the above
- ☐ Other (identify):
- ☐ Group purchasing
- ☐ Reengineering

7. Miscellaneous

A. Will this proposal result in new (or a change to) your teaching or research responsibilities?

☐ Yes ☐ No

If you checked "Yes," please provide an explanation.

B. Are there any characteristics of your patient/physician mix that makes your proposal unique?

☐ Yes ☐ No

If you checked "Yes," please provide an explanation.

8. Financial Information

A. Type of ownership: (Please check off all that apply)

- ☐ Corporation (Inc.)
- ☐ Partnership
- ☐ Joint Venture
- ☐ Other (Specify):
- ☐ Limited Liability Company (LLC)
- ☐ Professional Corporation (PC)

[1] DPH – Department of Public Health; JCAHO – Joint Commission on Accreditation of Hospitals Organization; AAAHC – Accreditation Association for Ambulatory Health Care, AAAASF – American Association for Accreditation of Ambulatory Surgery Facilities, Inc.

B. Provide the following financial information:

i) 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 Applicant is a hospital that has filed its most recently completed fiscal year audited financial statements, the Applicant may reference that filing for this proposal.

ii) Provide the total current assets balance as of the date of submission of this application.

iii) Provide a copy of the most recently completed internal monthly financial statements, including utilization volume totals to date. (For new service only)

9. Major Cost Components/Total Capital Expenditure

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

Medical Equipment (Purchase)	
Major Medical Equipment (Purchase)	
Non-Medical Equipment (Purchase)*	
Land/Building (Purchase)	
Construction/Renovation	
Other (Non-Construction) Specify:_____	
Total Capital Expenditure	
Medical Equipment (Lease (FMV))	
Major Medical Equipment (Lease (FMV)	
Non-Medical Equipment (Lease (FMV))*	
Fair Market Value of Space – (Capital Leases Only)	
Total Capital Cost	
Capitalized Financing Costs (Informational Purpose Only)	
Total Capital Expenditure with Cap. Fin. Costs	

* Provide an itemized list of all non-medical equipment.

10. Renovation Information

A. Provide a detailed description of the proposed new construction/renovation including the related gross square feet of new construction/renovation.

B. Provide all schematic drawings related to the project that are available, including existing and proposed floor plans.

C. Please explain how the patients will be transitioned from the existing MRI scanner at the Hospital campus to the proposed temporary mobile MRI scanner to the new proposed 1.5 Tesla MRI scanner.

D. Explain how the proposed new construction or renovations will affect the delivery of patient care.

11. Capital Equipment Lease

If the CON involves any capital equipment lease and/or purchase, please answer all of the following that apply:

What is the anticipated residual value at the end of the lease or loan term?	$_____
What is the useful life of the equipment?	___ Years
Please submit a copy of the vendor quote or invoice as an attachment. **For the temporary mobile MRI and the proposed MRI scanner.**	
Please submit a schedule of depreciation for the purchased equipment as an attachment.	

12. Type of Financing

A. Check type of funding or financing source and identify the following anticipated requirements and terms: (Check all which apply)

☐ Applicant's equity:

Source and amount:

Operating Funds Source/Entity Name Available Funds	$_____ _____
Contributions	$_____
Funded depreciation	$_____
Other	$_____

☐ Grant:

Amount of grant	_____
Funding institution/ entity	_____

☐ Conventional loan or
☐ Connecticut Health and Educational Facilities Authority (CHEFA) financing:

Current CHEFA debt	_____
CON Proposed debt financing	_____
Interest rate	_____%
Monthly payment	_____
Term	_____ Years
Debt service reserve fund	_____

☐ Lease financing or
☐ CHEFA Easy Lease Financing:

Current CHEFA Leases	_____
CON Proposed lease financing	_____
Fair market value of leased assets at lease inception	_____
Interest rate	_____%
Monthly payment	_____
Term	_____ Years

☐ Other financing alternatives:

Amount	
Source (e.g., donated assets, etc.)	

B. Please provide copies of the following, if applicable:
   i. Letter of interest from the lending institution,
   ii. Letter of interest from CHEFA,
   iii. Amortization schedule (if not level amortization payments),
   iv. Lease agreement.

13. Revenue, Expense and Volume Projections

A.1. Payer Mix Projection

Please provide both the current payer mix and the projected payer mix with the CON proposal for the Total Facility based on the Gross Patient Revenue in the following reporting format:

Total Facility Description	Current Payer Mix	Year 1 Projected Payer Mix	Year 2 Projected Payer Mix	Year 3 Projected Payer Mix
Medicare*	%	%	%	%
Medicaid* (includes other medical assistance)				
CHAMPUS and TriCare				
Total Government Payers				
Commercial Insurers*				
Uninsured				
Workers Compensation				
Total Non-Government Payers				
Payer Mix	100.0%	100.0%	100.0%	100.0%

*Includes managed care activity.

A.2. Please describe the impact of the proposal on the interests of consumers of health care services and the payers of such services.

C. Provide the following for the financial and statistical projections:

i) A summary of revenue, expense and volume statistics, without the CON project, incremental to the CON project, and with the CON project. **See attached, Financial Attachment I.** Please note that the actual results for the fiscal year reported in the first column must agree with the Applicant's audited financial statements.

ii) Please complete the enclosed, OHCA's **Financial Attachment II**.

iii) The assumptions utilized in developing the projections (e.g., FTE's by position, volume statistics, other expenses, revenue and expense % increases, project commencement of operation date, etc.).**Be sure to include all related assumptions for the temporary mobile MRI scanner.**

iv) An explanation for any projected incremental losses from operations contained in the financial projections that result from the implementation and operation of the CON proposal.

v) Provide a copy of the rate schedule for the proposed service.

vi) Describe how this proposal is cost effective.

The Stamford Hospital

13. C (i). Please provide one year of actual results and three years of projections of **Total Facility** revenue, expense and volume statistics without, incremental to and with the CON proposal in the following reporting format:

Total Facility: Description	FY Actual Results	FY Projected W/out CON	FY Projected Incremental	FY Projected With CON	FY Projected W/out CON	FY Projected Incremental	FY Projected With CON	FY Projected W/out CON	FY Projected Incremental	FY Projected With CON
NET PATIENT REVENUE										
Non-Government				$0			$0			$0
Medicare				$0			$0			$0
Medicaid and Other Medical Assistance				$0			$0			$0
Other Government				$0			$0			$0
Total Net Patient Patient Revenue	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Operating Revenue										
Revenue from Operations	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
OPERATING EXPENSES										
Salaries and Fringe Benefits				$0			$0			$0
Professional / Contracted Services				$0			$0			$0
Supplies and Drugs				$0			$0			$0
Bad Debts				$0			$0			$0
Other Operating Expense				$0			$0			$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Depreciation/Amortization				$0			$0			$0
Interest Expense				$0			$0			$0
Lease Expense				$0			$0			$0
Total Operating Expense	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gain/(Loss) from Operations	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Plus: Non-Operating Revenue				$0			$0			$0
Revenue Over/(Under) Expense	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FTEs				0			0			0

*Volume Statistics:
Provide projected inpatient and/or outpatient statistics for any new services and provide actual and projected inpatient and/or outpatient statistics for any existing services which will change due to the proposal.

The Stamford Hospital

13.C(ii). Please provide three years of projections of incremental revenue, expense and volume statistics **attributable to the proposal** in the following reporting format:

Type of Service Description
Type of Unit Description:
# of Months in Operation

Year 1	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FY Projected Incremental Total Incremental Expenses:		Rate	Units	Gross Revenue	Allowances/ Deductions	Charity Care	Bad Debt	Net Revenue	Operating Expenses	Gain/(Loss) from Operations
				Col. 2 * Col. 3				Col.4 - Col.5 -Col.6 - Col.7	Col. 1 Total * Col. 4 / Col. 4 Total	Col. 8 - Col. 9
Total Facility by Payer Category:										
Medicare				$0				$0	$0	$0
Medicaid		$0		$0				$0	$0	$0
CHAMPUS/TriCare		$0		$0				$0	$0	$0
Total Governmental			0	$0	$0	$0	$0	$0	$0	$0
Commericial Insurers		$0	5	$0				$0	$0	$0
Uninsured		$0	2	$0				$0	$0	$0
Total NonGovenrment		$0	7	$0	$0	$0	$0	$0	$0	$0
Total All Payers		$0	7	$0	$0	$0	$0	$0	$0	$0

JEFFERS & IRELAND
PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
55 WALLS DRIVE
FAIRFIELD, CONNECTICUT 06824

KAREN A. JEFFERS
PAMELA T. IRELAND
STEPHEN M. COWHERD
CAROLYN R. LINSEY

TINA PASSALARIS
JASON A. MARSH
MICHELLE S. GOGLIA

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CONNECTICUT OFFICE OF HEALTH CARE ACCESS

TELEPHONE (203) 259-7900
TELECOPIER (203) 259-1070
WWW.JEFFIRE.COM

November 21, 2007

VIA COURIER
Cristine A. Vogel, Commissioner
Office of Health Care Access
410 Capitol Avenue
MS #13HCA
P.O. Box 340308
Hartford, CT 06134-0308

Re: The Stamford Hospital ("TSH")
Docket Number 07-31059-CON
Emergency Certificate of Need for the Acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner

Dear Commissioner Vogel:

On behalf of the above-named Applicant, enclosed please find an original and five (5) copies of TSH's Emergency Certificate of Need Application concerning the acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner for its main hospital campus. An electronic copy of the CON Application along with the filing fee is also enclosed.

TSH would like to thank the Office of Health Care Access for its prompt consideration of this request. Should you have any questions or if I can be of further assistance, please do not hesitate to contact me at (203) 259-7900.

Very truly yours,

Stephen M. Cowherd

SMC:rrc

cc: David L. Smith, Stamford Health System (w/enc.)

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HEALTH CARE ACCESS

HOSPITAL AFFIDAVIT

Applicant: The Stamford Hospital

Project Title: Emergency Certificate of Need for the Acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner

I, Brian G. Grissler (Name), Chief Executive Officer (Position – CEO or CFO)

of The Stamford Hospital being duly sworn, depose and state that the (Hospital Name) information submitted in this Certificate of Need application is accurate and correct to the best of my knowledge. With respect to the financial impact related to this CON application, I hereby affirm that:

1. The proposal will have a capital expenditure in excess of $15,000,000.

   ☐ Yes ☒ No

2. The combined total expenses for the proposal's first three years of operation will exceed one percent of the actual operating expenses of the Hospital for the most recently completed fiscal year as filed with the Office of Health Care Access.

   ☐ Yes ☒ No

Signature

11/19/07
Date

Subscribed and sworn to before me on Nov 19, 2007

Notary Public/Commissioner of Superior Court

My commission expires:

ILAINE PEREZ
NOTARY PUBLIC
MY COMMISSION EXPIRES APR. 30, 2011

OFFICE OF HEALTH CARE ACCESS

REQUEST FOR NEW CERTIFICATE OF NEED

FILING FEE COMPUTATION SCHEDULE

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CONNECTICUT OFFICE OF HEALTH CARE ACCESS

APPLICANT:	The Stamford Hospital	FOR OHCA USE ONLY:	
PROJECT TITLE:	Emergency Certificate of Need for the Acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner	1. Check logged (Front desk)	DATE: 11.21.07 INITIAL: lmg
		2. Check rec'd (Clerical/Cert.)	11/21/07
		3. Check correct (Superv.)	KH 11/21/07
DATE:	November 21, 2007	4. Check logged (Clerical/Cert).)	11/21/07

SECTION A – NEW CERTIFICATE OF NEED APPLICATION	
1. Check statute reference as applicable to CON application (see statute for detail):	
_____ 19a-638.Additional function or service, change of ownership, service termination. **No Fee Required.**	
_____ 19a-639 Capital expenditure exceeding $3,000,000 or capital expenditure exceeding $3,000,000 for major medical equipment, CT scanner, PET scanner, PET/CT scanner, MRI scanner, cineangiography equipment or linear accelerator. **Fee Required.**	
_____ 19a-638 and 19a-639. **Fee Required.**	
2. Enter $0 on "Total Fee Due" line (SECTION B) if application is required pursuant to Section 19a-638 only, otherwise go on to line 3 of this section.	
3. Enter $400 on "Total Fee Due" line (SECTION B) if application is for capital expenditure for major medical equipment, imaging equipment or linear accelerator less than $3,000,000	
4. Section 19a-639 fee calculation (applicable if section 19a-639 capital expenditure for major medical equipment, imaging equipment or linear accelerator exceeding $3,000,000 or other capital expenditure exceeding $3,000,000 is checked above **OR** if both 19a-638 and 19a-639 are checked):	
a. Base fee: _____	$ 1,000.00
b. Additional Fee: (Capital Expenditure Assessment)_____	$_____.00
(To calculate: Total requested Capital Expenditure/Cost excluding capitalized financing costs multiplied times .0005 and round to nearest dollar.) ($_____ x .0005)	$_____.00
c. Sum of base fee plus additional fee: (Lines A4a + A4b)_____	
d. Enter the amount shown on line A4c. on "Total Fee Due" line (SECTION B).	
SECTION B TOTAL FEE DUE:_____	$ 400.00

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

RECEIVED

2007 NOV 21 PM 3:15

CONNECTICUT OFFICE OF HEALTH CARE ACCESS

FILING FEE COMPUTATION SCHEDULE

APPLICANT: The Stamford Hospital	FOR OHCA USE ONLY:
PROJECT TITLE: Emergency CON Certificate of Need for the Acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner	DATE / INITIAL 1. Check logged (Front desk) _____ _____ 2. Check rec'd (Clerical/Cert.) _____ _____ 3. Check correct (Superv.) _____ _____ 4. Check logged (Clerical/Cert).) _____ _____
DATE: November 21, 2007	

SECTION A – NEW CERTIFICATE OF NEED APPLICATION

1. Check statute reference as applicable to CON application (see statute for detail):

_____ 19a-638.Additional function or service, change of ownership, service termination.
No Fee Required.

_____ 19a-639 Capital expenditure exceeding $3,000,000 or capital expenditure exceeding $3,000,000 for major medical equipment, CT scanner, PET scanner, PET/CT scanner, MRI scanner, cineangiography equipment or linear accelerator.
Fee Required.

_____ 19a-638 and 19a-639.
Fee Required.

2. Enter $0 on "Total Fee Due" line (SECTION B) if application is required pursuant to Section 19a-638 only, otherwise go on to line 3 of this section.

3. Enter $400 on "Total Fee Due" line (SECTION B) if application is for capital expenditure for major medical equipment, imaging equipment or linear accelerator less than $3,000,000

4. Section 19a-639 fee calculation (applicable if section 19a-639 capital expenditure for major medical equipment, imaging equipment or linear accelerator exceeding $3,000,000 or other capital expenditure exceeding $3,000,000 is checked above **OR** if both 19a-638 and 19a-639 are checked):

a. Base fee: _____ $ 1,000.00
b. Additional Fee: (Capital Expenditure Assessment)_____ $_____.00
(To calculate: Total requested Capital Expenditure/Cost excluding capitalized financing costs multiplied.times .0005 and round to nearest dollar.) ($_____ x .0005) $_____.00
c. Sum of base fee plus additional fee: (Lines A4a + A4b)_____
d. Enter the amount shown on line A4c. on "Total Fee Due" line (SECTION B).

SECTION B TOTAL FEE DUE:_____ $ 400.00

499156243924 499157 REV2 07/06 8410007940

TOUCH HOLD: DOCUMENT UP TO THE LIGHT TO VIEW TRUE WATERMARK — **OFFICIAL CHECK** — TOUCH HOLD: DOCUMENT UP TO THE LIGHT TO VIEW TRUE WATERMARK 23-97/1020

Check Number: 051217429

Date: November 19, 2007

WACHOVIA

Pay to the order of Treasurer State of CT **$400.00**

Four Hundred and 00/100

Drawer: Wachovia Bank, National Association

For

Authorized Signature

Issued By Integrated Payment Systems Inc., Englewood, Colorado
JPMorgan Chase Bank, N.A., Denver, Colorado

Security Features Details on Back

00068 (Rev 05)

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

Please complete all questions. If any question is not relevant to your project, Not Applicable may be an acceptable response. Your Certificate of Need application will be eligible for submission no earlier than November 9, 2007, and may be submitted no later than January 8, 2008. The Analysts assigned to your application are Steven W. Lazarus and Alexis G. Fedorjaczenko and they may be reached at the Office of Health Care Access at (860) 418-7001.

Note: Due to the emergent nature of this application, Office of Health Care Access anticipates that The Stamford Hospital will complete and submit the enclosed application no later than November 21, 2007.

Docket Number: 07-31059-CON

Applicant Name: The Stamford Hospital

Contact Person: David L. Smith
Contact Title: Senior Vice President, Strategy and Market Development
The Stamford Hospital
Contact Address: 30 Shelburne Road
P.O. Box 9317
Stamford, CT 06904

Project Location: Stamford

Project Name: Emergency Certificate of Need for the Acquisition of a 1.5 Tesla Magnetic Resonance Imaging Scanner

Type proposal: Section 19a-639, C.G.S.

Est. Capital Expenditure: $2,113, 831

1. Expansion of Existing or New Service

What services are currently offered at your facility that the proposed expansion or new service will augment or replace? Please list.

Augment: *Not applicable.*

Replace: *The Stamford Hospital ("TSH" or the "Hospital") is proposing to purchase a new 1.5 Tesla Signa HDx magnetic resonance imaging ("MRI") scanner (the "New Unit") from GE Healthcare, a division of the General Electric Company ("GE Healthcare"), to replace the only MRI scanner currently operating at TSH's main hospital campus (the "Old Unit"). The Old Unit, a refurbished 1991 Signa 1.5 Tesla Horizon MRI that TSH acquired from GE Medical Systems in 1998, (a) is available to inpatients and patients treated in TSH's Emergency Department; (b) operates twenty-four (24) hours per day, seven (7) days per week; and (c) performed 7,338 scans during FY 2007.*

The Old Unit is more than fifteen (15) years old, is fully depreciated and its functionality has been surpassed by new technologies. Installation of the New Unit will immediately improve MRI services in terms of faster scan times, more robust clinical applications and improved image quality and resolution.

The installation of the New Unit also will allow TSH to comply with a City of Stamford ordinance which prohibits MRI scanners and similar pieces of equipment from being cooled using the municipal water supply. The Old Unit is incapable of meeting this ordinance and is only able to operate subject to a grandfathering provision that allows certain older equipment to operate until it is replaced.

TSH will use the New Unit to perform the same types of scans as the Old Unit. Unlike the Old Unit, the New Unit also is capable of enhanced cardiac function and brain perfusion scans. This added functionality will complement the current diagnostic imaging services available at the main Hospital campus.

The New Unit will be installed in the same space (approximately 1,995 square feet) *where the Old Unit is currently installed. Installation of the New Unit will require modest electrical and mechanical renovations over a two (2)*

month period to support the new magnet. The key renovations include installation of cabinetry and a new ceiling as well as all associated electrical wiring and piping installed and connected to all new MRI components and associated equipment. No redesign or reshielding of the space is required.

2. State Health Plan

No questions at this time.

3. Applicant's Long Range Plan

Is this application consistent with your long-range plan?

☒ Yes ☐ No

If "No" is checked, please provide an explanation.

4. Clear Public Need

A. Explain how it was determined there was a need for the proposal in the proposed service area.

As noted above, the Old Unit is more than fifteen years old and its functionality has been surpassed by new technologies. The Old Unit also is the only MRI operating on the Hospital's main campus. This results in it being the only MRI that can serve hospital inpatients who cannot access TSH's other MRIs available at TSH's Tully Health Center and Darien Imaging Center outpatient locations. The Old Unit is also the only MRI available to patients treated in TSH's Emergency Department.

MRI services are crucial to the Hospital's diagnostic imaging capabilities in general and its designation as a stroke center in particular. The Old Unit operates 24-hours per day, 7-days a week, and in Fiscal Year 2007 it performed 7,338 scans (an average of 24 scans per weekday and 10 per weekend day).

The age of the Old Unit, its constant use, ongoing maintenance requirements, and the scarcity of replacement parts, has greatly increased the risk that a malfunction in this equipment could result it in being placed out of service for an extended period of time. The quality and resolution of images from the Old Unit is also less than optimal and there is a continued risk that further degradation in image quality could occur rapidly. If such events were to occur, quality of

care for patients accessing the main Hospital campus would be severely compromised.

Installation of the New Unit will immediately improve MRI services in terms of faster scan times, more robust clinical applications and the improved image quality that a new MRI magnet and updated software will provide.

B. Please discuss the emergent nature of the proposed application (i.e. excessive down time, lack of available parts for the existing scanner, etc.).

In the interest of maintaining continued access to high quality healthcare for its patients, TSH believes it is vital that the New Unit be installed on an expedited timetable. The Old Unit is more than fifteen years old. Its constant use, ongoing maintenance requirements and the scarcity of replacement parts, has greatly increased the risk that a malfunction in this equipment could result it in being placed out of service for an extended period of time. As noted above, this would seriously compromise the ability of TSH to treat and diagnose patients at the main Hospital campus.

The quality of images from the Old Unit is also less than optimal and there is a continued risk that further degradation in image quality could occur rapidly. In order to avoid a situation where there is no operable MRI scanner to service patients at the Hospital's main campus, TSH has worked out an arrangement with GE Healthcare whereby the New Unit could be delivered and installed by no later than December 31, 2007. In the interim period following removal of the Old Unit and preceding installation of the New Unit, a modest two (2) month refurbishment of the space housing the Old Unit is planned in order to accommodate the New Unit and a temporary mobile MRI scanner will be leased by TSH and put into operation on the Hospital's main campus.

C. Provide the primary and secondary service area towns for The Stamford Hospital's ("TSH") MRI service.

The primary service area towns are Stamford and Darien, CT. The secondary service area towns are New Canaan, Greenwich, Old Greenwich, Riverside, Cos Cob, Norwalk, Wilton, Weston and Westport.

D. Provide the following information for TSH's existing MRI scanners at all locations:

Facility Name & Location	**MRI Description** (i.e. Tesla, Open, Fixed, etc.)	**First Year of Operation**	**CON Docket Number**
TSH	*1.5 Tesla*	*1998*	*As noted in TSH's letter to OHCA dated November 6, 2007, TSH acquired the Old Unit from GE Medical Systems in 1998 for $399,000 after application of a $500,000 trade-in allowance. At that time, TSH traded in a 1.5 Signa 5x MRI built in 1994 (the "1994 Unit") for which it had obtained a CON under Docket No. 93-528R. Senior administration and Radiology Department staff at TSH, none of whom were affiliated with TSH in 1998, only recently learned that the Old Unit was purchased below the former statutory threshold amount of $400,000 and, thereby, without CON approval as was permitted under the regulatory framework at that time.*
Tully Health Center	*1.5 Tesla*	*2002*	*00-558R, which modified CON authorization under 98-503*
Darien Imaging	*1.5 Tesla*	*2006*	*04-30369-WVR*

E. Provide the units of service (i.e. procedure, scan, visit, etc.) for the past three fiscal years for each MRI scanner operated by TSH by location.

MRI Volumes for All TSH Units 2005 – 2007

	2005	2006	2007
TSH Main Campus	7,468	6,957	7,325
Tully Health Center	4,471	4,360	3,991
Darien Imaging Center*	441	674	1,653

Note: This facility operated a .2T Open MRI until June 2006.

F. Provide the projected units of service (i.e. procedure, scans, visits, etc.) for each of the MRI scanners operated by TSH for the first three years of operation of the proposed MRI scanner. **Include the derivation/calculation.**

Projected Volumes for New Unit 2008 – 2010

2008	2009	2010
7,825	7,950	8,075

The projected volumes set forth above are based on the following assumptions and calculations:

2008 – Given the increased throughput (speed) of the New Unit and its enhanced functionality (cardiac function and brain perfusion), it is assumed that the New Unit, on average, will perform 2 additional scans per day for 250 days per year, for a total of 500 additional scans per year over 2007.

2009 – Given that efficiencies in using the New Unit are expected to continue to increase as professional and technical staff become more familiar with the technology, it is assumed that the New Unit will accommodate an additional ½ scan per day for 250 days per year, for a total of 125 additional scans per year over 2008.

2010 – Due to the same efficiencies described above, it is assumed that the New Unit, on average, will accommodate an additional ½ scan per day for 250 days per year, for a total of 125 additional scans per year over 2009.

Note: Applicant was unable to develop data responsive to this request for the Tully Health Center ("Tully") and Darien Imaging Center ("DIC") MRIs in the time allotted for submitting this emergency CON application. As neither the Tully nor DIC MRI units are proximate to the TSH main campus or transportable via a mobile van, these MRI scanners cannot assist TSH in maintaining continued access to MRI services that is vital to inpatients and Emergency Department patients. Therefore, since the projected volumes for the Tully and DIC outpatient scanners is not material to the Hospital's showing that the need for the New Unit is of an emergency nature under §19a-638(b), TSH respectfully requests that OHCA not require this information for purposes of issuing a final decision in this docket.

G. Please discuss the capacity for each of TSH's existing MRI scanners.

MRI Capacity of Old Unit

MRI - Hospital				
Open	Close	Hrs	Avail	Adj
7:00 AM	10:00 PM	14.0	34	25
7:00 AM	10:00 PM	14.0	34	25
7:00 AM	10:00 PM	14.0	34	25
7:00 AM	10:00 PM	14.0	34	25
7:00 AM	10:00 PM	14.0	34	25
8:00 AM	4:00 PM	7.5	18	14
8:00 AM	4:00 PM	7.5	18	14
	Total	**85**	204	153

Annual Volumes		**Actual**	**Utilization**	
Avail	**Adj (75%)**	**FY 07**	**Avail**	**Adj (75%)**
10,608	**7,956**	**7,325**	**69%**	**92%**

As demonstrated by the above table, the Old Unit is open from 7:00am through 10:00pm, Monday through Fridays, and from 8:00am through 4:00pm, on Saturdays and Sundays. This means that there are 85 available hours for scanning in any given week. The average scanning time is 25 minutes, which means that there are approximately 204 scans that can be scheduled in any given week (5100 minutes / 25 minutes) or 10,608 scans per year (204 per week x 52 weeks) if TSH were operating the Old Unit at 100% capacity. TSH, however, prefers to only schedule approximately 153 scans per week or 7,956 scans per year – which equates to operating the unit at 75% of total capacity -- so that emergency cases can be accommodated. In 2007, 7,325 scans were performed – which equates to operating the unit at 69% of total capacity but 92% of available capacity at the more preferable 75% level.

Note: Applicant was unable to develop data responsive to this request for the Tully and DIC MRIs in the time allotted for submitting this emergency CON application. As neither the Tully nor DIC MRI units are proximate to the TSH main campus or transportable via a mobile van, these MRI scanners cannot assist TSH in maintaining continued access to MRI services that is vital to inpatients and Emergency Department patients. Therefore, since the capacity of the Tully and DIC outpatient scanners is not material to the Hospital's showing that the need for the New Unit is of an emergency nature under §19a-

638(b), TSH respectfully requests that OHCA not require this information for purposes of issuing a final decision in this docket.

H. Provide the hours of operation of all existing *and* proposed MRI scanners operated by TSH.

TSH Old Unit: Monday through Friday, 7:00am to 10:00 pm.
Saturday through Sunday, 8:00am to 4:00 pm.
Call after hours.

TSH New Unit: Monday through Friday, 7:00am to 10:00 pm.
Saturday through Sunday, 8:00am to 4:00pm.
Call after hours.

Tully Health Center: Monday through Friday, 8:00am to 8:00pm.
Saturday through Sunday, 8:00am to 4:00pm.

Darien Imaging Center: Monday through Friday, 8:00am to 4:00pm.

I. What will be the effect of your proposal on existing providers (i.e. patient volume, financial stability, quality of care, etc.)?

There will be no impact on existing providers as TSH's proposal is for a replacement MRI on its main hospital campus.

J. Provide the information as outlined in the following table concerning the existing providers' (in the Applicant's PSA and SSA) current operations:

Description of Service[1]	Provider Name and Location	Hours and Days of Operation[2]	Current Utilization[3]
.7 Tesla Open	Dr. Mark H. Camel Orthopaedic & Neurosurgery Associates, P.C. 6 Greenwich Office Park Greenwich, CT 06831	8:00am – 5:00pm, M-F	Unknown
1.5 Tesla	Greenwich Hospital 5 Perryridge Rd. Greenwich, CT 06830	7:30am – 9:00pm, M-F 7:30am – 6:45pm, Sat/Sun	Unknown
3.0 Tesla	Greenwich Hospital 5 Perryridge Rd. Greenwich, CT 06830	7:30am – 9:30pm, M-F	Unknown
1.5 Tesla	Greenwich Hospital Diagnostic Center 2015 West Main St. Stamford, CT 06902	7:30am – 5:00pm, M-F	Unknown
1.5 Tesla	Advanced Radiology Consultants 1315 Washington Blvd. Stamford, CT 06902	7:00am – 10:15pm, M-F 7:15am – 2:15pm, Sat	Unknown
1.5 Tesla	Norwalk Hospital 34 Maple Street Norwalk, CT 06850	7:30am – 9:40 pm, M-F 7:30am – 3:30pm, Sat/Sun	Unknown
1.5 Tesla	Norwalk Radiology and Mammography Center 148 East Avenue Norwalk, CT 06851	7:00am – 7:00pm, M-Th 7:00am – 5:00pm, F 7:00am – 11:00am, Sat	Unknown
.7 Tesla Open	Norwalk Radiology and Mammography Center 148 East Avenue Norwalk, CT 06851	7:00am – 7:00pm, M-Th 7:00am – 5:00pm, F 7:00am – 11:00am, Sat	Unknown
23 Tesla Open	Robert D. Russo, M.D. and Associates Radiology 111 East Avenue Suite 100 Norwalk, CT 06851	7:30am – 5:00 pm, M-F 8:00am – 12:00pm, Sat	Unknown

[1] If proposal concerns imaging equipment, provide a description of the equipment used by the Provider, if known. For MRI scanners, include Tesla strength, and whether or not the scanner is considered to be "open" or "closed".
[2] Specify days of the week and start and end time for each day.
[3] Number of scans performed on specified scanner by Provider for the most recent 12 month period, if known.

K. Will your proposal remedy any of the following barriers to access? Please provide an explanation.

☐	Cultural	☐	Transportation
☐	Geographic	☐	Economic
☒	None of the above	☐	Other (Identify) _____

If you checked other than None of the above, please provide an explanation.

L. Provide copies of any of the following plans, studies or reports related to your proposal:

☐ Epidemiological studies
☐ Public information reports
☐ Needs assessments
☐ Market share analysis

☐ Other (Identify)
☒ None, *Explain* why no reports, studies or market share analysis was undertaken related to the proposal:

There were no reports, studies or market share analysis done for this project. The need for the New Unit was determined after considering (i) the advanced age of the Old Unit and its technological limitations; and (ii) the availability of advanced MRI technology which would vastly improve the diagnosis and treatment of patients.

5. Quality Measures

A. Check off all the Standard of Practice Guidelines that will be utilized by the Applicant for the proposed service. Please submit the most recent copy of each report related to the proposal:

☐ American College of Cardiology	☐ National Committee for Quality Assurance	☐ Public Health Code & Federal Corollary
☐ National Association of Child Bearing Centers	☐ American College of Obstetricians & Gynecologists	☐ American College of Surgeons
☐ Report of the Inter-Council for Radiation Oncology	☒ American College of Radiology	☐ Substance Abuse Society and Mental Health Services Administration

☐ Other, Specify:

The most recent American College of Radiology ("ACR") Practice Guidelines for Performing and Interpreting Magnetic Resonance Imaging are provided at Exhibit A.

B. Describe in detail how the Applicant plans to meet the each of the guidelines checked off above.

TSH is currently accredited by ACR for the Old Unit. A copy of the ACR accreditation certificate is attached at Exhibit B. TSH will pursue ACR accreditation for the proposed New Unit, which will meet or exceed applicable ACR performance standards and be subject to regular quality assurance measures.

TSH's Radiology Department operates, and will continue to operate, in strict compliance with the ACR practice guidelines. TSH maintains written policies and procedures relating to MRI scanning which follow the published ACR practice guidelines. Such policies include quality control procedures for machine maintenance and calibration and patient-specific quality control procedures.

In addition, medical staff, technical staff and physicists in the Radiology Department are current with continuing medical education ("CME") requirements as recommended by the ACR. Current staff in the Radiology Department also meet or exceed the qualifications for personnel as published in the ACR practice guidelines.

All these performance standards will be maintained in connection with the proposed New Unit.

Finally, training on the New Unit will be conducted by GE Healthcare. TSH personnel using the New Unit will be fully trained before treating any patients.

C. Submit a list of **all** key professional and administrative personnel, including the Applicant's Chief Executive Officer (CEO) and Chief Financial Officer (CFO), Medical Director, physicians, nurses, therapists, counselors, etc., related to the proposal and a copy of their Curriculum Vitae.

***Note**: For physicians, please provide a list of hospitals where the physicians have admitting privileges.*

Curriculum Vitaes for the following key professional and administrative personnel are included at Exhibit C:

- *Brian G. Grissler, Chief Executive Officer*
- *Derrick Hollings, Chief Financial Officer*
- *David J. Sack, Director of Radiology and Radiation Therapy, TSH*
- *Harvey L. Hecht, M.D. ,Acting Chairman, TSH Department of Radiology and Radiation Therapy*
- *Ravi Thakur, M.D., Radiologist*
- *Michael H. King, M.D., Radiologist*
- *Inna Shtramel, Chief MRI Technologist, TSH*
- *Barbara Demchuk, Senior MRI Technologist, TSH*

The physicians identified above only have privileges at TSH.

D. Provide a copy of the most recent inspection reports and/or certificate for your facility:

☒	DPH	☒	JCAHO
☒	Fire Marshall Report	☐	Other States Health Dept. Reports (New Out-of-State Providers)
☐	AAAHC		AAAASF
☐	Other:		

Note: Above referenced acronyms are defined below. [1]

See Exhibit D for copies.

E. Provide a copy of the following (as applicable):

☒ A copy of the related Quality Assurance plan
☐ Protocols for service (new service only)

See Exhibit E for a copy of the most recent TSH Performance Improvement Plan and Exhibit F for protocols specific to MRI scanning. In addition, TSH follows the quality standards outlined in the ACR Practice Guidelines attached at Exhibit A.

[1] DPH – Department of Public Health; JCAHO – Joint Commission on Accreditation of Hospitals Organization; AAAHC – Accreditation Association for Ambulatory Health Care, AAAASF – American Association for Accreditation of Ambulatory Surgery Facilities, Inc.

6. Improvements to Productivity and Containment of Costs

In the past year has your facility undertaken any of the following activities to improve productivity and contain costs?

- ☒ Energy conservation
- ☒ Application of technology (e.g., computer systems, robotics, telecommunication systems, etc.)
- ☐ None of the above
- ☐ Other (identify):
- ☒ Group purchasing
- ☒ Reengineering

TSH regularly engages in the activities indicated above. As regards the Radiology Department specifically, it has undertaken efforts focused on operational, quality and facility improvements, as well as enhancing patient service. Examples include actions aimed at better scheduling and turnaround times and the continued implementation of a Picture Archiving Communication System (PACS), which will increase system wide productivity, enhance results reporting and decrease file expenses.

7. Miscellaneous

A. Will this proposal result in new (or a change to) your teaching or research responsibilities?

☐ Yes ☒ No

If you checked "Yes," please provide an explanation.

B. Are there any characteristics of your patient/physician mix that makes your proposal unique?

☐ Yes ☒ No

If you checked "Yes," please provide an explanation.

8. Financial Information

A. Type of ownership: (Please check off all that apply)

- ☒ Corporation (Inc.)
- ☐ Partnership
- ☐ Joint Venture
- ☐ Other (Specify):
- ☐ Limited Liability Company (LLC)
- ☐ Professional Corporation (PC)

B. Provide the following financial information:

i) 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 Applicant is a hospital that has filed its most recently completed fiscal year audited financial statements, the Applicant may reference that filing for this proposal.

TSH's most *recent audited financial statements are on file with OHCA.*

ii) Provide the total current assets balance as of the date of submission of this application.

TSH's current asset balance as of September 30, 2007 is $76,413,000.

iii) Provide a copy of the most recently completed internal monthly financial statements, including utilization volume totals to date. (For new service only)

Not applicable as this application relates to a replacement MRI scanner.

9. Major Cost Components/Total Capital Expenditure

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

Medical Equipment (Purchase)	$1,663,831
Major Medical Equipment (Purchase)	
Non-Medical Equipment (Purchase)*	
Land/Building (Purchase)	
Construction/Renovation	$450,000
Other (Non-Construction) Specify:_____	
Total Capital Expenditure	**$2,113,831**
Medical Equipment (Lease (FMV))	
Major Medical Equipment (Lease (FMV)	
Non-Medical Equipment (Lease (FMV))*	
Fair Market Value of Space – (Capital Leases Only)	
Total Capital Cost	**$2,113,831**
Capitalized Financing Costs (Informational Purpose Only)	
Total Capital Expenditure with Cap. Fin. Costs	**$2,113,831**

* Provide an itemized list of all non-medical equipment.

