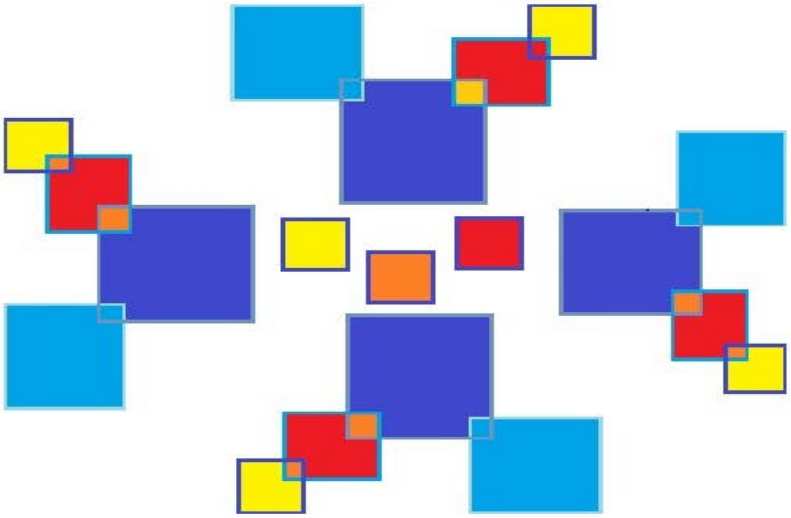
2014

Evaluating Connecticut's Health Information Technology Exchange

Physician Survey Report



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Connecticut Department of Public Health

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Executive Summary

In 2010, the Connecticut Department of Public Health (DPH) entered into a Cooperative Agreement with the Office of National Coordinator for Health Information Technology (ONC), to create and implement a State Health Information Exchange (HIE). DPH received an award of $7.3 million to initiate and sustain HIE activities in the state of Connecticut.[1,2] The Health Information Technology Exchange of Connecticut (HITE-CT), a quasi-public agency, was created by Public Act 10-117, "*An Act Concerning Revisions to Public Health Related Statutes and the Establishment of the Health Information Technology Exchange of Connecticut,*" Sec. 82-90,96 (codified at CGS §19a-750(c)(1)), by the 2010 Connecticut General Assembly and Governor Rell. HITE-CT received $4.3 million over the course of three years to create and implement an HIE infrastructure and facilitate exchange activities in the state. Additionally, DPH contracted with the University of Connecticut Health Center (UCHC) to evaluate the ongoing development and implementation of Connecticut's Health Information Exchange (CT-HIE).

This report summarizes the results of 1,346 responses (880 from the 2011 survey and 466 from the 2013 survey) representing 1,082 unique physicians. Six hundred sixteen physicians completed a survey during the first distribution only (2011 Cohort 1), 202 physicians completed a survey during the second distribution only (2013 Cohort 2), and 264 physicians completed surveys at both points (2011 Baseline and 2013 Follow-Up). The goal of the physician survey was to measure the rate of EHR adoption, extent of interoperability, and assess the knowledge and attitudes of physicians toward the creation of a Heath Information Exchange. These surveys provide valuable insight into what the physicians in Connecticut think about Connecticut's efforts in the HIT and HIE space, inform us about the level of EHR adoption, and report on the challenges associated with implementing HIT solutions.

Even though Connecticut did not have an operational statewide Health Information Exchange (CT-HIE) as of March 14, 2014, this report does demonstrate that physicians are increasingly adopting EHRs and participating in the EHR incentive program. The current rate of EHR adoption is between 53-62%, which is lower than the national average of 78%.

Key Findings

Physician Characteristics

- 2 out of 3 physicians were male.
- Age ranged from 29 to 88 with an average age in the mid-fifties.
- 8 out of 10 physicians were white and 9 out of 10 were non-Hispanic/Latino.
- Years of practicing medicine ranged from 1 to 56 years with a mean of over 20 years.
- 1 in 2 physicians reported they had "a lot" of computer experience.

Practice Characteristics

- Almost 6 out of 10 physicians were certified in a primary care specialty.
- 1 in 2 physicians reported working at a single practice site and 40-50% of physicians were from small (up to 3 physicians) practices.
- 7 out of 10 physicians saw the majority of their patients in an outpatient primary care setting and 1 in 2 characterized their practice as a single specialty group or partnership.

- 95% of physicians who participated in this survey were not affiliated with the Veteran's Administration health care system.
- 9 out of 10 physicians saw more than half of their patients at their main practice site. Around 50-60% of physicians reported up to 100 patient visits at their main practice site during the past week.
- A third or more of physicians received more than half of their patient revenues from private insurance payments.

Technology Infrastructure

- Most physicians reported some form of high-speed Internet access, with cable or digital subscriber line (DSL) being the most prevalent type of service.
- Fewer than 1 in 5 physicians said they needed additional Internet access at any of their practice sites.

Computerized Systems Use

- The majority of physicians reported their practice used at least some electronic billing, with the proportion of practices using electronic billing exclusively increasing significantly over time from 2011 to 2013.
- In 2011, 41% of the Cohort 1 physicians used EHR systems compared with 59% of the 2013 Cohort 2 physicians.
- 8 out of 10 physicians had a computerized system that gathered patient demographics. The proportion of physicians with computerized systems which gathered other patient health information (e.g., record lists of patients' health problems and medications, record clinical notes) increased significantly between 2011 and 2013 for both sub-samples.
- In terms of order entry management (e.g., ordering prescriptions, lab, or radiology tests), there was a similar pattern of significant increases in prevalence between 2011 and 2013 for both sub-samples.
    - By 2013, 83-87% of physicians whose computerized systems allowed them to order prescriptions said their systems provided warnings of drug interactions or contraindications.
    - Over 85% said they used their systems to order prescriptions electronically.
    - At least 7 out of 10 physicians reported they had computerized systems that allowed them to view lab results and around half were able to use their systems to view imaging results. More than half of physicians said electronic images were returned to their systems.
- Relatively few physicians have computerized systems that enable public health reporting, although the proportions increased significantly in both sub-samples: from 6-7% in 2011 to 10-11% in 2013.
- Support for creating or receiving documents related to continuity of care was also relatively uncommon (6-26%), but tended to increase from 2011 to 2013.
- Computerized systems that generated reminders for guideline-based interventions and screenings increased significantly from around 25% in 2011 to 33-41% in 2013.
- Over a third of physicians reported that their computerized systems were capable of providing patients with electronic copies of health information and clinical summaries of visits.

- The proportion of physicians who reported using each clinical function of their computerized system "most or all of the time" increased over time. For the 2011 baseline and 2013 follow-up samples, the prevalence of five clinical functions increased by 10 or more percentage points: medication lists (37% to 51%), record clinical notes (39% to 50%), order radiology tests (20% to 31%), and patient problem lists (35% to 45%).

Acquisition and implementation of EHR systems

- In the 2011 survey, 38-40% of physicians said their practice had fully implemented an EHR system compared with (53-62%) in 2013.
- Of those physicians whose practices had acquired or were in the process of implementing their EHR system, around one half expected to have completed their implementation within the next 12 months.
- Between 20-30% of physicians whose practices were in the process of implementing or had fully implemented their EHR system said they had been using the system for more than five years.
- During 2013, 57.2% of physicians reported their main practice site had fully-implemented EHR systems and 13.3% were in the process of implementing an EHR.
- Allscripts was the most commonly used system in both 2011 and 2013.

Factors Associated with EHR Adoption

- In 2011, the odds of EHR adoption were higher among physicians who reported they had "a lot" of computer experience, and those who worked in larger practice groups.
- In 2013, the odds of EHR adoption were higher among primary care (versus specialty care) physicians and those who worked in larger practice groups.

Effects of EHRs on Clinical Practice

- Between 36% to 52% of physicians felt that their EHR system had a positive effect and 38-51% of physicians felt that their EHR system had no effect on the quality of clinical decisions.
- 8 in 10 physicians said that their EHR system had a positive effect on timely access to medical records.
- More than half of physicians said their EHR system had a positive effect on preventing medication errors. Notably, few physicians felt their EHRs had a negative effect on quality of care.
- Between 64-74% of physicians reported that their EHR system had a positive effect on prescription refills.
- EHR systems appeared to have limited effects on the delivery of preventive and chronic disease care meeting practice guidelines.
- Relatively few physicians felt their EHR had a negative effect on the delivery of care.
- The majority of physicians indicated that their EHR system had improved communication with other providers. But 4 in 10 physicians said their EHR system had no effect on their communication with patients.
- More than half of physicians whose practices had fully-implemented EHR systems were satisfied their systems.

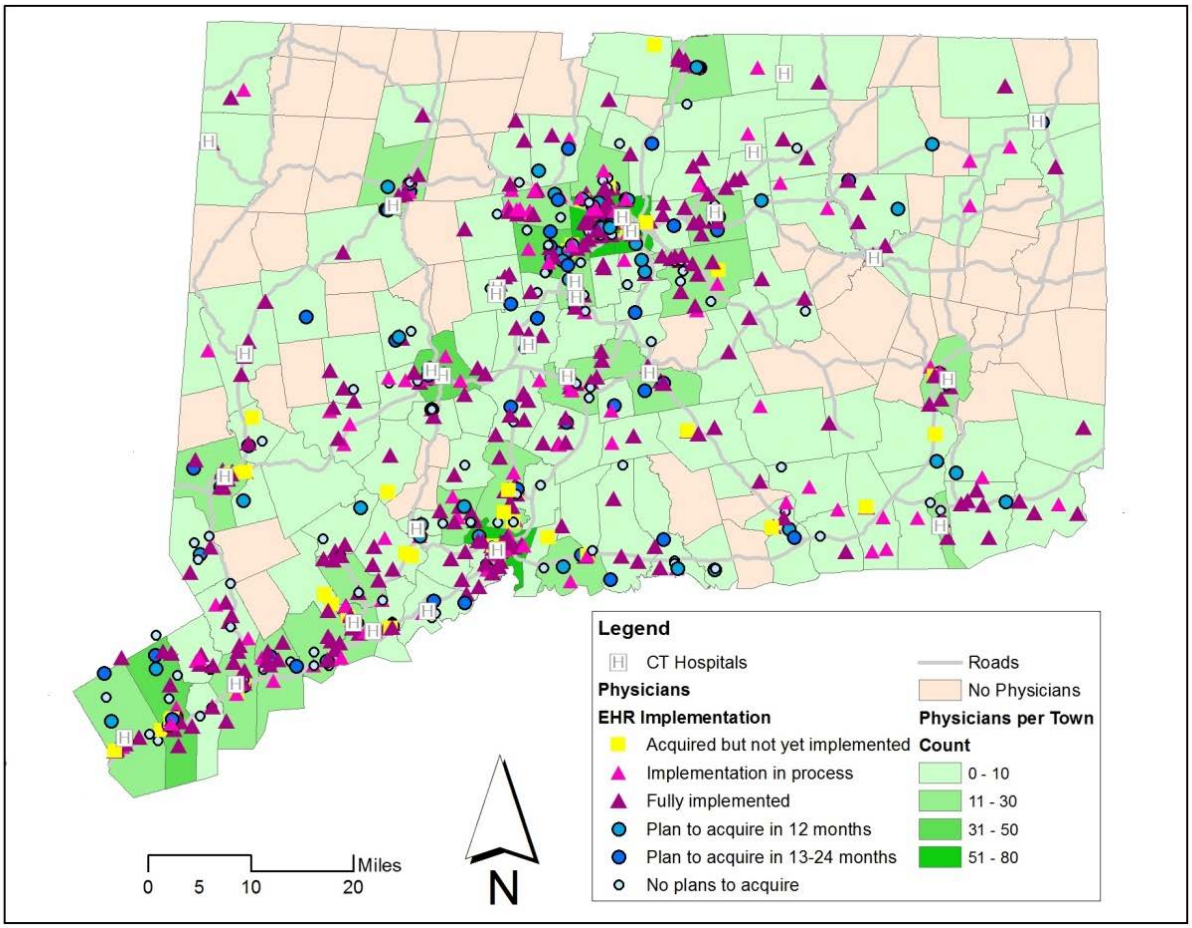
Certification standards and Centers for Medicare and Medicaid Incentive Programs

- 3 in 10 physicians said that their EHR was integrated with a hospital system.
- 8 in 10 physicians said their system met federal certification standards.
- Over a third of physicians did not know if they qualified for the Centers for Medicare and Medicaid EHR incentive programs.
- Incentives for adoption of EHRs
    - Around half of physicians said that incentives and additional payments would have a major positive effect on the decision to adopt an EHR system.
    - Around 40% of physicians felt that legal protection from personal liability in the event of privacy and security breaches would have a major positive effect on EHR adoption decisions.
    - More than half of physicians felt that certification standards could have a major or minor positive effect on the decision to adopt an EHR.
    - Around 20% of physicians said that the decision to adopt an EHR could be motivated by legal liability arising from not using the latest technology.
- Barriers to adoption of EHRs
    - EHR-related costs were seen as a significant barrier by the majority of physicians.
    - Around half of physicians cited uncertainty about the return on their investment in an EHR as a major barrier to adoption.
    - Concern about having the capacity to undertake all phases of EHR implementation (i.e., to select, contract, install, and implement an EHR system) was mentioned by 37-47% of physicians.
    - Between 30% and 37% of physicians mentioned physician resistance as a major barrier to EHR adoption.
    - Physicians appeared relatively unconcerned about legal barriers to EHR adoption. Between two-thirds and three-quarters of physicians said concerns about inappropriate disclosure of patient information, illegal record tampering, or legal liability resulting from patients' access to medical records were minor barriers or not barriers at all to EHR adoption.
    - 9 in 10 did not think that adoption would be constrained by concerns about the legality of a hospital-donated EHR.
    - Finding an EHR system that meets providers' needs was mentioned as a barrier by more than half of physicians. Between 41-46% of physicians expressed concerns that the EHR system would become obsolete.

Health Information Exchange and PHRs

- 60-64% of physicians were not familiar with the Connecticut Health Information Exchange (CT-HIE).
- 3 out of 4 physicians had not heard of Connecticut's Regional Extension Center (REC) (eHealthConnecticut) and the majority (63-73%) had not used REC services.
- The majority of physicians' write-in comments echoed the lack of awareness of the CT-HIE. Other comments suggested physicians were interested in learning more about the CT-HIE or looking forward to using it when it is established.
- Support for adoption of patient personal health records (PHRs) was divided, with 40% of physicians expressing support and 30-40% saying they did not know if they supported PHRs. Physicians offered a variety of reasons for supporting PHRs related to improvements in health care quality, safety, efficiency, and patient empowerment. Reasons given for lack of support for PHRs included concerns about privacy and security, lack of interest or technology skills, perceived lack of benefit to patients, and cost (both in terms of time and money).

Locations of physicians by EHR adoption



Introduction

Background

More than a decade ago, the Institute of Medicine (IOM) published two reports describing the United States' lack of quality health care and the alarming proportions of patient morbidity and mortality attributable to medical errors.[3] Within these reports, the IOM made specific recommendations for improving the quality of health care, proposing strategies for advancing the health care system by focusing on the six aims of quality health care: safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity.[3] The IOM report also identified seven challenges related to the achievement of good quality health care: re-engineered care processes, effective use of information technologies, knowledge and skills management, development of effective teams, coordination of care across patient-conditions and service sites over time, and making change possible.

Effective use of health information technologies (HITs) in medicine should play a critical role in achieving better and cost-effective care. HIT can provide an infrastructure to measure indicators that allow us to determine when we have reached our goal of "quality healthcare for all." For improved measurement we need better data in digital form. To this end, there has been an increase in the number of health providers collecting health data electronically in the past two decades; the goal has been to replace paper-based processes with electronic ones. This switch to electronic data storage and processing has resulted from advances in security, falling hardware prices, and exponential increases in processing speed and data storage.

In the early stages of HIT, it was assumed that most of the challenges of delivering quality health care would be addressed by implementing electronic health records (EHRs); this assumption over-estimated EHRs' actual impact. Now we know that the mere adoption of HIT solutions will not improve services in the absence of policies focused on improving quality of care.[4] In summary, the EHR should be thought of as a tool to facilitate informed discussions about how new programs can be designed to improve health outcomes and address issues of equity and disparities.

Concurrently, the Healthy People 2000, 2010 and 2020 initiatives have focused on addressing disparities and utilizing HIT to identify the social determinants associated with disparities as well as eliminating disparities and improving health of all groups. One of the proposed goals of Healthy People 2010[5] was that each person should have access to his or her health information by 2012. This goal was not achieved, though substantial progress is being made toward adoption of EHRs at the practitioner level.

Health IT and Quality of Care

According to the 2011 World Bank data, the United States (US) has a population of 311.6 million with a Gross Domestic Product (GDP) of 14.99 trillion US dollars and a life expectancy of 79 years.[6] Health care expenditures constitute 17.9% of the GDP and we were spending $8,608 per capita in 2011. Every year healthcare spending is a larger part of the GDP than the year before.

Concern about people's experience with health care and the related expenses are well documented. Still people continue to experience poor quality of care in the US despite the highest per capita expenditure on the delivery and management of health care. For instance, only one in two people receive recommended care[7] and medical errors are the fifth leading cause of death in the United States.[8] A World Health Organization (WHO) report ranked the US health system 37th in quality of care among 191 countries that were ranked, with France being ranked No. 1.[9]

A majority of US health care consumers are dissatisfied with their levels of access to their physicians and to their medical records; 57% of respondents with Internet access wanted to email their doctors but were unable to, and 75% wanted access to their own medical records but were unable to access them.[10,11] The US, despite spending the most money on a per capita basis, was ranked seventh overall (Figure 1) out of seven countries for patient safety, patient-centeredness, efficiency, and equity in a study comparing it with Australia, Canada, Germany, New Zealand, and the United Kingdom.[12]

Figure 1. Comparing U.S. with six other countries on health quality

Exhibit ES-1. Overall Ranking

Country Rankings
1.00–2.33
2.34–4.66
4.67–7.00

	AUS	CAN	GER	NETH	NZ	UK	US
OVERALL RANKING (2010)	3	6	4	1	5	2	7
Quality Care	4	7	5	2	1	3	6
Effective Care	2	7	6	3	5	1	4
Safe Care	6	5	3	1	4	2	7
Coordinated Care	4	5	7	2	1	3	6
Patient-Centered Care	2	5	3	6	1	7	4
Access	6.5	5	3	1	4	2	6.5
Cost-Related Problem	6	3.5	3.5	2	5	1	7
Timeliness of Care	6	7	2	1	3	4	5
Efficiency	2	6	5	3	4	1	7
Equity	4	5	3	1	6	2	7
Long, Healthy, Productive Lives	1	2	3	4	5	6	7
Health Expenditures/Capita, 2007	$3,357	$3,895	$3,588	$3,837*	$2,454	$2,992	$7,290

Note: * Estimate. Expenditures shown in $US PPP (purchasing power parity).
Source: Calculated by The Commonwealth Fund based on 2007 International Health Policy Survey; 2008 International Health Policy Survey of Sicker Adults; 2009 International Health Policy Survey of Primary Care Physicians; Commonwealth Fund Commission on a High Performance Health System National Scorecard; and Organization for Economic Cooperation and Development, OECD Health Data, 2009 (Paris: OECD, Nov. 2009).