10. Renovation Information

A. Provide a detailed description of the proposed new construction/renovation including the related gross square feet of new construction/renovation.

The New Unit will be installed in the same space (approximately 1,995 square feet) *where the Old Unit is currently installed. Installation of the New Unit will require modest electrical and mechanical renovations over a two (2) month period to support the new magnet. The key renovations include installation of cabinetry and a new ceiling as well as all associated electrical wiring and piping installed and connected to all new MRI components and associated equipment. No redesign or reshielding of the space is required.*

B. Provide all schematic drawings related to the project that are available, including existing and proposed floor plans.

See Exhibit G

C. Please explain how the patients will be transitioned from the existing MRI scanner at the Hospital campus to the proposed temporary mobile MRI scanner to the new proposed 1.5 Tesla MRI scanner.

TSH will post clear and conspicuous signs directing patients to the mobile unit and, then, the New Unit. Patients will be reminded of the new accomodations as appointments are scheduled and confirmed. Staff throughout the Hospital campus also will be aware of the MRI locations and of all transitions so that they can direct patients to where they need to be.

The mobile unit will be placed against the Hospital building so that patients will have access through an enclosed connecting doorway.

D. Explain how the proposed new construction or renovations will affect the delivery of patient care.

The proposed renovations are not expected to affect the delivery of patient care. During the brief renovation period, MRI related services will not be disrupted inasmuch as the Hospital has made arrangements for a temporary mobile MRI unit to be brought onto the campus.

It is expected that the renovations will occur over a two (2) month period in a discrete area of the Hospital that currently houses the Old Unit. The area to be renovated will be sealed and cordoned off so that patients and staff do not come in contact with debris or other potential hazards.

11. Capital Equipment Lease

If the CON involves any capital equipment lease and/or purchase, please answer all of the following that apply:

What is the anticipated residual value at the end of the lease or loan term?	n/a
What is the useful life of the equipment?	5 Years
Please submit a copy of the vendor quote or invoice as an attachment. **For the temporary mobile MRI and the proposed MRI scanner.** *See Exhibit H for all purchase orders and quotes relating to the temporary mobile MRI scanner and the proposed New Unit.*	

Please submit a schedule of depreciation for the purchased equipment as an attachment.

A depreciation schedule for the purchased equipment and related renovations are attached at Exhibit I.

12. Type of Financing

A. Check type of funding or financing source and identify the following anticipated requirements and terms: (Check all which apply)

☒ Applicant's equity:

Source and amount:

Operating Funds Source/Entity Name Available Funds	$2,113,831
Contributions	$ _____
Funded depreciation	$ _____
Other	$ _____

☐ Grant:

Amount of grant	_____
Funding institution/ entity	_____

☐ Conventional loan or
☐ Connecticut Health and Educational Facilities Authority (CHEFA) financing:

Current CHEFA debt	_____
CON Proposed debt financing	_____
Interest rate	_____%
Monthly payment	_____
Term	_____ Years
Debt service reserve fund	_____

☐ Lease financing or
☐ CHEFA Easy Lease Financing:

Current CHEFA Leases	_____
CON Proposed lease financing	_____
Fair market value of leased assets at lease inception	_____
Interest rate	_____ %
Monthly payment	_____
Term	_____ Years

☐ Other financing alternatives:

Amount	_____
Source (e.g., donated assets, etc.)	_____

B. Please provide copies of the following, if applicable:
   i. Letter of interest from the lending institution,
   ii. Letter of interest from CHEFA,
   iii. Amortization schedule (if not level amortization payments),
   iv. Lease agreement.

Items (i) through (iv) are not applicable. Amortization will be level.

13. Revenue, Expense and Volume Projections

A.1. Payer Mix Projection

Please provide both the current payer mix and the projected payer mix with the CON proposal for the Total Facility based on the Gross Patient Revenue in the following reporting format:

Total Facility Description	Current Payer Mix	Year 1 Projected Payer Mix	Year 2 Projected Payer Mix	Year 3 Projected Payer Mix
Medicare*	28.4%	27.6%	27.6%	27.6%
Medicaid* (includes other medical assistance)	5.2%	5.6%	5.6%	5.6%
CHAMPUS and TriCare	0.0%	0.0%	0.0%	0.0%
Total Government Payers	**33.6%**	**33.2%**	**33.2%**	**33.2%**
Commercial Insurers*	62.0%	63.0%	63.0%	63.0%
Uninsured	2.1%	2.2%	2.2%	2.2%
Workers Compensation	2.3%	1.6%	1.6%	1.6%
Total Non-Government Payers	**66.4%**	**66.8%**	**66.8%**	**66.8%**
Payer Mix	**100.0%**	**100.0%**	**100.0%**	**100.0%**

*Includes managed care activity.

A.2. Please describe the impact of the proposal on the interests of consumers of health care services and the payers of such services.

The replacement of the Old Unit with state-of-the-art technology will provide a higher level of care. Patients requiring MRI scanning will benefit clinically from improved diagnostic capabilities, including faster scan times, more robust clinical applications, improved image quality and resolution and enhanced cardiac function and brain perfusion scanning.

Payers will also benefit due to the increased access to needed technology, enhanced efficiency and improved patient care for their beneficiaries.

No changes in the Hospital's payer mix or rate structure is expected to occur as a result of this project.

C. Provide the following for the financial and statistical projections:

i) A summary of revenue, expense and volume statistics, without the CON project, incremental to the CON project, and with the CON project. **See attached, Financial Attachment I.** Please note that the actual results for the fiscal year reported in the first column must agree with the Applicant's audited financial statements.

See Exhibit J.

ii) Please complete the enclosed, OHCA's **Financial Attachment II**.

See Exhibit K.

iii) The assumptions utilized in developing the projections (e.g., FTE's by position, volume statistics, other expenses, revenue and expense % increases, project commencement of operation date, etc.). **Be sure to include all related assumptions for the temporary mobile MRI scanner.**

Volume:

Year 1 – Assumes 2 additional scans per day at 250 days per year over 2007 volume = 500 additional scans.

Year 2 – Assumes 2.5 additional scans per day at 250 days per year over 2007 volume= 625 additional scans over the 2007 base year and 125 additional scans over Year 1.

Year 3 – Assumes 3 additional scans per day at 250 days per year over 2007 volume= 750 additional scans over the 2007 base year and 125 additional scans over Year 2.

Revenue:

The Gross Charge per scan of $4,000 is based on the expected average charge for the types of incremental scans to result from the replacement MRI.

Net Revenue is assumed to be 45% of the Gross Charge or $1,800 per scan. Thus, Net Revenue for Year 1 = $900,000 (500 x $1,800), Net Revenue for Year 2 = $1,125,000 (625 x $1,800) and Net Revenue for Year 3 = $1,350,000 (750 x $1,800).

Expenses:

Capital Expenditure is based on the replacement MRI cost of $1,663,831.

Renovation/Construction costs are $450,000.

Supply Expense is based on FY 2007 supply per case cost.

Mobile MRI Rental is $130,000, and is included in Year 1 under Operating Expenses.

Annual Maintenance is 10% of the Total MRI Capital Cost (10% x $1,633,831= $166,383) assumed per Year.

iv) An explanation for any projected incremental losses from operations contained in the financial projections that result from the implementation and operation of the CON proposal.

No losses from operations are anticipated in connection with the CON proposal.

v) Provide a copy of the rate schedule for the proposed service.

See Exhibit L.

vi) Describe how this proposal is cost effective.

This proposal is cost effective in the following ways:

- *As compared to the Old Unit, the new MRI scanner will have faster throughput, shorter scanning times and allow for more technologically advanced clinical testing and diagnosis to occur. With improved testing and diagnosis, patient outcomes should improve and the need for more expensive procedures and treatments may be avoided in many cases.*

- *Given the speed and efficiencies of the New Unit, TSH conservatively estimates that it will be able to perform two (2) additional MRI procedures per day at the main Hospital campus in the first year of operation; two and one half (2.5) additional MRI procedures per day in the second year of operation; and three (3) additional MRI procedures per day in the third year of operation. This means shorter waiting times for patients and better image quality and resolution which*

translates into more timely and effective diagnosis and treatment.

- *Simply put, the long term effects of this proposal will be to provide state-of-the art diagnostic imaging capabilities to Hospital patients thereby improving the way healthcare is delivered in the TSH service area.*

Exhibit List

Exhibit	Description
A	ACR Practice Guidelines
B	ACR Accreditation
C	Curriculum Vitae
D	TSH DPH License, Fire Marshal Report, and Joint Commission Accreditation
E	TSH Quality Assurance Plan
F	TSH MRI Protocols
G	Schematic Drawing Related to Proposal
H	Vendor Quotes and Purchase Orders
I	Depreciation Schedule
J	Financial Attachment I
K	Financial Attachment II
L	MRI Rate Schedule

EXHIBIT A

The American College of Radiology, with more than 30,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

1992 (Res. 14)
Amended 1995 (Res. 53)
Revised 1996 (Res. 1)
Revised 2000 (Res. 16)
Revised 2001 (Res. 12)
Amended 2002 (Res. 2)
Revised 2006 (Res. 15,16g,34,35,36)
Effective 10/01/06

ACR PRACTICE GUIDELINE FOR PERFORMING AND INTERPRETING MAGNETIC RESONANCE IMAGING (MRI)

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

Magnetic resonance imaging (MRI) is a multiplanar imaging method based on an interaction between radiofrequency (RF) electromagnetic fields and certain nuclei in the body (usually hydrogen nuclei) after the body has been placed in a strong magnetic field.[1] MRI differentiates between normal and abnormal tissues, providing a sensitive examination to detect disease. This sensitivity is based on the high degree of inherent contrast due to variations in the magnetic relaxation properties of

[1]See ACR Glossary of MR Terms, 5th edition, 2005.

different tissues, both normal and diseased, and the dependence of the MRI signal on these tissue properties.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A. Physician

The physician shall have the responsibility for all aspects of the study including, but not limited to, reviewing indications for the examination, specifying the pulse sequences to be performed, specifying the use and dosage of contrast agents, interpreting images, generating official interpretations (final reports), and assuring the quality of the images and the interpretations.

Physicians assuming these responsibilities for MR imaging of all anatomical areas (exclusive of cardiac MRI) should meet one of the following criteria:

> Certification in Radiology or Diagnostic Radiology by the American Board of Radiology, the American Osteopathic Board of Radiology, the Royal College of Physicians and Surgeons of Canada, or Le College des Medecins du Quebec, and involvement with the supervision, interpretation, and reporting of 300 MRI examinations within the last 36 months.[2]
>
> or
>
> Completion of an Accreditation Council for Graduate Medical Education (ACGME) approved diagnostic radiology residency program or an American Osteopathic Association (AOA) approved diagnostic radiology residency program and involvement with the supervision, interpretation, and reporting of 500 MRI examinations in the past 36 months.
>
> or
>
> Physicians not board certified in radiology or not trained in a diagnostic radiology residency program, who assume these responsibilities for MR imaging exclusively in a specific anatomical area, excluding cardiac MRI, should meet the following criteria:
>
> Completion of an ACGME approved residency program in the specialty practiced, plus 200 hours of Category I CME in MRI to include, but not limited to: MRI physics, recognition of MRI artifacts, safety, instrumentation, and clinical applications of MRI in the subspecialty area where MRI reading occurs; and supervision, interpretation, and reporting of 500 MRI cases in that specialty area in the past 36 months in a supervised situation. For neurologic MRI, at least 50 of the 500 cases shall have been MR angiography (MRA) of the central nervous system.

Specific qualifications for physicians performing cardiac MRI are described in the proposed ACR Practice Guideline for the Performance and Interpretation of Cardiac MRI.

Maintenance of Competence

All physicians performing MRI examinations should demonstrate evidence of continuing competence in the interpretation and reporting of those examinations. If competence is assured primarily on the basis of continuing experience, a minimum of 100 examinations per year is recommended in order to maintain the physician's skills. Because a physician's practice or location may preclude this method, continued competency can also be assured through monitoring and evaluation that indicates acceptable technical success, accuracy of interpretation, and appropriateness of evaluation.

Continuing Medical Education

The physician's continuing education should be in accordance with the ACR Practice Guideline for Continuing Medical Education (CME) and should include CME in MRI as is appropriate to the physician's practice needs.

B. Medical Physicist / MR Scientist

The personnel qualified to carry out acceptance testing and monitoring of MRI equipment for the purposes of this guideline include a medical physicist or an MR scientist.

A Qualified Medical Physicist is an individual who is competent to practice independently one or more subfields in medical physics. The American College of Radiology (ACR) considers certification and continuing education in the appropriate subfield(s) to demonstrate that an individual is competent to practice in one or more subfields in medical physics, and to be a Qualified Medical Physicist. The ACR recommends that the individual be certified in the appropriate subfield(s) by the American Board of Radiology (ABR) or for MRI, by the American Board of Medical Physics (ABMP), in magnetic resonance imaging physics.

The appropriate subfields of medical physics for this guideline are Diagnostic Radiological Physics and Radiological Physics.

A Qualified MR Scientist is an individual who has a graduate degree in a physical science involving nuclear magnetic resonance (NMR) or MRI. These individuals should have 3 years of documented experience in a clinical MR environment.

The continuing education of a medical physicist/MR scientist should be in accordance with the ACR Practice

[2]Board certification and completion of an accredited radiology residency in the past 24 months will be presumed to be satisfactory experience for the reporting and interpreting requirement.

Guideline for Continuing Medical Education (CME). 2006 (Res. 16g)

The medical physicist/MR scientist must be familiar with the principles of MRI safety for patients, personnel, and the public; the Food and Drug Administration's guidance for MR diagnostic devices; and other regulations pertaining to the performance of the equipment being monitored. The medical physicist/MR scientist shall be knowledgeable in the field of nuclear MR physics and familiar with MRI technology, including function, clinical uses, and performance specifications of MRI equipment, as well as calibration processes and limitations of the performance testing hardware, procedures, and algorithms. The medical physicist/MR scientist shall have a working understanding of clinical imaging protocols and methods of their optimization. This proficiency shall be maintained by participation in continuing education programs of sufficient frequency to ensure familiarity with current concepts, equipment, and procedures.

The medical physicist/MR scientist may be assisted in obtaining test data for performance monitoring by other properly trained individuals. These individuals must be properly trained and approved by the medical physicist/MR scientist in the techniques of performing the tests, the function and limitations of the imaging equipment and test instruments, the reason for the tests, and the importance of the test results. The medical physicist/MR scientist must review and approve all measurements.

C. Radiologist Assistant

A radiologist assistant is an advanced level radiographer who is certified and registered as a radiologist assistant by the American Registry of Radiologic Technologists (ARRT) after having successfully completed an advanced academic program encompassing an ACR/ASRT (American Society of Radiologic Technologists) radiologist assistant curriculum and a radiologist-directed clinical preceptorship. Under radiologist supervision, the radiologist assistant may perform patient assessment, patient management, and selected examinations as delineated in the Joint Policy Statement of the ACR and the ASRT titled "Radiologist Assistant: Roles and Responsibilities" and as allowed by state law. The radiologist assistant transmits to the supervising radiologists those observations that have a bearing on diagnosis. Performance of diagnostic interpretations remains outside the scope of practice of the radiologist assistant. 2006 (Res. 34)

D. Radiologic Technologist

The technologist should participate in assuring patient comfort and safety, preparing and positioning the patient for the MRI examination, and obtaining the MRI data in a manner suitable for interpretation by the physician. The technologist should also perform daily quality control testing of the MRI system.

The technologist performing MRI should:

1. Be certified by the American Registry of Radiologic Technologists (ARRT) or the Canadian Association of Medical Radiation Technologists (CAMRT) as an MRI technologist (RTMR).

   or

2. Be certified by the ARRT and/or have appropriate state licensure and have 6 months supervised clinical experience in MRI scanning.

   or

3. Have an associate's degree in an allied health field or a bachelor's degree and certification in another clinical imaging field and have 6 months of supervised clinical MRI scanning.

To assure competence, the responsible physician should evaluate any technologist who began performing MRI prior to October 1996 and who does not meet the above criteria.

Any technologist practicing MRI scanning should be licensed in the jurisdiction in which he/she practices, if state licensure exists. To assure competence, all technologists must be evaluated by the supervising physician.

III. POSSIBLE CONTRAINDICATIONS

Possible contraindications include, but are not limited to, the presence of cardiac pacemakers, ferromagnetic intracranial aneurysm clips, certain neurostimulators, certain cochlear implants, and certain other ferromagnetic foreign bodies or electronic devices. Possible contraindications should be listed on a screening questionnaire. All patients should be screened for possible contraindications prior to MRI scanning. Published test results and/or on-site testing of an identical device or foreign body may be helpful to determine whether a patient with a particular medical device or foreign body may be safely scanned [15]. There is no known adverse effect of MRI on the fetus. The decision to scan during pregnancy should be made on an individual basis [6].

IV. TECHNIQUES AND INDICATIONS

The currently accepted techniques and indications for MRI are discussed in various ACR Practice Guidelines that are based on anatomic sites of examination. It is very important that each site offering MRI have documented procedures and technical expertise and appropriate equipment to examine each anatomic site. Because the

clinical applications of MRI continue to expand, the enumerated techniques and indications in the reference documents may not be all-inclusive.

Each site's procedures should be reviewed and updated at appropriate intervals. The final judgment regarding appropriateness of a given examination for a particular patient is the responsibility of the appropriate physicians. The decision to use MRI to scan a particular part of the human body depends on the MRI software and hardware available and the relative cost, efficacy, and availability of competing imaging methods. The examination should provide images with suitable contrast characteristics, spatial resolution, signal-to-noise ratio, and section geometry appropriate to the specific clinical indications.

V. SPECIFICATIONS OF THE EXAMINATION

The examination should be performed within parameters currently approved by the FDA. Examinations that employ techniques not approved by the FDA may be considered when they are judged to be medically appropriate.

The written or electronic request for an MRI examination should provide sufficient information to demonstrate the medical necessity of the examination and allow for the proper performance and interpretation of the examination.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). The provision of additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. 2006 (Res. 35)

Images should be labeled with the following: a) patient identification, b) facility identification, c) examination date, and d) image orientation indicated by unambiguous polarity symbols (e.g., R, L, A, P, H, F).

VI. DOCUMENTATION

High-quality patient care requires adequate documentation. There should be a permanent record of the MRI examination and its interpretation. Imaging of all appropriate areas, both normal and abnormal, should be recorded in a suitable archival format. An official interpretation (final report) of the MRI findings should be included in the patient's medical record regardless of where the study is performed. Retention of the MRI examination should be consistent both with clinical need and with relevant legal and local health care facility requirements.

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

VII. EQUIPMENT SPECIFICATIONS

The MRI equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic field strength, maximum rate of change of magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

VIII. SAFETY GUIDELINES

Safety guidelines, practices, and policies shall be written, enforced, reviewed, and documented at least annually by the supervising physician. These guidelines should take into consideration potential magnetic field interactions for ferromagnetic objects in the MRI environment [6,22-23]. They should also consider potential hazards (e.g., from magnetic field interactions, heating, and induced electrical currents) posed by implanted objects and materials within the patient as well as other individuals in the MR environment [22-23].

For information regarding MR safety, see the ACR Paper on MR Safety: AJR 2002;178:1335-1347 and the 2004 ACR MR Safety Update: AJR 2004;182:1111-1114. A combined paper has been reprinted in the 2006 ACR Practice Guidelines and Technical Standards book. Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis.

When necessary, contrast and sedation shall be administered in accordance with institutional policy and state and federal law by a physician, a nurse, or a technologist[3] with training in cardiopulmonary

[3]The ACR approves of the injection of contrast material and diagnostic levels of radiopharmaceuticals by certified and/or licensed radiologic technologists and radiologic nurses under the direction of a radiologist or his or her physician designee who is personally and immediately available, if the practice is in compliance with institutional and state regulations. And, there must be prior written approval by the medical director of the radiology department/service of such individuals; such approval process having followed established policies and procedures, and the radiologic technologists and radiologic nurses who have been so approved maintain documentation of continuing medical education related to the materials being injected and to the procedures being performed. (Res. 1-H, 1987, 1997)

resuscitation. (See the ACR Practice Guideline for Adult Sedation/Analgesia and the ACR Practice Guideline for Pediatric Sedation/Analgesia.) An appropriately equipped emergency cart must be immediately available to treat adverse reactions associated with administered medications. The cart should be monitored for inventory and drug expiration dates on a regular basis and comply with institutional policies.

IX. QUALITY CONTROL PROGRAM

A documented quality control program shall be maintained at the MR site. Quality control testing should be conducted by the technologist and/or service engineer with review at least annually by the supervising physician and/or a medical physicist/MR scientist.

X. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

ACKNOWLEDGEMENTS

This guideline was revised according to the process described in the ACR Practice Guidelines and Technical Standards book by the Commission on Body Imaging.

Principal Reviewer: Peter H.B. McCreight, MD

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ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF MAGNETIC RESONANCE IMAGING (MRI) OF THE BREAST

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline was developed and written with the assistance of the International Working Group on Breast MRI and the American Society of Breast Disease.

Magnetic resonance imaging (MRI) of the breast is a useful tool for the detection and characterization of breast disease, assessment of local extent of disease, evaluation of treatment response, and guidance for biopsy and localization. Breast MRI may be bilateral or unilateral. To enhance the probability of accurate results, MRI findings should be correlated with clinical history, physical examination, and the results of other imaging examinations.

II. CURRENT INDICATIONS

A. Current indications for breast MRI include, but are not limited to:

1. Lesion characterization – Breast MRI may be indicated when other imaging examinations, such as ultrasound and mammography, and physical examination are inconclusive for the presence of breast cancer. Breast MRI may be helpful in patients who have had previous surgery for breast cancer, to distinguish between postoperative scarring and recurrent cancer. Other conditions that may impair conventional breast imaging, such as silicone augmentation or radiographically dense breasts, may warrant breast MRI depending on the clinical findings.

2. Neoadjuvant chemotherapy – Breast MRI may be employed before, during, and/or after a course of chemotherapy to evaluate chemotherapeutic response and the extent of residual disease prior to surgical treatment. MRI-compatible localization tissue markers placed prior to neoadjuvant chemotherapy may be helpful in the event of complete response with no detectable residual tumor for resection.

3. Infiltrating lobular carcinoma – Physical examination, mammography, and ultrasound may be limited in the evaluation of infiltrating lobular carcinoma. Breast MRI may be indicated for evaluation of extent, multifocality, and multicentricity.

4. Infiltrating ductal carcinoma – Breast MRI may be indicated in order to determine the extent of disease, particularly in breast conservation candidates. MRI determines the extent of disease more accurately than standard mammography and physical examination in many patients.

5. Axillary adenopathy, primary unknown – MRI may be indicated in patients presenting with axillary adenopathy and no mammographic or physical findings of primary breast carcinoma. In patients with breast cancers, breast MRI can locate the primary tumor and define the disease extent for definitive therapy. A negative breast MRI may exclude the breast as a potential primary site of cancer and avoid a mastectomy that would provide no treatment benefit.

6. Postoperative tissue reconstruction – Breast MRI may be indicated in the evaluation of suspected cancer recurrence in patients with tissue transfer flaps (rectus, latissimus dorsi, and gluteal) or implants.

7. Silicone and nonsilicone breast augmentation – Breast MRI may be indicated in the evaluation of patients with silicone implants and/or injections in whom mammography is difficult, and in patients with nonsilicone implants. In these settings, breast MRI may be helpful in the diagnosis of breast cancer and in the evaluation of implant integrity and rupture.

8. Invasion deep to fascia – MRI evaluation of breast carcinoma prior to surgical treatment may be indicated in both mastectomy and breast conservation candidates to define the relationship to the fascia, extension into pectoralis major, or extension into serratus anterior and intercostal muscles.

9. Contralateral breast examination in patients with breast malignancy – MRI can detect unsuspected disease in the contralateral breast in at least 4% - 5% of breast cancer patients. This is often in the face of negative findings on mammography and physical examination.

10. Postlumpectomy for residual disease – Breast MRI may be used in the evaluation of residual disease in patients who have not had preoperative MRI and whose pathology specimens demonstrate close or positive margins for residual disease. MRI can evaluate for multifocality and multicentricity to help determine which patients could be effectively treated by re-excision or whether a mastectomy is required due to the presence of more extensive disease.

11. Surveillance of high-risk patients – Recent clinical trials have demonstrated that breast MRI can significantly improve the detection of cancer that is otherwise clinically and mammographically occult. Breast MRI may be indicated in the surveillance of women with a genetic predisposition to breast cancer. Patients should be referred for surveillance breast MRI only after genetic counseling by experts in hereditary breast cancer.

12. Recurrence of breast cancer – Breast MRI may be indicated in women with a prior history of breast cancer and suspicion of recurrence when clinical and/or mammographic findings are inconclusive.

B. Precautions

1. Screening of general population

Screening breast MRI is not recommended at the current time in the general population of asymptomatic women.

2. False positives

   Breast MRI may detect additional abnormalities other than the clinically or mammographically detected lesions. These MRI-detected, clinically and mammographically occult lesions may or may not be clinically significant.

3. Treatment choices

   Patients being considered for breast-conserving treatment may be converted to mastectomy based on MRI information. Caution should be exercised in changing management based on MRI findings alone, as most mammographically occult lesions are successfully treated with irradiation and/or chemotherapy following surgical removal of the known lesion. Additional biopsies or correlation with other clinical and imaging information should be used along with good clinical judgment. Clinical trials are needed to determine the outcome significance of MRI-detected, clinically occult disease.

III. POSSIBLE CONTRAINDICATIONS

Possible contraindications to breast MRI may include, but are not limited to, the presence of cardiac pacemakers, ferromagnetic intracranial aneurysm clips, certain neurostimulators, certain cochlear implants, and certain other ferromagnetic implants, devices, foreign bodies, or electronic devices. Contraindications should be listed on a screening questionnaire. In other situations, reference to published test results and/or on-site testing of an identical device may be helpful to determine whether a patient may be safely scanned.

The decision to scan during pregnancy should be made on an individual basis. There is no known adverse effect of MRI on the fetus. The safety of gadolinium contrast has not been established for pregnant or nursing mothers. However, it is known that gadolinium-based MR contrast media crosses the human placenta and into the fetus when given in clinical dose ranges. Current data indicates that very little gadolinium is secreted in breast milk, with no known toxic effects on the infant. The supervising physician should take this into account, weighing potential risks and benefits, when counseling pregnant and lactating women referred for breast MRI. Refer to the ACR Manual on Contrast Media.

Enhancement of breast tissue in pregnant or nursing mothers may make image interpretation more difficult.

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI).

In addition, the facility should have access to expertise in breast imaging diagnosis and intervention and access to conventional breast imaging technology including mammography, breast ultrasound, stereotactic biopsy, and ultrasound-guided biopsy.

V. SPECIFICATIONS OF THE EXAMINATION

Patients should undergo standard mammography prior to breast MRI, and the mammography study and report should be available for review.

The written or electronic request for MRI of the breast should provide sufficient information to demonstrate the medical necessity of the examination and allow for the proper performance and interpretation of the examination.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). The provision of additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. 2006 (Res. 35)

A. Patient Selection and Preparation

The physician responsible for the breast MRI examination shall supervise patient selection and preparation. Patients shall be interviewed and screened prior to the examination to exclude individuals who may be at risk by exposure to strong magnetic fields. Patients suffering from claustrophobia may require sedation or medication for anxiety. Increased parenchymal enhancement has been observed normally during the secretory phase of the menstrual cycle. This normal enhancement can give rise to false positive MRI scans. It is therefore recommended that breast MRI scans be performed during the second menstrual week whenever possible. Bilateral imaging may help to improve specificity, as enhancement characteristics vary from patient to patient and during the menstrual cycle, and enhancement of some benign conditions such as fibrocystic changes is often bilateral.

B. Facility Requirements

Facility requirements include space for patient preparation and waiting. If sedation is to be administered (see the ACR Practice Guideline for Adult Sedation/Analgesia) a recovery area is necessary, and appropriate personnel must be available to monitor the patient following sedation. Sedation shall be administered in accordance with institutional policy and state and federal law by a physician or by a nurse with training in cardiopulmonary resuscitation.

An appropriately equipped emergency cart must be immediately available to treat adverse reactions.

C. Guided intervention

Since breast MRI can detect lesions not seen on other imaging methods or by physical examination, the availability of MRI-guided breast biopsy and localization is a valuable adjunct to diagnostic breast MRI.

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings. The report should follow the guidelines for terminology published in the ACR Lexicon for Breast MRI. The BI-RADS® assessment category should be included in the conclusion of the report.

Staging

Of additional value for breast cancer staging is the development of an extent classification scheme based on the TNM (tumor, nodes, metastasis) prototype. These interpretation criteria will facilitate the distribution of MRI-characterized lesions into groups for better treatment planning. This approach facilitates the selection of optimal treatment options. As breast MRI is further developed and refined, additional definitions can be added that would further refine treatment.

One limitation of the TNM classification is that it is based on the size of the largest lesion. Multiple lesions of almost the same size have the same T classification as a single lesion. In an attempt to categorize interpretations in a standardized format that could potentially translate to treatment and prognostic significance, reporting of the following parameters is recommended:

1. Lesion measurements – MRI is an inherently three-dimensional method and can readily yield measurement in three axes. Measurement of masses and lesions should be a routine part of breast MRI reporting, as should the relationship to or lesion distance from the nipple and its nearest approach to the chest wall and/or skin surface.

2. Distance – The distance across multiple lesions should be reported. This is the maximum distance across all the lesions inclusive of normal breast in between as if an imaginary lump encompasses all the lesions.

3. Chest wall – The relationship of the lesion to the chest wall should be stated. The depth of the lesion in relation to the fascia and the extent into deep musculature (serratus anterior or intercostals) can change the T stage.

VII. EQUIPMENT SPECIFICATIONS

The MRI equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic field strength, maximum rate of change of magnetic field strength (dB/dT), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

Technical guidelines

1. Field strength – The selection of field strength is a major technical decision. In previous reports, field strength of 1.5 T was considered a minimum technical requirement. Improvements in other components of the scanning process have resulted in improved scan quality at lower field strengths. However, the ability to perform chemical fat suppression at higher field strength and better homogeneity of these magnets remains a distinct advantage for most users. Also, the synergy between field strength of 3 T, parallel imaging, and phased array coils provides satisfactory spatial resolution when imaging both breasts. Therefore, higher field strength is preferred because of better fat suppression and decreased motion artifacts.

2. Resolution and contrast – Higher resolution is needed to avert the problem of volume averaging effects. The slice thickness should be 3 mm or less and in-plane pixel resolution should be 1.5 mm or less. Improved contrast between tumor and surrounding tissue is important. When high-resolution images are being obtained, chemical fat suppression is helpful as a method to reduce fat signal while preserving the signal-to-noise ratio. Subtraction is often used for low resolution, dynamic imaging. Sole reliance on subtraction for assessment of enhancement may

result in misregistration. Some protocols may incorporate both fat suppression and subtraction. Motion correction may be helpful in reducing artifacts encountered with image subtraction. Magnetization transfer contrast may reduce false positives by improving the contrast between ductal tissue and enhancing tumor.

3. Contrast – Gadolinium contrast enhancement is useful in the evaluation of breast cancer but is not generally necessary in the evaluation of implant integrity and rupture. Gadolinium contrast should be administered as a bolus with a standard dose of at least 0.1 mmol/kg.

4. Scan time – A precontrast scan should be obtained. Scan time in relation to contrast injection is extremely important for lesion characterization. The immediate postcontrast scan used for determining the presence of lesion enhancement should have a scan time extending no longer than 5 minutes after bolus injection. If kinetic information is reported, enhancement curves should be calculated at specified intervals.

5. All examinations should be performed with a dedicated breast MRI coil unless obesity or other patient considerations require modification of the imaging procedure.

VIII. SAFETY GUIDELINES

For information regarding MR safety, see the ACR White Paper on MR Safety. In: Kanal E, Borgstede JP, Barkovich AJ, et al. American College of Radiology White Paper on MR Safety. AJR 2002; 178:1335-1347. Reprinted with permission from the American Roentgen Ray Society in the ACR Practice Guidelines and Technical Standards book. Current peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis to ensure patient safety.

IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Equipment monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

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This guideline was developed according to the process described in the ACR Practice Guidelines and Technical Standards book by the Committee on Breast Cancer with assistance from the Guidelines and Standards Committee of the Neuroradiology and Body MR Commission.

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PRACTICE GUIDELINE FOR THE PERFORMANCE OF PEDIATRIC AND ADULT CEREBROVASCULAR MAGNETIC RESONANCE ANGIOGRAPHY (MRA)

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

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I. INTRODUCTION

This guideline was revised collaboratively by the American College of Radiology (ACR), the American Society of Neuroradiology (ASNR), the American Society of Interventional and Therapeutic Neuroradiology (ASITN), and the Society of Interventional Radiology (SIR).

Cerebrovascular magnetic resonance angiography (MRA) is a proven and useful tool for the evaluation, assessment of severity, and follow-up of diseases of the cerebrovascular system. MRA is a rapidly evolving technology. Consequently, only general recommendations can be made regarding imaging techniques. Detailed imaging protocols have been omitted here to avoid promoting obsolete methodology.

Cerebrovascular MRA should be performed only for a valid medical reason. Additional or specialized pulse sequences are frequently required to optimize the examination. While it is not possible to detect all abnormalities by using cerebrovascular MRA, adherence to the following guideline will enhance the probability of their detection.

MRA has important attributes that make it valuable in the assessment of vascular disease. Compared to radiographic catheter-based angiography, it is noninvasive with no risk of neurologic deficit, circulatory compromise due to vascular injury, or adverse effects of iodinated contrast material. Compared to vascular ultrasound, it is less operator-dependent, has greater freedom from interference by body habitus, and has greater three-dimensional capability.

Children demonstrate a different spectrum of disease than do adults, and the routine protocols used for evaluating the adult patient may not be optimal or even appropriate in evaluating children. As the brain and the cerebrovascular system develop during infancy and childhood, cerebrovascular MRA can provide valuable information regarding flow conditions and pathologic processes within the brain and spine. However, technical and safety issues are more complex in pediatric patients. The smaller size of the pediatric patient increases the demand for higher resolution. In addition, sedation is frequently required to successfully complete the examination.

Application of this guideline should be in accordance with the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI), the ACR Practice Guideline for Pediatric Sedation/ Analgesia, and the ACR Practice Guideline for Adult Sedation/Analgesia.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI).

III. INDICATIONS

A. Pediatric Indications for Cerebrovascular MRA

MRA is particularly applicable in children due to the risk (albeit low) related to angiographic procedures. Various studies of children with strokes that compared MRA to conventional angiography found MRA to be 1) accurate in the delineation of stenosis and/or occlusion, and 2) able to demonstrate collateral vascular anatomy. Indications for cerebrovascular MRA for children include, but are not limited to, the definition and evaluation of the following:

1. Arterial dissection.
2. Dural sinus thrombosis.
3. Cerebral arteriovenous malformations.
4. Vascular status following extracorporeal membrane oxygenation.
5. Intracranial aneurysm.
6. Vascular abnormalities associated with sickle cell anemia.
7. Blood supply to vascular neoplasms for operative planning.
8. Etiology of intracranial hemorrhage and spinal hemorrhage.
9. Presence, nature, and extent of injury to cervicocerebral vessels, including dissection.
10. Presence of intracranial venous occlusive disease and spinal venous drainage.
11. Nature and extent of other congenital or acquired vascular abnormality.

B. Indications for cerebrovascular MRA of adults include, but are not limited to, the definition and evaluation of the following:

1. Presence and extent of atherosclerotic occlusive disease and thromboembolic phenomena.
2. Etiology of intracranial hemorrhage and spinal hemorrhage.
3. Relevant vascular anatomy for determining the effect of therapeutic measures including post-treatment evaluation of endovascular treatment of aneurysm and arteriovenous malformation (AVM) ablation.
4. Presence, location, and anatomy of extracranial and intracranial aneurysms and vascular malformations.
5. Presence, nature, and extent of injury to cervicocerebral vessels, including dissection.
6. Vascular supply to tumors.
7. Presence of intracranial venous occlusive disease and spinal venous drainage.
8. Nature and extent of other congenital or acquired vascular abnormality.

C. Evaluation of the aortic arch and subclavian arteries in adults and children may require separate techniques and sequences. Indications include, but are not limited to, the following:

1. Dissection of the aorta and great vessels to the brain
2. Aneurysm of the aorta and/or its branches, and subclavian steal
3. Differentiation of aneurysms and masses
4. Definition of the relationship of masses to nearby vascular structures
5. Identification of congenital abnormalities of the aorta, such as coarctation, double arch, and aberrant subclavian artery

6. Evaluation of superior vena cava syndrome or unilateral upper extremity edema

IV. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI) and the ACR White Paper on Magnetic Resonance Safety.

Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis [53,55].