Source: The Commonwealth Fund Report, 2010[12]

EHRs and the Health Information Technology for Economic and Clinical Health Act

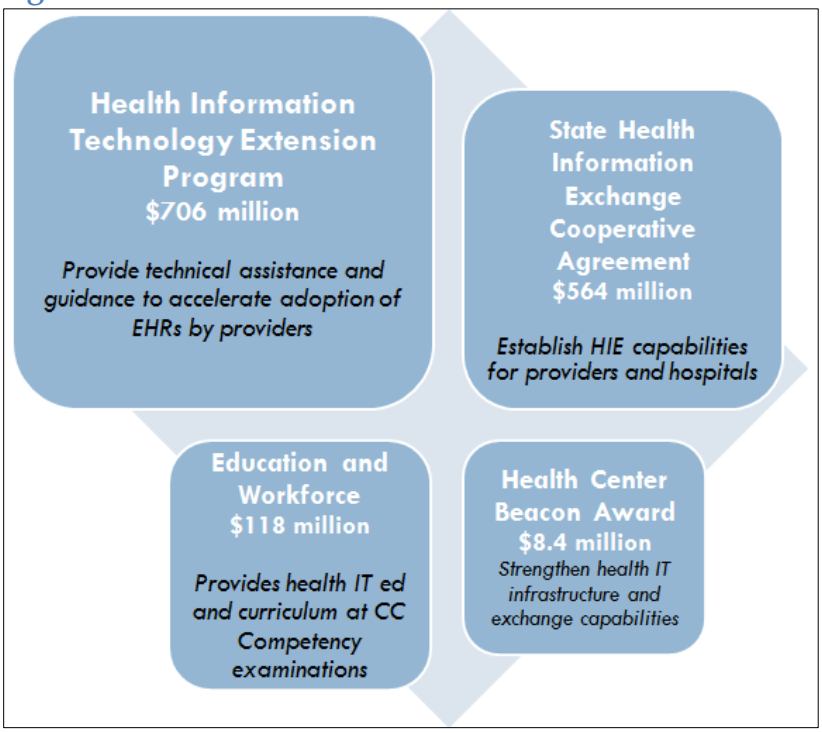
The slow uptake of EHRs over the last two decades was mainly believed to be due to the high costs associated with purchase and implementation of these technologies. The US government decided to step in and incentivize the use of EHRs for a few professional groups that deliver health care. These incentives were part of the American Recovery and Reinvestment Act of 2009 (ARRA). The EHR incentive program is being administered by the Centers for Medicare and

Medicaid (CMS) to eligible professionals (EPs), eligible hospitals (EHs), and critical area hospitals (CAHs) for adoption of certified EHRs and demonstration of meaningful use of these EHRs.[13] Whereas, the Office of the National Coordinator for Health Information Technology (ONC) is entrusted with the implementation of the Health Information Technology for Economic and Clinical Health (HITECH) Act. The mere adoption, implementation, or upgrade of certified electronic health records can benefit physicians who see Medicaid and Medicare patients by at least $21,250 and $18,000 and up to $63,759 and $44,000 respectively. The ONC has invested about $20 billion to implement the HITECH Act (Figure 2).[14-17]

The ONC made funds available to all states through multiple initiatives, such as the Health Information Technology Extension Program, State Health Information Exchange (HIE) Cooperative Agreement Program, and Community College Consortia to Educate Health Information Technology Professionals Program.

> The Health Information Technology for Economic and Clinical Health (HITECH) Act seeks to improve American health care delivery and patient care through an unprecedented investment in health information technology. The provisions of the HITECH Act are specifically designed to work together to provide the necessary assistance and technical support to providers, enable coordination and alignment within and among states, establish connectivity to the public health community in case of emergencies, and assure the workforce is properly trained and equipped to be meaningful users of certified Electronic Health Records (EHRs). These programs collaboratively build the foundation for every American to benefit from an EHR as part of a modernized, interconnected, and vastly improved system of care delivery.[18]

Figure 2. Funding distribution under HITECH Act



The Health Information Technology Extension Program goal is to increase the rate of EHR adoption among EPs through provision of technical assistance. Similarly, via the HIE program, states are expected to build infrastructure and mechanisms that support the exchange of health information among physicians' offices, hospitals, laboratories, pharmacies, registries, etc., and assist the EPs to qualify for EHR incentive program. The HIE initiative funds 56 Health Information Exchanges covering all states. One metric indicative of HIE success is the rate of change in the EHR adoption rate among physicians and another is the demonstration of their ability to exchange summary documents with another provider, the state, or a regional HIE among providers over the course of this four-year initiative. In the first year of the HIE cooperative agreements, states worked to establish a baseline for existing rates of EHR adoption and by the end of the four-year ONC grant the expectation is that the health information is flowing between health care entities to improve care delivery.

One advantage of the HITECH Act is that the HIT industry has had to work collaboratively to develop and adopt certification standards to realize the goal of inter-operability across platforms. Initially, HIT systems were implemented in the absence of defined standards. This led to the development of many proprietary solutions that were unique to the specific agencies or programs. As HIT standards are being established for the health industry, many specialty providers (e.g., behavioral health, long-term-care, and nurses) continue to struggle with their unique needs and government mandates regarding medical records. These providers are unable to access the funds made available through the HITECH Act to eligible providers and hospitals. Consequently, the difficulty of designing systems that easily connect with each other and exchange data seamlessly, still remains as the greatest challenge to interoperability and patient care.

Much has been written about the advantages of using EHRs[19-23] and HIEs[24-26] and their resulting benefits to improving quality of care, patient safety, and efficiency of delivering care. Much has also been written about the continued challenges associated with EHRs.[27-32] ONC defines EHRs as "…at their simplest, digital (computerized) versions of patients' paper charts. EHRs are real-time, patient-centered records. They make information available instantly, 'whenever and wherever it is needed.' And they bring together in one place everything about a patient's health."

EHRs can:

- Contain information about a patient's medical history, diagnoses, medications, immunization dates, allergies, radiology images, and lab and test results
- Offer access to evidence-based tools that providers can use in making decisions about a patient's care
- Automate and streamline providers' workflow
- Increase organization and accuracy of patient information
- Support key market changes in payer requirements and consumer expectations

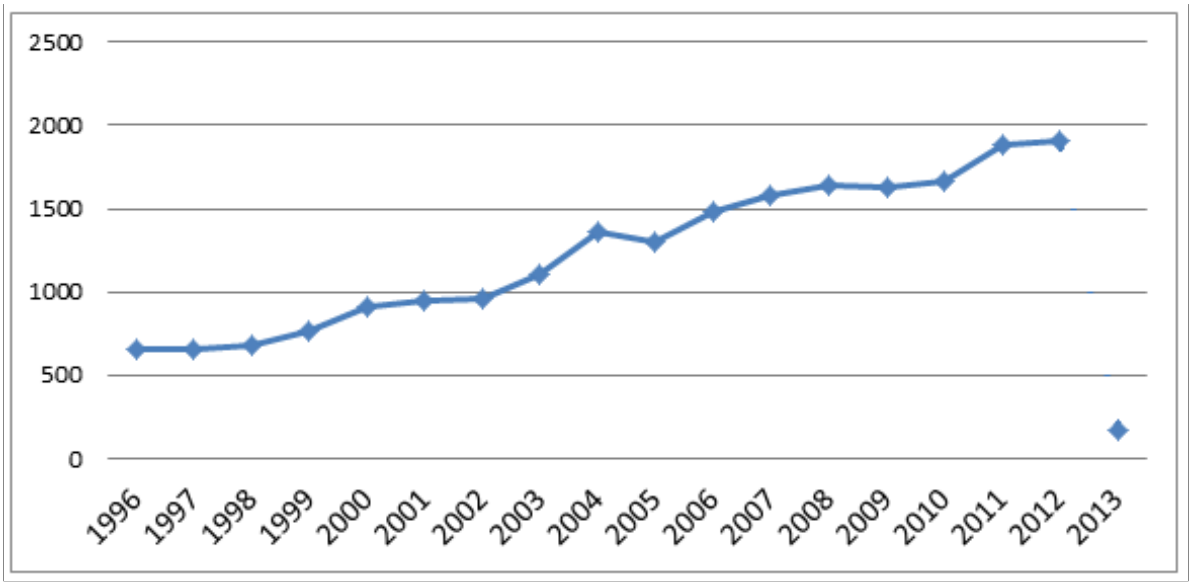
One of the key features of an EHR is that it can be created, managed, and consulted by authorized providers and staff across more than one health care organization.[33]

Potential benefits associated with EHR use

The ONC website has provided a great deal of guidance and insight into what is seen as certified EHR technologies[34] and CMS has provided evolving guidance on what "meaningful use" of EHRs means.[35] Despite the much discussed potential benefits of EHR implementation, conclusive evidence is still lacking in what is seen as an indisputable case for return on investment (ROI) and improved patient outcomes as a result of EHR implementation.

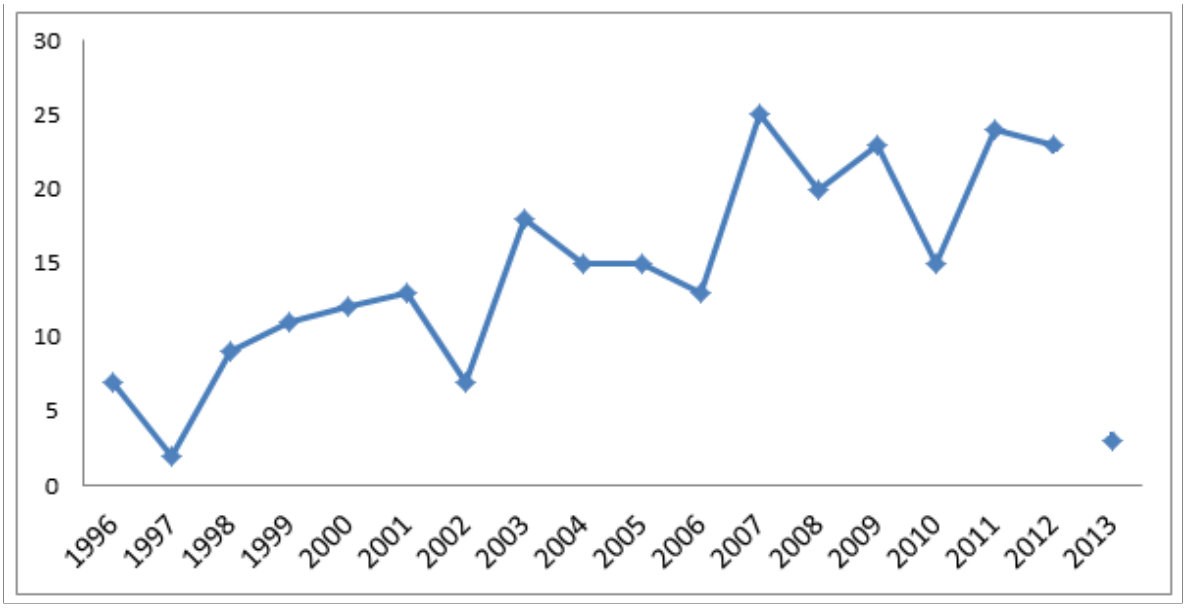
Much has been written about the benefits of EHRs, electronic medical records (EMRs), and computerized patient records in the published peer-reviewed and gray literature. Given that health data have been captured electronically for at least three decades, we believe that there should be sufficient evidence to ascertain whether or not implementing EHRs leads to improved system or patient outcomes. Since the implementation of the HITECH Act, there has been a doubling of the adoption of EHRs among physicians and hospitals. But, it is still difficult to establish a causal relationship between implementation of EHRs and better patient or system outcomes. The last few years have seen a tremendous increase in the number of review, systematic review, and other kinds of review articles that focus on the *potential* benefits of EHRs (refer to Figure 3 and Figure 4).

Figure 3. Number of EHR/Health Information Exchange (HIE) meta-analysis references that were reviews written between 1996 and 2013



Note: The 2013 data point is only for the first three months of data

Figure 4. Number of EHR/HIE meta-analysis references found for meta-analyses written between 1996 and 2013



Note: The 2013 data point is only for first three months of data

The number of studies that conclude with a statement on the potential benefits of EHRs far exceed studies that report conclusive evidence that supports the EHR benefits. We summarize the many potential benefits associated with adoption and use of EHRs on health care quality in Table 1.

Table 1. Summary of potential EHR benefits for providers and patients[36]

Benefits of EHRs for providers	Benefits of EHRs for patients
Accurate and complete information about patient's health	Create an avenue for communication
The ability to quickly provide care	Reduced need to fill out the same forms at each office visit
The ability to better coordinate care they give	Reliable point-of-care information and reminders notifying providers of important health interventions
A way to share information with patients and their family caregivers	Convenience of e-prescriptions electronically sent to pharmacy
Quick access to patient records from inpatient and remote locations for more coordinated, efficient care	Patient portals with online interaction for providers
Enhanced decision support, clinical alerts, reminders, and medical information	Electronic referrals allowing easier access to follow-up care with specialists
Performance-improving tools, real-time quality reporting	
Legible, complete documentation that facilitates accurate coding and billing	

Benefits of EHRs for providers	Benefits of EHRs for patients
Interfaces with labs, registries, and other EHRs	
Safer, more reliable prescribing by flagging dangerous drug interactions, verify medications and dosages, and reduce the need for potentially risky tests and procedures.	
Access experts for rural health care providers by sharing best practices and allowing for specialized care through telemedicine	
Standardization of data, order sets, and care plans helping to implement common treatment of patients using evidence-based medicine	
Better integration among providers by improved information sharing	
Convenient, faster, and simpler disease management	
Population management trended data and treatment and outcome studies	
Viewable and up-to-date medication and allergy lists	
Order entry at point of care or off-site	

A key goal of EHRs is to simplify care providers' jobs and to facilitate better client care using centrally-available electronic information. If individuals can carry a portable EHR when seeking treatment, then care providers will be able to provide and coordinate appropriate treatment. This portability assumes a level of inter-operability between systems that has not yet been realized.

Despite the advances in the HIT field and many articles espousing the advantages of EMRs, the evidence of the advantages of EHR/EMR adoption is mixed. For instance, Zhou concludes that there was no difference in performance on 18 quality measures representing six disease conditions between physicians who used EHRs and non-users of EHRs.[37] In addition, adoption rates are relatively low. Only 4% of the physicians have an extensive, fully-functional electronic system, while 13% report having some basic system.[38]

Some of the advantages of EHR adoption found in the peer-reviewed literature are centered on the themes of accuracy, quality, reduced costs, and task automation. Advantages include:

- Accurate medication lists, legible notes and prescriptions, immediately available charts, enhancement of health care delivery, facilitation in decision-making, and the ability to reduce medication errors via alerts delivered by the use of inpatient computerized physician order entry systems (CPOEs).[20]
- The ability to mine text information for improved and appropriate billing, thus increasing revenues.[21]
- Communication across providers resulting from the implementation of summary patient records.[19]

- The potential for improving the quality of care and physicians' and practices' efficiency due to increased access to stored medical information, with the concomitant ability to conduct outcome studies.[39]
- The ability to calculate prevention costs using standardized measures.[22]
- The ability of nurses to spend more time with clients.[23]
- Savings from preventing adverse drug events were estimated at $4.64 billion in the US VA system.[40]
- Use of HIT to provide access to health information for emergency medical professionals.[41]
- Reminders generated based on patient medical history can improve quality of care.[42]

On the other hand, many challenges and barriers to the adoption of EMRs and EHRs have been identified despite the early enthusiasm by practitioners and significant public expenditures on facilitating adoption. These challenges include:

- Limited evidence that the EMR improves quality of care.[30] Screening and sending results electronically to primary care physicians (PCPs) EMRs had little impact on three- and six-month clinical outcomes or on process measures for treating depression.[32]
- The use of an EMR during primary care was insufficient for insuring high-quality care. Practices not using the EMR were more likely to meet guidelines for process, treatment, and intermediate outcomes.[29]
- Costs, complex systems, lack of data standards, privacy concerns, and legal barriers hinder adoption.[27]
- Dysfunctional communication patterns, distribution of formal and informal decision-making power, and internal conflicts.[28]
- The high cost and complexity of quality improvement.[31]

EHR adoption rates among physicians as reported by national surveys

Few national studies are available that have reviewed the adoption rates of EHRs among physicians. According to one national study, 4% of the physicians reported having an extensive, fully-functional EHR and 13% reported having a basic system.[38] In December 2010, the Centers for Disease Control and Prevention (CDC) released statewide results of EHR adoption rates, based on a mailed supplement to the National Ambulatory Medical Care Survey (NAMCS).[43] This supplement was started in 2008. The CDC study reports that 48% of office-based physicians use an EHR, 22% use a basic system, and 7% use a fully-functional EHR. Both these studies have a limitation that at the time of these surveys there were no certification standards for EHRs.

EHR adoption rates were significantly higher in 2010 and 2011 when compared with 2009.[44] A 2011 national study reported a 57% EHR adoption rate among office-based physicians.[45] This rate is even higher among family physicians at 68%.[46] Fewer than 2% of solo or two-physician practices reported a fully functional EHR compared with 13% of physicians from 11+ groups.[47]

A 2014 update puts these numbers at 78% for office-based physicians using any EHR and 48% using a Basic EHR.[48] These numbers have increased substantially since the implementation of the HITECH Act and the EHR Incentive Program being administered by CMS. For the

providers and hospitals to be eligible for incentives, at a minimum, they have to have acquired certified EHRs based on the criteria laid out in the Federal Register notice.

The rates of EHR adoption vary greatly by state, with 21% in New Jersey to 83% in North Dakota.[48] According to this report, 30% of Connecticut's physicians had adopted a basic EHR. Currently, NAMCS data are the only state-level estimates available that systematically record EHR adoption rates, though not certified EHR adoption rates. However, there are two limitations that impact the applicability and usefulness of the NAMCS data. First, the supplement questionnaire does not ask the key question about whether or not the EHR in use is certified.[14] Second, the EHR adoption questions were asked at the practice level and not at the physician level. This distinction is important because the incentives being promoted by CMS are at the physician level and not at the practice level.

EHR adoption rates as reported by state surveys

State surveys tend to report different rates of EHR adoption than the NAMCS survey (Table 2). According to a 2008 study,[49] HIT has varying levels of adoption among Connecticut providers. Office technologies, including practice management applications and electronic billing, are the two most utilized technologies with 65% and 78% adoption among practices, respectively.[49] On the clinical side, electronic lab is the most utilized technology, with 63% practice adoption; however, only 26% of practices use an EHR.[50] According to 2010 NAMCS estimates for Connecticut, 48% of office-based physicians use an EHR and 15% report having a basic EHR system,[43] while another 2008 study puts this number at 26%[51] and a 2012 study puts this number at 36%.[52]

A 2007 survey administered to office-based physicians in Nebraska and South Dakota yielded an EHR adoption rate of 30%[53] compared with the 53% and 45% reported in 2009[43] and 54% and 58% in 2013 by NAMCS for office-based practices for Nebraska and South Dakota respectively.[48] A 2009 survey of medical practices in the state of Washington yielded a rate of 58% and this rate did not vary by practice location[54] compared with the 63% reported in 2009[43] and 61% in 2013 by NAMCS for office-based practices.[48]

Table 2. EHR adoption by physicians in Connecticut, Massachusetts, Nebraska, South Dakota, and Washington

State/year	State Survey report	2010 NAMCS	2014 NAMCS
CT/2011	36%	48%	30%
Massachusetts/2007	37%	77%	71%
Nebraska/2007	30%	53%	54%
South Dakota/2007	30%	45%	58%
Washington/2009	58%	63%	61%

Variables associated with physicians' adoption of EHRs

Physician characteristics

There are some contradictory results reported in the literature associating physicians' characteristics and adoption of EHRs. Women were more likely to use EHRs than men[55,56] though Bramble[53] reported no such difference. Physicians with education in addition to a medical diploma[55] and postgraduate education in a relevant clinical condition[57] were more likely to have a positive attitude toward HIT. Younger physicians were more likely than older physicians to use EHRs.[53,58,59] There was no association between race, ethnicity, and EHR use. Specialists were 44-94% less likely to adopt EHRs than general practitioners,[44] specifically family medicine/general practitioners were more likely to adopt EHRs in comparison to psychiatrists, dermatologists, pediatricians, ophthalmologists, and general surgeons,[44,60] while Menachemi[59] did not find any association between specialty and increased EHR adoption. Physicians serving higher volumes of elderly patients were less likely to adopt EHRs[61] whereas rates were no different among physicians serving more than 40% black or Hispanic patients.[62]

There is regional and state variability in EHR adoption rates,[46,48] with western states more likely to have higher rates of adoption.[38] Physicians who had more years of experience in using computers and technology had positive attitudes toward adoption.[55,58,63]

Physicians practicing in a multi-specialty group that adopted an EHR (represented by having at least 6-months of pre- and post-implementation visit volume and charge data) had an average increase of nine monthly patient visits per month whereas the patient visit volumes remained unchanged for non-adopters.[64] Similar results were found for average monthly charges.

Length of time using an EHR was not associated with physician performance on quality measures.[37]

Physician beliefs

Physicians who had positive views about the effects of computer systems on healthcare[65] and/or positive attitudes towards the EHR system,[66] reported a positive attitude toward adoption of EHRs. Physicians' perceived management support,[53,58,67] provider involvement,[67-69] and receipt of adequate training[53,67,70] were positively associated with adoption whereas perceived lack of usefulness[67] and provider autonomy[67] were negatively related with EHR use.