V. SPECIFICATIONS OF THE EXAMINATION

The supervising physician must have complete understanding of the indications, risks, and benefits of the examination, as well as alternative imaging procedures. The physician must be familiar with potential hazards associated with MRI, including potential adverse reactions to contrast media. The physician should be familiar with relevant ancillary studies that the patient may have undergone. The physician performing MRI interpretation must have a clear understanding and knowledge of the anatomy and pathophysiology relevant to the MRI examination.

The written or electronic request for MRA should provide sufficient information to demonstrate the medical necessity of the examination and allow for the proper performance and interpretation of the examination.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). The provision of additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. 2006 (Res. 35)

The supervising physician must also understand the pulse sequences to be employed and their effect on the appearance of the images, including the potential generation of image artifacts. Standard imaging protocols may be established and varied on a case-by-case basis when necessary. These protocols should be reviewed and updated periodically.

A. Patient Selection

The physician responsible for the examination shall supervise patient selection and preparation, and be available in person or by phone for consultation. Patients shall be screened and interviewed prior to the examination to exclude individuals who may be at risk by exposure to the MR environment.

Certain indications require administration of intravenous (IV) contrast media. IV contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization. (See the ACR Practice Guideline for the Use of Intravascular Contrast Media.)

Patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate or "conscious" sedation may enable achievement of the examination success. If moderate sedation is necessary, refer to the ACR Practice Guideline for Adult Sedation/Analgesia or the ACR Practice Guideline for Pediatric Sedation/Analgesia.

B. Facility Requirements

An appropriately equipped emergency cart must be available to treat adverse reactions associated with administered medications. The cart should be monitored for inventory and drug expiration dates on a regular basis.

C. Examination Technique

Magnetic resonance angiography is a general term that refers to a diverse group of MR pulse sequences. Three different mechanisms can be used to generate signal from flowing blood. The most common method, called time of flight (TOF), relies on inflow enhancement to generate images of blood flow. Flow images and quantitative measurements of flow velocity can be obtained using phase-contrast (PC) MRA methods in which the image contrast is generated by velocity-induced phase shifts. A third method relies on enhancement of the blood signal by paramagnetic contrast agents and employs rapid, three-dimensional (3D) T1-weighted gradient echo acquisitions. Individuals using MRA shall understand the artifacts and limitations of 2D TOF, 3D TOF, 2D or 3D PC, and contrast-enhanced 3D TOF imaging techniques. In certain instances, such as atherosclerotic disease of the arch, directional images or time resolved acquisition should be obtained.

1. Non-contrast TOF MRA
   The most commonly used inflow techniques are 2D TOF and 3D TOF. In 2D TOF acquisitions, multiple thin slices are obtained and combined to form a three-dimensional data set. Vascular

structures are isolated from the surrounding tissue by selecting the pixels with maximum intensity. The 3D TOF technique directly acquires a three-dimensional volume. The vascular structures are delineated by selecting the pixels with maximum intensity.

The MRA data sets are also displayed as two dimensional source images. The supervising physician should review the source images to reduce possible confusion of high signal material (e.g., fat) with flow signal. Review of the source images also aids diagnosis by eliminating overlapping structures and determining if artifacts are the cause of spurious signal or signal loss.

MRA data are routinely postprocessed using a maximum-intensity projection (MIP) reconstruction algorithm. Rotating displays of three-dimensional data sets allow separation of vessels that are superimposed on routine projections. The supervising physician shall be familiar with MIP, surface display, volume display, and multiplanar reformatting techniques, and with the limitations and strengths of each method. The type and frequency of artifacts will vary with the display technique; thus, the supervising physician must understand the potential errors with each display method.

2. Contrast-enhanced TOF MRA
Contrast-enhanced 3D TOF MRA combines a fast T1-weighted gradient echo acquisition with an intravenously administered paramagnetic contrast agent. Such agents reduce T1 relaxation time of blood and nearly eliminate the loss of signal related to saturation effects, thus leading to a more accurate assessment of stenosis. MRA with contrast enhancement has been evaluated for use in assessing the cervical carotid arterial system, the vertebrobasilar system, the dural venous sinuses, and the ascending and descending thoracic aorta. MRA with contrast has been successful in demonstrating atherosclerotic occlusive disease, dissection of the aorta, anomalies of the aortic arch, and vascular involvement by tumor. MRA with contrast does not require cardiac gating and is, therefore, more widely applicable in patients with irregular cardiac rhythms. Furthermore, respiratory artifacts are eliminated by breath holding, and artifacts due to flow-related enhancement are not encountered. These advantages make MRA with contrast extremely useful for imaging of the aortic arch and great vessels.

Contrast-enhanced cerebrovascular MRA is optimized when the center of k space is sampled during the peak arterial concentration of the gadolinium chelate. Elliptical centric encoding is an example of a technique that improves capture of the arterial phase of the bolus and reduces venous contamination of the image.

When using elliptical centric encoding, ringing artifacts occur when the center of k space is sampled while the concentration of contrast material is rapidly changing. The ringing artifacts are manifested in the image as linear regions of signal loss. By recessing the center of k space a few seconds from the arrival of the bolus, ringing artifacts can be reduced.

The concentration of contrast should be relatively constant during the acquisition. An injection rate of 2-3 mL/sec generates a bolus profile with a 5-7 second arterial phase which is desirable because most techniques require several seconds to sample the center of k space. The injection volume may vary based on the size of the patient. A common practice is to use 30-40 mL of a gadolinium chelate for the majority of adult patients. For very large patients the volume of contrast may need to be increased to offset the effects of contrast dilution in the blood pool. The use of a power injector facilitates control of the injection rate and helps to standardize the protocol. Following injection of the contrast material, the power injector can rapidly switch to inject the saline flush. The injection rate and dose of contrast material will need to be adjusted for pediatric patients.

Imaging of the cerebrovascular system is particularly challenging due to the roughly 10 second circulation times within the brain. Arch and carotid cerebrovascular MRA studies require very accurate timing of the acquisition in relation to the contrast injection. If the images are obtained too early, the arterial structures may not be visualized. Late acquisition will result in reduced arterial signal, venous opacification, and enhancement of the soft tissues. Ideally the center of k space is scanned during the first pass of the bolus.

A limitation of contrast-enhanced TOF MR angiography is that the extracellular gadolinium chelates are nonspecific MR contrast agents. Many normal and pathologic tissues will enhance. This makes repeat imaging more problematic. Subtraction techniques may help, but often there is incomplete subtraction of the background, and artifacts are generated due to

misregistration of the data sets. The high-signal-intensity enhanced stationary tissue will obscure vessels in the maximum intensity projection (MIP) images and may simulate flow signal pattern or degrade vessel detail.

Saturation (SAT) bands are less effective when the T1 of blood is significantly reduced. Venous structures such as the internal jugular vein cannot be eliminated from the MR angiogram by the selective placement of SAT bands and may obscure the carotid bifurcation. Similarly, arterial structures cannot be selectively eliminated by saturation techniques when contrast material is administered.

3. Phase contrast (PC) MRA
PC MRA is the third general category of MRA techniques. The PC data can be obtained as - either a two-dimensional or three-dimensional dataset. Contrast enhancement may also be employed to increase the signal obtained from blood. PC techniques are based on the physical properties of moving spins. As protons move through a magnetic field, they acquire a phase shift directly proportional to their velocity. The magnitude of the phase shift can be measured, and an image of the flowing blood can be generated. Display of the vessels is similar to that obtained with the TOF technique, although direction of flow can also be indicated. In some instances, it is necessary to gate the PC acquisition to the cardiac cycle to measure flow velocity or flow volume. Peripheral or cardiac gating should be available.

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

In addition to examining the vascular structures of interest, the MR source images should be examined for extravascular abnormalities that may have clinical relevance. These abnormalities should be described in the formal report of the examination.

VII. EQUIPMENT SPECIFICATIONS

The MR equipment specifications and performance shall meet all state and federal requirements. These requirements include, but are not limited to, specifications of maximum static magnetic field strength, maximum rate of change of the magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

A workstation capable of creating multiplanar reformations, maximum intensity projections, and volume renderings or shaded surface displays is required for most MR angiograms. The workstation should also allow the direct measurement of vascular diameters and, when appropriate, path lengths and branch angles either from source images or from reformatted images.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection control, and Patient Education concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Specific policies and procedures related to MRI safety should be in place with documentation that is updated annually and compiled under the supervision and direction of the supervising MRI physician. Guidelines should be provided that deal with potential hazards associated with the MRI examination of the patient as well as to others in the immediate area [50,53,55,56]. Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination [50,53,55,56].

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

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PRACTICE GUIDELINE FOR THE PERFORMANCE AND INTERPRETATION OF MAGNETIC RESONANCE IMAGING (MRI) OF THE KNEE

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This Practice Guideline for the Performance and Interpretation of Magnetic Resonance Imaging (MRI) of the Knee was developed and written collaboratively by the American College of Radiology (ACR) and the Society of Skeletal Radiology (SSR).

Magnetic resonance imaging (MRI) is a proven and well-established imaging modality for the detection, evaluation, assessment, staging, and follow-up of disorders of the knee. Properly performed and interpreted, MRI not only contributes to diagnosis but also serves as an important guide to treatment planning and prognostication. However, MRI of the knee should be performed only for a valid medical reason and after careful consideration of alternative imaging modalities. An analysis of the strengths of MRI and other modalities should be weighed against their suitability for particular patients and particular clinical conditions. Radiographs frequently will be the first imaging test performed for suspected bone and soft tissue abnormalities in the knee and will often suffice to diagnose or exclude an

abnormality or will direct further imaging work-up. Radionuclide bone scanning is often used when occult osseous disease is suspected or to screen the entire skeleton for conditions such as metastases. Other nuclear medicine examinations have a role for specific clinical scenarios (e.g., a labeled white blood cell study for suspected osteomyelitis). Computed tomography can show the detailed osseous anatomy, while sonography may be appropriate to examine relatively superficial soft tissue structures around the knee. Lastly, arthroscopy provides a detailed examination of the internal structures of the knee joint, allowing the surgeon to treat as well as to diagnose many internal derangements.

While MRI is one of the most sensitive, noninvasive diagnostic tests for detecting anatomic abnormalities of the knee, its findings may be misleading if not closely correlated with the clinical history, clinical examination, and physiologic tests. Adherence to the following guidelines will enhance the probability of detecting such abnormalities.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI).

III. INDICATIONS

A. Primary indications for MRI of the knee include, but are not limited to, diagnosis, exclusion, and grading of suspected:

1. Meniscal disorders: nondisplaced and displaced tears, discoid menisci, meniscal cysts † (1,2,3,4,5,6,7).
2. Ligament tears: cruciate, collateral, retinacular † (2,3,7,8,9,10,11,12).
3. Extensor mechanism abnormalities: quadriceps tendon, patellar tendon, patella (13,14,15,16,17).
4. Osteochondral and articular cartilage infractions: osteochondral fractures, osteochondritis dissecans, degenerative chondrosis, chondromalacia, chondral fissures, fractures, flaps, and separations † (18,19, 20,21,22,23,24).
5. Loose bodies: chondral, osteochondral, osseous † (25).
6. Synovial-based disorders: symptomatic plicae, synovitis (including pigmented villonodular synovitis), bursitis, and popliteal cysts * (26,27,28,29).
7. Marrow abnormalities: avascular necrosis, marrow edema syndromes, and stress fractures * (30,31).
8. Muscle and tendon disorders: strains, partial and complete tears, tendonitis, tendonopathy, infiltration (32,111,113-114).
9. Neoplasms of bone, joint, or soft tissue * (33,34).
10. Infections of bone, joint, or soft tissue * (35,36).
11. Congenital and developmental conditions: Blount disease, dysplasia, normal variants * (37,38).
12. Vascular conditions: entrapment, aneurysm, stenosis, occlusion, cystic change * (39).
13. Neurologic conditions: entrapment, compression, denervation, and peripheral neuritis * (40).

B. MRI of the knee may be indicated to further clarify and stage conditions diagnosed clinically and/or suggested by other imaging modalities, including, but not limited to:

1. Arthritides: inflammatory, infectious, neuropathic, degenerative, crystal-induced, post-traumatic * (41,42,43,44,45).
2. Primary and secondary bone and soft tissue tumors * (33,34).
3. Fractures and dislocations (46,47,48).

C. MRI of the knee may be useful to evaluate specific clinical scenarios, including, but not limited to:

1. Prolonged, refractory, or unexplained knee pain * †.
2. Acute knee trauma (49).
3. Mechanical knee symptoms: catching, locking, snapping, crepitus † (50).
4. Tibiofemoral and/or patellofemoral instability: chronic, recurrent, subacute, acute dislocation and subluxation † (46,48,51).
5. Tibiofemoral and/or patellofemoral malalignment (52,53,54,55,56,57).
6. Limited or painful range of motion.
7. Swelling, enlargement, mass, or atrophy *.
8. Iliotibial band friction syndrome (58,59).
9. Patients for whom diagnostic or therapeutic arthroscopy is planned † (60,61,62, 63,64,65).
10. Patients with recurrent, residual, or new symptoms following knee surgery † (24, 66,67,68,69,70,71).

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* Conditions in which intravenous contrast may be useful.
† Conditions in which intra-articular contrast (performed by direct intra-articular injection or indirect joint opacification following intravenous administration) may be useful.

IV. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI) and the ACR White Paper on Magnetic Resonance Safety.

Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis (72,74).

V. SPECIFICATIONS OF THE EXAMINATION

The supervising physician must have complete understanding of the indications, risks, and benefits of the examination, as well as alternative imaging procedures. The physician must be familiar with potential hazards associated with MRI, including potential adverse reactions to contrast media. The physician should be familiar with relevant ancillary studies that the patient may have undergone. The physician performing MRI interpretation must have a clear understanding and knowledge of the anatomy and pathophysiology relevant to the MRI examination.

The clinical request form should be initiated by the referring physician or any appropriate allied healthcare professional acting within his or her scope of practice. It should contain pertinent information regarding the clinical indication for the procedure.

The supervising physician must also understand the pulse sequences to be employed and their effect on the appearance of the images, including the potential generation of image artifacts. Standard imaging protocols may be established and varied on a case-by-case basis when necessary. These protocols should be reviewed and updated periodically.

A. Patient Selection

The physician responsible for the examination shall supervise patient selection and preparation, and be available in person or by phone for consultation. Patients shall be screened and interviewed prior to the examination to exclude individuals who may be at risk by exposure to the MR environment.

Certain indications require administration of intravenous (IV) contrast media. IV contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization. (See the ACR Practice Guideline for the Use of Intravascular Contrast Media.)

Patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate or "conscious" sedation may be needed to achieve a successful examination. If moderate sedation is necessary, refer to the ACR Practice Guideline for Adult Sedation/Analgesia or the ACR Practice Guideline for Pediatric Sedation/Analgesia.

B. Facility Requirements

An appropriately equipped emergency cart must be immediately available to treat adverse reactions associated with administered medications. The cart should be monitored for inventory and drug expiration dates on a regular basis.

C. Examination Technique

Diagnostic quality knee MRI can be performed using a variety of magnet designs (closed bore, whole body, open whole body, dedicated extremity) and field strengths (2,7,72,73). Regardless of magnet design, a local coil is mandatory to maximize signal-to-noise. Typically, a cylindrical coil is used that completely surrounds the knee (often called an "extremity" or "knee" coil). Occasionally a slightly larger coil (posterior neck coil, for example) may be needed to accommodate a very large extremity, but every attempt should be made to ensure that the size of the coil closely matches that of the knee circumference (74). The coil's placement should allow imaging of the major structures in and around the knee, or the coil and/or extremity should be repositioned during the examination to include any pertinent anatomy where an abnormality is suspected. For example, when a quadriceps tendon abnormality is clinically suspected or suggested by ancillary imaging findings in the knee, an additional set of images may be necessary above the knee after repositioning when using a dedicated extremity magnet.

Certain MR systems (e.g., low-field magnets) have inherently lower signal-to-noise ratios than others. When using such a system to perform knee MRI, other imaging parameters – such as the receiver bandwidth and number of acquisitions – will require modification to ensure adequate spatial and contrast resolution for confident diagnosis, often at the expense of longer examination times (75,76,77). It may also be more difficult to achieve uniform chemical fat suppression on low-field systems, necessitating the use of Dixon (78) or short-TI inversion recovery (STIR) techniques. Other systems may be more prone to imaging artifacts (e.g., chemical shift artifact on high field magnets) again necessitating that imaging parameters, like readout bandwidth, should be modified to ensure that these artifacts do not detract from the diagnostic quality of the resultant images. For some indications, imaging on a low-field system may be disadvantageous compared to a high-field system. For example, high-resolution images of articular cartilage are more difficult to achieve with low-field systems, and may necessitate the inclusion of alternate methods of fat suppression and/or the performance of MR arthrography (73,78,79,80,81.82). Detection of other conditions, like meniscal and anterior cruciate ligament tears, is probably less influenced by magnet strength and design.

Typically the patient is positioned supine with the affected knee completely or nearly completely extended. The coil is positioned to provide adequate anatomic

coverage. Mild external rotation of the leg is often comfortable for the patient and may orient the anterior cruciate ligament into the sagittal plane to facilitate its evaluation. Gentle immobilization of the extremity and use of comfort measures for the entire body will help to reduce involuntary patient motion and resultant artifacts.

Knee MRI examinations usually include images acquired in the transverse, sagittal, and coronal imaging planes (84). The sagittal and coronal images may be orthogonal to the magnet bore, or may be angled to better identify specific anatomic structures, such as the posterolateral corner ligaments (85,86). The coverage should include all the anterior, posterior, medial, and lateral supporting structures of the knee, though not all structures need to be included in every imaging plane. Superiorly, the distal aspects of the quadriceps tendon and suprapatellar bursa should be included. The distal insertions of the patellar tendon and pes anserinus should be included inferiorly. Volumetric data acquired in one imaging plane may be electronically reformatted and displayed in other imaging planes. Radially acquired images of the menisci may be used in addition to sagittal and coronal images (87).

The field of view (FOV) should be tailored to the size of the patient and the structures being examined, but for the standard sequences, the FOV should be 16 cm or smaller. Occasionally, additional sequences with a larger FOV will be appropriate to more fully evaluate a detected or suspected abnormality, for example, in the extensor mechanism or bone marrow. Slice thickness in the sagittal and coronal planes of 4 mm or less is necessary to adequately demonstrate subtle meniscal pathology, but even thinner sections may be advantageous for detailed analysis of other structures such as the articular cartilage. An interslice gap may be chosen to decrease signal loss due to cross talk (88), but should be no more than 50% of the slice width and should not impair complete visualization of the intra-articular structures. The imaging matrix should balance intravoxel signal-to-noise with desired in-plane spatial resolution and reduction of truncation artifacts, but should be at least 140 steps in the phase direction and 256 steps in the frequency direction for 2D imaging.

Knee MRI can be performed with a wide variety of pulse sequences (74). The choice of sequences can be tailored to optimize the examination for specific clinical questions, and may vary due to local preferences. Spin-echo, fast (turbo) spin-echo, and gradient-recalled sequences have all been used successfully for knee MRI. A typical imaging protocol will be composed of one or more of these pulse sequence types. The exact TR, TE, and flip angle chosen will depend on the field strength of the magnet and the relative contrast weighting desired.

Short-TE images with either a relatively short TR (T1-weighted) or long TR (proton-density-weighted) are used most frequently to examine the menisci. Because of the image blurring inherent in fast spin-echo images made with a short effective TE, conventional spin-echo imaging may be preferred for the menisci (5,89,90,91). However, some investigators have used properly optimized fast spin-echo imaging for this purpose (92,93). 2D and 3D gradient-recalled images can also be used for meniscal disorders (87,94,95,96). To demonstrate ligament pathology, T2-weighted imaging using conventional or fast (turbo) spin-echo sequences (97,98) or T2*-weighted gradient-recalled sequences (94,95,96) are most frequently used. Imaging of articular cartilage disorders can be done with many different pulse sequences, including fast spin-echo proton-density-weighted or T2-weighted sequences with or without fat suppression (23, 22,99,100,101), or 3D gradient-recalled sequences (96,102,103,104). In addition, MR arthrography can be done using T1-weighted spin-echo, fast spin-echo, or gradient-recalled sequences. Spin-echo long-TR images will show advanced abnormalities in the articular cartilage, but are relatively insensitive to lower stages of disease (107,108). T1-weighted sequences have a role in characterizing marrow abnormalities (110), various stages of hemorrhage (111,112), and muscle pathology (113,114), and for showing enhancement when gadolinium-based contrast agents are used (115).

Suppressing the signal from fat may enhance the diagnostic yield of some pulse sequences (74). Fat suppression can be performed using spectral suppression of water protons, a phase-dependent method such as the Dixon method, and short-T1 inversion recovery (78,116,117,118,119,120). The latter two techniques may be necessary on low-field systems. Fat suppression is useful for identifying marrow abnormalities (116,117,119) and may be a useful adjunct when short effective TE (proton-density-weighted) fast spin-echo sequences are used to examine the menisci, ligaments, and articular surfaces of the knee.

Additional imaging techniques may have a role for specific knee disorders. Kinematic examinations performed with varying degrees of active or loaded knee flexion (i.e., movement against resistance) are beneficial for the evaluation of patellofemoral joint abnormalities (52,53,54,55,56,57). Direct and indirect MR arthrography may be beneficial for various internal knee derangements and for imaging postoperative conditions (19,25,66,69, 105,106,121,122).

Various techniques may be used to reduce artifacts that can reduce imaging quality. Wraparound artifact, including that originating from signal received from the contralateral knee, can be reduced by phase oversampling, by swapping the phase and frequency orientations, or by using radiofrequency shielding between the knees (123, 124). Truncation (Gibbs) artifacts may obscure or mimic meniscal tears, and can be reduced by changing the phase-encoding direction, or by increasing the imaging matrix (124,125). Involuntary patient motion is best controlled by ensuring patient comfort combined with gentle immobilization when necessary (74). Flowing blood can produce ghosting artifacts, which can be reduced with presaturation pulses or the use of gradient moment nulling

(124,126). Chemical shift artifact is more severe at higher field strengths, and may necessitate an increase in the readout bandwidth (116,128). Susceptibility artifacts, which originate from heterogeneity of the local field, are also more severe at higher field strengths and when using gradient-recalled pulse sequences. Avoiding gradient-echo imaging and reducing the voxel size by increasing the imaging matrix and/or decreasing the slice thickness and field of view will help reduce the magnitude of susceptibility artifacts (124,127).

For interpretation, the images can be printed on film or viewed on a workstation (129). If hardcopy viewing is used, some practices may film the images of the menisci a second time, magnified and with narrow window settings, but this can be left to local preferences since there does not appear to be a demonstrable advantage to this practice (130).

It is the responsibility of the supervising physician to determine whether or not additional pulse sequences or unconventional pulse sequences and imaging techniques would confer added benefit for the diagnosis and management of the patient. Examinations that employ techniques not approved by the Food and Drug Administration – such as the intra-articular injection of gadolinium chelates (direct MR arthrography) (131,132,133) – can be considered when they are judged to be medically appropriate.

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings. The report should address the condition of the menisci, major ligaments, articular cartilage, bone marrow, and extensor mechanism. In selected cases, a description of findings in the neurovascular structures, muscles and tendons, synovium, and cortical bone would be appropriate.

VII. EQUIPMENT SPECIFICATIONS

The MRI equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic strength, maximum rate of change of the magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Specific policies and procedures related to MRI safety should be in place with documentation that is updated annually and compiled under the supervision and direction of the supervising MRI physician. Guidelines should be provided that deal with potential hazards associated with the MRI examination of the patient as well as to others in the immediate area (134,135,136,137). Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination (134,135,136,137).

Equipment monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

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PRACTICE GUIDELINE FOR THE PERFORMANCE AND INTERPRETATION OF MAGNETIC RESONANCE IMAGING (MRI) OF THE ELBOW

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline was developed and written collaboratively by the American College of Radiology (ACR) and the Society of Skeletal Radiology (SSR).

Magnetic resonance imaging is a proven, established imaging modality for the detection, evaluation, staging, and follow-up of disorders of the elbow. Properly performed and interpreted, MRI not only contributes to diagnosis but also serves as an important guide to treatment planning and prognostication. However, it should be performed only for a valid medical reason, and only after careful consideration of alternative imaging modalities. The strengths of MRI and other modalities should be weighed against their suitability in particular patients and in particular clinical conditions.

Radiographs should be the first imaging test performed to evaluate the elbow [1,2], especially for trauma in both adults and children [3,4]. Radiographs can screen for osteochondritis dissecans (OCD) and osseous loose bodies [5,6,7], although they are less sensitive than MRI for these entities [8]. Nevertheless, there are soft tissue conditions such as heterotopic ossification for which radiographs may be more sensitive than MRI [9].

Radiographs taken during valgus stress can aid in the diagnosis and management of ulnar collateral ligament injuries [10,11]. While conventional arthrography can help diagnose internal derangements in the elbow joint, computed tomography (CT) arthrography and MR arthrography have largely replaced it [12]. Bone scintigraphy is sensitive to early osseous diseases, which may be radiographically occult, but bone scans lack specificity, often necessitating additional imaging studies for complete evaluation [1]; in the elbow, scintigraphy may be used evaluating athletes with suspected stress injuries [13], although MRI is a more comprehensive examination in this population.

Elbow sonography can image many of the soft tissues of the elbow [14,15]. Ultrasound can show elbow effusions [16], bursitis [17,18], nerve abnormalities [19,20], and tendon abnormalities [3,4,21,22] in adults, as well as cartilage and soft tissue abnormalities in the infant elbow [23]. However, MRI is probably more sensitive than sonography for demonstrating elbow effusions [16] and lateral epicondylitis [24]. Dynamic ultrasound examination may be useful for elbows with torn ulnar collateral ligaments [25,26] or snapping of the distal triceps [19], and arthrosonography following intra-articular saline injection can be used to search for loose bodies [27]. Furthermore, sonography can guide diagnostic and therapeutic injections [18].

Elbow CT is most frequently used to evaluate and prognosticate complex fractures in children and adults [28-30], to visualize the articular surfaces [31], and for surgical planning [3], especially with multiplanar and surface-rendered reformatting of the data. When combined with single-contrast or double-contrast arthrography, CT is an effective test for intra-articular bodies [7,32-34], symptomatic synovial folds [32], and the staging of chondral and osteochondral infractions [1,33].

Lastly, arthroscopy, an invasive procedure, provides direct visualization of the internal structures of the elbow joint [35, 36], and can be use for therapeutic as well as diagnostic purposes [37].

While MRI is often the most sensitive, noninvasive diagnostic test for detecting anatomic abnormalities of the elbow, its findings may be misleading if not closely correlated with the clinical history, physical examination, physiologic tests such as nerve conduction analysis and electromyography, and other imaging studies. Adherence to the following guidelines will enhance the probability of detecting clinically important abnormalities.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI).

III. INDICATIONS

A. Primary indications for MRI of the elbow include, but are not limited to, diagnosis, exclusion, and grading of suspected:

1. Ligament disorders (ulnar collateral, lateral ulnar collateral, radial collateral, and annular ligaments): strains, partial and complete tears [12,38-48]. †
2. Disorders of the flexor and extensor tendon origins (epicondylitis): partial and complete tears, tendonopathy [24,48-52]. *
3. Distal biceps tendon disease: partial and complete tears, tendonopathy [46,48,53-56].
4. Distal triceps tendon disease: partial and complete tears, tendonopathy, snapping, subluxation [46,48,57-59].
5. Muscle and myotendinous injuries [46].
6. Occult fractures [60-62].
7. Osteochondritis dissecans [5,6,12,44,46,62-66)]. *†
8. Cartilage lesions: chondral fractures and flaps, chondromalacia, degenerative chondrosis [12,46,65,67]. †
9. Joint effusions and inflammatory or proliferative synovitis [16,42,68-70]. *
10. Intra-articular bodies: chondral, osteochondral, osseous [7,12,34,44,46,64-66]. †
11. Symptomatic plicae, synovial folds, and elbow menisci [12,71]. †
12. Olecranon and bicipitoradial bursitis: septic, traumatic, crystal-induced, inflammatory [17,42,46,70,72,73]. *
13. Marrow abnormalities: bone contusions, osteonecrosis, marrow edema syndromes, stress fractures [13,62,64,74]. *
14. Peripheral nerve disorders: entrapment, compression, cubital tunnel syndrome, muscle denervation [46,48,75-80]. *
15. Congenital and developmental abnormalities [81].
16. Neoplasms of bone, joint, or soft tissue [82]. *
17. Infections of bone, joint, or soft tissue [42]. *
18. Proximal forearm disorders [78,83].

B. MRI of the elbow may be indicated to further clarify and stage conditions diagnosed clinically and/or suggested by other imaging modalities, including but not limited to:

1. Arthritides: inflammatory, infectious, neuropathic, degenerative, crystal-induced, post-traumatic [42,68]. *
2. Primary and secondary bone and soft tissue tumors [82]. * See also the ACR Practice Guideline for the Performance and Interpretation

of Magnetic Resonance Imaging (MRI) of Bone and Soft Tissue Tumors.
3. Fractures and stress fractures [4,47,60,61,62,65,84,85].

C. MRI of the elbow may be useful to evaluate specific clinical scenarios, including but not limited to:

1. Prolonged, refractory, or unexplained elbow pain. †
2. Sports injuries, especially in throwing athletes [13,38,39,45,46,62,74,86,87]. †
3. Elbow instability: acute, recurrent, chronic [41,47,88]. †
4. Painful elbow snapping or mechanical symptoms [15,58,59,71].
5. Refractory tennis elbow [48,50,52].
6. Limited or painful range of motion, or contracture [89].
7. Unexplained elbow swelling, mass, or atrophy [82]. *
8. Patients for whom diagnostic or therapeutic arthroscopy or elbow surgery is planned [45]. †
9. Patients with recurrent, residual, or new symptoms following elbow surgery. †

* Conditions in which intravenous (IV) contrast may be useful.
† Conditions in which intra-articular contrast (performed by direct intra-articular injection or indirect joint opacification following IV administration) may be useful.

IV. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI) and the ACR White Paper on Magnetic Resonance Safety.

Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis [90,91].

V. SPECIFICATIONS OF THE EXAMINATION

The supervising physician must have complete understanding of the indications, risks, and benefits of the examination, as well as alternative imaging procedures. The physician must be familiar with potential hazards associated with MRI, including potential adverse reactions to contrast media. The physician should be familiar with relevant ancillary studies that the patient may have undergone. The physician performing MRI interpretation must have a clear understanding and knowledge of the anatomy and pathophysiology relevant to the MRI examination.

The written or electronic request for MRI of the elbow should provide sufficient information to demonstrate the medical necessity of the examination and allow for the proper performance and interpretation of the examination.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). The provision of additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. 2006 (Res. 35)

The supervising physician must also understand the pulse sequences to be employed and their effect on the appearance of the images, including the potential generation of image artifacts. Standard imaging protocols may be established and varied on a case-by-case basis when necessary. These protocols should be reviewed and updated periodically.

A. Patient Selection

The physician responsible for the examination shall supervise patient selection and preparation and be available in person or by phone for consultation. Patients shall be screened and interviewed prior to the examination to exclude individuals who may be at risk by exposure to the MR environment.

Certain indications require administration of intravenous (IV) contrast media. IV contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization. (See the ACR Practice Guideline for the Use of Intravascular Contrast Media.)

Patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate or "conscious" sedation may be needed to achieve a successful examination. If moderate sedation is necessary, refer to the ACR Practice Guideline for Adult Sedation/Analgesia or the ACR Practice Guideline for Pediatric Sedation/Analgesia.

B. Facility Requirements

An appropriately equipped emergency cart must be immediately available to treat adverse reactions associated with administered medications. The cart should

be monitored for inventory and drug expiration dates on a regular basis and comply with institutional policies.

C. Examination Technique

Elbow MRI can be performed using a variety of magnet designs (closed or open) and field strengths (low, medium, or high), including dedicated, extremity-only scanners [51, 92]. On lower field systems, however, the lower signal-to-noise ratio (SNR) may necessitate modifications in the imaging parameters to prevent image degradation [93, 94]. For example, the number of signals averaged can be increased, at the expense of longer imaging times and increased risk of involuntary patient motion [94,95]. Alternatively, the voxel size can be increased (by a combination of larger field of view (FOV), thicker slices, and/or decreased matrix) at the expense of spatial resolution. Fat suppression techniques that rely on the difference between fat and water frequencies (chemical shift) are unreliable at low field strength, and substituting short-TI inversion recovery (STIR) images may be necessary.

Regardless of system design, a local receiver coil is mandatory to maximize the SNR [96]. In general, the coil size should closely approximate the size of the elbow [97]. Thus, a wrist coil may be appropriate for a small child's elbow, while an adult who cannot completely straighten the elbow may require a knee coil [62]. Circumferential, cylindrical coils — constructed in saddle, birdcage, or phased array configurations — provide the most homogenous receptive field [47,98]. However, many cylindrical coils are too large to fit at the side of a supine patient [98]. Other choices include an anterior neck, shoulder, or flexible coil, or a pair of surface coils joined in a Helmholtz configuration [12,47,62,98]. Because it must be oriented perpendicular to the B_0 magnetic field, elbow MRI can only utilize a solenoid coil on a low field system with a vertically oriented B_0 field [94].

Patient positioning for elbow MRI is more difficult than for other joints [99]. The position chosen for the patient and arm also limits the available coil choices. Lying prone with the affected arm overhead allows the elbow to be placed near the magnet isocenter, where the field is most homogeneous. Additionally, the prone position may be easier to tolerate for some patients with severe claustrophobia [100]. Nevertheless, this position is uncomfortable for many patients, resulting in involuntary motion and associated imaging artifacts [62,94,99]. Having the patient pronate the forearm may alleviate some discomfort, but this position may distort the anatomy of the collateral ligaments and tendons in the coronal plane [47,62,94]. Conversely, lying supine with the affected elbow at the side is more comfortable for most patients, but this position places the elbow towards the side of the magnet where the field is less homogeneous, affecting image quality and the ability to achieve effective chemical fat suppression. Furthermore, many cylindrical coils are too large to place alongside a supine patient [98]. A third position for elbow MRI is laying the patient on the side with the elbow overhead [101]. The patient should extend the elbow as much as possible for routine MRI [94]. However, for specific indications, performing part of the examination with the elbow flexed assists in diagnosis. Full elbow flexion is often necessary to demonstrate snapping of the distal triceps or dislocation of the ulnar nerve [59,101]. The contents and size of the cubital tunnel may be easier to visualize with elbow flexion [88]. Lastly, elbow flexion with forearm supination (achievable with the patient prone and the arm overhead) allows imaging of the entire distal biceps tendon in one long-axis plane [102].

Elbow MRI should usually include images in three imaging planes [47,62,88]. Short-axis (transverse) images, perpendicular to the humerus and forearm bones, should extend distally to include the radial tuberosity [62]. Together with the sagittal images, the transverse images are important for grading abnormalities of the distal biceps tendon [54, 53]. Coronal and sagittal images need to be prescribed from the transverse images, parallel and perpendicular respectively to the epicondylar axis of the distal humerus [12, 47,94]. Some practices will also angle the coronal images posteriorly by 20-30 degrees (either by using the sagittal images as a second localizer or by flexing the elbow slightly) to better show the collateral ligaments [40,62,88]. When a severe flexion contracture is present, acquiring separate transverse and coronal images for the humerus and forearm bones may be necessary; alternatively, curved coronal reformatted images can be created from sagittal images 3D gradient-recalled images [89].

Accurate diagnosis of elbow disorders requires high spatial resolution. The FOV should be 10 to 16 cm [47,62,98,99]; if the coil provides a high enough SNR to support it, a FOV at the low end of this range is desirable [98]. Thin slices (1.5 to 4 mm thickness) are also necessary; on most systems, slice thickness less than 2 to 3 mm requires a 3D gradient-echo sequence. For 2D images, an interslice gap no more than 33% of the slice width can increase coverage and decrease signal loss due to cross talk [103] but should not impair complete visualization of the intra-articular structures. The imaging matrix should balance intravoxel SNR with desired in-plane spatial resolution but should be at least 256 steps in the phase and frequency encoding directions. Smaller pixels are preferred, but the available SNR limits the attainable resolution [94]. High-resolution images are especially important for evaluating the collateral ligaments when the MRI is performed without arthrography [43,104]. Depending on the size of the elbow, using a rectangular FOV can save imaging time without sacrificing in-plane resolution [99].