Self-reported ease of use of EHRs, pre-implementation satisfaction, and stress were associated with post-implementation satisfaction with EHR adoption.[56] Users ranked ease of use as the primary reason that motivates them to continue using the EHR, whereas perceptions about ease of use and usefulness were the prime motivators for nonusers to adopt EHRs.[71] Thirty percent of physicians believed that EHRs create new opportunities for error, however only 2% believed that their EHRs had created more errors than they prevented.[72] No EHR has satisfactorily met all physicians' needs; physicians maintain that EHRs continue to impact workflow and team communication negatively.[73]

Practice characteristics

Physicians in group practices,[46] single-practice,[59] multi-specialty,[44] or practices of more than seven physicians,[74] those that were hospital-based,[74] and practices that are involved in training medical students,[46,74] or associated with HMOs[44,46] were more likely to use an EHRs. Physicians

who were assisted by highly skilled autonomous staff were able to demonstrate greater gains in productivity after adoption of EHRs than physicians without such staff.[75] Additionally, practices that demonstrated higher levels of uniform use of EHR features and EHR-enabled communication patterns were likely to have within-practice communication patterns that were represented by mindfulness and respect for members in the practice.[76] Small group practices are projected to be the least likely to adopt EHRs. Ford[77] estimates that 47% of physicians in small practices will have implemented an EHR by 2014.

Physicians who treated larger proportions of Medicare patients[59,63] and those who had greater proportions of private insurance[78] were more likely to adopt EHRs, though in an earlier paper Menachemi[78] reported there was no difference in EHR adoption rates among physicians with high percentage of Medicare patients. Percentage of Medicaid patients in the practice was not associated with increased use of EHRs[59] though in an earlier paper Menachemi[78] reported that physicians with high percentage of Medicaid patients were less likely to use an EHR. Practices that involved physicians in the selection and implementation of EHRs[68,69] and practices involved in quality improvement[56,58] were more likely to report positive attitude toward adoption.

Practice location (i.e., rural versus urban) had no association with EHR adoption.[46] Medically underserved areas,[46] health professional shortage areas,[46] and being an international medical graduate[46] were negatively associated with adoption of EHRs.

Most commonly used EHR functions

Integrated EHRs come with many useful features, such as e-prescribing, ordering and reviewing labs, the ability to communicate securely with the patient, and sending information to a PHR. Although the most commonly used function is electronic prescribing. Among a group of Massachusetts physicians' the rate of e-prescribing increased from 20% in 2005 to 43% in 2007.[79] A 2007 article lists the following as the most commonly used EHR functions by physicians: 85% had the ability to view lab results, 84% were able to document the visits, 47% were able to order labs, and 44% were able to transmit prescriptions to a pharmacy.[74] Physicians using EHRs were more likely to be aware of and engaged with PHRs.[80] Currently, the EHRs are being used with basic functionality to meet minimum requirements. One can hypothesize that the true meaningful use of EHRs is even lower than the current estimates, which represent minimum functionality.[79,81]

Barriers to EHR adoption

EHR usability[82] and return on investment[83] are significant concerns among physicians as they evaluate EHR adoption. Smaller practices were more likely to report financial barriers[47,54] and concerns about future obsolescence as a concern.[47]

HIE and quality of care

Most HIEs aim to reduce medical errors, improve patient safety, and reduce costs by creating seamless information systems. Yet, as mentioned earlier in the report, the current quality of US health care is unimpressive. Only one in two people receive recommended care.[7] Medical errors are the fifth leading cause of death in the United States.[8] Preventable medical errors include adverse events, temporary injuries, death, and permanent disabilities. It is believed that widespread adoption of HIE has the potential to result in cost savings, to decrease medical errors, and to improve overall health.[84,85] Kadry, Sanderson, & Macario[86] summarized why they

believe that of the 400 HIEs that were initiated in the last decade only 143 remain active today. The authors list multiple factors that played a role in HIE failure, ranging from infrastructure challenges to technical issues, none of which incorporate the role for the patient.[86]

One metric indicative of HIE success is the percent of physicians who successfully exchange summary documents with another provider, the state, or a regional HIE. As a first step to establishing HIEs, most states are establishing Health Information Service Providers (HISPs) and Security/Trust Authority (STA), which require a complete and accurate list of practicing physicians in each state. As a result, in the first year of the HIE cooperative agreements, states have been working to create provider directories and third party certificate issuing authorities to build an infrastructure that is minimal yet sufficient to support simple point-to-point exchange of health information among providers in a secure manner. The exchanges that are mature and were operational before this funding were (a) the Delaware Exchange which focused on the exchange of lab results and added e-prescribing and (b) the Indiana exchange which focused on exchange of summaries and information between hospitals. In the second year of the grant, most states were asked to focus on point-to-point exchange (Direct Protocol) rather than the "query-based" HIEs that had been proposed initially. Everyone realized quickly how difficult it was to reach the goal of interoperability, which is critical for data flow and seamless exchange.

Interoperability

Today providers use fax, mail, and email to exchange healthcare information within and across organizations, providers, and patients. The Direct messaging protocol aims to improve this exchange by making it faster, less expensive, and more secure.

Interoperability "is the ability of two or more health care information systems to exchange information and to use the information that has been exchanged (pg. 174)."[87] Interoperability can be defined as the ability of two disparate systems to communicate information meaningfully. There are three aspects of meaningful exchange,

- technical: the sender and receiver must have a trusted mechanism to exchange messages
- process: they should be able to structure and format the content of the message, and
- semantic: ability to understand the meaning in the same fashion (usually driven by use of standard terminology).

To accomplish secure exchange of messages containing health information, ONC started the Direct Project in 2010. The aim of this project was to specify "…a simple, secure, scalable, standards-based way for participants to send authenticated, encrypted health information directly to known, trusted recipients over the (public) internet" (pg. 4).[88] It was clear that ONC was interested in using the existing infrastructure to make exchange of health information easy and achievable. First, the project scope was well defined and focused only on the transport, and not on structure or content of the message. Second, the policy and standards-making were left to the federal or other appropriate organizations. Third, the project was focused on simple health care scenarios that happen every day in coordinating patient care. Fourth, the focus was on a "push" rather than a "pull" system. Last, the group wanted to develop a messaging capability that could be used by providers that had certified EHRs, modular EHRs, or no EHR.

> "The Direct Project establishes standards and documentation to support simple scenarios of pushing data from where it is to where it's needed, in a way that will support more sophisticated interoperability in the future."[88]

Currently, most states have shifted their HIE efforts to focus on enabling systems to use Direct messaging protocol. This is being implemented in many different ways. One way states are making Direct available to their providers is by making the HISP maintain the Direct addresses and take the responsibility of also maintaining the certificates that accompany direct messages. Another way the providers can use Direct is through the use of EHRs that have integrated the Direct message functionality into their product so that it is a seamless way for the provider to send secure messages without ever having to leave their system. Last, Direct messaging protocol is available to providers who do not have EHRs but would like to coordinate care and exchange health information with other providers in a simple and secure manner.

The content that was initially intended for exchange was the Continuity of Care Document (CCD), or discharge summaries or clinician notes. Direct does not push the use of HL7 standard as there has been a slow adoption of HL7 version 3, though most states have the capability to receive and send HL7 version 2.5.1 messages to exchange relevant public health data with the state lab and the CDC.

In the last year, states have increasingly pushed for the exchange of lab and prescription data for exchange using Direct messages, which was not the intent of the Direct project. E-prescribing has a high adoption across the country and systems are interoperable mainly because of the monopoly of Surescripts that is present in all states and has an adoption rate between 60-90% depending on the states. In the case of e-prescribing interoperability has been achieved but only because everyone is using one system. This does not really fit the definition of interoperability as there are not two types of systems exchanging information.

In the case of lab exchange, the story is slightly different because the two big players in this space, mainly LabCorp and Quest Diagnostics, were unable to negotiate an agreement with ONC that would allow states access to state level data on the volume of lab results being exchanged electronically. Some states are proposing to use Direct to exchange lab information using HISP and a certificate authority. A few states such as Florida, West Virginia, North Carolina, and Alaska are piloting the process of using Direct to exchange lab data. Some of these pilots involve manual data entry because the content of the message is in Adobe portable document format (PDF) and not structured data. Finally, last year when Google decided to stop offering its personal health record services, people could use the Direct messaging protocols to send their Google Health profile directly to a Microsoft HealthVault account.[89]

Summary

Much has been written about the benefits of EHRs, EMRs, and computerized patient records in the published peer-reviewed and gray literature. Since the implementation of the HITECH Act, there has been a doubling of the adoption of EHRs among physicians and hospitals. However, it is still difficult to establish a causal relationship between implementation of EHRs and better patient or system outcomes.

Even though establishing HIEs with querying capabilities is a gold standard, many states are struggling to sustain all activities related to the actual exchange of information. The HIE cooperative agreements are ending and many states that have implemented HIEs are finding it hard to sustain their efforts. The ONC, together with the states, is re-thinking the capabilities and capacities for HIEs and concluding that before pushing for the gold standard, it may be meaningful to start with ensuring that all providers can exchange summaries and other relevant documents and communicate with each other (also called point-to-point communication) to coordinate patient care. Most agree that this simple exchange capability should definitely come before querying functions and population-based analytics. Currently, the ONC is advocating the use of Direct messaging to ensure reliable, secure, and safe delivery of sensitive health information using existing infrastructure and technologies. At the writing of this report all states except two (Washington and Idaho) intend to implement the Direct protocol.[90]

Despite the publication of over 75,000 articles and 30,000 reviews since the early 1990s on the topic of HIT and improvement of care, a definitive answer about the value of EHR implementation has not been found. The jury is still out on the fundamental efficacy of EHR adoption for improving the quality of care to patients.

Meaningful electronic exchange amongst physicians, laboratories, pharmacies, and HIE has the potential to improve patient-care experience and health outcomes. The goal of the physician survey was to measure the extent of interoperability, assess the knowledge and attitudes of physicians toward the creation of Heath Information Exchange. These findings will help inform stakeholders about the level of health IT adoption and provide insight into the challenges associated with adoption of EHRs from the physician perspective, so that these viewpoints can be taken into consideration as the HIE initiative moves forward. The information obtained from this research will be instrumental in characterizing the HIT landscape within Connecticut. Currently, there is limited knowledge of physician attitudes towards and adoption of HIT and this survey represents a critical step towards obtaining that knowledge.

Methodology

Study design

We conducted a two-wave panel survey[91] of Connecticut physicians' attitudes toward and use of health information technology and exchange. Licensed physicians who currently practiced in Connecticut were eligible to participate. The study was approved by the University of Connecticut Health Center Institutional Review Board.

Survey instrument

The survey items were drawn from an instrument used in a national study conducted by DesRoches and colleagues.[38] Additional questions pertaining to Connecticut's health information exchange, whether or not the physician practiced in Connecticut, federal EHR incentive programs, and the availability of specific EHR functions were added by the principal investigator. The University of Connecticut Health Center Institutional Review Board approved the final surveys. Please see Appendix A for copies of the survey instruments.

Survey administration

Details regarding the survey protocol are found in Appendix B. In summary, physicians licensed to practice in Connecticut received a postcard containing a brief set of survey questions and a request for contact information to allow the University of Connecticut Health Center research team to send them two subsequent in-depth surveys over the course of the evaluation period (please see Appendix A for a copy of the postcard). Physicians who returned the postcard and indicated they currently practiced in Connecticut received the survey by the administration method they had requested (i.e., web-based, mailed paper survey, telephone or in-person interview). Two rounds of data were collected by the research team. The first round (using the "baseline" version of the survey instrument) took place between June 27, 2011 and April 25, 2013. The second round (using the "follow-up" version of the survey instrument) took place between July 1, 2013 and February 19, 2014.

Figure 5 and Figure 6 summarize the flow of survey participants for the two data collection rounds, beginning with the initial list of licensed physicians and concluding with the physicians who responded to the surveys.

Figure 5. Physician survey Round 1 flow diagram

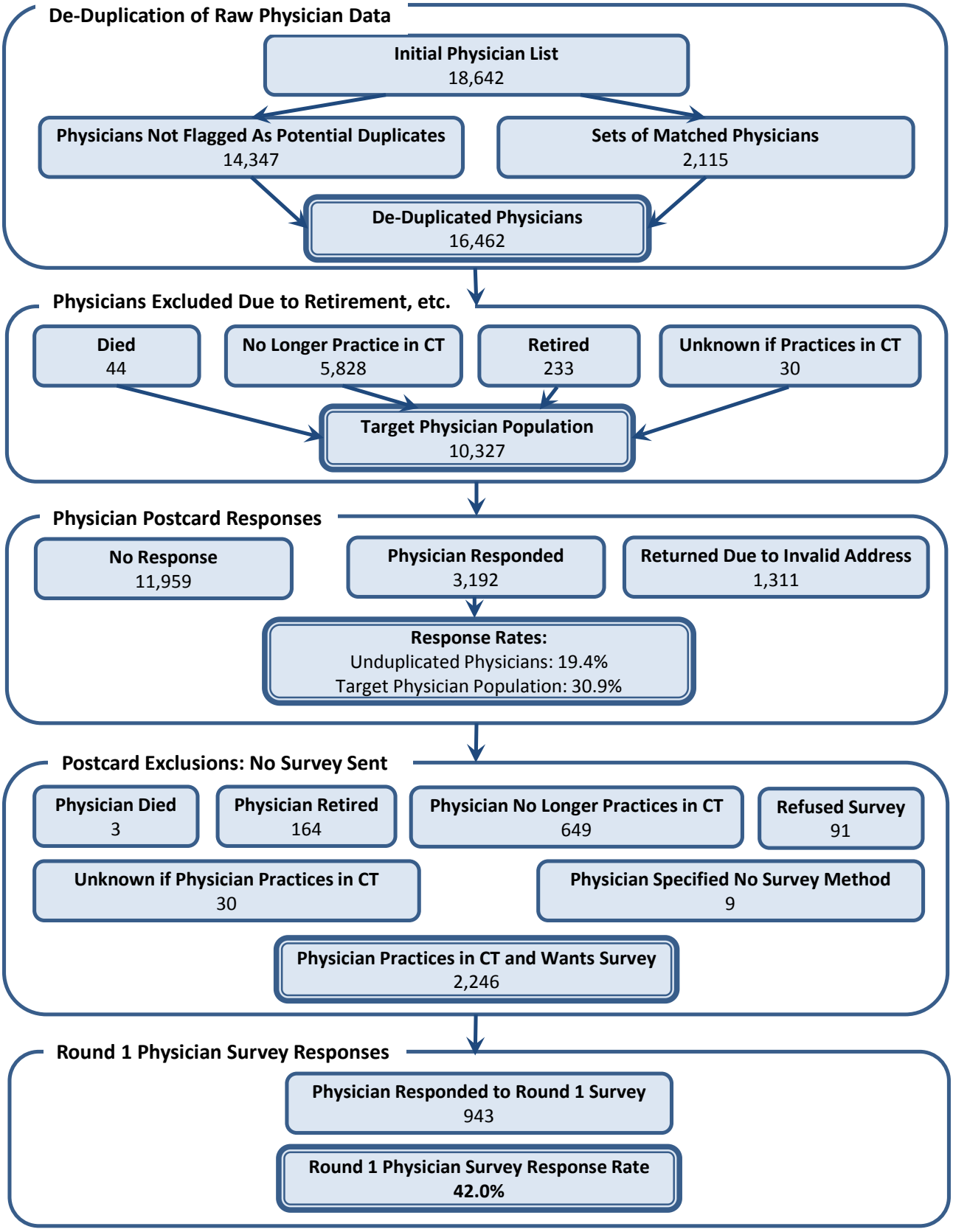
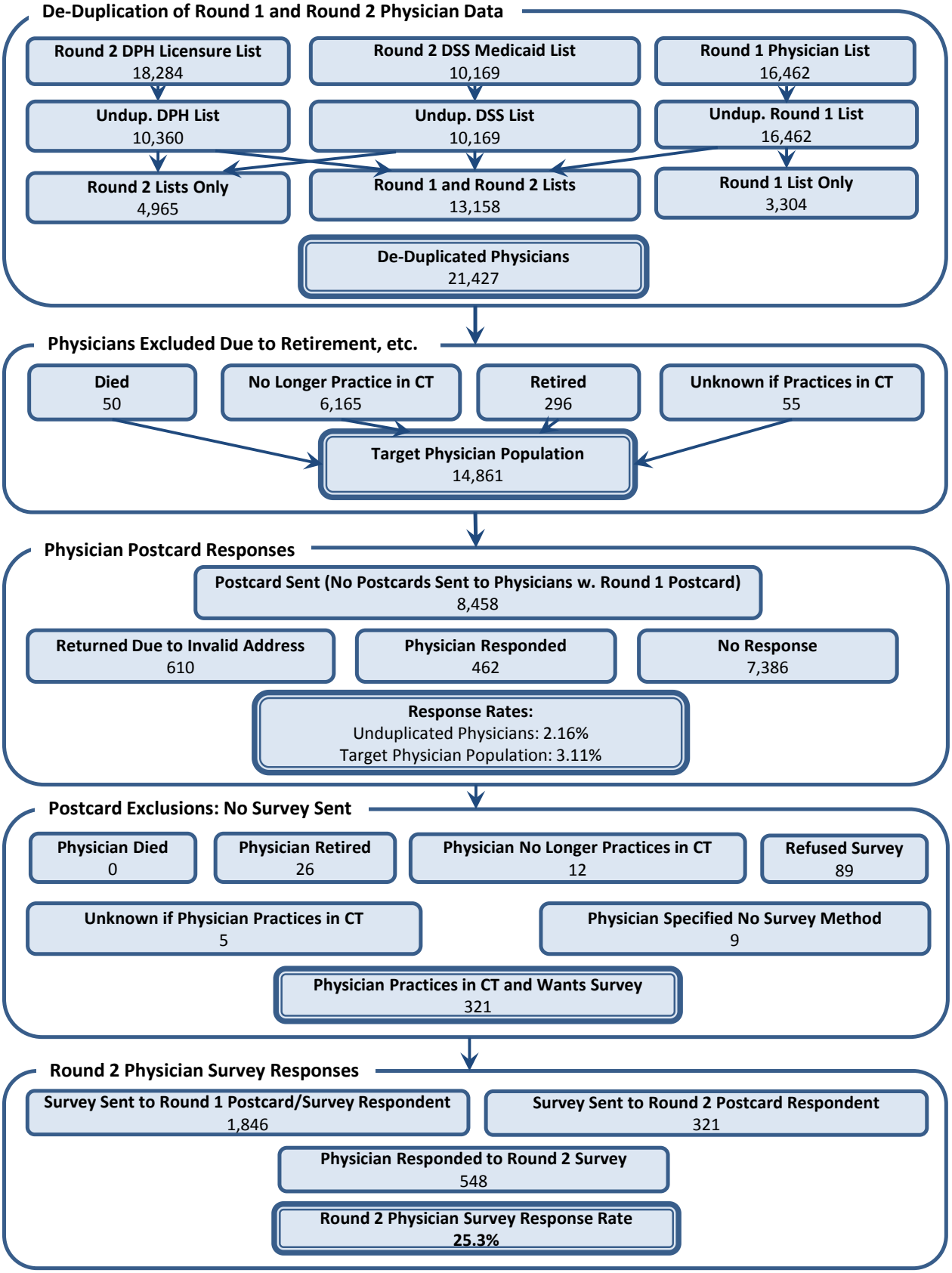


Figure 6. Physician survey Round 2 flow diagram



Analytic sample

Survey data were collected using REDCap (Research Electronic Data Capture), a secure web-based application hosted at the University of Connecticut Health Center. A total of 1,492 surveys were recorded in REDCap. We set aside 146 surveys: 52 duplicate surveys, 41 surveys submitted by physicians who no longer practiced in Connecticut, 20 surveys that could not be matched to postcard mailings, 18 surveys that were missing most or all of the survey data, 8 surveys submitted by physicians who indicated they did not see patients, 4 surveys from retired physicians, and 3 test surveys. The analytic sample included the remaining 1,346 participants (880 from the 2011 round and 466 from the 2013 round of the survey).

Analytic approach

Descriptive statistics were used to summarize the distributions of the survey variables. We examined change in the proportions of physicians reporting whether various functions were available in their main practice site's computer systems using chi-squared and Fisher's exact tests when comparing the 2011 and 2013 cohorts, and using Bhapkar's test (an approximation of the Stuart-Maxwell test) when comparing the 2011 and 2013 baseline and follow-up groups.

We identified factors associated with the presence of an EHR system (defined as either being in the process of implementation or having a fully-implemented EHR system) using chi-squared and Fisher's exact tests. Factors that were significantly associated ($p<.05$) with the presence of an EHR in the bivariate analyses were then included in multivariable logistic regression models. Factors used in our models included demographic characteristics (sex, age, years practicing medicine, practice specialty, and computer experience), practice characteristics (number of physicians in the practice, practice type) and perceived barriers to EHR adoption (amount of capital needed to acquire and implement an EHR system, concern about inappropriate disclosure of patient information, and concern about illegal record tampering). We used SAS 9.4 for all statistical analyses.