A wide variety of pulse sequences — conventional spin-echo, fast (turbo) spin-echo, and gradient-recalled — is available for elbow MRI. The choice of sequences, like other aspects of the imaging protocol, can be tailored to

optimize the examination to answer the specific clinical questions [94,99], and may vary due to local preferences. A typical imaging protocol will be composed of several pulse sequences. The exact TR, TE, and flip angle chosen will depend on the field strength of the magnet and the desired relative contrast weighting. T1-weighted sequences are useful for characterizing marrow abnormalities [99], various stages of hemorrhage [105], and muscle disorders [106]. T2-weighted images can identify tendon degeneration [50,52,99] as well as muscle and soft tissue edema [99]. Including at least one T2-weighted sequence with fat suppression (or a STIR sequence) will increase the sensitivity of the examination for marrow and soft tissue edema [62]. Some practices use high-resolution long TR, short effective-TE (proton-density-weighted) fast spin-echo images to examine the collateral ligaments [104, 43]. Most elbow imaging protocols will combine short-TE (proton-density-weighted or T1-weighted) images and fluid-sensitive (T2-weighted or STIR) images [88]. An additional option is the use of gradient-recalled pulse sequences. Two-dimensional T2*-weighted images can be used for the diagnosis of intra-articular loose bodies [12,101] and ligament tears [99], or to identify hemosiderin in disorders such as pigmented villonodular synovitis [69]. Gradient-echo imaging performed in 3D mode, with volume acquisition of data, can create thin, contiguous sections. Images with thin slices (2 mm or less) are useful for analyzing the elbow tendons [49], physeal injuries in children [84], and the collateral ligaments in patients with elbow instability or throwing injuries [41,47,84,87,88,99]. However, susceptibility artifacts severely affect gradient-recalled images, limiting their use in postoperative elbows [47,62], where microscopic metal shavings are often present.

T1-weighted images are also used when IV contrast is administered, or when MR arthrography is done with gadolinium-based contrast [64,101]. Intravenous contrast may be helpful in the diagnosis of bursitis [70], tendonopathy [51], osteochondritis dissecans [64], and tumors and inflammation [101]. Elbow MR arthrography can be performed by direct injection of saline or dilute gadolinium into the joint [12,101] or by indirect diffusion of contrast into the joint following IV administration [107]. Exercising the elbow and a delay of 10 to 15 minutes after IV injection will enhance joint opacification for indirect MR arthrography [107]. Direct or indirect MR arthrography can be used to evaluate the elbow ligaments [39,43,44,62,104,108] and articular cartilage [67], and to stage osteochondritis dissecans and identify intra-articular bodies [44,62, 101]. While fat-suppressed T1-weighted images are typically used for MR arthrography, at least one additional T2-weighted sequence needs to be performed to detect pathology that does not communicate with the joint [12,39,43,62,107]. Additionally, at least one T1-weighted sequence without fat suppression is useful for evaluating the bone marrow and characterizing soft tissue lesions.

Suppressing the signal from fat may enhance the diagnostic yield of some pulse sequences [97]. Fat suppression can be performed using spectrally selective RF pulses, a phase-dependent method (e.g., the Dixon technique), or a STIR sequence [109-111]. The latter technique may be necessary on low-field systems. Adding fat suppression to T2-weighted images (or using a STIR sequence) increases the conspicuity of subtle marrow and soft tissue edema [62]. Additionally, fat suppression is a useful adjunct to T1-weighted images when IV contrast is used, or when MR arthrography is performed [112], especially indirect MR arthrography, because of the inherently low gadolinium concentration in the elbow joint achieved after IV injection [107].

Various techniques can minimize artifacts that reduce imaging quality. Aliasing is usually not a problem when the elbow is imaged over the head. However, with the elbow at the patient's side, phase-encoding in the left-to-right direction should be avoided; if that is not possible, phase oversampling should be used to prevent wraparound artifact [113]. Presaturation pulses or gradient moment nulling will reduce ghosting artifacts from flowing blood and other periodic motion [113,114]. Chemical shift artifact is most severe at high field strengths and may necessitate an increase in the receiver bandwidth [95,113]. Susceptibility artifacts, which originate from heterogeneity of the local field, are also more severe at higher field strengths, in the presence of metallic implants, and when using gradient-recalled pulse sequences. Reducing the voxel size by increasing the imaging matrix and/or decreasing the slice thickness and FOV will help reduce the magnitude of susceptibility artifacts [113].

It is the responsibility of the supervising physician to determine whether additional or unconventional pulse sequences and imaging techniques confer added benefit for the diagnosis and management of the patient. Examinations that employ techniques not approved by the Food and Drug Administration, such as the intra-articular injection of gadolinium chelates (direct MR arthrography) [115] can be considered when they are judged to be medically appropriate.

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

At a minimum, the report should address the condition of the major elbow ligaments and tendons and the articular surfaces, as well as any abnormalities in the surrounding structures. In selected cases, a description of findings in the bone marrow, synovium, muscles, neurovascular structures, and subcutaneous tissue would be appropriate. The report should use standard anatomic nomenclature

and precise terms for describing identified abnormalities, whenever possible.

VII. EQUIPMENT SPECIFICATIONS

The MRI equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic strength, maximum rate of change of the magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Specific policies and procedures related to MRI safety should be in place along with documentation that is updated annually and compiled under the supervision and direction of the supervising MRI physician. Guidelines should be provided that deal with potential hazards associated with the MRI examination of the patient as well as to others in the immediate area [90,91,116]. Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination [117].

Equipment monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

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PRACTICE GUIDELINE FOR THE PERFORMANCE AND INTERPRETATION OF MAGNETIC RESONANCE IMAGING (MRI) OF THE SHOULDER

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This Practice Guideline for the Performance and Interpretation of Magnetic Resonance Imaging (MRI) of the Shoulder was developed and written collaboratively by the American College of Radiology (ACR) and the Society of Skeletal Radiology (SSR).

Magnetic resonance imaging (MRI) is a proven and well-established imaging modality for the detection, evaluation, assessment, staging, and follow-up of disorders of the shoulder. Properly performed and interpreted, MRI contributes not only to diagnosis but also serves as an important guide to treatment planning and prognostication. However, it should be performed only for a valid medical reason and after careful consideration of alternative imaging modalities. An analysis of the strengths of MRI and other modalities should be weighed against their suitability for particular patients and particular clinical conditions. Radiographs frequently will be the first imaging test performed for suspected bone and soft tissue abnormalities in the shoulder and will often diagnose or exclude an abnormality or will direct further imaging work-up. Radionuclide bone scanning is often used when occult

osseous disease is suspected or to screen the entire skeleton in addition to the shoulder for disease such as metastases. Other nuclear medicine examinations have a role for specific clinical scenarios (e.g., a labeled white blood cell study for suspected osteomyelitis around the shoulder). Single- or double-contrast arthrography can accurately depict tears of the rotator cuff (1,2). Sonography can be used to evaluate the rotator cuff and biceps tendon and has the advantage of imaging during physiologic motion (3,4,5,6). Computed tomography (CT) can show the detailed osseous anatomy and evaluate the alignment of the glenoid fossa, humerus, and glenohumeral joint. When combined with arthrography, CT can also be used for evaluation of the labrum and loose bodies (7). Lastly, arthroscopy provides a detailed examination of the internal structures of the shoulder joint, allowing the surgeon to treat as well as diagnose many internal derangements.

While MRI is one of the most sensitive diagnostic tests for detecting anatomic abnormalities of the extremities, findings may be misleading if not closely correlated with the clinical history, clinical examination, and physiologic tests. Adherence to the following guideline will enhance the probability of detecting such abnormalities.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI). The interpreting physician needs a thorough knowledge and understanding of the anatomy of the shoulder, including the numerous normal variations in the glenohumeral capsular and labral configurations, and their corresponding MR imaging appearances.

III. INDICATIONS

A. Primary indications for MRI of the shoulder include, but are not limited to, diagnosis, exclusion, and grading of suspected:

1. Rotator cuff abnormalities: Supraspinatus, infraspinatus, and/or subscapularis full-thickness and partial-thickness tears, tendonopathy, tendonitis † (8,9,10,11,12).
2. Disorders of the long head of the biceps brachii: full-thickness and partial-thickness tears, tendonopathy, tendonitis, subluxation, dislocation † (13,14,15,16).
3. Conditions affecting the supraspinatus outlet: acromial shape, os acromiale, subacromial spurs, acromioclavicular joint disorders, subacromial bursitis † (17,18,19).
4. Labral abnormalities: cysts, degeneration, and tears, including superior labrum anterior posterior (SLAP) and Bankart lesions and their variants † (7,20,21,22,23,24,25,26,27,28,29,30).
5. Muscle disorders affecting the shoulder girdle: atrophy, hypertrophy, denervation, masses, injuries (10,31,32,33,34).
6. Osteochondral and articular cartilage infractions of the glenohumeral joint: osteochondral fractures, osteochondritis dissecans, degenerative chondrosis, chondromalacia, and chondral fissures, fractures, flaps, and separations † (35,36,37).
7. Loose bodies: chondral, osteochondral, osseous. †
8. Synovial-based disorders: synovitis, bursitis, metaplasia, and neoplasia * (38,39).
9. Marrow abnormalities: avascular necrosis, marrow edema syndromes, and stress fractures *.
10. Neoplasms of bone, joint, or soft tissue * (40).
11. Infections of bone, joint, or soft tissue * (41,42).
12. Congenital and developmental conditions: dysplasia, normal variants* (43,44,45).
13. Vascular conditions: entrapment, aneurysm, stenosis, and occlusion * (46).
14. Neurologic conditions: entrapment, compression, masses, and peripheral neuritis * (27,47,48,49).

B. MRI of the shoulder may be indicated to further clarify and stage conditions diagnosed clinically and/or suggested by other imaging modalities including, but not limited to:

1. Arthritides: inflammatory, infectious, neuropathic, degenerative, crystal-induced, post-traumatic * (50,51,52).
2. Primary and secondary bone and soft tissue tumors * (53).
3. Fractures and dislocations (54).

C. MRI of the shoulder may be useful to evaluate specific clinical scenarios, including, but not limited to:

1. Prolonged, refractory, or unexplained shoulder pain *†.
2. Acute shoulder trauma.
3. Impingement syndrome: subacromial, subcoracoid, internal (17,18,19,55,56,57) †.
4. Glenohumeral instability: chronic, recurrent, subacute, acute dislocation and subluxation † (58,59,60,61).
5. Shoulder symptoms in the overhead or throwing athlete (62,63,64,65) †.
6. Mechanical shoulder symptoms: catching, locking, snapping, crepitus †.
7. Limited or painful range of motion.
8. Swelling, enlargement, mass, or atrophy *.
9. Patients for whom diagnostic or therapeutic arthroscopy is planned †.
10. Patients with recurrent, residual, or new symptoms following shoulder surgery † (10,34,66,67,68,69,70).

* Conditions in which intravenous contrast may be useful.
† Conditions in which intra-articular contrast (performed by direct intra-articular injection or indirect joint opacification following intravenous administration) may be useful.

IV. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI) and the ACR White Paper on Magnetic Resonance Safety.

Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis (122,124).

V. SPECIFICATIONS OF THE EXAMINATION

The supervising physician must have complete understanding of the indications, risks, and benefits of the examination, as well as alternative imaging procedures. The physician must be familiar with potential hazards associated with MRI, including potential adverse reactions to contrast media. The physician should be familiar with relevant ancillary studies that the patient may have undergone. The physician performing MRI interpretation must have a clear understanding and knowledge of the anatomy and pathophysiology relevant to the MRI examination.

The clinical request form should be initiated by the referring physician or any appropriate allied healthcare professional acting within his or her scope of practice. It should contain pertinent information regarding the clinical indication for the procedure.

The supervising physician must also understand the pulse sequences to be employed and their effect on the appearance of the images, including the potential generation of image artifacts. Standard imaging protocols may be established and varied on a case-by-case basis when necessary. These protocols should be reviewed and updated periodically.

A. Patient Selection

The physician responsible for the examination shall supervise patient selection and preparation, and be available in person or by phone for consultation. Patients shall be screened and interviewed prior to the examination to exclude individuals who may be at risk by exposure to the MR environment.

Certain indications require administration of intravenous (IV) contrast media. IV contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization. (See the ACR Practice Guideline for the Use of Intravascular Contrast Media.)

Patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate or "conscious" sedation may be needed to achieve a successful examination. If moderate sedation is necessary, refer to the ACR Practice Guideline for Adult Sedation/Analgesia or the ACR Practice Guideline for Pediatric Sedation/Analgesia.

B. Facility Requirements

An appropriately equipped emergency cart must be available to treat adverse reactions associated with administered medications. The cart should be monitored for inventory and drug expiration dates on a regular basis.

C. Examination Technique

Shoulder MRI can be performed using a variety of magnet designs (closed or open) and field strengths (low, medium, or high). Since the inherent signal-to-noise ratio is reduced with lower field strength MR systems, imaging parameters may require modifications. For example, the number of acquisitions can be increased, at the expense of longer imaging times and increased risk of involuntary patient motion (73,74,75,76). Alternatively, the voxel size can be increased (by a combination of larger field of view (FOV), thicker slices, and/or decreased matrix) at the expense of spatial resolution (73,75,77,78). Fat suppression techniques that rely on the difference between fat and water frequencies (chemical shifts) are unreliable at low field strength, and substituting short-TI inversion recovery (STIR) images may be necessary (76,78). Even when the imaging protocol is optimized for shoulder imaging on a low-field open system, subjective image quality will likely be inferior to that obtained with a high-field system (75,78). Various investigators using different equipment and scanning parameters have reached contradictory conclusions regarding the diagnostic performance of low-field-strength MR scanners for shoulder disorders. Some studies have found that the accuracy for complete and partial rotator cuff tears and for labral abnormalities is not significantly different for open, low-field and closed, high-field systems, with careful attention to technique (78,79,80,81). MR arthrography can further enhance the diagnostic yield for shoulder MRI performed on low-field strength systems (75,76). Other investigators have found lower accuracy for the evaluation of disorders like SLAP tears, capsular abnormalities, and small rotator cuff tears with specific low-field systems compared to high-field ones (77,79,82).

Regardless of system design, a local coil is mandatory to maximize the signal-to-noise ratio. Commercially available coils appropriate for shoulder imaging include single-loop contoured or flat-surface coils (83, 84), paired coils in a Helmholtz configuration (23, 85), circularly

polarized flexible coils (77), solenoid coils (73), and phased array designs (24, 26).

Patients are positioned supine with the affected arm at the side. For evaluation of the rotator cuff and anterior labrum, internal rotation of the arm should be avoided (59,84,86). When MR arthrography is performed, repositioning the affected arm into the abduction external rotation (ABER) position may increase sensitivity for anterior inferior labral tears (7,22,87), and may increase accuracy for rotator cuff tears, especially partial-thickness ones (88,89).

Shoulder MR examinations usually include images acquired in the transverse, oblique sagittal, and oblique coronal planes. The oblique sections are prescribed orthogonal to either the glenoid face, or to the axis of the supraspinatus. The transverse images demonstrate the extra-articular portion of the long head of the biceps and the anterior and posterior glenoid labrum (7,16,21,23). Evaluation of the rotator cuff is done using both oblique coronal and oblique sagittal images (90); tilting the oblique sagittal images in the frontal plane so that they are perpendicular to the distal supraspinatus tendon may be useful for identifying subtle partial-thickness rotator cuff tears (91). Transverse images may aid in the detection of anterior rotator cuff tears. Additionally, the oblique coronal images show the superior labrum and intra-articular segment of the biceps tendon to advantage (92), while the oblique sagittal images can be used to depict the acromial anatomy and supraspinatus outlet (17,18). The use of radial imaging for the glenoid labrum has been reported (93), but it is not widely used.

The field of view (FOV) should be tailored to the size of the patient and the structures being examined, but for the standard sequences, the FOV should be 16 cm or smaller on medium-field and high-field units; FOVs of up to 20 cm may be necessary to obtain an adequate signal-to-noise ratio on low-field scanners (75,78). When larger FOVs are used, accuracy decreases (94), but can be partly compensated for with use of intravenous contrast. Occasionally, additional sequences with a larger FOV will be appropriate to more fully evaluate a detected or suspected abnormality, for example, in the scapulothoracic articulation. Slice thickness in the oblique sagittal and coronal planes of 4 mm or less is needed to demonstrate subtle tendon pathology, but thinner sections may be advantageous for detailed analysis of other structures such as the labrum and articular cartilage. An interslice gap may be selected to decrease signal loss due to cross talk (95), but should be no more than 50% of the slice width and should not impair complete visualization of the intra-articular structures. The imaging matrix should balance intravoxel signal-to-noise ratio with desired in-plane spatial resolution and reduction of truncation artifacts, but should be at least 160 steps in the phase direction and 256 steps in the frequency direction for 2D imaging, for nontumor image. Some practices may use higher imaging matrices (up to 512 steps) to increase spatial resolution for the diagnosis of labral lesions, including SLAP tears (21,24).

Shoulder MRI can be performed with a wide variety of pulse sequences (96). The choice of sequences can be tailored to optimize the examination for specific clinical questions, and may vary due to local preferences. Conventional spin-echo, fast (turbo) spin-echo, and gradient-recalled sequences have all been used successfully for shoulder MRI. A typical imaging protocol will be composed of one or more of these pulse sequence types. The exact TR, TE, and flip angle chosen will depend on the field strength of the magnet and the relative contrast weighting desired.

Fluid sensitive sequences such as long TR-long TE (T2-weighted) images with or without fat suppression or STIR images are typically used for evaluation of the rotator cuff, either with conventional spin-echo or fast (turbo) spin-echo technique (9,97,100,101). T2*-weighted gradient-echo recalled sequences can also be used for diagnosing rotator cuff abnormalities, but probably with lower accuracy compared with conventional spin-echo or fast spin-echo sequences (102,103). To show labral abnormalities, long-TR (proton-density weighted or T2-weighted) spin-echo or fast spin-echo images, or T2*-weighted gradient recalled images are typically used (21,23,104), although gradient echo imaging may be less accurate, when used in isolation for anterior labrum abnormalities compared with conventional spin-echo or fast spin-echo imaging (84). Lesions of the superior labrum, such as SLAP tears, can be visualized on fast spin-echo, long-TR images (24,26), or with gadolinium-enhanced MR arthrography (25,28). MR arthrography using intra-articular saline (59) or dilute gadolinium (58) may improve diagnostic accuracy in unstable shoulders. Gadolinium-enhanced MR arthrography additionally may improve diagnostic performance for some rotator cuff tendon tears, particularly partial-thickness tears and subscapularis tears (12,87,105,106). T1-weighted images either without (7,58,105) or with fat suppression (22,25,106) are most frequently employed when MR arthrography is performed with gadolinium-based contrast. At least one fluid sensitive sequence is still necessary when performing MR arthrography to detect pathology that does not communicate with the joint. T1-weighted sequences also have a role in characterizing marrow abnormalities (54), various stages of hemorrhage (107,108), and muscle pathology (10,31,32,33,34,110).

Suppressing the signal from fat may enhance the diagnostic yield of some pulse sequences (96). Fat suppression can be performed using spectrally selective RF pulses, a STIR sequence, or a phase-dependent method (e.g., the Dixon method) (76,78,110,111). The latter two techniques may be necessary on low-field systems (78,88). The addition of fat suppression may increase diagnostic accuracy for rotator cuff tears (97), especially partial-thickness tendon tears (9,112). Fat suppression is a useful adjunct to T1-weighted images

when MR arthrography is performed using a dilute gadolinium mixture (22,25, 106).

Additional imaging techniques may have a role for specific shoulder disorders. Applying axial traction to the affected arm via a weight attached to the wrist may aid in the visualization of SLAP lesions (113). The ABER position may help with the MR arthrographic diagnosis of instability lesions and partial-thickness rotator cuff tears (7,22,87,88,89). Direct MR arthrography may be beneficial for various internal shoulder derangements and for imaging postoperative conditions in the shoulder (7,12,15,25,27, 28,36,59,61,69,105,106,113).

Various techniques may be used to minimize artifacts that can reduce imaging quality. Wraparound artifact should be reduced by phase oversampling (114). Involuntary patient motion is best controlled by ensuring patient comfort combined with gentle immobilization when necessary (96). Securing the affected arm against the thigh may further reduce motion artifacts (59). When available, software that compensates for motion by the use of navigator echoes can be useful (115). Flowing blood and other periodic motion produce ghosting artifacts, which can be reduced with presaturation pulses or gradient moment nulling (114,116). Chemical shift artifact is more severe at higher field strengths, and may necessitate an increase in the receiver bandwidth (74, 114). Susceptibility artifacts, which originate from heterogeneity of the local field, are also more severe at higher field strengths and when using gradient-recalled pulse sequences. Avoiding gradient-echo imaging and reducing the voxel size by increasing the imaging matrix and/or decreasing the slice thickness and FOV will help reduce the magnitude of susceptibility artifacts (114,115). Vacuum phenomena in the shoulder joint can also result in artifact generation, especially when gradient-recalled pulse sequences are used (118). Lastly, magic angle artifact can produce apparent increased signal intensity on short-TE images within the supraspinatus tendon as it curves over the humeral head, mimicking intratendinous pathology (119). This pitfall is best avoided by confirming abnormal signal intensity in the tendon on long TR images, and correlating apparent signal intensity abnormalities with changes in tendon thickness.

It is the responsibility of the supervising physician to determine whether or not additional pulse sequences or unconventional pulse sequences and imaging techniques would confer added benefit for the diagnosis and management of the patient. Examinations that employ techniques not approved by the Food and Drug Administration, such as the intra-articular injection of gadolinium chelates (direct MR arthrography) (120), can be considered when they are judged to be medically appropriate.

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

At a minimum, the report should address the condition of the rotator cuff muscles and tendons, supraspinatus outlet, biceps tendon, and labrum. In selected cases, a description of findings in the major ligaments and capsule, articular cartilage, bone marrow, synovium, and cortical bone would be appropriate. An effort should be made to adopt a standardized lexicon of terms, and the report should use precise anatomic descriptions of identified abnormalities whenever possible (121).

VII. EQUIPMENT SPECIFICATIONS

The MRI equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic strength, maximum rate of change of the magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Specific policies and procedures related to MRI safety should be in place with documentation that is updated annually and compiled under the supervision and direction of the supervising MRI physician. Guidelines should be provided that deal with potential hazards associated with the MRI examination of the patient as well as to others in the immediate area (122,123,124). Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination (122,123,124,125).

Equipment monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

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PRACTICE GUIDELINE FOR THE PERFORMANCE AND INTERPRETATION OF MAGNETIC RESONANCE IMAGING (MRI) OF BONE AND SOFT TISSUE TUMORS

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This Practice Guideline for the Performance and Interpretation of Magnetic Resonance Imaging (MRI) of Bone and Soft Tissue Tumors was developed and written collaboratively by the American College of Radiology and the Society of Skeletal Radiology (SSR).

Magnetic resonance imaging (MRI) is a proven and well-established imaging modality in the detection, evaluation, assessment, staging, and follow-up of tumors of the musculoskeletal system. Properly performed and interpreted, MRI not only contributes to diagnosis but also serves as an important guide to treatment planning, prognosis, and follow-up of tumors. However, MRI of a tumor or suspected mass should be performed only for a valid medical reason and after careful consideration of alternative imaging modalities. An analysis of the strengths of MRI and other modalities should be weighed against their suitability for particular patients and particular clinical conditions. Radiographs should be used

as the initial diagnosis for primary bone tumors. In addition, radiographs are usually the first imaging test to be performed for suspected soft tissue masses, in particular for the value of showing calcification. Radionuclide bone scanning is often used when occult osseous disease is suspected, or to screen the entire skeleton, for conditions such as metastases. Other nuclear medicine examinations have a role for specific clinical scenarios (e.g., a labeled white blood cell study for suspected osteomyelitis). Computed tomography can show the detailed osseous anatomy and better identify osteoid and chondoid matrix. Sonography may be appropriate to examine relatively superficial soft tissue masses (1,2). Angiography still remains useful for the evaluation of tumor vascularity, for the presence and location of major arteries, and for planning surgical resection and reconstruction (3). MR angiography may be used as well.

While MRI is one of the most sensitive, noninvasive diagnostic tests for detecting anatomic abnormalities of the musculoskeletal system, findings may be misleading if not closely correlated with the clinical history, clinical examination, and physiologic tests. Adherence to the following guidelines will enhance the probability of detecting such abnormalities.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI).

III. INDICATIONS

Indications for MRI of soft tissue and bone tumors include, but are not limited to:

1. Initial characterization, detection or exclusion of bone tumors and soft tissue tumors or suspected masses (4-19).
2. Staging of known bone and soft tissue tumors (20-24).
3. Preoperative evaluation and surgical planning of bone and soft tissue tumors (11,20,25-27).
4. Evaluation of the response of tumors to treatment, including neoadjuvant chemotherapy, postresection chemotherapy, and radiation therapy (28-38).
5. Detection and evaluation of complications related to bone and soft tissue tumors, or to their treatment, including hemorrhage, infection, and neurologic and vascular conditions (36-48).
6. Post-treatment and long-term surveillance and characterization of local, regional, and distant tumor recurrences.

IV. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI) and the ACR White Paper on Magnetic Resonance Safety.

Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis (69,71).

V. SPECIFICATIONS OF THE EXAMINATION

The supervising physician must have complete understanding of the indications, risks, and benefits of the examination, as well as alternative imaging procedures. The physician must be familiar with potential hazards associated with MRI, including potential adverse reactions to contrast media. The physician should be familiar with relevant ancillary studies that the patient may have undergone. The physician performing MRI interpretation must have a clear understanding and knowledge of the anatomy and pathophysiology relevant to the MRI examination.

The clinical request form should be initiated by the referring physician or any appropriate allied healthcare professional acting within his or her scope of practice. It should contain pertinent information regarding the clinical indication for the procedure.

The supervising physician must also understand the pulse sequences to be employed and their effect on the appearance of the images, including the potential generation of image artifacts. Standard imaging protocols may be established and varied on a case-by-case basis when necessary. These protocols should be reviewed and updated periodically.

A. Patient Selection

The physician responsible for the examination shall supervise patient selection and preparation, and be available in person or by phone for consultation. Patients shall be screened and interviewed prior to the examination to exclude individuals who may be at risk by exposure to the MR environment.

Certain indications require administration of intravenous (IV) contrast media. IV contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization. (See the ACR Practice Guideline for the Use of Intravascular Contrast Media.)

Patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate or "conscious" sedation may be needed to

achieve a successful examination. If moderate sedation is necessary, refer to the ACR Practice Guideline for Adult Sedation/Analgesia or the ACR Practice Guideline for Pediatric Sedation/Analgesia.

B. Facility Requirements

An appropriately equipped emergency cart must be immediately available to treat adverse reactions associated with administered medications. The cart should be monitored for inventory and drug expiration dates on a regular basis.

C. Examination Technique

Diagnostic quality MRI of suspected bone and soft tissue masses can be performed using a variety of magnetic designs (closed-bore whole body, open whole body) and a variety of field strengths (5,8,10,13). Regardless of system design, efforts should be made to maximize signal-to-noise ratios. Field of view (FOV) should be tailored to the size of the patient and the size of the suspected mass (8,49,50,51). For example, a 48 cm FOV would be appropriate for an extremely large tumor of the pelvis or thigh, whereas a 12 cm FOV may be appropriate for a small mass in the foot. At times, additional sequences with a larger FOV will be necessary to evaluate proximal or distal spread of disease. It is important to obtain as many axial, sagittal, or coronal images through the lesion as is reasonable. Slice thicknesses will also vary depending on the size of the lesion (8). For example, a 1 cm mass might require 3 mm thick slices, whereas a tumor greater than 30 cm in size may be appropriately imaged with 1 cm slice thickness (8). An interslice gap may be chosen to decrease signal loss due to cross-talk (50), but in general should be no more than one-half of the slice width and should not impair complete visualization of the mass. The imaging matrix should balance intravoxel signal-to-noise with desired in-plane spatial resolution.

The size of the lesion would also dictate whether it is more appropriate to use a local surface or cylindrical coil, in particular for a small lesion, whereas the body coil may be more appropriate for extremely large lesions (8,24,27). Every attempt should be made to include the entire soft tissue or bone tumor in the imaged volume. Additionally, for high-grade sarcomas of bone, the entire bone should be imaged to evaluate for more proximal skip lesions and regional metastases.

For patients with more than one suspected bone or soft tissue mass it may be necessary to perform separate MR examinations. For example, a patient with a pelvic and leg mass may require a separate examination of the leg and pelvis.

When using a low-field system to perform MRI of bone and soft tissue tumors, other imaging parameters – such as the receiver bandwidth and number of acquisitions – will require modification to ensure adequate spatial and contrast resolution for confident diagnosis, often at the expense of longer examination times (49,52). It may also be more difficult to achieve uniform fat suppression on low-field systems, using spectrally selective RF pulses, necessitating the use of Dixon or short TI inversion recovery (STIR) techniques (53,54,55,56). Other systems may be more prone to imaging artifacts (e.g., chemical shift artifact on high-field magnets), again necessitating modification of imaging parameters such as receiver bandwidth to ensure that these artifacts do not detract from the diagnostic quality of the resultant images. Some MR imaging systems may not be appropriate for specific indications. For example, high-resolution evaluation of a sub centimeter mass may not be feasible with a low-field, open magnet, regardless of the chosen imaging parameters (57).

MRI imaging of bone and soft tissue tumors usually includes images in at least two, and in some cases three orthogonal planes (transverse, sagittal, and coronal) (5,7,8,18,49). The sagittal and coronal images may be oriented orthogonal to the magnetic bore, or may be angled to better identify specific anatomic structures. The coverage of the tumor ideally should include all of the anterior, posterior, medial, lateral, superior, and inferior margins of the mass (5,8,25).

MRI of suspected bone and soft tissue tumors can be performed with a variety of pulse sequences. The choice of sequences can be tailored to optimize the examination for specific clinical questions and according to local preferences. In general, however, conventional spin-echo and fast (turbo) spin-echo images are preferred (5,8,49). Gradient-recalled sequences may also be valuable, in particular in evaluating for internal areas of hemorrhage, ossification, or calcification. An imaging protocol would usually be composed of one or more of these pulse sequence types, but typically would include at least T1-weighted images and T2-weighted images with and/or without fat suppression (8,49). The exact TR, TE, and flip angle chosen will depend on the field-strength of the magnet and the relative contrast weighting desired (5,49,52).

Short-TE images with a relatively short TR (T1-weighted) are commonly used to evaluate tumors (5,8,51,52). Because of the image blurring inherent in a fast spin-echo image made with a short effective TE, conventional spin-echo imaging may be preferred (5,8,51,52). Properly optimized, however, some investigators have used fast spin-echo imaging for T1-weighted images. To demonstrate pathologic tissues, T2-weighted imaging

using conventional spin-echo or fast spin-echo sequences are most commonly used (8,53,54,55,56).

T1-weighted sequences are routinely done without fat suppression to depict anatomic relationships; however, the addition of fat suppression may be helpful to detect hemorrhage or fat within a mass, and when intravenous contrast is given (58). Water sensitive images, obtained with long TR using conventional or fast spin-echo sequences, can be used to characterize bone and soft tissue tumors, providing complementary information to the T1-weighted images. Therefore, a combination of both T1-weighted and T2-weighted images is typically performed in each imaging plane (5,8,53,54,55). Lesion conspicuity may be increased with the addition of fat suppression to the water-sensitive images, but for enhancement and optimal characterization of hemorrhage, calcification, and osteoid tissue, T2-weighted sequences can be performed with and/or without fat suppression, or STIR sequences can be used (8,53,54). For example, the transverse images may be obtained without fat suppression and the long axis planes (sagittal and/or coronal images) performed with fat suppression or STIR sequences.

Various techniques may be used to reduce the MR artifacts that can reduce imaging quality. Wraparound artifact, including that originating from signal received from other parts of the body, can be reduced by phase oversampling, by switching the phase and frequency readout directions, or by using radiofrequency shielding. Truncation (Gibbs) artifacts may obscure or mimic intralesional detail and can be reduced by changing the phase-encoding direction. Involuntary patient motion is best controlled by ensuring patient comfort combined with gentle immobilization when necessary (49,59). Flowing blood can produce ghosting artifacts, which can be reduced with presaturation pulses or the use of gradient moment nulling (49,59).

In many cases it may be advantageous to administer a gadolinium-based intravenous contrast agent (60-66). Intravenous contrast may be helpful to differentiate cysts from solid masses and may provide additional details of the imaging features of bone and soft tissue masses (8,61,62). Follow-up MR examinations of patients with previously treated soft tissue tumors often benefit by the addition of intravenous gadolinium chelates (34,36). Subtracting the precontrast images from the postcontrast ones may be beneficial to show subtle areas of enhancement. The decision to use intravenous contrast should be based on medical appropriateness.

For interpretation, the images can be printed on film or viewed on a workstation. If hardcopy viewing is used, some practices may film the images with magnified or narrowed window settings, but this can be left to local preferences. MR examinations in patients with suspected tumors should be read cautiously and preferably in conjunction with available radiographs. There are many pitfalls and artifacts which can suggest that a non-neoplastic mass is an aggressive tumor, or that a malignant tumor appears to be a benign lesion based on the MR appearance alone (8,67,68). Furthermore, imaging artifacts can also contribute to incorrect staging of tumors (8,67,68).

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

The report should address the presence or absence of a mass, the size of the lesion and its composition, signal intensity, and enhancement characteristics. A description of the anatomic location of a tumor, including its relationships to adjacent major muscles, vessels, and nerves, will contribute to the tumor's grading and staging.

VII. EQUIPMENT SPECIFICATIONS

The MRI equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic strength, maximum rate of change of the magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Specific policies and procedures related to MRI safety should be in place with documentation that is updated annually and compiled under the supervision and direction of the supervising MRI physician. Guidelines should be provided that deal with potential hazards associated with MRI examination to the patient as well as to others in the immediate area (69,70,71). Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination (69,70,71,72).

Equipment monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics

Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

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Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

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PRACTICE GUIDELINE FOR THE PERFORMANCE AND INTERPRETATION OF MAGNETIC RESONANCE IMAGING (MRI) OF THE BRAIN

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. It should be recognized, therefore, that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline was developed collaboratively by the American Society of Neuroradiology (ASNR) and the American College of Radiology (ACR).

Magnetic resonance imaging (MRI) of the brain is a proven and well-established imaging modality in the evaluation and assessment of normal and abnormal conditions of the brain. MRI of the brain is the most sensitive technique available because of its high sensitivity in exploiting inherent contrast differences of tissues as a result of variable magnetic relaxation properties and magnetic susceptibilities. MRI is a rapidly changing technology, and ongoing technical improvements will continue to improve MRI diagnosis of brain disorders. This guideline outlines the principles for performance of high-quality MRI of the brain.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI).

III. INDICATIONS

Indications for MRI of the brain include, but are not limited to:

A. Primary Indications

Seizures, cranial nerve dysfunction, diplopia, ataxia, acute and chronic neurologic deficits, suspicion of neurodegenerative disease, primary and secondary neoplasm, aneurysm, cortical dysplasia and other morphologic brain abnormalities, vasculitis, encephalitis, brain maturation, headache, mental status change, hydrocephalus, ischemic disease and infarction, suspected pituitary dysfunction, inflammation or infection of the brain or meninges or their complications, postoperative evaluation, demyelination and dysmyelination disorders, vascular malformations, and arterial or venous/dural sinus abnormalities.

B. Extended Indications

Suspicion of acute intracranial hemorrhage or evaluation of chronic hemorrhage, neuroendocrine dysfunction, functional imaging, brain mapping, blood flow and brain perfusion study, image guidance for intervention or treatment planning, spectroscopy (including the evaluation of brain tumor, infectious processes, brain development and/or degeneration, and ischemic conditions), and post-traumatic conditions.

IV. POSSIBLE CONTRAINDICATIONS

Possible contraindications include, but are not limited to, the presence of cardiac pacemakers, ferromagnetic intracranial aneurysm clips, certain neurostimulators, certain cochlear implants, and certain other ferromagnetic foreign bodies or electronic devices (1,2,3). Contraindications should be listed on a screening questionnaire (1,2,3,4). In other situations, referring to published test results and/or on-site testing of an identical device may be helpful to determine whether a patient may be safely scanned (1,2,3). There is no known adverse effect of MRI on the fetus (5). The decision to scan during pregnancy should be made on an individual basis (6,7).

V. SPECIFICATIONS OF THE EXAMINATION

The supervising physician must have complete understanding of the risks, benefits, and alternatives of the examination. The physician must also clearly understand the indications prior to performance of the MRI examination. The physician should be familiar with relevant ancillary studies that the patient may have undergone. The clinical request form should contain information regarding the clinical indications for the procedure. The clinical request form should be issued by the referring physician or any appropriate allied healthcare professional acting within the scope of practice.

The physician performing MRI interpretation must have, in addition to a clear understanding of the indications, a clear understanding and knowledge of the anatomy of the brain and central nervous system, as well as the pathophysiologic imaging correlates.

The physician must also understand the pulse sequences and have a general understanding of the underlying physics surrounding the pulse sequences to be deployed. The physician must be familiar with potential hazards associated with MRI of the brain. The responsible physician should be able to treat adverse reactions arising during the MRI examination associated with the administration of contrast agents or of medications used for sedation.

A. Patient Safety and Selection

Policies and procedures should be in place with documentation that is updated annually and compiled under the supervision and direction of the supervising MRI physician. Guidelines should be provided that deal with potential hazards associated with MRI examination of the brain to the patient as well as to others in the immediate area (1,2,3). Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination (1,2,3,4).

For complete information regarding MR safety see the ACR White Paper on MR Safety. In: Kanal E, Borgstede JP, Barkovich AJ, et al. American College of Radiology White Paper on MR Safety. AJR 2002; 178:1335–1437. Reprinted with permission from the American Roentgen Ray Society in the ACR Practice Guidelines and Technical Standards book.

The supervising physician should be available in the event that a patient may not be able to tolerate an examination. That physician may also be able to achieve examination success by administering conscious sedation. If conscious sedation is necessary, refer to the ACR Practice Guideline for Adult Sedation/Analgesia or the ACR Practice Guideline for Pediatric Sedation/Analgesia. Conscious sedation should be performed in accordance with institutional policy and state and federal law. Conscious sedation may be performed by the supervising physician or by a nurse with training in cardiopulmonary resuscitation. An emergency cart must be available to treat adverse reactions associated with administered medications.

B. Examination

MRI examination of the brain can be performed with a wide array of pulse sequences. This is a rapidly evolving field, and the appropriate pulse sequence must be individualized and tailored to the clinical question at hand under the supervision of the MRI physician. The most commonly accepted imaging protocols for MRI of the brain currently include a T1-weighted sequence in the sagittal plane. Long repetition time (TR) sequences with double-echo (T2-weighted images) are also generally performed in the axial plane. A fast-spin-echo or turbo-spin-echo (or equivalent) technique can substitute for these axial sequences. Under certain clinical circumstances, very rapid acquisitions such as echoplanar imaging or single shot fast-spin-echo imaging can be performed to obtain T2 information. Fluid-attenuated inversion recovery (FLAIR) imaging can also be added or substituted for the proton density weighted sequence in the T2 acquisition.

The TR and echo time (TE) required to optimize image quality depends on the field strength of the magnet. These parameters must therefore be adjusted by the supervising physician for image optimization. Lower field strength magnets may require lower TRs, while higher field strength magnets may require longer TRs for image optimization.

Slice thickness, spatial resolution, signal-to-noise ratio, acquisition time, and contrast are all interrelated. To optimize spatial resolution, imaging of the brain should be performed with slice thickness of no greater than 5 mm and an interslice gap of no greater than 2.5 mm. Thinner slices (less than 5 mm) may be applied if clinical circumstances warrant.

Gadolinium chelates may be administered intravenously when there is suspicion of breakdown of the blood-brain barrier. Post-contrast images are obtained in the axial and/or coronal and/or sagittal planes with short TR and TE sequences (T1-weighted). Post-contrast T1-weighted images should be compared to pre-contrast images, although the pre-contrast images do not necessarily have to be performed in the same planes as the post-contrast images.

With the advent of high-performance gradient coil assemblies and amplifiers, faster imaging is also an option when the appropriate hardware and software exist. Improvements in the receiver and data acquisition systems also allow for more rapid imaging. Rapid pulse sequences and imaging techniques that may also have utility for MRI of the brain can include but are not limited to: echoplanar imaging, diffusion weighted imaging, rapid gradient-echo pulse sequences (capable of providing T1 or T2 information), functional imaging, perfusion imaging, volumetric, and other quantitative applications. Certain clinical circumstances may warrant the use of proton MR spectroscopy. Additional techniques that may be useful under the appropriate clinical circumstances include magnetization transfer imaging, cerebral spinal fluid (CSF) flow study using phase-contrast pulse sequences, and single shot fast or turbo spin-echo imaging.

It is the responsibility of the supervising physician to determine whether additional pulse sequences or nonconventional pulse sequences and imaging techniques confer added benefit for the diagnosis and management of the patient. Generally MRI examination of the brain should be performed within parameters approved by the FDA. Examinations that employ techniques not approved by the FDA can be considered when they are judged to be medically appropriate.

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication: Diagnostic Radiology.

VII. EQUIPMENT SPECIFICATIONS

The MRI equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic strength, maximum rate of change of magnetic field strength (dB/dT), maximum radio-frequency power deposition (specific absorption rate), and maximum auditory noise levels.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment.

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92. Weight DG, Bigler ED. Neuroimaging in psychiatry. Psychiatr Clin North Am 1998; 21:725–759.

93. Yang Y, Glover GH, van Gelderen P, et al. A comparison of fast MR scan techniques for cerebral activation studies at 1.5 tesla. Magn Reson Med 1998; 39:61–67.
94. Yuh WT, Ueda T, White M, et al. The need for objective assessment of the new imaging techniques and understanding the expanding roles of stroke imaging. Am J Neuroradiol 1999; 20:1779–1784.
95. Zimmerman RA, Wang ZJ. The value of proton MR spectroscopy in pediatric metabolic brain disease. Am J Neuroradiol 1997; 18:1872–1879.

EXHIBIT B

American College of Radiology

MRI Services of

The Stamford Hospital
Stamford, CT

were surveyed by the
Committee on MRI Accreditation of the
Commission on Quality and Safety

The following magnet was approved

General Electric HORIZON LX 2000

Accredited from:

May 15, 2005 through May 15, 2008

CHAIRMAN, COMMITTEE ON MRI ACCREDITATION

PRESIDENT, AMERICAN COLLEGE OF RADIOLOGY

MRAP#: 01207-01

EXHIBIT C

Brian G. Grissler

Brian G. Grissler is president & chief executive officer of Stamford Health System, the parent corporation of The Stamford Hospital and its affiliated corporations. Mr. Grissler assumed his role in July 2001. He earned his bachelor's degree in Economics from Rutgers University and his M.B.A. in Health Services Administration from Wagner College in Staten Island, New York. He completed his administrative residency at Overlook Hospital in Summit, New Jersey. Prior to joining Stamford Health System, Mr. Grissler had been the president and chief executive officer of Suburban Hospital Healthcare System for nine years. He is a Fellow of the American College of Healthcare Executives and is a member of the American Hospital Association. Mr. Grissler, his wife, Patty, and their three children reside in New Canaan.

SpencerStuart

DERRICK O. HOLLINGS

Education

University of Alabama, Birmingham, AL
B.A., Accounting, 1980 (verified)

SUMMARY OF EXPERIENCE

2003-Present	**HOWARD UNIVERSITY HOSPITAL** Washington, DC Chief Financial Officer
1998-2002	**PRIVATE CONSULTANT** Braintree, MA President and Chief Executive Officer
1990-1997	**UNIVERSITY OF MASSACHUSETTS MEDICAL SCHOOL** Worcester, MA Chief Financial Officer, Clinical Division
1987-1990	**MEDIVISION, INC.** Boston, MA Vice President of Finance and Treasurer

SpencerStuart

1984-1987	**HOTEL DIEU HOSPITAL** El Paso, TX Controller
1981-1984	**LAKESHORE REHABILITATION HOSPITAL** Birmingham, AL Controller
1980-1981	**BANKS FINLEY WHITE & CO CPA** Birmingham, AL Auditor

SpencerStuart

DETAIL OF EXPERIENCE

2003-
Present

HOWARD UNIVERSITY HOSPITAL
Washington, DC

Howard University Hospital, a 482-bed award winning university and teaching hospital, has proudly served the global community with a commitment to innovative patient care, teaching and research. The hospital has an exceptional medical and nursing staff, together with technologically advanced programs and services which makes Howard University Hospital a world-class institution committed to leadership in healthcare, leadership for America.

Chief Financial Officer

Mr. Hollings is responsible for the overall hospital financial performance and all aspects of the financial services division's daily operations. He is a key advisor to management on productivity, cost efficiencies and revenue opportunities necessary for maximizing available resources. Some of his accomplishments include:

- Organized the financial services division of the hospital into financial planning, general accounting, budgeting and cost containment, reimbursement, payroll, cash management, patient access, billing and collections, controllership and revenue-cycle functions.
- Created models for evaluating opportunities for acquisition, divestitures, joint venture and other strategic alliances. The model measured a proposal contribution toward achieving strategic direction.
- Developed clear and informative methods for presenting financial information on the hospital, special projects and studies to executive management and the University leadership.
- Key facilitator of organization-wide financial planning, business prioritization and resource allocation.
- Directs and controls a comprehensive budget process that includes resource allocations for fiscal year operations, capital budgets and new programs in collaboration with executive management.
- Provides highly visible leadership within the hospital and serves as an advisor to the CEO regarding financial management of the hospital.

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1998-2002 **PRIVATE CONSULTANT**
Braintree, MA

President and Chief Executive Officer

Mr. Hollings founded the company to provide customized web-based solutions and system integration services. He acquired Quoin Incorporated, a boutique software engineering and consulting firm – this created the company's technical capabilities. Some of his accomplishments included:

- Performed project management services for Meditech patient accounting and lab software applications.
- Developed primary goals, business plans, policies, and short- and long-range objectives.
- Directed and coordinated activities to achieve growth, profit and return on shareholder's equity.
- Led company through start-up and turbulent dot.com evolution.
- Managed the product development phase and created the company's identity.
- Represented the company to the financial community, major customers, government agencies, shareholders and the public.

1990-1997 **UNIVERSITY OF MASSACHUSETTS MEDICAL SCHOOL**
Worcester, MA

UMass Memorial Medical Center, in Worcester, Massachusetts, is a 783-bed facility, including bassinets, on three campuses (Memorial, University and Hahnemann Campuses). The Medical Center offers a full complement of sophisticated technology and support services, providing the region with specialists renowned for their work in areas such as cancer, cardiology, emergency medicine, children's medical services, including an internationally recognized newborn intensive care unit, and women's health.

UMass Memorial Medical Center is accredited by the American College of Surgeons as the only designated Level I trauma center for adults and children in Central Massachusetts. The University Campus is home to the new Duddie Massad Emergency and Trauma Center and LifeFlight, New England's first hospital-based air ambulance. The Memorial Campus houses the region's only Level III Newborn Intensive Care Unit.

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Chief Financial Officer, Clinical Division

Mr. Hollings was responsible for implementing, directing, managing, monitoring and evaluating the accounting and financial functions of the clinical division. Some of his accomplishments included:

- Led the budgeting process and ensured effective integration of financial functions with hospital departments and the University at large.
- Supervised every aspect of financial services for multi-hospital and multi-physician organizations, real estate holding and various other joint ventures for the leading healthcare delivery system serving Worcester County.
- Developed and maintained a complete accounting, statistical and financial reporting system. Streamlined, authorized and controlled disbursement of monies; monitored the cash position and planned for adequate funding to meet outstanding obligations and commitments.
- Responsible for implementing, directing, managing, monitoring and evaluating the accounting and financial functions of the clinical division.

1987-1990 **MEDIVISION, INC.**
Boston, MA

Vice President of Finance and Treasurer

Mr. Hollings supervised the ambulatory surgery center – physician billing and collections, general accounting, accounts payable, tax preparation and payroll functions. Some of his accomplishments included:

- Prepared financial statements and supporting schedules for the external auditors and provided all information requested by investor groups.
- Maintained reports on volume, financial performance and profitability for each ambulatory surgery center and physician practice.
- Responsible for local, state, federal taxes and other corporate compliance, with applicable law.
- Closely monitored and analyzed the company's financial performance throughout the year.
- Provided in-depth business and financial analysis for organizational planning and decision making. Provided a succinct analysis of the company's financial

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results and trends for corporate executives, regional vice presidents and site administrators.

- Developed and maintained relationships with banking, insurance and other business relationships in order to facilitate financial activities.
- Performed due diligence for mergers and acquisitions.

1984-1987 **HOTEL DIEU HOSPITAL**
El Paso, TX

Controller

Mr. Hollings maintained the hospital's system of accounts and kept books and records on all transactions and assets. Some of his accomplishments included:

- Developed, analyzed and interpreted statistical and accounting information in order to appraise operating results in terms of profitability, performance against budget and other matters bearing on the fiscal soundness and operating effectiveness of the hospital.
- Departments under supervision were general accounting, accounts payable, budgeting, reimbursements, payroll, billing and collections.
- Prepared monthly reports that outlined the hospital's financial position in the areas of income, expenses and profits based on past, present, and future operations.
- Responsible for providing effective financial controls for the hospital.

1981-1984 **LAKESHORE REHABILITATION HOSPITAL**
Birmingham, AL

Controller

Mr. Hollings was responsible for accounting and financial reporting. Some of his accomplishments included:

- Prepared financial statements, forecasts and analysis for administrative and managerial functions.
- Supervised general accounting, payroll, accounts payables, material management, admissions and registration.

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- Maintained written analysis and reconciliations of balance sheet accounts.
- Applied professional judgment in the application of accounting principles and analyzed procedures and processes to ensure compliance with generally accepted accounting principles.
- Planned and conducted meetings with subordinates to ensure compliance with established practices and to implement new policies.

1980-1981 **BANKS FINLEY WHITE & CO CPA**
Birmingham, AL

Auditor

Mr. Hollings examined and analyzed accounting records to determine compliance with generally accepted accounting principles. Some of his accomplishments included:

- Verified journal and ledger entries of cash and check payments, purchases, inventory, capital, payroll, operating expenses and trial balances by examining and authenticating related transactions.
- Prepared reports for the board of trustees concerning scope of audit, financial conditions found and opine on the financial statements.

DAVID J. SACK

B.S.R.T., RTR, CRA, F.A.H.R.A.

EDUCATION

1968 – 1970	University of Missouri - Bachelor of Science in Radiologic Technology
1966 – 1968	School of Radiologic Technology - Quincy City Hospital & Northeastern Univ.

WORK HISTORY

April 2004 to present	Director of Radiology and Radiation Therapy Stamford Hospital, Stamford, Connecticut
Oct 2003 to Jan 2004	Interim Director of Radiology St. Joseph's Medical Center, Reading, Pennsylvania **Accomplishments:** Reorganized long-term film files into terminal digit order, Created RFI for PACS, analyzed RFP's & selected PACS vendor, selected CR for network, improved radiologist/staff relationships & department morale, Rearranged FTE and supply expenses to correct cost centers
Mar 2002 to Aug 2003	Network Director of Radiology New Hanover Health Network, Wilmington, North Carolina **Responsibilities:** 200 FTES, Revenue Budget: $100million, Expense Budget: $20million. 2 hospitals, 1 imaging center, 220,000 procedures/year
Mar 1992 to Feb 2002	Administrative Director, Department of Radiology St. Luke's Episcopal Hospital, Texas Medical Center - Houston **Responsibilities:** 185 FTES, Revenue Budget: $90million, Expense Budget: $18million, 600 beds, 1 outpatient imaging center, 220,000 procedures/year
1993 to Present	Instructor in Radiologic Technique The Advanced Health Education Center - Houston
Nov 1975 to Dec 1991	Technical Director - Department of Radiology Brigham & Women's Hospital - Boston, Massachusetts
Sep 1971 to 1986	Lecturer in Radiologic Technique Northeastern University - Boston, Massachusetts
Apr 1972 to Nov 1975	Coordinator, Schools of Radiologic Technology Boston University Medical Center - Boston, Massachusetts
Apr 1970 Mar 1972	Assistant Chief X-Ray Technologist Boston University Medical Center - Boston, Massachusetts
Sep 1969 Apr 1970	Radiologic Technologist Milton Hospital - Milton, Massachusetts
Jan 1968 Sep 1969	Radiologic Technologist University of Missouri Medical Center - Columbia, Missouri

PROFESSIONAL HIGHLIGHTS

Resume Pg. 2

APPOINTMENTS

1998 - 2003	Premier Imaging Subcommittee - Member
1987 - 1992	Advisory Commission for Radiologic Technologists - Commonwealth of Mass.
1988 - 1990	Governor's Task Force on AIDS, Massachusetts

PUBLICATIONS

2001 "Moving Radiology into the Digital Age: The Experience at St. Luke's Hospital"
Radiology Management, Fall 2001

1987 "AIDS in the Workplace," Commentary
Radiology Management, 9:3, 1987, p. 51

1985 "Our Product is Us" - Administrative Radiology
August 1985, Vol. IV, No. 8

1985 "Radiology Department Management System"
Radiology BJ, Sapienza A, Van Gerpen T, Sheriff CR,
Gillis AE, Sack DJ, Komaroff AL. 156:57, 1985

PRESENTATIONS

"Save Your Bottom Line: How to Decrease Costs Through Outcomes Mgmt."
Odyssey 2001 – AHRA Annual Meeting, August 2001 - Las Vegas, Nevada

"Image Quality & Processors for Technologists"
Bay Area Medical Imaging Society Meeting, April 2001 - Houston, Texas

"Image Quality ~ Sharpness & Detail"
Bay Area Medical Imaging Society Meeting, April 1996 - Houston, Texas
Southeast Area Counselors Seminar, January 1995 - Houston, Texas

"The Technologist of Yesterday, Today and Tomorrow"
C.V. Symposium, June 1996 - Houston, Texas
Mass. Society of Radiologic Technologists, Keynote Speaker
May 1995, Annual Meeting - Boston, Massachusetts

"Measurement of Financial Performance"
Physicians World Seminars, September 1995, Workshops - Dallas & San Francisco

"Productivity Enhancement ~ Easy Method for Success"
Texas Society of Radiologic Technologists, March 1995, Annual Meeting - Houston, Tx
AHRA, August 1994, 22nd National Meeting - Las Vegas, Nevada
Premier Hospital Alliance, June 1993, Radiology Directors Meeting - Chicago, Illinois

"How to Justify and Implement a Radiology Renovation Project"
AHRA, July 1993, 21st National Meeting - Orlando, Florida

"AIDS and the Family" - Region I, Pediatric AIDS Conference
Department of Health & Human Services, March 1989 - Nashua NH

"Pitfalls in Installation of Radiology Information Systems"
American Healthcare Radiology Administrators Annual Meeting - Las Vegas, Nevada

"AIDS in the Workplace" - Works in Progress Presentation

American Healthcare Radiology Administrators, No. Atlantic Meeting - Saratoga Springs
"Licensure: Its Effect on Technologists"
New England Conference of Radiologic Technologists, Annual Mtg - Sturbridge, Mass.

PROFESSIONAL HIGHLIGHTS

Resume Pg. 3

PROFESSIONAL ORGANIZATIONS

New England Hemophilia Association 1972 to 1991
President
General Executive Board Member
AIDS Task Force Member

American Healthcare Radiology Administrators 1980 to Present
Member Annual Planning Committee
Achieved Fellow Status
President, North Atlantic Region
President-Elect, North Atlantic Region
Secretary, North Atlantic Region
Member, Chairman, James B. Conway Award
Selection Committee, North Atlantic Region
North Atlantic Region, Legislative Affairs Committee

Massachusetts Society of Radiologic Technologists 1966 to Present
Awarded Lifetime membership
Chairman, Government Affairs
Commercial Liaison, Annual State Conference
Chairman, Public Relations
Co-Chairman, State Convention
Co-Chairman, Membership Committee
Chairman, Nominating Committee, Boston District
Vice President

LICENSURE & CERTIFICATION

1968 to Present	American Registry of Radiologic Technologists - Registration # 060217
1990 to Present	Licensed Radiologic Technologist - Massachusetts License #00001
2002 to Present	Certified Radiology Administrator - AHRA

CURRICULUM VITAE

Harvey L. Hecht, M.D., D.A.B.R., F.A.C.R., D.A.B.N.M.
50 Brewster Road
Scarsdale, New York 10583

EMPLOYMENT:

1970 – Present	Attending Radiologist The Stamford Hospital; Stamford, Connecticut
1967 – Present	Clinical Assistant Professor of Radiology College of Physicians and Surgeons Columbia University; New York, New York Chief of Service: Philip Alderson, M.D.
1967 – 1968	Head of Bone Room Columbia Presbyterian Radiology Department
1968 – 1970	Head of G.I. Section Columbia Presbyterian Radiology Department
1970 – 2006	Columbia Presbyterian Hospital New York, New York Teaching Radiology elective students 2 hours, once a month Teaching Residents 1 hour per month Noon Conference twice per year

EDUCATION:

RESIDENCIES:

Columbia Presbyterian Hospital; New York, NY
Radiology: 3rd Year (July 1966 – June 1967)

Columbia Presbyterian Hospital; New York, NY
Radiology: 2nd Year (July 1965 – June 1966)

Columbia Presbyterian Hospital; New York, NY
Radiology: 1st Year (July 1964 – June 1965)

Montefiore Hospital; Bronx, New York
Medicine: One Year (July 1963 – June 1964)

INTERNSHIP:

Montefiore Hospital; Bronx, New York
Mixed Internship in Medicine and Surgery
7/1/62 – 6/30/63

MEDICAL SCHOOL:

Albert Einstein College of Medicine; Bronx, New York
M.D. Degree - 1962

CONTINUING MEDICAL EDUCATION
FOR CURRICULUM VITAE FOR HARVEY L. HECHT, M.D.

2001 (Continued)

Clinical Assistant Professor of Radiology — 8 Hours
NY Columbia Presbyterian Medical Center
January 2001 – December 2001

2002

New York Academy of Medicine — 22 Hours
ACCME Approved
NY Roentgen Ray Annual Spring Conference
April 24-27, 2002
Includes 4 hours of Mammography

Columbia University College of Physicians and Surgeons — 24 Hours
Tutorial in PET Imaging at
Kreitchman PET Center
September 11-13, 2002

NYU Post Graduate Medical School — 22.5 Hours
MRI Clinical State of the Art
October 16-18, 2002

American College of Radiology — 36 Hours
Radiology Continued Professional Improvement
January – December 2002
Includes 6 hours of Breast Radiology

Clinical Assistant Professor of Radiology at — 8 Hours
NY Columbia Presbyterian Medical Center
January – December 2002

2003

University of California, San Diego — 22.5 Hours
12th Annual Musculoskeletal MR Course
January 27-31, 2003

New York Roentgen Society — 22 Credits
Spring Conference
April 2-3, 2003
Includes 4 hours of Mammography

CONTINUING MEDICAL EDUCATION
FOR CURRICULUM VITAE FOR HARVEY L. HECHT, M.D.

2003 (Continued)

NYU School of Medicine
Summer Radiology Practicum
June 30 – July 4, 2003
21.25 Credits

Clinical Assistant Professor Radiology
Columbia Presbyterian Medical Center
12 Hours

American College of Radiology
Radiology Continued Professional Improvement
January 2003 – December 2003
Includes 6 hours of Breast Radiology
36 Hours

Nuclear Medicine
Albert Einstein College of Medicine
October 24-27, 2003
22 Hours

2004

University of Chicago
Videotape, Breast Imaging Weekend
March 29, 2004
18 Credits

New York Roentgen Society
Spring Conference
April 13-16, 2004
32 Credits

NYU School of Medicine
Summer Radiology Practicum
June 28 – July 2, 2004
21.25 Credits

Clinical Assistant Professor Radiology
Columbia Presbyterian Medical Center
12 Credits

American College of Radiology
Radiology Continued Professional Improvement
January – December 2004
Includes 6 hours of Breast Radiology
36 Hours

Reviewer for Journal of Nuclear Medicine

CONTINUING MEDICAL EDUCATION
FOR CURRICULUM VITAE FOR HARVEY L. HECHT, M.D.

2005

New York Academy of Medicine New York Roentgen Society Imaging 2005: Hot Topics and Current Issues March 30 – April 2, 2005	14.5 Hours
NYU Post Graduate Medical School Summer Radiology Practicum June 27 – July 1, 2005	23.5 Hours
American College of Radiology Radiology Continued Professional Improvement January – December 2005	36.0 Hours
Columbia Presbyterian Medical Center Clinical Assistant Professor of Radiology January – December 2005	10.0 Hours
Reviewer for Journal of Nuclear Medicine January – December 2005	4.0 Hours

2006

New York Roentgen Society Spring Conference April 5-8, 2006 Includes 6 hours of Mammography	24 Credits

Ravi Thakur, MD
Stamford Radiological Associates
PO Box 1092
Stamford, CT 06094
203.276.7881
rthakur@stamhealth.org

Work Experience

July 2005-present
Stamford Radiological Associates
Radiologist
Stamford, CT

Postgraduate Education

July 2004-June 2005
MRI Fellow
NYU Medical Center
New York, NY

April 2002-June 2004
Radiology resident (Chief Resident for 2003-4)
New York Presbyterian Hospital
Weill Medical College of Cornell University
New York, NY

July 2000-April 2002
Radiology resident
Beth Israel Deaconess Medical Center
Boston, MA

July 1999-June 2000
Transitional intern
St. Vincents Hospital and Medical Center
New York, NY

Medical Education

August 1995-May 1999
University of Virginia School of Medicine
Charlottesville, VA
Doctor of Medicine
Alpha Omega Alpha

Undergraduate Education

September 1991-May 1995
Amherst College
Amherst, MA
B.A. in Neuroscience

Board Certification: American Board of Radiology; June 9, 2004

Medical License: Connecticut, New York

Publications

Detection of small pulmonary nodules using direct digital radiography and picture archiving and communication systems. Wu N, Gamsu G, Czum J, Held B, Thakur R, Nicola G. *Journal of Thoracic Imaging*. 2006 Mar;21(1):27-31

Are T2-weighted images necessary in renal mass characterization? Dann P, Thakur R, Chin D, Krinsky G, Israel GM. European Journal of Radiology. 2006 Mar 9; [Epub ahead of print]

Comparison of surgically attached and non-attached repair of the rat achilles tendon-bone interface. Cellular organization and type X collagen expression. Fujioka H, Thakur R, Wang GJ, Mizuno K, Balian G, Hurwitz SR. *Connective Tissue Research* 37(3-4):205-18, 1998.

The new era in breast cancer. Invasion, size, and nodal involvement dramatically decreasing as a result of mammographic screening. Cady B, Stone MD, Schuler JG, Thakur R, Wanner MA, Lavin PT. *Archives of Surgery* 131:301-8, Mar 1996.

Poster Presentations

MR evaluation of biliary anatomy: Comparison of conventional T2-weighted MR cholangiopancreatography, 3D T2-weighted MR cholangiopancreatography, and mangafodipir trisodium-ehanced MR cholangiography. Thakur R, Hecht E, Israel G, Taouli B, Lee V. International Society for Magnetic Resonance in Medicine 13th Scientific Meeting May 2005.

Diffusion-weighted imaging for characterization of renal masses. Thakur R, Israel G, Lee V Hecht E, Taouli B. International Society for Magnetic Resonance in Medicine 13th Scientific Meeting May 2005.

Alteration of cartilage expression in fracture healing in experimental diabetes. Gooch HL, Hurwitz S, Funk J, Hale JE, Carmines D, Thakur RK, Anderson P, Balian G. *43rd Annual Meeting of the Orthopedic Research Society* Feb 1997.

MICHAEL H. KING, M.D.
288 Ocean Drive West
Stamford, CT. 06902
(203) 964-1401

CURRENT:

2000- Present — **Stamford Hospital,** Stamford CT. Attending Radiologist
Majority of time spent with MRI and CT/US diagnostic interpretation

MEDICAL LICENSING: States of Connecticut, New York, New Jersey, Massachusetts and Florida

EDUCATION:

1999 - 2000 — **Columbia University,** Presbyterian Hospital, New York, NY.
Body Imaging Fellowship (MRI, CT and Ultrasound)

1995-1999 — **Yale University**, Norwalk Hospital and New Haven Hospital, CT.
Chief Radiology Resident and Diagnostic Radiology Resident

1991-1995 — **University of Health Sciences Chicago Medical School**, Chicago, IL.
M.D. awarded June 1995 (Top 1/3 of Class)

1988-1991 — **Clark University**, Worcester, MA. G.P.A. 3.6/4.0
Bachelor of Arts in Biology, May 1991

SCHOLASTIC TESTING:
Board Certified Radiologist, May 1999
Diplomate of the National Board of Medical Examiners, 1996

HONORS:
Chief Radiology Resident, 1998-1999
Cum Laude, Clark University 1991
Fiat Lux Honor Society 1991
Viola D. Fuller Research Fellowship American Cancer Society 1990
Tri-Beta National Honor Society for Biology 1989
Dean's List All Semesters

RESEARCH:
T2 Weighted MRI Imaging of the Liver: Optimization of Turbo Spin-Echo Sequences
Presented at the 1995 American Roentgen Ray Society Annual Meeting

PROFESSIONAL ASSOCIATIONS:
American College of Radiology, 1995-Present
Roentgen Ray Society, 1995-Present
American Medical Association, 1991
Connecticut Radiological Society, 1995-1999
Illinois State Medical Society, 1991-1995
Chicago Medical Society, 1991-1995

ACTIVITIES:

University of Health Sciences Chicago Medical School, Chicago, IL.
Tour Guide and Interviewer for Prospective First Year Medical Students, 1992-1995
Student Advisory Committee, 1993-1995
Intramural Athletics, 1991-1994

Clark University, Worcester, MA.
Pre-Medical Society President, 1991
Pre-Medical Society Executive Board, 1989-1991
Biology Club President, 1990 and 1991
Tour Guide for Prospective First Year Students, 1990 and 1991
Intramural Athletics Coordinator, 1989-1991
Intercollegiate Clubs: Basketball, Softball, Soccer, Tennis and Volleyball, 1988-1991

INNA SHTRAMEL, B.S. R.T. (R),(M),(MR).

679 Glenbrook Rd.
Stamford, CT 06906
203-359-6805

EDUCATION

Harrisburg Area Community College 1992-1996
Harrisburg, Pennsylvania
Graduated with A.A. in Allied Health Sciences.

Polyclinic Medical Center, School of Radiography 1994-1996
Harrisburg, Pennsylvania
Graduated with A.A in Radiological Science
- Mallinckrodt award for academic Excellence

Tashkent University of Civil Engineering. 1979-1984
Tashkent, Uzbekistan
Graduated with B.S. in Engineering.

EXPERIENCE

Stamford Hospital, Stamford, Connecticut
Chief MRI Technologist **May 2001-present**
Staff MRI Technologist **1999-2001**
Staff Radiologic Technologist **1998-1999**

Norwalk Hospital, Norwalk, Connecticut
Staff MRI Technologist **1991-2001**

Pinnacle Health System, Harrisburg, Pennsylvania
Staff Radiologic Technologist **1996-1998**

COMPUTER SKILLS

Proficient in Excel, Access.

PERSONAL

Fluent in Russian.

CERTIFICATION

State of Connecticut licensed Radiologic Technologist, ARRT, Mammography, MR, CPR certified.

65 Hickory Hill Drive
Northfield, CT 06778

Home: (860) 283-9105
Work: (203) 276-7934

Barbara Demchuk

Objective: MRI Technologist

Experience:

2000-present *Stamford Hospital* *Stamford, CT*
Senior MRI Technologist

- Proficient on PACS / Synapse computer system.
- Familiar with MRA imaging using power injector.
- Involved in direct patient care with in and out patient population including anesthesia cases and pediatric patients.
- Schedules in-patient, emergency and add on examinations.
- Records and edits examinations with RIS computer systems.
- Orders, stocks and inventories department supplies.

1993–2000 *St. Francis Hospital and Medical Center* *Hartford, CT*
MRI Technologist

- Staff MRI Technologist performed all aspects of MRI and specialized MRA imaging in a multi-million dollar hospital setting.
- Experience with GE 1.5T Signa, and performed imaging on a Siemens 1.5T Symphony.

1999–2001 *UCONN Medical Center* *Farmington, CT*
MRI Technologist—*Per Diem*

- 1.5 Siemens Vision.

1999–2001 *Greater Waterbury Imaging Center* *Waterbury, CT*
MRI Technologist—*Per Diem*

- Performed all aspects of MR imaging on a GE 1.5 LX Horizon.

1991–1993 *Alliance/Mobile Technology, Inc.* *Farmington, CT*
MRI Technologist

- Performed all aspects of MRI Imaging on a .5T GE and 1.0 Siemens Impact.

Education

Thomas Jefferson University — **Philadelphia, PA**

- Bachelor of Science Degree

South Central Community College — **New Haven, CT**

- Associates of Science Degree
- Clinical rotation at Yale New Haven Hospital

Qualifications

- Experience with MRI hospital policies and procedures.
- Organized in record management, statistics, and schedules.
- Initiate and apply process improvement strategies to department operations.
- Experience in all aspects of MRI technology.
- Provide technical advice to physicians, residents, staff technologist, and students.
- Ability to adapt to different protocols and procedures at various hospital sites.

Certification

- State of Connecticut--Licensed Radiologic Technologist, ARRT, MR and CPR Certified

EXHIBIT D

STATE OF CONNECTICUT

Department of Public Health

LICENSE

License No. 0059

General Hospital

In accordance with the provisions of the General Statutes of Connecticut Section 19a-493:

The Stamford Hospital of Stamford, CT, d/b/a The Stamford Hospital is hereby licensed to maintain and operate a General Hospital.

The Stamford Hospital is located at 30 Shelburne Road, Stamford, CT 06904

The maximum number of beds shall not exceed at any time:
305 General Hospital beds
25 Bassinets

This license expires **June 30, 2009** and may be revoked for cause at any time.

Dated at Hartford, Connecticut, July 1, 2007. RENEWAL.

License revised to reflect:
Removed 2 Satellites effective 6/5/07

Satellites

Immediate Care Center, 32 Strawberry Hill Court, Stamford, CT
Behavioral Health Clinic, 32 Strawberry Hill Court, Stamford, CT
Stamford Surgical Center, 32 Strawberry Hill Court, Stamford, CT

J Robert Galvin M.D., M.P.H.

J. Robert Galvin, M.D., M.P.H.,
Commissioner

Department of Public Safety
Division of Fire, Emergency & Building Services
Office of State Fire Marshal

STATE OF CONNECTICUT

On ***April 18, 2007***, the ***City of Stamford, Office of the Fire Marshal*** conducted an inspection of **STAMFORD HOSPITAL** located at **1 Shelburne Road** in the **City of Stamford** to determine the degree of compliance with the fire safety requirements of Connecticut General Statutes Chapter 541 as authorized by Section 29-305 of the statutes. This facility was evaluated as a(n) ☐ *New* ☒ *Existing* **HEALTH CARE Occupancy** as classified by the *Connecticut Fire Safety Code*. As a result of this inspection, the following conditions were found.

I. ☒ At the time of inspection, no code violations were identified. **Certificate of approval recommended.**

II. ☐ At the time of inspection, conditions were discovered to be contrary to the minimum requirements of these codes. An acceptable plan of correction was submitted. *{See attached information}* **Certificate of approval recommended.**

III. ☐ At the time of inspection, conditions were discovered to be contrary to the minimum requirements of these codes. No approved plan of correction was submitted. *{See attached information}* **Certificate of approval NOT recommended.**

IV. ☐ Based on the extreme hazard to public safety discovered at the time of this inspection, this office is currently seeking an injunction from the court through our Town/City Attorney for the purpose of closing or restricting usage of this facility by the public. *{See attached information}* **Certificate of approval NOT recommended.**

This Certificate of Inspection Expires Apri 18, 2008

April 18, 2007
Date

Willie Baldwin

Willie Baldwin/Deputy Fire Marshal

Distribution:
Original: **Owner/Permittee/Operator**
Copy: **Fire Marshal File**

The Stamford Hospital

Stamford, CT

has been Accredited by the

Joint Commission

on Accreditation of Healthcare Organizations

Which has surveyed this organization and found it to meet the requirements for accreditation.

November 18, 2006

Accreditation is customarily valid for up to 39 months.

This award excludes skilled nursing and nursing home services.

Fred L. Brown
Chairman of the Board of Commissioners

5696
Organization ID #

Dennis S. O'Leary, M.D.
President

The Joint Commission on Accreditation of Healthcare Organizations is an independent, not-for-profit, national body that oversees the safety and quality of health care and other services provided in accredited organizations. Information about accredited organizations may be provided directly to the Joint Commission at 1-800-994-6610. Information regarding accreditation and the accreditation performance of individual organizations can be obtained through the Joint Commission's web site at www.jcaho.org.

EXHIBIT E

STAMFORD HOSPITAL | The Regional Center for Health

30 Shelburne Road
P.O. Box 9317
Stamford, CT 06904-9317
203 276-1000
www.stamhealth.org

THE STAMFORD HOSPITAL PERFORMANCE IMPROVEMENT PLAN

I. Purpose and Mission

The purpose of the Performance Improvement Plan is to define and appropriately align performance improvement goals and activities with the newly developed strategic plan. This plan is further designed to support our corporate mission: "Together with our physicians we provide a broad range of high quality health and wellness services focused on the needs of our communities."

II. Objectives

A. To integrate key aspects of organizational performance including clinical, organizational, and customer satisfaction.

B. To provide a system for performance improvement throughout the organization that focuses on listening to our customers in order to meet and exceed their needs and expectations.

C. To promote optimal, safe patient care and reduce liability exposure through the ongoing systematic assessment of important aspects of care.

D. To establish priorities for the investigation and resolution of issues so that those with the greatest impact and benefit will be addressed.

E. To ensure that all employees are trained in performance improvement methodologies, which contribute to improved services and better patient outcomes.

F. To coordinate medical staff performance improvement activities with relevant hospital wide performance improvement activities.