We analyzed physicians' responses to open-ended survey questions asking them to comment about their EHR system, the Connecticut Health Information Exchange, and reasons why they would or would not support the widespread adoption of personal health records for patients as follows. First, we coded each comment to extract key words that represented the main point of the comment. Second, we identified common themes or concepts expressed in the recoded statements. Finally, we generated a "word cloud" (also known as a "tag cloud") using Wordle[92] to display the frequency with which physicians mentioned the common themes or concepts.

Results

Respondent characteristics

A total of 880 surveys were completed in the first distribution of survey (2011) and 466 surveys were completed in the second distribution of the survey (2013). Six hundred sixteen physicians completed a survey during the first distribution only (2011 Cohort 1) and 202 physicians completed a survey during the second distribution only (2013 Cohort 2). Two hundred and sixty-four physicians completed surveys at both points (2011 Baseline and 2013 Follow-Up).

We compared the physicians who completed a survey (1,082 unduplicated physicians from the 2011 and 2013 survey distributions) to those who completed a postcard but did not complete a survey (2,521 unduplicated physicians) using the subset of characteristics that were collected by both the postcard and the survey (gender, age, race, ethnicity, type of practice, method of health record storage, and sources of patient revenue). Physicians who completed a survey ("respondents") differed from physicians who did not complete a survey ("non-respondents") in several ways. In terms of demographic characteristics, respondents were younger ($t(2186)=5.78$, $p < .0001$) and less likely to be Black/African American or other/multiracial than non-respondents ($X^2(2, N=3289)=7.59$, $p=.02$). Respondents were more likely than non-respondents to work in single-specialty partnerships or groups and less likely to work in multi-specialty partnerships or groups ($X^2(2, N=3024)=10.41$, $p=.006$). Respondents were more likely than non-respondents to store patients' health records using a paper-based system ($X^2(1, N=3603)=133.72$, $p<.0001$), a DIMS system ($X^2(1, N=3603)=88.37$, $p<.0001$), or an EHR ($X^2(1, N=3603)=103.73$, $p<.0001$). Finally, respondents reported a lower percentage of their patient revenue came from Medicare ($X^2(3, N=2416)=96.19$, $p<.0001$), Medicaid ($X^2(3, N=2331)=50.69$, $p<.0001$), or from self-paying patients ($X^2(3, N=2082)=104.42$, $p<.0001$). However, a third or more of the data on patient revenue was missing, so these apparent differences should be interpreted with caution.

In order to simplify the presentation of the results, we summarize our discussion of the following measures across each sub-sample (i.e., Cohort 1, Cohort 2, Baseline and Follow-Up), except in instances where the sub-sample results differed markedly.

As shown in Table 3, around two-thirds of the physicians were male. Age ranged from 29 to 88 across the sub-samples and the average age was mid-fifties. The majority of physicians were white and non-Hispanic/Latino. More than half of the physicians were certified in a primary care specialty. Years of practicing medicine ranged from 1 to 56 years, although most physicians reported 10 or more years in practice. Around half of the physicians reported they had "a lot" of computer experience.

Table 3. Physician characteristics

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
Physician Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Age								
29-39	80	13.0	27	13.4	22	8.3	16	6.1
40-49	123	20.0	28	13.9	47	17.8	46	17.4
50-59	196	31.8	64	31.7	86	32.6	76	28.8
60-69	133	21.6	49	24.3	73	27.6	75	28.4
70+	47	7.6	18	8.9	26	9.9	40	15.1
Missing	37	6.0	16	7.9	10	3.8	11	4.2
Gender								
Male	409	66.4	126	62.4	180	68.2	179	67.8
Female	175	28.4	65	32.2	75	28.4	78	29.6
Missing	32	5.2	11	5.4	9	3.4	7	2.6
Ethnicity								
Hispanic/Latino	17	2.8	7	3.5	9	3.4	10	3.8
Not Hispanic/Latino	555	90.1	178	88.1	236	89.4	243	92.0
Missing	44	7.1	17	8.4	19	7.2	11	4.2
Race								
White	488	79.2	156	77.2	230	87.1	228	86.4
Black	10	1.6	4	2.0	1	0.4	2	0.8
Other	57	9.3	22	10.9	16	6.1	15	5.7
Missing	61	9.9	20	9.9	17	6.4	19	7.2
Years practicing medicine								
1-9	110	17.9	34	16.8	33	12.5	31	11.7
10-19	142	23.0	43	21.3	58	22.0	48	18.2
20-29	181	29.4	56	27.7	79	29.9	82	31.1
30+	151	24.5	56	27.7	82	31.1	96	36.4
Missing	32	5.2	13	6.4	12	4.5	7	2.6
Specialty[1]								
Primary care	349	56.7	130	64.4	157	59.5	157	59.5
Non-primary care	244	39.6	68	33.7	103	39.0	103	39.0
Missing	23	3.7	4	2.0	4	1.5	4	1.5
Computer experience								
A lot	334	54.2	111	54.9	137	51.9	128	48.5
Some	237	38.5	79	39.1	100	37.9	112	42.4
A little	36	5.8	8	4.0	24	9.1	21	7.9
None	4	0.7	1	0.5	2	0.8	2	0.8
Missing	5	0.8	3	1.5	1	0.4	1	0.4

[1]Primary care specialties included Family Medicine, Internal Medicine, Obstetrics and Gynecology, Pediatrics, and Preventive Medicine. Non-primary care specialties included Allergy and Immunology, Anatomic Pathology, Anatomic and Clinical Pathology, Anesthesiology, Colon and Rectal Surgery, Dermatology, Emergency Medicine, General Surgery, Neurological Surgery, Neurology, Neurosurgery, Ophthalmology, Oral and Maxillofacial Surgery, Orthopaedic Surgery, Other, Osteopathic Manipulative Medicine, Osteopathic Neuromusculoskeletal Medicine, Otolaryngology, Pathology, Physical Medicine and Rehabilitation, Plastic Surgery, Psychiatry, Radiation Oncology, Radiology, Thoracic Surgery, Urology

Around one half of the physicians reported working at a single practice site and 40-50% of physicians were from small (up to 3 physicians) practices (Table 4). Over two-thirds of physicians saw the majority of their patients in an outpatient primary care setting (e.g., primary care clinic, subspecialty clinic, or medical and surgical specialty clinic) and around one half characterized their practice as a single specialty group or partnership. The vast majority of physicians who participated in this survey were not affiliated with the Veteran's Administration health care system.

In terms of technology, most physicians reported some form of high-speed Internet access, with cable or digital subscriber line (DSL) being the most prevalent type of service. More than half of the physicians said they did not need additional service at any of their practice sites.

Table 4. Practice characteristics

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
Practice Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Number of practice sites								
1	284	46.1	112	55.5	141	53.4	141	53.4
2	183	29.7	38	18.8	64	24.2	71	26.9
3 or more	149	24.2	50	24.7	57	21.6	46	17.4
Missing	0	0.0	2	1.0	2	0.8	6	2.3
Number of physicians in practice								
1	123	20.0	31	15.3	70	26.5	72	27.3
2-3	146	23.7	49	24.3	64	24.2	64	24.2
4-6	140	22.7	52	25.7	79	29.9	65	24.6
7+	195	31.7	64	31.7	50	18.9	59	22.4
Missing	12	1.9	6	3.0	1	0.4	4	1.5
Clinical setting[1]								
Outpatient primary care	423	68.7	146	72.3	192	72.7	204	77.3
Hospital or medical center	142	23.0	41	20.3	38	14.4	34	12.9
Outpatient ancillary services	15	2.4	0	0.0	7	2.6	0	0.0
Long-term care facility	11	1.8	1	0.5	2	0.8	2	0.8
Type of practice								
Single specialty group	332	53.9	113	55.9	134	50.8	135	51.1
Multi-specialty group	126	20.4	45	22.3	39	14.8	43	16.3
Solo practice	108	17.5	31	15.3	67	25.4	58	22.0
Other	46	7.5	13	6.4	24	9.1	25	9.5
Missing	4	0.6	0	0.0	0	0.0	3	1.1
Practice location								
Urban	324	52.6	95	47.0	127	48.1	121	45.8
Rural	59	9.6	19	9.4	29	11.0	29	11.0
Neither	220	35.7	88	43.6	102	38.6	112	42.4
Missing	13	2.1	0	0.0	6	2.3	2	0.8
Affiliated with VA								
Yes	14	2.3	8	4.0	10	3.8	11	4.2
No	589	95.6	193	95.5	252	95.4	249	94.3

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
Unsure	3	0.5	0	0.0	0	0.0	0	0.0
Missing	10	1.6	1	0.5	2	0.8	4	1.5
Type of Internet access								
Broadband (cable, DSL)	358	58.1	122	60.4	163	61.7	146	55.3
T-1	123	20.0	36	17.8	36	13.6	41	15.5
Broadband (satellite)	16	2.6	7	3.5	5	1.9	8	3.0
Dial-up/non-broadband	9	1.5	1	0.5	4	1.5	4	1.5
Other	33	5.4	6	3.0	14	5.3	16	6.1
None	9	1.5	4	2.0	13	4.9	12	4.6
Missing	68	11.0	26	12.9	29	11.0	37	14.0
Need additional Internet access								
Yes	110	17.9	39	19.3	45	17.1	33	12.5
No	344	55.8	106	52.5	154	58.3	151	57.2
Unsure	118	19.2	39	19.3	40	15.1	54	20.4
Missing	44	7.1	18	8.9	25	9.5	26	9.9

[1]Some physicians selected more than one clinical setting where they saw the majority of their patients.

Table 5 illustrates that the majority of physicians saw more than half of their patients at their main practice site. Around 50-60% of physicians reported up to 100 patient visits at their main practice site during the past week. A third or more of physicians received more than half of their patient revenues from private insurance payments.