G. To ensure that all performance improvement requirements of the JCAHO, Qualidigm, CMS, State of Connecticut Department of Health and other insurance and regulatory bodies are met.

H. To facilitate communication and reporting of performance improvement activities among staff, department heads, administration and trustees.

Authority and Accountability

The Board of Trustees of The Stamford Hospital has the ultimate responsibility for ensuring the quality and effectiveness of the patient care services provided by medical staff and other professional and support staff. The CEO, empowered by the Board of Trustees, has authorized our performance improvement initiatives. The Medical Staff peer review activities are authorized through the Medical Executive Committee empowered by the Board of Trustees.

The organization's leaders set expectations, develop plans and implement procedures to assess and improve the quality of the organization's governance, management, clinical and support processes. The organization's leaders include members of the Board of Trustees, Medical Executive Committee of the Medical Staff, and the Clinical Leadership Council. These committees and the Board review periodic reports of findings, conclusions, actions and results from performance improvement activities in order to assess effectiveness.

Performance improvement activities are coordinated by the Clinical Leadership Council under the direction of the Quality and Clinical Affairs Committee of the Board. The Senior Vice President of Medical Services chairs the Clinical Leadership Council. The Senior Vice President of Medical Services in conjunction with the Director of Quality Assurance, the Senior Vice President of Operations in conjunction with the Executive Director of the Organizational and Clinical Effectiveness Group, and the Senior Vice President of Patient Services in conjunction with the Nursing Performance Improvement Coordinator primarily directs the organization's performance improvement activities.

Scope and Organization

A. Improving Organizational Performance Program

1. Organization of Performance Improvement Activities

All services participate in performance improvement activities. Performance improvement activities fall into two major categories: activities that improve service/care rendered with associated support processes; and medical staff peer review activities. The Quality and Clinical Affairs Committee of the Board, the Clinical Leadership Council and the Medical Executive Committee provide guidance of the organization wide performance improvement efforts.

2. Departmental Leaders' Responsibilities

Each department leader will develop a performance improvement plan that delineates the scope of service and those important aspects of care/service that they will monitor to assure optimal performance. This plan guides the systematic ongoing process for monitoring and evaluation, performance improvement and cost effectiveness of care and service. The monitoring and evaluation plan will:

- Assign accountability & responsibility

- Define scope of service
- Identify important aspects of care/service
- Identify indicators/measures which will be used
- High volume, high risk, problem prone indicators, if relevant
- Identify thresholds/standards for each indicator
- Identify data sources and data collection methods
- Collect, organize and evaluate data
- Compare data to threshold/standard comparative databases
- Actions to improve service
- Assess effectiveness of action
- Indicate necessary monitoring to assure stability of the process
- Communicate results to relevant individuals and groups

The department leaders will bring reports at least annually to the Clinical Leadership Council for feedback and direction.

3. Performance Improvement Team Responsibilities

a. Interdepartmental teams

When it is determined by the Clinical Leadership Council and/or identified by a department leader through their department performance improvement monitoring that a cross-departmental process improvement activity requires a team approach, an interdepartmental team will be formed under the direction of the department leader and facilitated by the Organizational and Clinical Effectiveness Group. Team leaders and facilitators are selected based on specific criteria. Team leaders will select team members. The responsibilities of the interdepartmental teams are guided by the FOCUS - PDCA process improvement model. Once a process improvement opportunity is determined and a team is organized, the team is to:

- Refine the opportunity statement being as specific as possible including customer identification
- Clarify current knowledge of the process through flowcharting, brainstorming and other tools
- Understand causes of process variation through data collection and analysis
- Select and develop the process improvement
- When solutions are implemented, teams will follow the PDCA model of plan, do, check, and act

Teams will present their findings and proposed solution to the Clinical Leadership Council on a periodic basis for purposes of communication, guidance, and direction. Team leaders will meet with relevant department directors impacted by solutions for implementation.

b. Intradepartmental Teams

Specific departmental processes requiring improvement/redesign will be addressed by an intradepartmental team, which will have the same process responsibilities as the interdepartmental teams. Reports will be presented to their respective Vice President for review.

c. Data Collection

Each team will assess needs and expectations of customers and determine process improvement through data collection. Data collection is to be conducted by the following methods:

- Surveys of customers including employees regarding current performance and opportunities for improvement.
- Surveys regarding needs and expectations of patients and others.
- Time studies to determine time efficiency/inefficiency of the process.
- Flowcharting in order to gather specific information concerning process flow.
- Conduct research of published data to determine comparative performance benchmark indicators.

d. Proposing and Implementing Solutions

It is the responsibility of the team leader to keep the channels of communication open during the team process and discuss ideas for solutions with the affected Department Leader or Vice President. When a team has decided on a solution for process improvement the following should occur:

- The team should present solution(s) to the appropriate committee including rationale for the proposed solution(s) and procedure for implementation
- The respective committee will review proposal, ask questions, review data and recommend idea changes
- The team leader(s) will discuss implementation of the solution with the appropriate VP/Department manager
- The team or designated appointee(s) will be responsible for monitoring the effectiveness of the solution

4. Commitment to Allocating Resources to Performance Improvement

Department managers will support team members' involvement in performance improvement activities by allowing them the time to attend meetings, training and special events.

5. Reports of Performance Improvement Activity

The team members will make reports of performance improvement activity to the appropriate committee and the Executive Staff. In addition department-specific performance improvement plans will be presented to the department managers and others overseeing the performance improvement efforts of the department

A. Clinical Leadership Council

1. Authority

The Medical Executive Committee empowered by the Board of Trustees established the Clinical Leadership Council as a standing committee of the Medical Staff in accordance with the Bylaws of the Medical Staff.

2. Organization and Membership

This is a multidisciplinary committee composed of a constant and rotating membership. The Senior Vice President Medical Services serves as Chairman. The constant members of the committee include, in addition to the chairman, the Senior Vice President of Operations, Senior Vice President of Patient Services, Chair of the Medical Staff, Executive Director of the Organizational and Clinical Effectiveness Group, Director of Human Resources and Education/Organization Development, Director of Health Information Management, Director of Case Management/Social Work, Risk Management representative, Nursing Performance Improvement Coordinator, and the Director of Clinical Effectiveness. Other members include the chiefs of service and clinical medical directors and chairs.

3. Responsibilities

- Monitor performance indicators related to patient, employee and physician satisfaction developed by performance improvement teams
- Ensure that each department's performance improvement plan adequately reflects the overall organizational performance improvement objectives and properly supports the strategic plan.
- Ensure that performance is continuously improved, that established monitors are effective and that an action plan is developed to address monitoring outcomes
- Continue to identify opportunities for system improvement/redesign
- Ensure appropriate prioritization of monitoring and study evaluation
- Review findings and recommendations from the peer review committee meetings, from the reports of departmental quality reviews and from other medical staff review reports such as drug usage, invasive procedure, blood usage, medical records, P&T, etc.
- Receive biannual risk management reports and reports these to the board.
- Recommend the need for clinical outcome teams and medical staff participation.
- Report medical staff performance improvement issues to the medical board.

4. Indicators/Standards

Departments establish monitors and standards that are approved by the Clinical Leadership Council. The JCAHO ORYX Indicators, Core Measures, professional recommendations and consensus statements are used in the development of clinical practice guidelines and performance improvement measures. Hospital departments use criteria specific to the identified important aspects of care/dimensions of performance. Where relevant, high volume, high risk, problem prone criteria are

Patient Safety Committee -The Patient Safety Committee is an interdisciplinary team whose responsibility is to provide oversight to ensure those actions to reduce risk is initiated through prospective analysis and redesign of vulnerable patient systems. Additionally, the committee ensures compliance with regulatory agency standards related to patient safety.

The committee is co-chaired by the Senior Vice President Medical Services and the Nursing Performance Improvement Coordinator, with representatives from Risk Management, Regulatory Compliance, Pharmacy, Nursing, Respiratory Care, Infection Control, Emergency Department, Operating Room, Professional Development, Rehabilitation, Laboratory, Radiology, and the Environmental of Care Committee. In addition, Hospitalists, House Officers and Chiefs of Service participate whenever possible.

Patient Safety Committee Responsibilities:

Review patient safety occurrence information from aggregated data reports and prioritize organizational patient safety efforts.

Select a minimum of one high-risk safety process for proactive risk assessment annually through review of internal data reports and reports from external sources (including but not limited to JCAHO Sentinel event report information, reported adverse events, current literature) and through the Stamford Hospital Performance Improvement Program.

Develop policy statement that reflects minimization of individual blame or retribution for involvement in a medical/health care error. Ensure organizational support for the concept that errors occur due to a breakdown in systems and processes and that there is a focus on improving systems and processes rather than disciplining those responsible for medical/medication errors.

Review Root Cause Analyses (RCA) and Failure Mode Effects and Criticality (FMECA) Analyses related to patient safety that are performed by Department Heads/interdisciplinary teams. Ensure that analyses are complete and that monitoring is ongoing.

Set measurable objectives for improving patient safety.

Reporting Structure:

The Patient Safety Committee submits reports to Clinical Leadership Council at least annually, with information flowing on a continuous basis to the Executive Staff through the Senior Vice President Medical Services. The Patient Safety Committee reports quarterly to the Board of Trustees, through the Quality and Clinical Affairs Committee, via the organizational scorecard. In addition, an annual Patient Safety report is presented at Quality and Clinical Affairs Committee.

B. Utilization Management Committee

1. Authority

The Medical Executive Committee, empowered by the Board of Trustees, established the Utilization Management Committee as a standing committee of the Medical Staff in accordance with the Bylaws of the Medical Staff.

2. Organization and Membership

This multidisciplinary committee is composed of physician cochairmen, one permanent physician member from each department, four unit assigned utilization physician advisors, five rotating physician advisors, Case Managers, Health Information Management, Administration, Nursing, and Social Work. The six permanent physician members representing each department serve as reviewers and consultants to case managers for identified physician utilization and practice guideline variations. The five rotating physician advisors are appointed for a three-month rotation and serve as consultants to the case managers in the level of care determinations and denial process. Social Work serves as the resource for planning and placement issues.

3. Activities/Functions

The case managers and physician advisors perform daily review activities. When appropriate, patients are followed through diagnosis and procedure specific care maps and clinical practice guidelines supplemented with individual care plans.

Preadmission Review
When notified of a potential admission, cases are reviewed with the following parameters: appropriate care plan, patient education needs, level of care placement and post acute discharge plan.

Level of care recommendations - Cases are reviewed to ensure they are at the most appropriate setting and level of care. SNF, ICF, Home Care Home: Patients who do not meet the acute level of care criteria are appropriately referred to an alternative level of care.

Transferred cases: Patients who are to be transferred to The Stamford Hospital are reviewed for appropriate level of care, infection and coverage issues prior to their transfer. Discharge planning needs will be assessed and referred.

Discharge Planning

All patients are screened for discharge planning needs. A comprehensive assessment is performed as part of the patient care plan. Patient and family education is part of discharge planning.

Concurrent Review on admission and at designated points in the length of stay is conducted for:

- Determination of level of care
- Appropriateness of admission and continued stay
- Assessment of discharge planning needs
- Referral to Social Work for financial planning and transfers
- Variations in care and outcomes with referral for Peer review
- Identification of risk exposure and referral to risk management who sets reserves and initiates a claim file according to the Risk Management Plan.
- Identification of system problems. System problems are identified as well as practitioner variation. These system problems are referred to the Clinical Leadership Council for further analysis.
- Identification of over utilization, under utilization, misutilization issues
- Completion of focused studies based on application of clinical practice guidelines

4. **Performance Improvement Data Sources**

- Benchmark data: National Perinatal Information Center; ORYX Indicators; VHA/HBSI data; Neonatal ICU Vermont oxford Database; State of Connecticut Chime Database; MIDAS+ Comparative Database.
- Internal data base of physician performance from case management and peer review data
- Qualidigm comparative data reports on denials and DRG changes
- Qualidigm comparative data on performance variations.
- Comparative state data on DRG/LOS provided through Connecticut Health Information Management Exchange (CHIME) Towards Excellence in Care (TEIC)
- Executive Information System (EIS)
- Financial/Clinical Decision Support Data
- Internal risk management data: occurrences, claims, infections etc.
- Data from staff interviews and observation
- Customer surveys
- Patient surveys and complaints - internal and comparative
- Monitoring activities of hospital departments
- Performance Improvement team activities
- Focused Studies
- Literature

Communication

Communication between all committees and organizational groups responsible for performance improvement is essential to the success of the plan. Formal liaisons are identified within each committee and team. The Senior Vice President for Medical

Services is the Chairman of the Clinical Leadership Council and a member of the Medical Executive Committee. There is a designated Administrative member on every medical staff committee and there is an administrative liaison for each performance improvement team. The Utilization Chairmen are members of the Clinical Leadership Council. Information Management linkages are built into the data collection system through Case Management and Health Information Management.

Communication links are provided throughout the organization with Hospital publications as well as storyboard presentations displayed throughout the hospital.

Retention of Data and Reports

Retention of medical records and results of testing are kept in accordance with State statute. Inpatient records are retained for 25 years and ancillary testing reports and other outpatient records are retained for seven years. Performance Improvement data will be archived so that comparative analyses can be effected.

Confidentiality

There will be no patient or practitioner identifiers noted on study or report forms, which are reported to committees. Coded data will be used with practitioner specific assessment data and distribution limited to the Chiefs of Service. Individual physicians may have access to their own profile upon individual request. Medical records information is to be considered confidential and available only to persons actively participating in the review process. Every employee in The Stamford Hospital signs a confidentiality statement upon being hired. The administrative policy governing creation and access to electronic clinical information addresses security and access issues. All confidentiality and privacy policies and procedures are HIPAA compliant.

Annual Appraisal

There will be an annual review and appraisal of the Performance Improvement Plan of The Stamford Hospital.

1/98 Revised 5/99, 10/2000, 01/2003, Revised 01/2004, Revised 1/2006

EXHIBIT F

Equipment

The MR equipment specifications and performance shall meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic field strength, maximum rate of change of magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum auditory noise levels.

Quality Control

Acceptance Testing

Acceptance testing is intended to measure quantifiable system parameters, which may then be compared to the manufacturer's specifications. A complete evaluation of the system performance should be performed after completion of installation and prior to patient imaging.[2]

Quality Control Testing

All facilities applying for accreditation must maintain a documented quality control (QC) program and must comply with the minimum frequencies of testing outlined below. Detailed instructions for each of the QC tests listed below are contained in the *2004 ACR MRI Quality Control Manual.* Upon acceptance of a facility's initial application, the manual will be sent to the MRI supervising physician at the practice site address under separate cover.

The ongoing QC program assesses relative changes in system performance as determined by the technologist, service engineer, qualified medical physicist/MR scientist, or supervising physician. A qualified medical physicist/MR scientist ***should*** have the responsibility for overseeing the equipment quality control program and for monitoring performance upon installation and routinely thereafter. All facilities applying for accreditation or renewal must demonstrate compliance with the ACR requirements for quality control (QC) by including a copy of the facility's most recent **Annual MRI System Performance Evaluation** (must be dated within 1 year of the date of ACR MRI submission for accreditation) and copies of the facility's weekly on-site QC data (forms on pages 64, 65, and 66 of the *2004 ACR MRI Quality Control Manual*) for the most recent quarter. If the facility has been conducting QC for less than one quarter, the facility will submit whatever they have on these forms. Additionally, if the **Annual MRI System Performance Evaluation** and/or QC files show performance deficits (e.g. problems with the system and/or data outside of the action limits), the facility must state what steps it has taken to correct the problems. All QC testing must be carried out in accordance with the written procedures and methods outlined in the ACR *2004 MRI Quality Control Manual.*

[2] A suggested protocol for acceptance testing is contained in "Acceptance Testing of Magnetic Resonance Imaging Systems: Report of American Association of Physicists in Medicine (AAPM) Nuclear Magnetic Resonance Task Group No. 6, Medical Physics. 1992; 19:217-219. This document is meant only to serve as a reference. The substance of this document is not intended to be incorporated by reference into the ACR Practice Guideline for Performing and Interpreting Magnetic Resonance Imaging (MRI).

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Continuous Quality Control

The following is a list of QC tests and frequencies that must be performed by technologists and medical physicists/MR scientists:

Technologist's Weekly QC Tests

- Center Frequency
- Table Positioning
- Setup and Scanning
- Geometric Accuracy
- High-Contrast Resolution
- Low-Contrast Resolution
- Artifact Analysis
- Film Quality Control
- Visual Checklist

Physicist/MR Scientist's Annual QC Tests

- Magnetic Field Homogeneity
- Slice Position Accuracy
- Slice Thickness Accuracy
- Radiofrequency Coil Checks
- Inter-Slice Radiofrequency Interference
- Soft-Copy Displays (Monitors)

Preventive Maintenance

Preventive maintenance shall be scheduled, performed, and documented by a qualified service engineer on a regular basis. Service performed to correct system deficiencies shall also be documented and service records maintained by the MR site.

Quality Assurance

Physician Peer-Review Requirements

Examinations should be systematically reviewed and evaluated as part of the overall quality improvement program at the facility. Monitoring should include evaluation of the accuracy of interpretation as well as the appropriateness of the examination. Complications and adverse events or activities that may have the potential for sentinel events must be monitored, analyzed and reported as required, and periodically reviewed in order to identify opportunities to improve patient care. These data should be collected in a manner that complies with statutory and regulatory peer-review procedures in order to ensure the confidentiality of the peer-review process.[3]

All sites initially applying for ACR accreditation and all sites renewing their accreditation must actively participate in a physician peer review program that performs the following functions:

- Includes a double reading (2 MDs interpreting the same study) assessment.
- Allows for random selection of studies to be reviewed on a regularly scheduled basis.
- Exams and procedures representative of the actual clinical practice of each physician.
- Reviewer assessment of the agreement of the original report with subsequent review (or with surgical or pathological findings).

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3 2005 ACR Guidelines and Technical Standards. ACR Position Statement on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns. Page IV.

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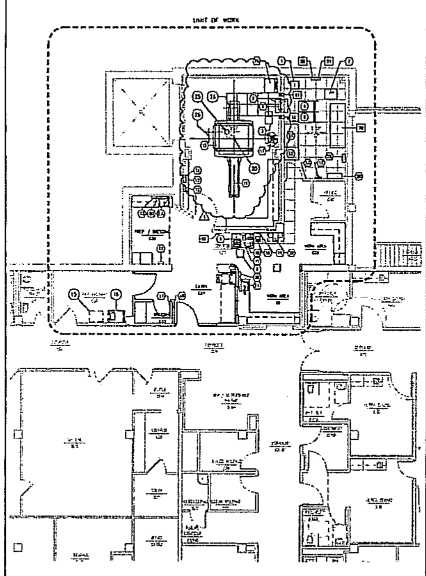
QA

1. **Technologist's Weekly QC Tests**
   - Center Frequency
   - Table positioning
   - Setup and Scanning
   - Geometric Accuracy
   - High contrast resolution
   - Low contrast resolution
   - Artifact analysis
   - Visual Checklist

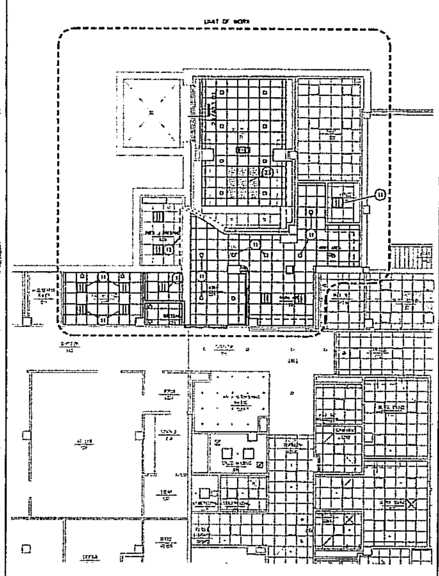
2.PM Bi monthly

3.Physicist's annual QC test
   - Magnetic field homogeneity
   - Slice position accuracy
   - Slice thickness accuracy
   - Radiofrequency coil checks
   - Inter-slice radiofrequency interference
   - Monitors

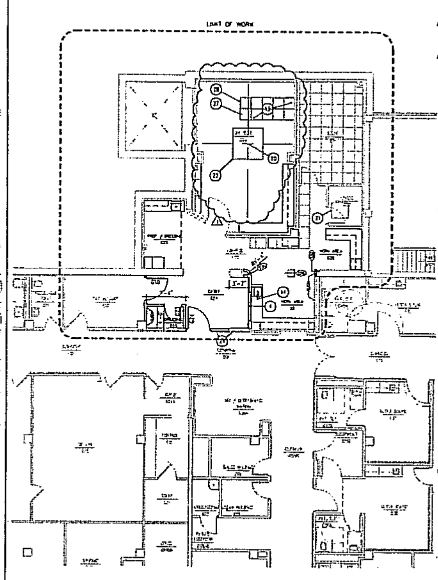
EXHIBIT G



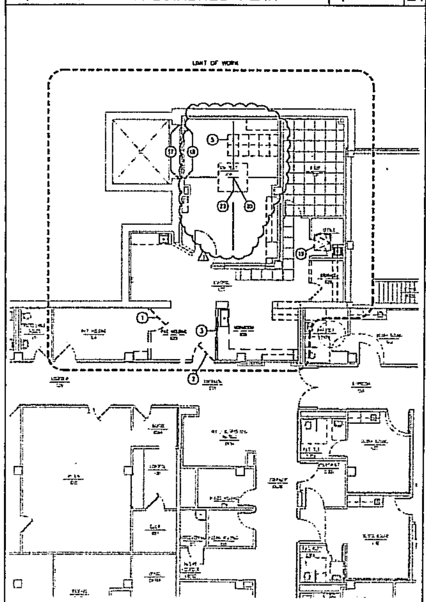
EQUIPMENT & SPECIALTIES PLAN | 1/8" = 1'0" | 21



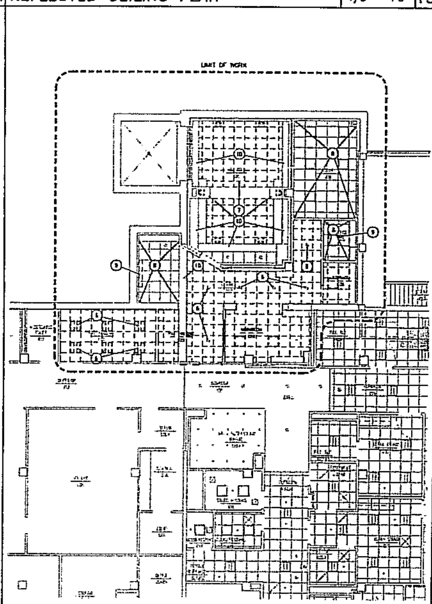
REFLECTED CEILING PLAN | 1/8" = 1'0" | 15



ARCHITECTURAL FLOOR PLAN | 1/8" = 1'0" | 9



ARCHITECTURAL DEMOLITION PLAN | 1/8" = 1'0" | 18



REFLECTED CEILING DEMOLITION PLAN | 1/8" = 1'0" | 12

RCP LEGEND

- WALL MOUNTED LIGHT FIXTURE
- CEILING MOUNTED LIGHT
- RECESSED DOWNLIGHT FIXTURE
- RECESSED FIXTURE (PUBLIC TOILETS)
- WALLWASH
- HIGH INTENSITY LIGHT FIXTURE (STAIR TOWER)
- LINEAR WALL MOUNTED LIGHT
- 2'0" x 2'0" FLUORESCENT LIGHT FIXTURE
- 2'0" x 4'0" FLUORESCENT LIGHT FIXTURE
- AIR SUPPLY REGISTER
- RETURN AIR / EXHAUST GRILLE
- 2'0" x 2'0" ACOUSTICAL PANEL CEILING
- 5/8" GYPSUM BOARD CEILING OR FURR DOWN
- CEILING HEIGHT INDICATION
- EXIT LIGHT FIXTURE
- WALL MOUNTED EXIT LIGHT

GE EQUIPMENT LISTING

1 RELOCATE EXISTING DOOR, FRAME, AND HARDWARE. LOCATION TO BE AT DOOR DESIGNATION C1D AS INDICATED ON ARCHITECTURAL FLOOR PLAN
2 RELOCATE EXISTING CARD READER
3 RELOCATE EXISTING WINDOW. REFER TO ARCHITECTURAL FLOOR PLAN FOR NEW LOCATION. REPAIR AND REPAINT AS REQUIRED
4 RELOCATED WINDOW
5 REMOVE EXISTING FLOOR PANELS AND PEDESTALS. REUSE FLOOR PANELS AND PEDESTALS AS NEEDED IN EQUIPMENT ROOM C31. EXISTING PEDESTALS ARE TO BE REUSED IN AREAS WHERE HEAVY EQUIPMENT REQUIRES ADDITIONAL SUPPORT. G.C. TO COORDINATE SUPPORT REQUIREMENTS WITH ACCESS FLOORING CONTRACTOR
6 RELOCATE EXISTING LIGHT FIXTURE
7 REMOVE PORTIONS OF GYP. BOARD SOFFIT AS REQUIRED TO INSTALL NEW ACOUSTICAL CEILING AND LIGHT FIXTURES
8 EXISTING CEILING AND CEILING DEVICES TO REMAIN, U.N.O.
9 REMOVE EXISTING LIGHT FIXTURE
10 EXISTING GYP. BOARD SOFFIT TO REMAIN
11 RELOCATED LIGHT FIXTURE
12 EXISTING CUBICLE CURTAIN TRACK TO REMAIN
13 ACCESS FLOORING (TBD ACTIVITY)
14 EMERGENCY EYE WASH
15 PEDI. CRASH CART (OFOI)
16 CRASH CART (OFOI)
17 REMOVE EXISTING CURTAIN WALL SYSTEM FOR REMOVAL OF EXISTING MAGNET AND DELIVERY OF NEW MAGNET. AFTER DELIVERY OF NEW MAGNET REINSTALL CURTAIN WALL SYSTEM BACK TO ORIGINAL CONDITION
18 EXISTING R/F WINDOW WALL ASSEMBLY TO BE REMOVED BY SHIELDING CONTRACTOR FOR REMOVAL OF EXISTING MAGNET AND DELIVERY OF NEW MAGNET. AFTER DELIVERY OF NEW MAGNET, THE SHIELDING CONTRACTOR SHALL REINSTALL R/F WINDOW WALL ASSEMBLY BACK TO ORIGINAL CONDITION
19 ACID TANK TO BE REMOVED
20 MAGNET ISOCENTER
21 PATCH FLOOR AS REQUIRED TO MATCH EXISTING ADJACENT SLAB
22 SLAB DEPRESSION. REFER TO STRUCTURAL DRAWINGS
23 PHOTO MURAL, PHOSPOINS, CUT 6' x 6' CUT INTO (9) 23.825" x 23.825" PANELS FOR INCLUSION WITHIN MEDLUX LED CPI LED LIGHT BOXES (1/4" THICK ACRYLIC)
24 ALIGN NEW PARTITION WALL WITH EXISTING. MATCH EXISTING ADJACENT WALL CONSTRUCTION
25 EXISTING CRYOGEN VENT TO REMAIN
26 ISOCENTER OF NEW MAGNET TO BE LOCATED BASED ON THE LOCATION OF EXISTING CRYOGEN VENT (FIELD VERIFY). REFER TO GE EQUIPMENT DRAWINGS FOR DIMENSIONS OF MAGNET ISOCENTER FROM CRYOGEN VENT.
27 FILL-IN PORTION OF EXISTING TRENCH AS REQUIRED TO SUPPORT REAR PEDESTAL OF NEW MAGNET.
28 RAISE ACCESS FLOORING AS REQUIRED TO ROUTE UTILITIES THROUGH BACK OF REAR PEDESTAL OF NEW MAGNET. ACCESS FLOORING SHALL COVER ALL UTILITIES ON TOP AND ALL EXPOSED SIDES.

GENERAL NOTES

A REFERENCES TO THE PROJECT MANUAL SHALL BE TO PROJECT MANUAL WHR NO. H05023.01 IMAGING RENOVATION PHASE 1B PART 2 (DATED MAY 30, 2007), INCLUDING ALL REVISIONS

DEMOLITION GENERAL NOTES

A DEMOLITION WITHIN THE MRI TEST ROOM (C26) SHALL BE CAREFULLY PLANNED AND PREFORMED WITHOUT DAMAGING EXISTING R/F SHIELDING AT FLOORS, WALLS, AND CEILINGS.
B ALL EXISTING PLUMBING FIXTURES MAY NOT BE SHOWN IN THIS DRAWING.
C REMOVE EXISTING FLOORING THROUGHOUT THE LIMITS OF WORK UNLESS NOTED OTHERWISE.
D ITEMS SHOWN DASHED ARE TO BE REMOVED, INCLUDING CABINETWORK AND PLUMBING FIXTURES.
E REMOVE EXISTING HANDRAILS, CRASHRAILS, CORNERGUARDS, AND SHEET WALL PROTECTION PANELS THROUGHOUT THE LIMITS OF WORK UNLESS NOTED OTHERWISE.
F REMOVE EXISTING CEILING AND ALL CEILING DEVICES THROUGHOUT THE LIMITS OF WORK UNLESS NOTED OTHERWISE.
G REMOVE AND DELIVER TO OWNER ALL EQUIPMENT, FIXTURES, OR ACCESSORIES IDENTIFIED BY THE OWNER TO BE SALVAGED.
H REMOVE EXISTING PLUMBING FIXTURES THROUGHOUT THE LIMITS OF WORK UNLESS NOTED OTHERWISE.
I COORDINATE SLAB DEMOLITION AND RESTORATION WITH PLUMBING, ELECTRICAL & MECHANICAL WORK.
J DELIVER SALVAGEABLE ITEMS TO THE OWNER AS DIRECTED

FLOOR PLAN GENERAL NOTES

A REFER TO THE PROJECT MANUAL FOR FRAMED OPENING SCHEDULE AND HARDWARE SCHEDULE.
B PARTITIONS SHALL BE TYPE [G31] UNLESS NOTED OTHERWISE.
C REFER TO SHEET A11.01 FOR PARTITION TYPES.
D PARTITION ARE DIMENSIONED TO FINISH FACE OF GYPSUM BOARD UNLESS NOTED OTHERWISE.
E REFER TO SHEET A13.00 FOR TYPICAL INTERIOR PARTITION DETAILS.

RCP GENERAL NOTES

A THE PRIMARY CEILING DEVICES ARE SHOWN IN THE REFLECTED CEILING PLAN. COORDINATE WITH THE MEP DOCUMENTS FOR ADDITIONAL CEILING MOUNTED DEVICES.
B ARCHITECTURAL REFLECTED CEILING PLAN SHALL GOVERN FOR LOCATION OF ALL CEILING MOUNTED DEVICES.
C REFER TO ELECTRICAL LIGHTING PLAN FOR LIGHTING LAYOUT IN UTILITY SPACES SUCH AS MECHANICAL ROOMS, ELECTRICAL CLOSETS, ELEVATOR SHAFTS, STAIRS, ETC.
D TYPICAL CEILING HEIGHT IS 8'-0" ABOVE FINISH FLOOR UNLESS NOTED OTHERWISE.
E ACOUSTICAL PANEL CEILING IS TYPE APC-5 UNLESS NOTED OTHERWISE.
F WHERE CEILINGS ABUT EXISTING CEILINGS, HEIGHTS GIVEN ARE APPROXIMATE. ALIGN CEILINGS UNLESS NOTED OTHERWISE.

FIRE RATING LEGEND

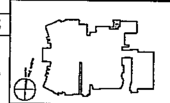
SYMBOL	PARTITION	DOOR
	CORRIDOR (NON-RATED)	POSITIVE LATCH
	ONE HOUR SMOKE BARRIER	20 MIN
	ONE HOUR	20 MIN
	ONE HOUR	45 MIN
	ONE HOUR	60 MIN
	TWO HOUR	90 MIN
	THREE HOUR	3 HR
	FOUR HOUR	3 HR
	EXISTING	EXISTING
	EXIT	

6 NOTE: FOR SCHEDULED DOORS WHERE SMOKE AND FIRE SEPARATIONS COINCIDE, THE MORE STRINGENT FIRE RATING SHALL APPLY.

WHR ARCHITECTS

WHR ARCHITECTS, INC
1111 LOUISIANA
26TH FLOOR
HOUSTON, TEXAS 77002
(713) 665-5665 FAX (713) 665-6215
WWW.WHRARCHITECTS.COM

NO.	DATE	DESCRIPTION
	11/02/2007	ISSUE FOR BID
1	11/15/2007	ADDENDUM # 1



KEY PLAN

STAMFORD HOSPITAL | The Regional Center for Health

MRI RENOVATION

GROUND LEVEL
STAMFORD, CONNECTICUT

ARCHITECTURAL FLOOR PLAN

1995 sq ft

JOB NO.: H07023.00
PHASE: CD
DATE: 11-02-07

DRAWING NO.
A2.01

EXHIBIT H

Purchase Order #: 050969

Hospital: THE STAMFORD HOSPITAL
30 SHELBURNE RD
PO BOX 9317
STAMFORD CT 06904

Vendor: 04061
ALLIANCE IMAGING, INC.
1900 SOUTH STATE COLLEGE BLVD.
SUITE 600
ANAHEIM, CA 92806

Date: 10/23/07
Status: OPEN
Buyer: MDEVITO MARIE DEVITO
Type: REGULAR CAPITAL

Ship To: 142 WEST BROAD
STAMFORD, CT 06902

VIA: Exp Del: 10/23/07

Invoice To: ATTN. ACCOUNTS PAYABLE
P.O. BOX 9317
STAMFORD CT 06904

Vendor Acct #:

Terms: INV NET 60
FOB:
Contact:M (714)688-7100
VENDOR'S REG #: 17146887111
CT EXEMPT PURCH CERT #: E00765

LINE	ITEM #	VEND'S CATLG / MFR's CATLG	DESCRIPTION	PACKAGING / MANUFACTURER	QTY UE	PRICE	EXT COST	G/L ACCOUNT / DEPT or INVEN
1	MISC.CAP	LEASE PAYMENT	CAPITAL ITEM CAP # MUST GO IN DESCRIP LINE AS PER ATTACHED LEASE AGREEMENT SEE SCHEDULE A EQUIPMENT RENTAL FOR G.E. 1.5T MOBILE MRI SYSTEM	EA	2 EA	62000.0000	124000.00	01.16000.16800 TSH RAD ADMIN

Comments:

TOTAL 124000.00

Vendor:

1. INCLUDE IN ALL SHIPMENTS A PACKING SLIP SHOWING CONTENTS AND PURCHASE ORDER NUMBER.
2. SHOW OUR ORDER NUMBER ON ALL INVOICES, PACKAGES, SHIPPING PAPERS, AND CORRESPONDENCE.
3. RENDER INVOICES IN DUPLICATE.
4. PURCHASE ORDER IS SUBJECT TO ALL TERMS AND CONDITIONS AS PROVIDED TO THE VENDOR.

By: _____
Authorized Signature

COPY

SCHEDULE A

1. **UNIT DESCRIPTION.** G.E. 1.5T mobile MRI system.
If the Unit described above is deemed to be unavailable, in Alliance's sole discretion, a reasonably comparable Unit may be substituted.

2. **FEES.**

A. Equipment rental per month	$62,000.00
B. Transportation charge of $2.50 per mile	$ TBD
C. A cleaning fee	$ 1,000.00
D. After the primary term of this Agreement, Equipment rental per week	$15,500.00

(The cleaning fee shall be refunded if the Unit is found to be in a comparable condition equal to when it was delivered.)

3. **SCHEDULING.** Alliance shall make the Unit available to the Client and Client agrees to accept the Unit the following number of day(s) of each week: full-time. Alliance currently observes the following holidays, which may be increased from time-to-time: New Years Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day.

4. **TERM.** The initial term of this Agreement shall be for two (2) months commencing upon delivery of the Unit to Client (the "Commencement Date") expected to be on or about November 12, 2007. Fees under this Agreement shall begin to accrue on the Commencement Date. The term of the Agreement shall also be extended coterminously with any period(s) services are suspended pursuant to Section 8.2. The term of this Agreement may be extended beyond the initial term, provided, however, Client must notify Alliance in writing at least thirty (30) days prior to scheduled expiration of its request to extend beyond the initial term and provided, further, such extended period(s) are subject to Unit availability. In the event this Agreement terminates and Client continues to accept services, the terms and conditions of this Agreement shall apply to the provision of services.

THIS AGREEMENT IS CONTINGENT UPON ALLIANCE'S BOARD OF DIRECTORS APPROVAL AND SUBJECT TO UNIT AVAILABILITY AS DETERMINED BY ALLIANCE.

Alliance and Client have duly executed this Agreement as of date and year written below.

ALLIANCE IMAGING, INC.
a Delaware corporation
Federal Tax ID # 33-0239910

Signature: _____
Printed Name: Eli Glovinsky
Title: E.V.P., General Counsel & Corporate Secretary
Date: _____
Address:
1900 South State College Boulevard, Suite 600
Anaheim, California 92806
Telephone No. (714) 688-7100
Facsimile No. (714) 688-7111

STAMFORD HOSPITAL
a Connecticut not for profit corporation
Federal Tax ID #: 06-0646917 (required)

Signature: _____
Printed Name: Andrew Singer
Title: Exec Director, Materials Management
Date: 22 Oct. '07
Address:
30 Shelbourne Road
Stamford, Connecticut 06902
Telephone No.: 203/876-7000
Facsimile No.: 203 276 7898
Email address: ASinger@stamhealth.org

Return Signed Agreement to: Contracts Administration, Alliance Imaging, Inc., 15 Massirio Drive, Suite 202, Berlin, CT 06037.

PO #: 030971

Hospital: THE STAMFORD HOSPITAL
30 SHELBURNE RD
PO BOX 9317
STAMFORD CT 06904

Vendor: 03729
GE HEALTHCARE
PO BOX 640200
PITTSBURGH, PA 15264-0200

Date: 10/23/07 Page: 1
Status: OPEN
Buyer: MDEVITO - MARIE DEVITO
Type: REGULAR CAPITAL

Ship To: 142 WEST BROAD
STAMFORD, CT 06902

VIA: Exp Del: 11/17/07

Invoice To: ATTN. ACCOUNTS PAYABLE
P.O. BOX 9317
STAMFORD CT 06904

Vendor Acct #: 118646

Terms: INV NET 1
FOB:
Contact: ORDER DEPT. (800)874-7378
VENDOR'S REG #: 8008072382
CT EXEMPT PURCH CERT #: E00765

LINE	ITEM #	VEND'S CATLG MFR'S CATLG	DESCRIPTION	PACKAGING MANUFACTURER	QTY UP	PRICE	EXT COST	G/L ACCOUNT DEPT or INVEN
1	MISC.CAP	10% DEPOSIT	CAPITAL ITEM CAP # MUST GO IN DESCRIP LINE SIGNA LX MRI SYSTEM TOTAL PRICE $1,663,831.20 AS PER QUOTE# P6-C18682V8 - ATTACHED CONTINGENT UPON CON APPROVAL 10% DEPOSIT UPON SIGNATURE	EA	1 EA	166383.1200	166383.12	01.16000.16800 TSH RAD ADMIN
2	MISC.CAP	40% DEPOSIT	CAPITAL ITEM CAP # MUST GO IN DESCRIP LINE 40% OF TOTAL PRICE UPON DELIVERY CONTINGENT UPON CON APPROVAL QUOTE# P6-C18682V8	EA	1 EA	665532.4800	665532.48	01.16000.16800 TSH RAD ADMIN
3	MISC.CAP	20% INSTALLATIO	CAPITAL ITEM CAP # MUST GO IN DESCRIP LINE 20% FINAL BALANCE DUE UPON INSTALLATION CONTINGENT UPON CON APPROVAL QUOTE# P6-C18682V8	EA	1 EA	332766.2400	332766.24	01.16000.16800 TSH RAD ADMIN
4	MISC.CAP	30% AT ACCEPTAN	CAPITAL ITEM CAP # MUST GO IN DESCRIP LINE 30% UPON ACCEPTANCE CONTINGENT UPON CON APPROVAL QUOTE# P6-C18682V8	EA	1 EA	499149.3600	499149.36	01.16000.16800 TSH RAD ADMIN

Comments:

*** RE: CONFIRMATION OF PRICING & DELIVERY

*** PLEASE CONFIRM PRICING AND DELIVERY INFO FOR PURCHASE ORDER
*** VIA FAX 203-276-7898. IF YOU HAVE ANY QUESTIONS CALL
*** 203-276-7531.

TOTAL 1663831.20

Purch- ler #: 050971

Hospital: THE STAMFORD HOSPITAL
30 SHELBURNE RD
PO BOX 9317
STAMFORD CT 06904

Vendor: 03729
GE HEALTHCARE
PO BOX 640200
PITTSBURGH, PA 15264-0200

Date: 10/23/07
Status: OPEN
Buyer: MDEVITO MARIE DEVITO
Type: REGULAR CAPITAL

LINE	ITEM #	VEND'S CATLG / MFR's CATLG	DESCRIPTION	PACKAGING / MANUFACTURER	QTY UP	PRICE	EXT COST	G/L ACCOUNT / DEPT or INVEN

Vendor:

1. INCLUDE IN ALL SHIPMENTS A PACKING SLIP SHOWING CONTENTS AND PURCHASE ORDER NUMBER.
2. SHOW OUR ORDER NUMBER ON ALL INVOICES, PACKAGES, SHIPPING PAPERS, AND CORRESPONDENCE.
3. RENDER INVOICES IN DUPLICATE.
4. PURCHASE ORDER IS SUBJECT TO ALL TERMS AND CONDITIONS AS PROVIDED TO THE VENDOR.

By: _____
Authorized Signature

Quotation Number: P6-C18682 V 8

Stamford Hospital
30 Shelburne Rd
tamford CT 06902

Attn: David Sack
Rad Admin
Shelburne Rd & W Broad St
Stamford CT 06902

Date: 11-01-2007

This agreement is by and between the customer and the GE Healthcare entity (referred to herein as "GE Healthcare"), each as identified in the applicable signature block below. GE Healthcare agrees to provide and customer agrees to pay for the products and/or services set forth in this agreement, all in accordance with the terms and conditions set forth herein. This agreement is comprised of:

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 agreement of the parties relating to GE Healthcare's delivery of the products and/or services identified in the GE Healthcare Quotation and supersedes all prior oral or written proposals, statements, agreements, commitments, or understandings with respect to the matters provided for herein. Quotation expiration date is as stated below unless otherwise indicated. This Quotation is subject to pricing, configuration and credit approval.

- Terms of Delivery: FOB Destination
- Quotation Expiration Date: 11-16-2007
- Billing Terms: 10% down / 70% delivery / 20% installation or first patient use
- Payment Terms: UPON RECEIPT
- Contract Price Protection: 12 months from date of contract execution, subject to increase 0.5% per month after such 12 months period.
  Novation-DI

ch party has caused this agreement to be signed by an authorized representative on the date set forth below.
neral Electric Company, GE Healthcare
A GE Healthcare business
3200 N. Grandview Blvd., Mail Code WT-897, Waukesha, WI 53188
www.gemedical.com

Submitted By:

Emily Kloeblen
Sales Representative
Date

Agreed To By:

Authorized Company Representative
Date

CUSTOMER
Agreed To By:

Authorized Customer Representative
11-2-07
Date

Print or Type Name: Andrew Singer

Title: Executive Director, Materials

Please return to your local sales representative.

PO#

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General Electric Company
General Electric Company, GE Healthcare

Qty	Catalog No.	Description
1		**Signa LX to HDx Forklift 1.5T Upgrade**
1	S7505MG	Signa HDx 1.5T 16-channel EchoSpeed Upgrade for Signa LX Systems

Signa HDx 1.5T 16-channel EchoSpeed Upgrade for Signa LX Systems

The Signa HDx EchoSpeed 16CH Upgrade provides a complete system Upgrade, with hardware technology and software applications, to bring Signa LX or Pre-LX systems with long-bore magnets to the HDx EchoSpeed 16 Channel level. Specifically, this upgrade package includes:

- CXK4 short-bore, high-performance 1.5T magnet.
- HDx High Definition eXtended performance MR system electronics.
- EchoSpeed 33 mT/m SR120 gradients with Hi fidelity gradient driver.
- HDx EXCITE data pipeline with 16 independent simultaneous receiver channels.
- XVRE reconstruction engine with 2700 2DFFT IPS for a 256x256 matrix.
- HDx integrated workstation with 23" LCD wide screen monitor.

HDx ScanTools 14.0 with:

- Enhanced Productivity Suite
- Signa Advanced Neuro Imaging Suite
- Signa Advanced Body Imaging Suite
- Signa Advanced Cardio-Vascular Imaging Suite

HDx Signature Applications

- PROPELLER
- 3D COSMIC
- LAVA-XV
- TRICKS-XV

Signa HDx Technology Upgrade: Signa HDx 1.5T technology upgrades your Signa LX or Pre-LX system to high-definition MR imaging with the CXK4 short-bore magnet, EchoSpeed Hi-fidelity gradients and 16 independent receiver channels linked to the dual -blade XVRE reconstruction engine. The HDx upgrade includes a new operator workspace featuring a wide-screen LCD monitor that hosts a single-screen user-interface and a new host workstation featuring dual-CPU's running a Linux operating system. In addition, the RF and systems cabinet are consolidated to reduce space requirements in the equipment room. The result is an MR system capable of accelerated productivity and high-definition imaging in even the most challenging cases.

The HDx 16-channel receiver architecture enables simultaneous data reception for enhanced SNR and the XVRE Volume Reconstruction architecture builds on the HDx data pipeline utilizing dual-blade computing technology to deliver real time data reconstruction. Each XVRE blade consists of dual 2.6Ghz CPU's, 8GB local RAM, and dual 73GB hard drives that are mirrored for

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Qty	Catalog No.	Description

data redundancy and reliability. This combination yields the fastest, most reliable image reconstruction hardware in the industry.

The HDx EchoSpeed gradients are designed to create the most accurate and repeatable gradient waveforms while attaining the maximum amplitude of 33 mT/m at a slew rate of 120 mT/m/ms. The results are a 5X improvement in fidelity with new levels of accuracy and repeatability.

The HDx operator workstation includes the HP 9300 host computer, housed in a single cabinet and running a Linux operating system, along with a single 23" LCD wide screen monitor and an ergonomically designed scan control keyboard. The flat panel LCD provides 1910x1200 high dot resolution with 500:1 contrast ration. The HDx user interface simplifies and speeds workflow through single-screen prescription, HD Secure Coil Connect, and HD Vector Gating.

The new patient table is still detachable, a long-standing GE exclusive, enhancing patient safety and speeding workflow.

Signa HDx ScanTools and Imaging Suites: The HDx ScanTools and Imaging Suites deliver a full range of foundation pulse sequences, acceleration techniques, analysis packages and advanced applications for optimized whole-body imaging on the Signa HDx system.

HDx ScanTools delivers the core pulse sequence families that provide a broad range of clinical applications capability, along with analysis

packages that complement with tools that enable the optimization of image quality or quantitative the optimization of image quality or quantitative analysis. HDx ScanTools includes the spin echo, fast spin echo, gradient echo, fast gradient echo, time-of-flight, phase contrast and echo planar pulse sequence families along with the ClariView, FuncTool, Interactive Vascular Imaging and VoxTool Multi-planar Volume Reformat analysis packages.

The Signa Enhanced Productivity Suite simplifies and speeds your workflow with features that expand your capability while reducing operator interaction. Key features of this package include ProtoCopy, Enhanced Rx, Auto Functions, DynaPlan, iDrivePro Plus and Top Spins.

ProtoCopy facilitates the rapid exchange of protocols from system to system and site to site by enabling you to automatically extract scan parameters from an image on CD/DVD. Extracted protocols can be downloaded directly into the scan desktop or stored in your custom protocol library. Notes can be added to stored protocols

Enhanced Rx makes scan prescription easier and faster. The wizard guided UI provides on screen assistance. Related parameters are grouped and available on a single screen, and coils are automatically identified to the system reducing mouse clicks. In addition, 3-Plane Graphic Rx provides more contrast choices for localization and eliminates the need to change screens/menus for access to scan parameters.

Auto Functions includes automated features such has Auto MinTR, AutoStart, and AutoVoice that

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Qty	Catalog No.	Description

simplify or speed scan set-up or scan performance without restricting the ability to optimize your scans as you desire. Auto MinTR guides the selection of TR and number of slices, and AutoStart begins the localizer scan as soon as the scan room door closes. AutoVoice provides consistent breathing instructions for breath-held exams.

DynaPlan speeds and optimizes multi-phase Body and Breast exam planning. DynaPlan allows you to easily select variable inter-scan timing so that you can acquire each phase at the desired time point. DynaPlan also allows you to select auto-subtraction eliminating manual post-processing.

iDrivePro Plus provides real-time interactive MR imaging that makes it easier to optimize and streamline scan prescription. The iDrive tool uses the 2D FGRE/FSPGR sequence and allows the user to change-on-the-fly geometric and image contrast scan parameters. Results can be evaluated immediately and bookmarked or saved. Scan locations can also be easily exported to pre-programmed protocols.

The Signa Advanced Neuro Imaging Suite provides the 3D FIESTA, FIESTA-C and BRAVO-XV applications designed for optimized high-resolution Neuro imaging, and the EchoPlus, 2D MERGE and 3D COSMIC applications designed specifically for diffusion imaging and optimized cervical-spine imaging respectively.

3D FIESTA and FIESTA-C combines 3D acquisition with fluid sensitive steady-state imaging for high resolution imaging of small structures such as the internal auditory canal, middle ear or joints. FIESTA-C adds phase cycling to minimize the build-up of artifacts.

BRAVO-XV combines IR-prepped 3D FSPGR with ASSET acceleration for high-resolution T1 weighted images in one-third the scan time as typical 3DFSPGR sequences. Use it for pre and post contrast enhanced T1-weighted brain imaging or as the high-definition anatomical overlay for functional studies.

EchoPlus uses motion sensing gradient pulses in three directions to generate isotropic diffusion-weighted images in conjunction with T2 FLAIR images. B-value selection ranges provide the flexibility to balance diffusion sensitivity and background suppression.

2D MERGE is an optimized FGRE sequence that yields enhanced SNR and enhanced gray-white matter contrast for the evaluation of cervical cord parenchyma.

The Signa Advanced Body Imaging Suite provides a portfolio of applications designed for optimized body imaging. Key features include ASSET, LAVA, 2D FAT SAT FIESTA, and E-MRCP.

ASSET is a parallel imaging technique that uses the geometry of multi-element coils to accelerate data collection and reduce RF deposition. As a result, the user may choose to reduce scan time, increase in-plane resolution, or increase slice coverage. ASSET is an option employed in conjunction with compatible pulse sequences that span a broad range of applications that are part of the ScanTools package: 2D FGRE, 2D FSPGR, 3D FGRE, 3D FSPGR, eFGRE3D, 3D

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Qty	Catalog No.	Description

TOF-SPGR, 3D TOF-GRE, 2D FSE, 2D-FSE-XL, 2D FRFSE, 2D FRFSE-XL, 2D-FSE-IR SSFSE, 2D T1 FLAIR, EPI, DW-EPI and LAVA.

LAVA makes multi-phase body imaging easy and consistent with whole organ coverage in a breath-hold of typically less than 20 seconds with high spatial resolution, robust Fat Saturation and consistent image contrast. LAVA enables high quality reformations from the axial image data.

2D Fat Sat FIESTA combines 2D FIESTA with fat saturation for optimized fluid sensitive fat suppressed body imaging.

E-MRCP is a FSE based technique optimized for either short breath-hold or respiratory-gated MR cholangio-pancreatograhy. Pulse sequence design minimizes echo spacing and enables longer echo trains for faster imaging without introducing edge blurring.

The Signa Advanced Cardio-Vascular Imaging Suite provides a portfolio of applications designed to simplify and optimize cardiovascular imaging. Key features include SmartPrep, SmartStep, FTMRA, 2D FIESTA, 3D Fat Sat FIESTA, Cine, FastCine and Blood Suppression. SmartPrep and SmartStep enables both automated bolus detection and automated bolus chasing for time-course vascular imaging. SmartPrep uses a special tracking pulse sequence positioned over a blood vessel volume by the user to trigger data acquisition when the threshold signal intensity is reached. SmartStep adds automated table stepping for multi-station time-course vascular exams.

FTMRA (Fluoro-Trigger MRA) enables real-time monitoring and manual triggering for vascular time-course imaging. FTMRA allows the user to view real time images of the area of interest and then manually trigger data acquisition at the optimum time.

2D FIESTA is a fluid sensitive steady-state imaging technique that yields high contrast between the blood and myocardium for cardiac imaging.

3D Fat Sat FIESTA combines 3D acquisition with fluid sensitive steady-state imaging and fat saturation for coronary artery imaging.

Cine and FastCine are gradient echo sequences that acquire data throughout the cardiac cycle providing a "cine-mode" for dynamic cardiac imaging. Both are white-blood techniques that use a retrospective ordering technique to link the image data to the cardiac phase.

Blood Suppression adds an IR-prep plus and chemical fat saturation capability to the Fast Spin Echo sequence for black-blood and morphological cardiac imaging. The inversion pulse is optimized to suppress blood flow artifact and can be used alone or in conjunction with chemical fat saturation.

HDx Signature Applications The Signa HDx

EchoSpeed 16 CH Upgrade includes five HDx Signature Applications designed to address the challenges of brain, spine, body, breast and vascular imaging.

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General Electric Company
General Electric Company, GE Healthcare

Qty	Catalog No.	Description
		PROPELLER creates motion insensitive T2 FSE and T2 FLAIR FSE images with enhanced CNR and without time penalties. PROPELLER DWI reduces the susceptibility that challenges traditional EPI-DWI imaging and provides high quality results even in the presence of dental work. 3D COSMIC is a unique fluid-weighted contrast that yields enhanced visualization of the cervical nerve roots and intervertebral disks. LAVA-XV extends the performance of LAVA multi-phase body imaging enabling increased coverage or higher resolution in the same short breath-hold time. LAVA-XV uses 2D GEM acceleration with self-calibration that allows faster scanning, extended slice coverage and higher spatial resolution. TRICKS-XV eliminates the need to time bolus arrival and provides enhanced flow dynamics without sacrificing small vessel detail. The result is optimal arterial, venous and equilibrium 3D volumes even in areas of high velocity flow or delayed flow. GE proprietary coils • 12-Channel Body Array Coil • 8-Channel Brain Array Coil • 8-Channel CTL Array Coil
1	M3335PB	Signa HDx 1.5T EchoSpeed Magnet Signa HDx 1.5T EchoSpeed Magnet With its uniquely contoured system enclosures, the compact 1.5T Signa HDx superconducting magnet offers superb homogeneity; and it includes 18 GE-designed superconducting shim coils to further improve homogeneity, particularly for fat saturation with large or off-center fields of view. The magnets active shielding minimizes the stray ambient magnetic field to increase everyones safety and minimize interference with equipment operation. The combination of a wide, 60-cm-diameter bore and patient table assembly that rests close to bore bottom creates ample room even for large patients. And innovative K4 cooling technology prevents helium boil-off while making refills an extremely rare occurrence. The Gradient Module installed within the magnet bore consists of three gradient coils and the quadrature transmit/receive body RF coil. Each gradient coil is designed to change magnetic-field strength linearly with increasing distance from the center of the magnet by as much as 33 mT/m.
1	M1060MA	Vibroacoustic Damping Kit Vibroacoustic Damping Kit Material in the Vibroacoustic Damping Kit can significantly attenuate the transmission of gradient-generated acoustic noise through the building structure to nearby areas, including

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		adjacent rooms and floors above or below the MR suite. The kit is compatible only with the short-bore 1.5T LCC or 3.0T magnets. If this kit is applied during the installation of a new magnet, no additional service charges are necessary. However, installation of the Vibroacoustic Damping kit under an existing magnet requires special steps. The steps to prepare the site and steps to install, such as modifications to the RF screen room, and other magnet rigging, modifications to the RF screen room, and other finishing work, are not covered in the pricing.
1	M1060JW	1.5T and OpenSpeed Magnet Compressor 1.5T and OpenSpeed Magnet Compressor for CXK4 Fixed, Relocatable & Mobile Systems Compressor designed for CXK4 magnet subsystems for 0.7T or 1.5T and compatible with fixed, relocatable and mobile magnet configurations. Compressor is water cooled and all water cooling systems must be a closed loop design to eliminate the possibility of magnetic contaminants entering into the system.
1	M3335NJ	Signa HDx 1.5T EchoSpeed Phased Array 16-Channel Cables (Config A) Signa HDx 1.5T EchoSpeed Phased Array 16-Channel Cables (Config A) This is a required collection of high performance phased-array cables specifically engineered for the Fixed Site 1.5T Signa HDx EchoSpeed MR system.
	M3088TL	10 kW Indoor/Outdoor Air-Cooled Chiller 10 kW Indoor/Outdoor Air-Cooled Chiller This chiller is mandatory for all MR systems with the TwinSpeed gradient coil (1.5T or 3.0T) at sites without a source of chilled water. It is also an option for cooling the coldhead on a 1.5T LCC magnet or 3.0T short-bore magnet, regardless of the type of gradients. Cooling of both the coldhead and the gradients requires two separate chillers. The air-cooled chiller consists of a refrigeration unit, coolant reservoir and pump contained within an enclosure that allows the unit to be operated indoors or outdoors. There is a remote panel that can stop or restart the chiller as well as display water temperatures. This remote panel can be placed in the equipment room to provide complete and convenient control over a chiller installed outdoors. Operates at either 50Hz or 60Hz
1	S7502TZ	MR Accessories Kit MR Accessories Kit The Accessories Kit combines a physician's chair, a complete set of positioning pads, and a set of Velcro security straps. The Physician's Chair has padded arms for comfort and comes in a charcoal gray color that blends with any environment.

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Qty	Catalog No.	Description
		The MR Accessories Kit contains a complete set of coated positioning pads in a lightweight tote case that can be a permanent fixture in an MR suite or can be easily carried from room to room. The following pads are included: 1 knee rest, 1 knee coil insert, 1 extremity rest, segment table pads, 4 body wedges, 4 rectangle stack pads, and 2 rectangle elbow pads. The Velcro Security Straps include one 14 inch wide set and one 6 inch wide set.
1	M3335KF	Detachable Patient Table Detachable Patient Table GEs exclusive HD detachable patient table features a mechanism for fast table docking and undocking. This feature has proven invaluable for patient safety and emergency response whenever patient resuscitation may be required. And by allowing staff to prep patients outside of the scan room, it avoids wasted scan-room time between procedures, boosting both room utilization and departmental productivity.
1	M3090LR	Diffusion Tensor Imaging Diffusion Tensor Imaging Diffusion Tensor imaging creates contrast based on the degree of diffusion anisotropy in cerebral tissues such as white matter. DTI builds on the EchoPlus sequence using motion sensing gradient pulses along 6 to 55 orientations in order to generate component images. On the operator console, FuncTool provides algorithms to generate Fractional Anisotropy (FA) Maps and Volume Ratio Anisotropy (VRA) Maps.
1	M3333WJ	PROBE 2D CSI PROBE 2D CSI PROBE 2D CSI expands proton brain spectroscopy capability enabling simultaneous acquisition of multiple in-plane voxels. PROBE 2D CSI uses the PRESS pulse sequence to acquire and display volume-localized, water suppressed 1H spectra in a multi-voxel mode for the non-invasive assessment of invivo metabolites. Metabolite maps are automatically generated in FuncTool on the operator console.
1	M3333WH	PROBE-PRESS and STEAM Single-Voxel Spectroscopy PROBE-PRESS and STEAM Single-Voxel Spectroscopy PROBE-PRESS and STEAM Single-Voxel Spectroscopy for EXCITE allows you to non-invasively evaluate the relative concentrations of invivo metabolites. It lets you acquire and display volume-localized, water-suppressed 1H spectra in single-voxel mode. This package includes PROBE-P (PRESS) and PROBE-S (STEAM) pulse sequences, as well as automated reconstruction, acquisition set-up and graphic prescription of spectroscopic volumes.

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Qty	Catalog No.	Description
1	M3335KP	SWIFT (SWItch on Fly Technique) SWIFT (SWItch on Fly Technique) SWIFT is a unique pulse sequence for imaging the vascular structures of the lower leg. It allows the user to prescribe two unique and independent 3D volumes over each leg in an oblique sagittal orientation. During the acquisition, a TRICKS (Temporally Resolved Imaging with Contrast KineticS) scan is performed, continually alternating the TR between the left and right volumes. ASSET is also used to improve the temporal resolution of the SWIFT acquisition. During the scan, the left and right legs of the HD Lower Leg Array coil are switched on and off for signal reception of the alternating pulse sequence. Each single leg of the HD Lower Leg Array coil receives data using 8 RF channels. SWIFT is therefore a technique that enables 8-channel HDx MRI systems to scan both legs simultaneously during an MR angiogram in an oblique sagittal plane. This effectively brings 16-channel capability in lower leg MRA to 8-channel MRI scanners. SWIFT is also particularly useful in 16-channel scanners; it can reduce scan time by 45% compared with conventional approaches to acquiring this much anatomical coverage in both lower legs.
	M3090KR	2D MDE 2D MDE Myocardial Delayed Enhancement 2D MDE (Myocardial Enhancement) combines a Fast Gradient Echo pulse sequence with an inversion pulse and cardiac gating to enable delayed time course imaging of the heart. The technique uses an IR preparation pulse to suppress or enhance selected tissues, typically the myocardium and blood. Image data are collected in a 2D slice mode.
1	S7502WH	1.5T Dual Array Package with HDe/HDx Adapter 1.5T Dual Array Package with HDe/HDx Adapter The HDe/HDx Dual Array Package includes two 3-inch General Purpose Coils, two General Purpose Flex Coils, one Dual Array Adapter, one Medrad TMJ Positioning Device, and one Eye and Ear Surface Coil Holder.
1	F7000MR	1.5T 16-Channel Head/Neck/Spine Array-USAI (for new systems) 1.5T 16-Channel Head/Neck/Spine Array USAI The 1.5T Head/Neck/Spine (HNS) Array delivers convenience without compromise. Compatible with new 16-Channel HDx MR systems, this 29-element coil serves as a high-resolution brain coil, high-density neuro-vascular array, and a multi-element spine coil in one convenient

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Qty	Catalog No.	Description
		package. Designed to accommodate multi-dimensional parallel imaging in any scan plane, this coil yields unprecedented imaging speed and superior image quality, thanks in large part to a unique element arrangement that focuses the signal over the anatomy of interest. This quote includes a future product delivery commitment by GEHC for the above specified product(s). Customer is responsible for downtime, if any, associated with the installation of the product(s) ordered under this commitment. If customer has a service contract with GEHC, customer is also responsible for any changes to service contract pricing due to the installation of the product(s) ordered under this commitment. This commitment is expressly limited to the above specified product(s) that are FDA-cleared, but not yet commercially available. Customer shall not be entitled to any refund in connection with this commitment and no monies may be allocated to any product(s) except the product(s) specified by this commitment. Customer is responsible for the proper accounting for all payments made in the manner required under any state or federal program which provides reimbursement to the customer for or related to any products or services provided under this agreement. Amounts paid by customer under this agreement may include payments toward future acquisitions by customer under the terms and conditions of this agreement. Before order entry, GEHC may remove the future product delivery commitment catalog number item(s) from this order and create a separate order for such catalog number item(s). However, payment terms shall remain the same as originally stated in the quotation and payment for the future product delivery commitment catalog number item(s) shall be included with the payment for the original order.
1	M3335M	1.5T 8-Channel HDe/HDx Neurovascular Array - Invivo 1.5T 8-Channel HDe/HDx Neurovascular Array by Invivo Designed for use with 1.5T 8- and 16-channel MR systems, the 8-Channel Neurovascular Array enables combined head-and-neck imaging without the need for patient repositioning. The coil is optimized for ASSET parallel imaging in a wide range of soft-tissue neck, skull-base and brain studies. Its head portion generates high-SNR brain images with uniform coverage. For vascular imaging, the coil delivers coverage from the aortic arch to the circle of Willis. And it is excellent for a wide range of additional applications, including imaging of the cervical spine, as well as soft-tissue neck and carotid applications. The coil's removable top has multiple openings and an adjustable mirror to reduce claustrophobia and facilitate patient positioning.
1	M3335MD	1.5T 8-Channel HDx Cardiac Array - GE Coils 1.5T 8-Channel HDx Cardiac Array - GE Coils The 8-Channel HDx Cardiac Array produces high-definition MR images of the heart and mediastinum on 8- or 16-channel 1.5T HDx MR systems. The 8-element quadrature phased array coil provides 28-cm S/I coverage and 26-cm R/L coverage. Its flexible design easily

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Qty	Catalog No.	Description
		contours to the patients anatomy, for comfort and optimum image quality in both anatomical and vascular imaging. The array features windows to accommodate ECG-lead placement. It's optimized for use with ASSET acceleration for enhanced breath-hold imaging procedures.
1	M3335LY	1.5T 16-Channel HDx Lower Leg Array Coil - GE Coils 1.5T 16-Ch HDx Lower Leg Array Coil-GE Coils The 1.5T HDx Lower Leg Array with a single connection produces high-definition MR images of the lower leg and foot on new 16-ch 1.5T HDx MR systems. The 32-element quadrature, phased-array coil delivers about 12 times the SNR of a body coil; that translates into unprecedented detail in vascular imaging of the lower extremity, with a high level of patient comfort. The array includes a quality-assurance phantom.
1	M3335MN	1.5T 3-Ch HDe/HDx Shoulder Array - GE Coils 1.5T 3-Channel HDe/HDx Shoulder Array - GE Coils The 1.5T 3-channel HDe/HDx Shoulder Array offers the increased signal-to-noise characteristic of phased-array technology, along with a unique sleeve design that delivers exceptional joint-imaging capabilities. The coil provides clear definition of the shoulder joint, specifically the head of the humerus, clavicle, acromion, supraspinatus muscle and ligaments. Patient comfort pads and restraining straps are included.
1	M3335LJ	1.5T 8-Channel HDx Wrist Array - Invivo 1.5T 8-Channel HDx Wrist Array - Invivo The 8-Channel HDx Wrist Array generates high-definition MR wrist images on 1.5T 8- and 16-channel HDx MR systems. The one-piece, ovoid, hinged design is optimal for small-FOV imaging and provides 12-cm S/I coverage. The coil can be positioned overhead or at the patient's side, vertically or horizontally. The coil is optimized for ASSET imaging to improve acquisition times.
1	M3087JF	1.5T HD 8-Channel Knee Array - Invivo 1.5T HD/HDe/HDx 8-Channel Knee Array - Invivo The 1.5T T/R Knee Array is designed for high definition MR imaging of the knee on 8-channel or 16-channel 1.5T HD/HDe/HDx MR systems. This array uses unique hybrid technology using separate birdcage coils for transmit and receive functions. Designed uniquely for GE, the 8 element receive coil delivers 30% to 100% more SNR than the standard extremity coil. The array is compatible with PURE for uniform signal intensity and ASSET for accelerated imaging speed.
1	M3335ME	1.5T HDe/HDx Quad Extremity Coil - Invivo 1.5T HDe/HDx Quad Extremity Coil - Invivo

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Qty	Catalog No.	Description
		The transmit/receive design of the HDe/HDx Quad Extremity Coil helps ensure optimal results in studies of the knee, ankle and foot. Its unique anterior extension increases the imaging volume for thorough evaluations in dorsi-flexed foot and ankle studies, covering FOVs up to 30 cm for the foot and ankle, and up to 20 cm for the knee.
1	E8801RG	Medrad 8-Ch Coil Interface Device for 1.5T HDx Systems Medrad 8-Ch Coil Interface Device 1.5T HDx Systems This Medrad 8 channel interface device combines the MEDRAD eCoil and GE 8-channel HDx Body Array for phased array imaging of the pelvis. It allows for high resolution, small FOV imaging of prostate, cervix, colon, and other regions of the pelvis. It provides improved ability to visualize internal architecture of the prostate and periprostatic structures; including prostate capsule and neurovascular bundles, which leads to better treatment planning, and may assist in tumor staging. It is compatible with 1.5T eCoils - prostate, cervix and colon - and supports the 8-channel HDx Body Array from GE. It is supported on GE 1.5T HDx systems. Warranty Code: B Warranty Period- 1 year- New or exchange replacement parts at no charge to correct non-conforming products or parts during the warranty period Note: Installation, parts, application training and on-site service is the buyer's responsibility. GE Field Engineers may be available at prevailing HBS rates
	E8801R	Disposable Endorectal Prostate Coils for Signa 1.5T Disposable Endorectal Prostate Coils for Signa 1.5T These one-use, disposable endorectal surface coils are optimized for imaging the prostate, and increase patient comfort and safety. For use with the Signa 1.5T endocavitary coil system. Coils are packaged 5 per box. This is an Accessory coil and the warranty and service is managed through the original coil manufacturer and not GE Service. During the one year warranty period, GE Service will facilitate the replacement of any failed coil with the original manufacturer. The replacement lead time will be a minimum of two weeks for shipments outside of the US. Warranty Period- 6 months-Exchange of non conforming products, which are returned to GE during warranty period Note: Installation, parts, application training and on-site service is the buyer's responsibility
1	E4502SP	25 KAIC MR Signa Main Disconnect Panel w/ Shield Cooler Compressor 25 KAIC MR 3T & 1.5T Signa Main Disconnect Panel w/ Shield Cooler Compressor This 25 KAIC MR Signa Main Disconnect Panel with Shield Cooler Compressor has an auto restart feature that restores power to the shield cooler compressor after power outages, minimizing helium loss to the magnet, resulting in a decrease in downtime. It also reduces installation time and cost by providing a single-point power connection eliminating the need to mount and wire a number of individual components. The standardized design and testing assures high product

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Qty	Catalog No.	Description
		quality and system reliability. Field re-configurable for two power feeds allowing for shield coolers to maintain system integrity by the use of an essential power source. Compatible with Fixed, Modular, and Mobile installations of the GEHC MR 3T & 1.5T Signa Systems. Not compatible with Profile, OpenSpeed and SP. Customer is responsible for rigging and arranging for installation with a certified electrician. ITEM IS NON-RETURNABLE AND NON-REFUNDABLE. Warranty Code: Y"
1	E8822J	Newmatic MRI Music System Package Newmatic MRI Music System Package Newmatic MRI sound system includes a Denen stereo with auto reversing tape drive, AM/FM tuner, multi-disk CD player, remote control and operator speakers, a Newmatic customer patient amplifier, and a Newmatic patented transducer. Also includes one each of the noise guard head set, Slimline noise guard head set, standard head set, ear piece head set, and foam ear piece head set. UL and CE approved. Installation provided by GE...E Warranty Period-6 months-Exchange of non conforming products, which are returned to GE during warranty period Note: Installation, parts, application training and on-site service is the buyer's responsibility
1	E8822JA	Slimline Headset for Newmatic MR Sound System Slimline Headset for Newmatic MR Sound System Newmatic Slimline noise guard head set provides 25 db of noise reduction, protecting the patient from the loud sound of gradient amplifiers even during head coil and spinal exams. Fits into most headcoils...H
1	M1099MD	MR Masters Voucher MR Masters Voucher The MR Masters Voucher entitles one clinician to attend one MR Masters program within one year of system transfer. Courses are listed on the GE Healthcare website at http://www.gehealthcare.com/usen/mr/education/ products/physiciantrain.html. Courses are scheduled at various times throughout the year and course selection is subject to change. Course length varies from 1 day to 5 days -- there is no rebate if a shorter course is selected. The voucher voucher covers tuition only for the attendee (regardless of course length) and does not include travel and living expenses which are the responsibility of the attendee.
1	W0101MR	TiP Applications 1.5T or 3T Succeed Elite TiP Applications 1.5T or 3T Succeed Elite TiP Applications 1.5T or 3T Succeed Elite training includes: • 19 onsite days covered over 7 site visits

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Qty	Catalog No.	Description
		• 12 Hrs TVA, 1 hr per week over 12 weeks starting 6-8 weeks post install • 2 TiP Headquarter Classes All elements of the programs are completed within 6 months post installation. Onsite training and TVA are delivered Monday through Friday between 8AM and 5PM. T&L expenses are included. Headquarter classes are delivered in the Milwaukee area and include travel and modest living expenses.
1		**Signa HDx 1.5T IB Options**
1	M3335MC	1.5T 8-Channel HDe/HDx Body Array - GE Coils 1.5T 8-Channel HDe/HDx Body Array - GE Coils The 8-Channel HDe/HDx Body Array is designed for high-definition MR imaging of the chest, abdomen and pelvis on 8- or 16-channel 1.5T MR systems. This 12-element, quadrature phased-array coil provides extensive coverage, enabling multi-station anatomical and vascular imaging of the chest-abdomen or abdomen-pelvis without repositioning the coil. The array is optimized for use with ASSET acceleration for enhanced breath-hold imaging procedures.
		Quote Summary: **Total Quote Net Selling Price** **$1,663,831.20** (Quoted prices do not reflect state and local taxes if applicable. Total Net Selling Price Includes Trade In allowance, if applicable.)

This pricing is based upon the common goal of delivery by December 28th, 2007 (pending CON approval) and Stamford Hospital's history as a GE MR customer.

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EXHIBIT I

Depreciation Schedule for Stamford Hospital MRI Replacement

	Year 1	Year 2	Year 3	Year 4	Year 5
Equipment	$332,766	$332,766	$332,766	$332,766	$332,766
Construction/Renovation	$45,000	$45,000	$45,000	$45,000	$45,000
Total	$377,766	$377,766	$377,766	$377,766	$377,766

Note: 5-year straight-line depreciation is used for equipment. 10-year straight-line depreciation is used for construction/renovation.

EXHIBIT J

Financial Attachment I

Stamford Hospital, Inc.

12. C (i). Please provide one year of actual results and three years of ***Total Hospital*** projections of revenue, expense and volume statistics without, incremental to and with the CON proposal in the following reporting format:

Stamford Hospital:	FY06 Actual	FY07 Projected	FY08 Projected	FY08 Projected	FY08 Projected	FY09 Projected	FY09 Projected	FY09 Projected	FY10 Projected	FY10 Projected	FY10 Projected
Description	**Results**	**Results**	**W/out CON**	**Incremental**	**With CON**	**W/out CON**	**Incremental**	**With CON**	**W/out CON**	**Incremental**	**With CON**
NET PATIENT REVENUE											
Non-Government	210,911	$233,260	$254,140		$254,140	$273,657		$273,657	$294,633		$294,633
Medicare	84,988	$86,561	$88,914		$88,914	$95,743		$95,743	$103,081		$103,081
Medicaid and Other Medical Assis	20,688	$19,166	$23,218		$23,218	$25,001		$25,001	$26,917		$26,917
Other Government	-	$0	$0		$0	$0		$0	$0		$0
Total Net Patient Patient Revenue	316,588	$338,988	$366,272	$900,000	$1,266,272	$394,401	$1,125,000	$1,519,401	$424,632	$1,350,000	$1,774,632
Other Operating Revenue	19,393	$17,288	$20,059		$20,059	$20,480		$20,480	$20,910		$20,910
Revenue from Operations	335,981	$356,276	$386,331	$900,000	$1,286,331	$414,881	$1,125,000	$1,539,881	$445,542	$1,350,000	$1,795,542
OPERATING EXPENSES											
Salaries and Fringe Benefits	145,625	$152,115	$167,633		$167,633	$179,853		$179,853	$192,964		$192,964
Professional / Contracted Services	39,637	$43,565	$40,657		$40,657	$41,740		$41,740	$42,852		$42,852
Supplies and Drugs	35,877	$40,358	$42,372	$9,065	$51,437	$46,678	$11,331	$58,009	$51,422	$13,598	$65,019
Bad Debts	33,466	$39,081	$42,512		$42,512	$45,654		$45,654	$49,028		$49,028
Other Operating Expense	40,414	$41,344	$50,313	$296,383	$346,696	$56,906	$166,383	$223,289	$64,363	$166,383	$230,746
Subtotal	295,019	$316,463	$343,487	$305,448	$648,935	$370,831	$177,714	$548,546	$400,629	$179,981	$580,610
Depreciation/Amortization	21,482	$22,299	$23,532	$377,766	$401,298	$24,026	$377,766	$401,792	$24,531	$377,766	$402,297
Interest Expense	4,314	$5,159	$4,748		$4,748	$6,000		$6,000	$6,000		$6,000
Lease Expense					$0			$0			$0
Total Operating Expense	320,815	$343,921	$371,767	$683,214	$1,054,981	$400,858	$555,480	$956,338	$431,160	$557,747	$988,906
Income/(Loss) from Operations	15,166	$12,355	$14,564	$216,786	$231,350	$14,024	$569,520	$583,544	$14,382	$792,254	$806,636
Non-Operating Income	3,969	$2,390	$2,941		$2,941	$2,941		$2,941	$2,941		$2,941
Income Before Provision for Incom	19,135	$14,745	$17,505	$216,786	$234,291	$16,965	$569,520	$586,485	$17,323	$792,254	$809,577
Provision for Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income	19,135	$14,745	$17,505	$216,786	$234,291	$16,965	$569,520	$586,485	$17,323	$792,254	$809,577
Retained Earnings Balance	103,839	$118,574	$136,079		$352,865	$153,044		$939,350	$170,367		$1,748,926
FTEs	1801	1,758	1,932		1,932	1,980		1,980	2,030		2,030
*Volume Statistics:				500			625			750	

EXHIBIT K

The Stamford Hospital

13.C(ii). Please provide three years of projections of incremental revenue, expense and volume statistics **attributable to the proposal** in the following reporting format:

Type of Service Description	Replacement MRI									
Type of Unit Description:	# of Scans									
# of Months in Operation	12 months									
Year 1	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FY Projected Incremental		Rate	Units	Gross	Allowances/	Charity	Bad	Net	Operating	Gain/(Loss)
Total Incremental Expenses:	**$683,214**			Revenue	Deductions	Care	Debt	Revenue	Expenses	from Operations
				Col. 2 * Col. 3				Col.4 - Col.5	Col. 1 Total *	Col. 8 - Col. 9
Total Facility by								-Col.6 - Col.7	Col. 4 / Col. 4 Total	
Payer Category:										
Medicare		$4,000	173	$692,000	$380,600			$311,400	$236,392	$75,008
Medicaid		$4,000	33	$130,000	$71,500			$58,500	$44,409	$14,091
CHAMPUS/TriCare		$4,000	0	$0	$0			$0	$0	$0
Total Governmental			206	$822,000	$452,100	$0	$0	$369,900	$280,801	$89,099
Commericial Insurers		$4,000	265	$1,058,000	$581,900			$476,100	$361,420	$114,680
Uninsured		$4,000	30	$120,000		$66,000		$54,000	$40,993	$13,007
Total NonGovenrment		$4,000	295	$1,178,000	$581,900	$66,000	$0	$530,100	$402,413	$127,687
Total All Payers		$4,000	500	$2,000,000	$1,034,000	$66,000	$0	$900,000	$683,214	$216,786

The Stamford Hospital

13.C(ii). Please provide three years of projections of incremental revenue, expense and volume statistics **attributable to the proposal** in the following reporting format:

Type of Service Description	Replacement MRI									
Type of Unit Description:	# of Scans									
# of Months in Operation	12 months									
Year 2	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FY Projected Incremental		Rate	Units	Gross	Allowances/	Charity	Bad	Net	Operating	Gain/(Loss)
Total Incremental Expenses:	**$555,480**			Revenue	Deductions	Care	Debt	Revenue	Expenses	from Operations
				Col. 2 * Col. 3				Col.4 - Col.5	Col. 1 Total *	Col. 8 - Col. 9
Total Facility by								-Col.6 - Col.7	Col. 4 / Col. 4 Total	
Payer Category:										
Medicare		$4,000	216	$865,000	$475,750			$389,250	$192,196	$197,054
Medicaid		$4,000	41	$162,500	$89,375			$73,125	$36,106	$37,019
CHAMPUS/TriCare		$4,000	0	$0	$0			$0	$0	$0
Total Governmental			257	$1,027,500	$565,125	$0	$0	$462,375	$228,302	$234,073
Commericial Insurers		$4,000	331	$1,322,500	$727,375			$595,125	$293,849	$301,276
Uninsured		$4,000	38	$150,000		$82,500		$67,500	$33,329	$34,171
Total NonGovenrment		$4,000	368	$1,472,500	$727,375	$82,500	$0	$662,625	$327,178	$335,447
Total All Payers		$4,000	625	$2,500,000	$1,292,500	$82,500	$0	$1,125,000	$555,480	$569,520

The Stamford Hospital

13.C(ii). Please provide three years of projections of incremental revenue, expense and volume statistics **attributable to the proposal** in the following reporting format:

Type of Service Description	Replacement MRI									
Type of Unit Description:	# of Scans									
# of Months in Operation	12 months									
Year 3	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FY Projected Incremental		Rate	Units	Gross	Allowances/	Charity	Bad	Net	Operating	Gain/(Loss)
Total Incremental Expenses:	**$557,747**			Revenue	Deductions	Care	Debt	Revenue	Expenses	from Operations
				Col. 2 * Col. 3				Col.4 - Col.5	Col. 1 Total *	Col. 8 - Col. 9
Total Facility by								-Col.6 - Col.7	Col. 4 / Col. 4 Total	
Payer Category:										
Medicare		$4,000	260	$1,038,000	$570,900			$467,100	$192,980	$274,120
Medicaid		$4,000	49	$195,000	$107,250			$87,750	$36,254	$51,496
CHAMPUS/TriCare		$4,000	0	$0	$0			$0	$0	$0
Total Governmental			308	$1,233,000	$678,150	$0	$0	$554,850	$229,234	$325,616
Commericial Insurers		$4,000	397	$1,587,000	$872,850			$714,150	$295,048	$419,102
Uninsured		$4,000	45	$180,000		$99,000		$81,000	$33,465	$47,535
Total NonGovenrment		$4,000	442	$1,767,000	$872,850	$99,000	$0	$795,150	$328,513	$466,637
Total All Payers		$4,000	750	$3,000,000	$1,551,000	$99,000	$0	$1,350,000	$557,747	$792,253

EXHIBIT L

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI -- 3 SITES						
MRI0174001	MRI BRAIN W/O CONTRAST	01.73501	611	2,695.82	70551	
MRI0174003	MRI CERVICAL SPINE W/O CONTRAS	01.73501	612	2,695.82	72141	
MRI0174005	MRI THORACIC SPINE W/O CON	01.73501	612	2,695.82	72146	
MRI0174007	MRI LUMBAR SPINE W/O CON	01.73501	612	2,695.82	72148	
MRI0174009	MRI UPPER EXTREMITY W/O CON	01.73501	610	2,695.82	73218	
MRI0174013	MRI LUMBAR SPINE W CON	01.73501	610	2,864.12	72149	
MRI0174015	MRI PELVIS W/O CONTRAST	01.73501	610	2,695.82	72195	
MRI0174017	MRI ABDOMEN W/O CON	01.73501	610	2,695.82	74181	
MRI0174019	MRI LOWER EXTREMITY W/O CON	01.73501	610	2,695.82	73718	
MRI0174021	MRI CHEST W/0 CON	01.73501	610	2,695.82	71550	
MRI0174023	MRI ORBITS FACE/NECK W/O CON	01.73501	610	2,695.82	70540	
MRI0174025	MRI UPPER JOINT W/O CON	01.73501	610	2,695.82	73221	
MRI0174027	MRI LOWER JOINT W/O CON	01.73501	610	2,695.82	73721	
MRI0174029	MRI LOWER JOINT W/CON	01.73501	610	2,864.12	73722	
MRI0174031	MRI TMJ	01.73501	610	2,342.94	70336	
MRI0174033	MRA PELVIS W CON	01.73501	610	2,864.12		C8918
MRI0174035	MRA PELVIS W/O CON	01.73501	610	2,695.82		C8919
MRI0174037	MRA PELVIS W/O CON FOLLOW W CO	01.73501	610	3,908.33		C8920
MRI0174039	MRI NEEDLE LOCALIZATION	01.73501	360	787.53	19290	
MRI0174041	MRI ASPIR FINE NDL W IMAGE GUI	01.73501	360	1,003.29	10022	
MRI0174043	MRI-ABDOMEN WITH & W/O CONTRAS	01.73501	610	3,908.33	74183	
MRI0174045	MRI-UPPER EXTREMITY W/WO CONTR	01.73501	610	3,908.33	73220	
MRI0174047	MRA-UPPER EXTREMITY W OR W/O C	01.73501	610	2,654.61	73225	
MRI0174049	MRI-UPPER JOINT WITH & W/O CON	01.73501	610	3,908.33	73223	
MRI0174051	MRI-LOWER JOINT W/WO CONTRAST	01.73501	610	3,908.33	73723	
MRI0174053	MRI-ABDOMEN WITH CONTRAST	01.73501	610	2,864.12	74182	
MRI0174055	MRI-LOWER EXTREMITY WITH CONTR	01.73501	610	2,864.12	73719	
MRI0174057	MRI-LOWER EXTREMITY WITH W/O C	01.73501	610	3,908.33	73720	
MRI0174059	MRI-ORBIT, FACE, NECK WITH & W	01.73501	610	3,908.33	70543	
MRI0174061	MRI - PELVIS WITH CONTRAST	01.73501	610	2,864.12	72196	
MRI0174063	MRI-PELVIS WITH & W/O CONTRAST	01.73501	610	3,908.33	72197	
MRI0174065	MRI-CHEST WITH & W/O CONTRAST	01.73501	610	3,908.33	71552	
MRI0174067	MRI-CHEST WITH CONTRAST	01.73501	610	2,695.82	71550	
MRI0174069	MRI - RECONSTRUCTION	01.73501	610	281.93	76376	
MRI0174070	MRI - 3-D RECONSTRUCT SEP W.S.	01.73501	610	694.50	76377	
MRI0174071	MRI - SPECTROSCOPY	01.73501	610	690.25	76390	

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI0174073	MRA-SPINAL CANAL/CONTENTS,W/O	01.73501	618	1,344.75	72159	
MRI0174075	MRI-THORACIC SPINE WITH CONTRA	01.73501	612	2,864.12	72147	
MRI0174077	MRI-SPINE WITH CONTRAST	01.73501	612	2,864.12	72142	
MRI0174079	MRI-BRAIN WITH CONTRAST	01.73501	611	2,864.12	70552	
MRI0174081	MRA-NECK WITH & W/O CONTRAST	01.73501	610	3,908.33	70549	
MRI0174083	MRA - NECK WITH CONTRAST	01.73501	610	2,864.12	70548	
MRI0174085	MRA-NECK WITHOUT CONTRAST	01.73501	610	2,695.82	70547	
MRI0174087	MRA-HEAD WITH & W/O CONTRAST	01.73501	610	3,908.33	70546	
MRI0174089	MRA-HEAD WITH CONTRAST	01.73501	610	2,864.12	70545	
MRI0174091	MRA-HEAD WITHOUT CONTRAST	01.73501	610	2,695.82	70544	
MRI0174093	MRI-UPPER JOINT WITH CONTRAST	01.73501	610	2,864.12	73222	
MRI0174095	MRI-UPPER EXTREMITY WITH CONTR	01.73501	610	2,864.12	73219	
MRI0174097	MRI-ORBIT,FACE,NECK WITH CONTR	01.73501	610	2,864.12	70542	
MRI0174103	MRI LUMBAR SPINE WO&W CON	01.73501	612	3,908.33	72158	
MRI0174105	MRI THORACIC SPINE WO&W CON	01.73501	612	3,908.33	72157	
MRI0174107	MRI CERVICAL SPINE WO&W CON	01.73501	612	3,908.33	72156	
MRI0174109	MRI BRAIN WO&W CON	01.73501	611	3,908.33	70553	
MRI0174111	MRI NEEDLE PLACEMENT GUIDANCE	01.73501	320	2,342.94	76393	
MRI0174113	MRA W/CONT, ABD	01.73501	610	2,864.12		C8900
MRI0174115	MRA W/O CONT, ABD	01.73501	610	2,695.82		C8901
MRI0174117	MRA W/O FOL W/CONT, ABD	01.73501	610	3,908.33		C8902
MRI0174119	MRI W/CONT, BREAST, UNI	01.73501	610	2,864.12	76093	
MRI0174121	MRI W/O CONT, BREAST, UNI	01.73501	610	2,695.82	76093	
MRI0174123	MRI W/O FOL W/CONT, BRST, UNI	01.73501	610	3,908.33	76093	
MRI0174125	MRI W/CONT, BREAST, BI	01.73501	610	2,864.12	76094	
MRI0174127	MRI W/O CONT, BREAST, BI	01.73501	610	2,695.82	76094	
MRI0174129	MRI W/O FOL W/CONT, BREAST, BI	01.73501	610	3,908.33	76094	
MRI0174131	MRA W/CONT, CHEST	01.73501	610	2,864.12		C8909
MRI0174133	MRA W/O CONT, CHEST	01.73501	610	2,695.82		C8910
MRI0174135	MRA W/O FOL W/CONT, CHEST	01.73501	610	3,908.33		C8911
MRI0174137	MRA W/CONT, LWR EXT	01.73501	610	2,864.12		C8912
MRI0174139	MRA W/O CONT, LWR EXT	01.73501	610	2,695.82		C8913
MRI0174141	MRA W/O FOL W/CONT, LWR EXT	01.73501	610	3,908.33		C8914
MRI0174143	MRI BREAST NEEDLE CORE	01.73501	610	1,646.29	19102	
MRI0174145	MRI BREAST- ROTATING BIOPSY OF	01.73501	360	2,751.41	19103	
MRI0174147	MRI* NEEDLE 9G TITAN ROTATE MR	01.73501	270	939.25		
MRI0174149	MRI* NEEDLE 20G X 5CM MRI LOC	01.73501	270	129.82		

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI0174151	MRI* NEEDLE 20G X 7.5CM MRI LO	01.73501	270	129.82		
MRI0174153	MRI* NEEDLE 20G X 10CM MRI LOC	01.73501	270	129.82		
MRI0174155	MRI* MARKER CLIP 9G MR & US CO	01.73501	270	296.96		
MRI0174157	MRI* MARKER CLIP 12G MR & US C	01.73501	270	296.96		
MRI0174159	MRI MARKER CLIP IMAGE GUIDE PL	01.73501	610	739.34	19295	
MRI0174161	MRI PUNCTURE ASPIR BREAST CYST	01.73501	360	816.47	19000	
MRI0174163	MRI BREAST NDL LOC EA ADD LESI	01.73501	360	519.66	19291	
MRI0174165	MRI BREAST ADDITIONAL CYST	01.73501	360	816.47	19001	
MRI0174170	MRICB BRAIN/HEAD/NECK W/O CON	01.73501	611	-		
MRI0174172	MRICB BRAIN/HEAD/NECK W CON	01.73501	611	-		
MRI0174174	MRICB BRAIN/HEAD/NECK W & W/O	01.73501	611	-		
MRI0174176	MRACB ABD/PEL/EXT2 W/O CON	01.73501	610	-		
MRI0174178	MRACB ABD/PEL/EXT2 W CON	01.73501	610	-		
MRI0174180	MRACB ABD/PEL/EXT2 W & W/O CON	01.73501	610	-		
MRI0174182	MRICB BRAIN WO&W/MRA HD/NK W/O	01.73501	611	-		
MRI0174184	MRICB SPINE SURVEY	01.73501	612	-		
MRI0174186	MRICB BRST BILT WO FOL W RECON	01.73501	610	-		
MRI0374001	MRI BRAIN W/O CONTRAST	01.73503	611	2,695.82	70551	
MRI0374003	MRI CERVICAL SPINE W/O CONTRAS	01.73503	612	2,695.82	72141	
MRI0374005	MRI THORACIC SPINE W/O CON	01.73503	612	2,695.82	72146	
MRI0374007	MRI LUMBAR SPINE W/O CON	01.73503	612	2,695.82	72148	
MRI0374009	MRI UPPER EXTREMITY W/O CON	01.73503	610	2,695.82	73218	
MRI0374013	MRI LUMBAR SPINE W CON	01.73503	610	2,864.12	72149	
MRI0374015	MRI PELVIS W/O CONTRAST	01.73503	610	2,695.82	72195	
MRI0374017	MRI ABDOMEN W/O CON	01.73503	610	2,695.82	74181	
MRI0374019	MRI LOWER EXTREMITY W/O CON	01.73503	610	2,695.82	73718	
MRI0374021	MRI CHEST W/0 CON	01.73503	610	2,695.82	71550	
MRI0374023	MRI ORBITS FACE/NECK W/O CON	01.73503	610	2,695.82	70540	
MRI0374025	MRI UPPER JOINT W/O CON	01.73503	610	2,695.82	73221	
MRI0374027	MRI LOWER JOINT W/O CON	01.73503	610	2,695.82	73721	
MRI0374029	MRI LOWER JOINT W/CON	01.73503	610	2,864.12	73722	
MRI0374031	MRI TMJ	01.73503	610	2,342.94	70336	
MRI0374033	MRA PELVIS W CON	01.73503	610	2,864.12		C8918
MRI0374035	MRA PELVIS W/O CON	01.73503	610	2,695.82		C8919
MRI0374037	MRA PELVIS W/O CON FOLLOW W CO	01.73503	610	3,908.33		C8920
MRI0374039	MRI NEEDLE LOCALIZATION	01.73503	360	787.53	19290	
MRI0374041	MRI ASPIR FINE NDL W IMAGE GUI	01.73503	360	1,003.29	10022	

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI0374043	MRI-ABDOMEN WITH & W/O CONTRAS	01.73503	610	3,908.33	74183	
MRI0374045	MRI-UPPER EXTREMITY W/WO CONTR	01.73503	610	3,908.33	73220	
MRI0374047	MRA-UPPER EXTREMITY W OR W/O C	01.73503	610	2,654.61	73225	
MRI0374049	MRI-UPPER JOINT WITH & W/O CON	01.73503	610	3,908.33	73223	
MRI0374051	MRI-LOWER JOINT W/WO CONTRAST	01.73503	610	3,908.33	73723	
MRI0374053	MRI-ABDOMEN WITH CONTRAST	01.73503	610	2,864.12	74182	
MRI0374055	MRI-LOWER EXTREMITY WITH CONTR	01.73503	610	2,864.12	73719	
MRI0374057	MRI-LOWER EXTREMITY WITH W/O C	01.73503	610	3,908.33	73720	
MRI0374059	MRI-ORBIT, FACE, NECK WITH & W	01.73503	610	3,908.33	70543	
MRI0374061	MRI - PELVIS WITH CONTRAST	01.73503	610	2,864.12	72196	
MRI0374063	MRI-PELVIS WITH & W/O CONTRAST	01.73503	610	3,908.33	72197	
MRI0374065	MRI-CHEST WITH & W/O CONTRAST	01.73503	610	3,908.33	71552	
MRI0374067	MRI-CHEST WITH CONTRAST	01.73503	610	2,695.82	71550	
MRI0374069	MRI - RECONSTRUCTION	01.73503	610	281.93	76376	
MRI0374070	MRI - 3-D RECONSTRUCT SEP W.S.	01.73503	610	694.50	76377	
MRI0374071	MRI - SPECTROSCOPY	01.73503	610	690.25	76390	
MRI0374073	MRA-SPINAL CANAL/CONTENTS,W/O	01.73503	618	1,344.75	72159	
MRI0374075	MRI-THORACIC SPINE WITH CONTRA	01.73503	612	2,864.12	72147	
MRI0374077	MRI-SPINE WITH CONTRAST	01.73503	612	2,864.12	72142	
MRI0374079	MRI-BRAIN WITH CONTRAST	01.73503	611	2,864.12	70552	
MRI0374081	MRA-NECK WITH & W/O CONTRAST	01.73503	610	3,908.33	70549	
MRI0374083	MRA - NECK WITH CONTRAST	01.73503	610	2,864.12	70548	
MRI0374085	MRA - NECK WITHOUT CONTRAST	01.73503	610	2,695.82	70547	
MRI0374087	MRA-HEAD WITH & W/O CONTRAST	01.73503	610	3,908.33	70546	
MRI0374089	MRA-HEAD WITH CONTRAST	01.73503	610	2,864.12	70545	
MRI0374091	MRA-HEAD WITHOUT CONTRAST	01.73503	610	2,695.82	70544	
MRI0374093	MRI-UPPER JOINT WITH CONTRAST	01.73503	610	2,864.12	73222	
MRI0374095	MRI-UPPER EXTREMITY WITH CONTR	01.73503	610	2,864.12	73219	
MRI0374097	MRI-ORBIT,FACE,NECK WITH CONTR	01.73503	610	2,864.12	70542	
MRI0374103	MRI LUMBAR SPINE WO&W CON	01.73503	612	3,908.33	72158	
MRI0374105	MRI THORACIC SPINE WO&W CON	01.73503	612	3,908.33	72157	
MRI0374107	MRI CERVICAL SPINE WO&W CON	01.73503	612	3,908.33	72156	
MRI0374109	MRI BRAIN WO&W CON	01.73503	611	3,908.33	70553	
MRI0374111	MRI NEEDLE PLACEMENT GUIDANCE	01.73503	320	2,342.94	76393	
MRI0374113	MRA W/CONT, ABD	01.73503	610	2,864.12		C8900
MRI0374115	MRA W/O CONT, ABD	01.73503	610	2,695.82		C8901
MRI0374117	MRA W/O FOL W/CONT, ABD	01.73503	610	3,908.33		C8902

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI0374119	MRI W/CONT, BREAST, UNI	01.73503	610	2,864.12	76093	
MRI0374121	MRI W/O CONT, BREAST, UNI	01.73503	610	2,695.82	76093	
MRI0374123	MRI W/O FOL W/CONT, BRST, UNI	01.73503	610	3,908.33	76093	
MRI0374125	MRI W/CONT, BREAST, BI	01.73503	610	2,864.12	76094	
MRI0374127	MRI W/O CONT, BREAST, BI	01.73503	610	2,695.82	76094	
MRI0374129	MRI W/O FOL W/CONT, BREAST, BI	01.73503	610	3,908.33	76094	
MRI0374131	MRA W/CONT, CHEST	01.73503	610	2,864.12		C8909
MRI0374133	MRA W/O CONT, CHEST	01.73503	610	2,695.82		C8910
MRI0374135	MRA W/O FOL W/CONT, CHEST	01.73503	610	3,908.33		C8911
MRI0374137	MRA W/CONT, LWR EXT	01.73503	610	2,864.12		C8912
MRI0374139	MRA W/O CONT, LWR EXT	01.73503	610	2,695.82		C8913
MRI0374141	MRA W/O FOL W/CONT, LWR EXT	01.73503	610	3,908.33		C8914
MRI0374143	MRI BREAST NEEDLE CORE	01.73503	610	1,646.29	19102	
MRI0374145	MRI BREAST- ROTATING BIOPSY OF	01.73503	360	2,751.41	19103	
MRI0374147	MRI* NEEDLE 9G TITAN ROTATE MR	01.73503	270	939.25		
MRI0374149	MRI* NEEDLE 20G X 5CM MRI LOC	01.73503	270	129.82		
MRI0374151	MRI* NEEDLE 20G X 7.5CM MRI LO	01.73503	270	129.82		
MRI0374153	MRI* NEEDLE 20G X 10CM MRI LOC	01.73503	270	129.82		
MRI0374155	MRI* MARKER CLIP 9G MR & US CO	01.73503	270	296.96		
MRI0374157	MRI* MARKER CLIP 12G MR & US C	01.73503	270	296.96		
MRI0374159	MRI MARKER CLIP IMAGE GUIDE PL	01.73503	610	739.34	19295	
MRI0374161	MRI PUNCTURE ASPIR BREAST CYST	01.73503	360	816.47	19000	
MRI0374163	MRI BREAST NDL LOC EA ADD LESI	01.73503	360	519.66	19291	
MRI0374165	MRI BREAST ADDITIONAL CYST	01.73503	360	816.47	19001	
MRI0374170	MRICB BRAIN/HEAD/NECK W/O CON	01.73503	611	-		
MRI0374172	MRICB BRAIN/HEAD/NECK W CON	01.73503	611	-		
MRI0374174	MRICB BRAIN/HEAD/NECK W & W/O	01.73503	611	-		
MRI0374176	MRACB ABD/PEL/EXT2 W/O CON	01.73503	610	-		
MRI0374178	MRACB ABD/PEL/EXT2 W CON	01.73503	610	-		
MRI0374180	MRACB ABD/PEL/EXT2 W & W/O CON	01.73503	610	-		
MRI0374182	MRICB BRAIN WO&W/MRA HD/NK W/O	01.73503	611	-		
MRI0374184	MRICB SPINE SURVEY	01.73503	612	-		
MRI0374186	MRICB BRST BILT WO FOL W RECON	01.73503	610	-		
MRI0774001	MRI BRAIN W/O CONTRAST	01.73507	611	2,695.82	70551	
MRI0774003	MRI CERVICAL SPINE W/O CONTRAS	01.73507	612	2,695.82	72141	
MRI0774005	MRI THORACIC SPINE W/O CON	01.73507	612	2,695.82	72146	
MRI0774007	MRI LUMBAR SPINE W/O CON	01.73507	612	2,695.82	72148	

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI0774009	MRI UPPER EXTREMITY W/O CON	01.73507	610	2,695.82	73218	
MRI0774013	MRI LUMBAR SPINE W CON	01.73507	610	2,864.12	72149	
MRI0774015	MRI PELVIS W/O CONTRAST	01.73507	610	2,695.82	72195	
MRI0774017	MRI ABDOMEN W/O CON	01.73507	610	2,695.82	74181	
MRI0774019	MRI LOWER EXTREMITY W/O CON	01.73507	610	2,695.82	73718	
MRI0774021	MRI CHEST W/0 CON	01.73507	610	2,695.82	71550	
MRI0774023	MRI ORBITS FACE/NECK W/O CON	01.73507	610	2,695.82	70540	
MRI0774025	MRI UPPER JOINT W/O CON	01.73507	610	2,695.82	73221	
MRI0774027	MRI LOWER JOINT W/O CON	01.73507	610	2,695.82	73721	
MRI0774029	MRI LOWER JOINT W/CON	01.73507	610	2,864.12	73722	
MRI0774031	MRI TMJ	01.73507	610	2,342.94	70336	
MRI0774033	MRA PELVIS W CON	01.73507	610	2,864.12		C8918
MRI0774035	MRA PELVIS W/O CON	01.73507	610	2,695.82		C8919
MRI0774037	MRA PELVIS W/O CON FOLLOW W CO	01.73507	610	3,908.33		C8920
MRI0774039	MRI NEEDLE LOCALIZATION	01.73507	360	787.53	19290	
MRI0774041	MRI ASPIR FINE NDL W IMAGE GUI	01.73507	360	1,003.29	10022	
MRI0774043	MRI-ABDOMEN WITH & W/O CONTRAS	01.73507	610	3,908.33	74183	
MRI0774045	MRI-UPPER EXTREMITY W/WO CONTR	01.73507	610	3,908.33	73220	
MRI0774047	MRA-UPPER EXTREMITY W OR W/O C	01.73507	610	2,654.61	73225	
MRI0774049	MRI-UPPER JOINT WITH & W/O CON	01.73507	610	3,908.33	73223	
MRI0774051	MRI-LOWER JOINT W/WO CONTRAST	01.73507	610	3,908.33	73723	
MRI0774053	MRI-ABDOMEN WITH CONTRAST	01.73507	610	2,864.12	74182	
MRI0774055	MRI-LOWER EXTREMITY WITH CONTR	01.73507	610	2,864.12	73719	
MRI0774057	MRI-LOWER EXTREMITY WITH W/O C	01.73507	610	3,908.33	73720	
MRI0774059	MRI-ORBIT, FACE, NECK WITH & W	01.73507	610	3,908.33	70543	
MRI0774061	MRI - PELVIS WITH CONTRAST	01.73507	610	2,864.12	72196	
MRI0774063	MRI-PELVIS WITH & W/O CONTRAST	01.73507	610	3,908.33	72197	
MRI0774065	MRI-CHEST WITH & W/O CONTRAST	01.73507	610	3,908.33	71552	
MRI0774067	MRI-CHEST WITH CONTRAST	01.73507	610	2,695.82	71550	
MRI0774069	MRI - RECONSTRUCTION	01.73507	610	281.93	76376	
MRI0774070	MRI - 3-D RECONSTRUCT SEP W.S.	01.73507	610	694.50	76377	
MRI0774071	MRI - SPECTROSCOPY	01.73507	610	690.25	76390	
MRI0774073	MRA-SPINAL CANAL/CONTENTS,W/O	01.73507	618	1,344.75	72159	
MRI0774075	MRI-THORACIC SPINE WITH CONTRA	01.73507	612	2,864.12	72147	
MRI0774077	MRI-SPINE WITH CONTRAST	01.73507	612	2,864.12	72142	
MRI0774079	MRI-BRAIN WITH CONTRAST	01.73507	611	2,864.12	70552	
MRI0774081	MRA-NECK WITH & W/O CONTRAST	01.73507	610	3,908.33	70549	

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI0774083	MRA - NECK WITH CONTRAST	01.73507	610	2,864.12	70548	
MRI0774085	MRA - NECK WITHOUT CONTRAST	01.73507	610	2,695.82	70547	
MRI0774087	MRA-HEAD WITH & W/O CONTRAST	01.73507	610	3,908.33	70546	
MRI0774089	MRA-HEAD WITH CONTRAST	01.73507	610	2,864.12	70545	
MRI0774091	MRA-HEAD WITHOUT CONTRAST	01.73507	610	2,695.82	70544	
MRI0774093	MRI-UPPER JOINT WITH CONTRAST	01.73507	610	2,864.12	73222	
MRI0774095	MRI-UPPER EXTREMITY WITH CONTR	01.73507	610	2,864.12	73219	
MRI0774097	MRI-ORBIT,FACE,NECK WITH CONTR	01.73507	610	2,864.12	70542	
MRI0774103	MRI LUMBAR SPINE WO&W CON	01.73507	612	3,908.33	72158	
MRI0774105	MRI THORACIC SPINE WO&W CON	01.73507	612	3,908.33	72157	
MRI0774107	MRI CERVICAL SPINE WO&W CON	01.73507	612	3,908.33	72156	
MRI0774109	MRI BRAIN WO&W CON	01.73507	611	3,908.33	70553	
MRI0774111	MRI NEEDLE PLACEMENT GUIDANCE	01.73507	320	2,342.94	76393	
MRI0774113	MRA W/CONT, ABD	01.73507	610	2,864.12		C8900
MRI0774115	MRA W/O CONT, ABD	01.73507	610	2,695.82		C8901
MRI0774117	MRA W/O FOL W/CONT, ABD	01.73507	610	3,908.33		C8902
MRI0774119	MRI W/CONT, BREAST, UNI	01.73507	610	2,864.12	76093	
MRI0774121	MRI W/O CONT, BREAST, UNI	01.73507	610	2,695.82	76093	
MRI0774123	MRI W/O FOL W/CONT, BRST, UNI	01.73507	610	3,908.33	76093	
MRI0774125	MRI W/CONT, BREAST, BI	01.73507	610	2,864.12	76094	
MRI0774127	MRI W/O CONT, BREAST, BI	01.73507	610	2,695.82	76094	
MRI0774129	MRI W/O FOL W/CONT, BREAST, BI	01.73507	610	3,908.33	76094	
MRI0774131	MRA W/CONT, CHEST	01.73507	610	2,864.12		C8909
MRI0774133	MRA W/O CONT, CHEST	01.73507	610	2,695.82		C8910
MRI0774135	MRA W/O FOL W/CONT, CHEST	01.73507	610	3,908.33		C8911
MRI0774137	MRA W/CONT, LWR EXT	01.73507	610	2,864.12		C8912
MRI0774139	MRA W/O CONT, LWR EXT	01.73507	610	2,695.82		C8913
MRI0774141	MRA W/O FOL W/CONT, LWR EXT	01.73507	610	3,908.33		C8914
MRI0774143	MRI BREAST NEEDLE CORE	01.73507	610	1,646.29	19102	
MRI0774145	MRI BREAST- ROTATING BIOPSY OF	01.73507	360	2,751.41	19103	
MRI0774147	MRI* NEEDLE 9G TITAN ROTATE MR	01.73507	270	939.25		
MRI0774149	MRI* NEEDLE 20G X 5CM MRI LOC	01.73507	270	129.82		
MRI0774151	MRI* NEEDLE 20G X 7.5CM MRI LO	01.73507	270	129.82		
MRI0774153	MRI* NEEDLE 20G X 10CM MRI LOC	01.73507	270	129.82		
MRI0774155	MRI* MARKER CLIP 9G MR & US CO	01.73507	270	296.96		
MRI0774157	MRI* MARKER CLIP 12G MR & US C	01.73507	270	296.96		
MRI0774159	MRI MARKER CLIP IMAGE GUIDE PL	01.73507	610	739.34	19295	

MNEMONIC	DESC.	GL#	CAT.	CUR PRICE	CPT-4 CODE	HCPCS CODE
MRI0774161	MRI PUNCTURE ASPIR BREAST CYST	01.73507	360	816.47	19000	
MRI0774163	MRI BREAST NDL LOC EA ADD LESI	01.73507	360	519.66	19291	
MRI0774165	MRI BREAST ADDITIONAL CYST	01.73507	360	816.47	19001	
MRI0774170	MRICB BRAIN/HEAD/NECK W/O CON	01.73507	611	-		
MRI0774172	MRICB BRAIN/HEAD/NECK W CON	01.73507	611	-		
MRI0774174	MRICB BRAIN/HEAD/NECK W & W/O	01.73507	611	-		
MRI0774176	MRACB ABD/PEL/EXT2 W/O CON	01.73507	610	-		
MRI0774178	MRACB ABD/PEL/EXT2 W CON	01.73507	610	-		
MRI0774180	MRACB ABD/PEL/EXT2 W & W/O CON	01.73507	610	-		
MRI0774182	MRICB BRAIN WO&W/MRA HD/NK W/O	01.73507	611	-		
MRI0774184	MRICB SPINE SURVEY	01.73507	612	-		
MRI0774186	MRICB BRST BILT WO FOL W RECON	01.73507	610	-		
unassigned	MRI CARDIAC MORPHOLOGY W/O CONTRAST	1.73501	610	3,541.25		
unassigned	MRI CARDIAC MORPHOLOGY WITH CONTRAST	1.73501	610	3,821.22		
unassigned	MRICARDIAC FUNCTION W/O OR WITH CONTRAST: COMPLETE	1.73501	610	3,541.25		
unassigned	MRI CARDIAC FUNCTION W/O OR WITH CONTRAST: LIMITED	1.73501	610	3,541.25		