Table 5. Patient visit and payment characteristics

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
Patient Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
%Patient visits at main site								
<50%	38	6.2	7	3.5	8	3.0	9	3.4
>=50%	567	92.0	191	94.5	253	95.8	248	93.9
Missing	11	1.8	4	2.0	3	1.1	7	2.6
# Patient visits at main site								
0-50	175	28.4	35	17.3	73	27.7	76	28.8
51-100	183	29.7	71	35.1	79	29.9	78	29.5
101-200	96	15.6	30	14.9	44	16.7	42	15.9
>200	108	17.5	44	21.8	51	19.3	55	20.8
Missing	54	8.8	22	10.9	17	6.4	13	4.9
Patient revenue from Medicare								
0%	105	17.0	26	12.9	52	19.7	42	15.9
1-25%	141	22.9	56	27.7	63	23.9	64	24.2
26-50%	194	31.5	55	27.2	73	27.6	71	26.9
>50%	80	13.0	18	8.9	22	8.3	24	9.1
Missing	96	15.6	47	23.3	54	20.5	63	23.9
Patient revenue from Medicaid								

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
0%	114	18.5	27	13.4	45	17.1	38	14.4
1-25%	284	46.1	95	47.0	112	42.4	112	42.4
26-50%	74	12.0	27	13.4	29	11.0	26	9.9
>50%	42	6.8	4	2.0	17	6.4	23	8.7
Missing	102	16.6	49	24.3	61	23.1	65	24.6
Patient revenue from private ins.								
0%	25	4.1	4	2.0	8	3.0	7	2.7
1-25%	108	17.5	22	10.9	34	12.9	46	17.4
26-50%	197	32.0	53	26.2	82	31.1	73	27.6
>50%	201	32.6	83	41.1	95	36.0	89	33.7
Missing	85	13.8	40	19.8	45	17.0	49	18.6
Patient revenue from self-pay								
0%	76	12.3	25	12.4	21	7.9	27	10.2
1-25%	373	60.6	110	54.5	167	63.3	155	58.7
26-50%	14	2.3	3	1.5	7	2.6	5	1.9
>50%	16	2.6	8	4.0	16	6.1	14	5.3
Missing	137	22.2	56	27.7	53	20.1	63	23.9
Other patient revenue source								
0%	334	54.2	130	64.4	120	45.5	156	59.1
>0%	75	12.2	9	4.5	37	14.0	31	11.7
Missing	207	33.6	63	31.2	107	40.5	77	29.2

Computerized systems use

The majority of physicians reported their practice used at least some electronic billing, with the proportion of practices using electronic billing exclusively increasing significantly over time (Table 6). A similar pattern is reflected in the use of EHR systems for medical record storage. In 2011, 41% of the Cohort 1 physicians used EHR systems compared with 59% of the 2013 Cohort 2 physicians. The last two columns of Table 6 shows that EHR use increased from 40% to 53% among the physicians who were surveyed both in 2011 and 2013. However, physicians could select multiple systems for storing health records, so these comparisons may also suggest a shift to multiple storage systems rather than a transition from one type of system to another.

Table 6. Physician practices' use of computerized systems

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Submit claims electronically								
Yes, all electronic	358	**58.1**	133	**65.8**	146	**55.3**	160	**60.6**
Yes, paper and electronic mix	102	16.6	27	13.4	57	21.6	35	13.3
No	64	10.4	15	7.4	29	11.0	33	12.5
Unknown	82	13.3	23	11.4	28	10.6	31	11.7
Missing	10	1.6	4	2.0	4	1.5	5	1.9
Health record system storage[1]								
EHR system	250	40.6	119	58.9	105	39.8	141	53.4
Paper records and charts	298	48.4	57	28.2	137	51.9	101	38.3
DIMS[2]	88	14.3	42	20.8	34	12.9	33	12.5
Other	22	3.6	4	2.0	3	1.1	12	4.5

[1]Physicians could select more than one method.
[2]DIMS=A computer based system in which paper records and charts are scanned, and the scanned documents are filed electronically.
Note. Values in bold text represent statistically significant differences between 2011 and 2013 ($p<0.05$)

Table 7 through Table 12 summarize the availability of various clinical functions in computerized systems within physicians' main practice sites. Regardless of whether or not their practice had an EHR, physicians had the opportunity to respond to these questions.

The majority of physicians had a computerized system that gathered patient demographics (Table 7). The proportion of physicians with computerized systems which gathered other patient health information (e.g., record lists of patients' health problems and medications, record clinical notes) increased significantly between 2011 and 2013 for both sub-samples. The proportion of physicians with computerized systems which gathered patient demographic information increased significantly between 2011 and 2013 for the baseline-follow-up sub-sample only.

Table 7. Available functions of computerized systems related to patient information

Does your main practice site have a computerized system for…	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Patient demographics								
Yes	533	86.5	181	89.6	211	**79.9**	229	**86.7**
No	56	9.1	9	4.5	40	15.2	24	9.1
Don't know	12	2.0	4	2.0	4	1.5	2	0.8
Missing	15	2.4	8	4.0	9	3.4	9	3.4
Patient problem lists								
Yes	299	**48.5**	148	**73.3**	124	**47.0**	159	**60.2**
No	287	46.6	45	22.3	129	48.9	91	34.5
Don't know	14	2.3	2	1.0	4	1.5	6	2.3
Missing	16	2.6	7	3.5	7	2.6	8	3.0
Patient medication lists								
Yes	319	**51.8**	155	**76.7**	126	**47.7**	171	**64.8**
No	260	42.2	38	18.8	123	46.6	80	30.3
Don't know	8	1.3	2	1.0	6	2.3	3	1.1
Missing	29	4.7	7	3.5	9	3.4	10	3.8
Recording clinical notes								
Yes	327	**53.1**	151	**74.7**	133	**50.4**	165	**62.5**
No	260	42.2	44	21.8	115	43.6	83	31.4
Don't know	3	0.5	1	0.5	3	1.1	4	1.5
Missing	26	4.2	6	3.0	13	4.9	12	4.6
If yes, do they include medical history and/or follow-up notes?								
Yes	305	93.3	147	97.3	124	93.2	161	97.6
No	10	3.1	0	0.0	7	5.3	1	0.6
Don't know	7	2.1	3	2.0	1	0.7	1	0.6
Missing	5	1.5	1	0.7	1	0.7	2	1.2

Note. Values in bold text represent statistically significant differences between 2011 and 2013 ($p<0.05$)

In terms of order entry management (e.g., ordering prescriptions, lab, or radiology tests), there was a similar pattern of significant increases in prevalence between 2011 and 2013 for both sub-samples (Table 8). By 2013, 83-87% of physicians whose computerized systems allowed them to order prescriptions said their systems provided warnings of drug interactions or contraindications and over 85% said they used their systems to order prescriptions electronically.

Table 8. Available functions of computerized systems related to order entry management

Does your main practice site have a computerized system for…	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Ordering prescriptions								
Yes	375	**60.9**	171	**84.6**	169	**64.0**	198	**75.0**
No	207	33.6	26	12.9	84	31.8	54	20.5
Don't know	11	1.8	1	0.5	2	0.8	3	1.1
Missing	23	3.7	4	2.0	9	3.4	9	3.4
If yes, are prescriptions sent electronically								
Yes	307	81.9	149	87.1	144	85.2	174	87.9
No	52	13.9	14	8.2	22	13.0	17	8.6
Don't know	8	2.1	5	2.9	1	0.6	1	0.5
Missing	8	2.1	3	1.8	2	1.2	6	3.0
If yes, are warning of drug interactions or contraindications provided								
Yes	296	78.9	142	83.0	138	81.7	172	86.9
No	51	13.6	13	7.6	15	8.9	12	6.1
Don't know	20	5.3	11	6.4	13	7.7	10	5.0
Missing	8	2.1	5	2.9	3	1.8	4	2.0
Ordering laboratory tests								
Yes	284	**46.1**	125	**61.9**	116	**43.9**	146	**55.3**
No	297	48.2	65	32.2	134	50.8	107	40.5
Don't know	9	1.5	2	1.0	6	2.3	3	1.1
Missing	26	4.2	10	4.9	8	3.0	8	3.0
If yes, are lab orders sent electronically								
Yes	206	72.5	94	75.2	89	76.7	103	70.6
No	65	22.9	23	18.4	23	19.8	38	26.0
Don't know	6	2.1	3	2.4	1	0.9	1	0.7
Missing	7	2.5	5	4.0	3	2.6	4	2.7
Ordering radiology tests								
Yes	235	**38.1**	112	**55.4**	91	**34.5**	112	**42.4**
No	342	55.5	77	38.1	160	60.6	137	51.9
Don't know	15	2.4	4	2.0	5	1.9	6	2.3
Missing	24	3.9	9	4.5	8	3.0	9	3.4
If yes, are radiology orders sent electronically								
Yes	160	68.1	77	68.7	60	65.9	65	58.0
No	65	27.7	30	26.8	23	25.3	43	38.4
Don't know	7	3.0	2	1.8	2	2.2	2	1.8
Missing	3	1.3	3	2.7	6	6.6	2	1.8

Note. Values in bold text represent statistically significant differences between 2011 and 2013 (p<0.05)

With regard to managing the results of orders, a majority of physicians reported they had computerized systems that allowed them to view lab results and around half were able to use their systems to view imaging results (Table 9). More than half of physicians said electronic images were returned to their systems.

Table 9. Available functions of computerized systems related to results management

Does your main practice site have a computerized system for…	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Viewing lab results								
Yes	450	**73.0**	162	**80.2**	174	65.9	188	71.2
No	135	21.9	28	13.9	75	28.4	64	24.2
Don't know	3	0.5	1	0.5	3	1.1	3	1.1
Missing	28	4.6	11	5.4	12	4.6	9	3.4
If yes, are electronic images returned								
Yes	226	50.2	95	58.6	98	56.3	111	59.0
No	134	29.8	43	26.5	53	30.5	44	23.4
Don't know	67	14.9	15	9.3	14	8.0	20	10.6
Missing	23	5.1	9	5.6	9	5.2	13	6.9
Viewing imaging results								
Yes	342	55.5	124	61.4	125	47.3	125	47.3
No	221	35.9	57	28.2	115	43.6	108	40.9
Don't know	16	2.6	4	2.0	7	2.7	11	4.2
Missing	37	6.0	17	8.4	17	6.4	20	7.6
If yes, are electronic images returned								
Yes	199	58.2	78	62.9	79	63.2	75	60.0
No	58	17.0	21	16.9	16	12.8	25	20.0
Don't know	59	17.2	15	12.1	12	9.6	13	10.4
Missing	26	7.6	10	8.1	18	14.4	12	9.6

Note. Values in bold text represent statistically significant differences between 2011 and 2013 (p<0.05)

Relatively few physicians have computerized systems that enable public health reporting, although the proportions increased significantly in both sub-samples: from 6-7% in 2011 to 10-11% in 2013 (Table 10).

Table 10. Available functions of computerized systems related to public health reporting

Does your main practice site have a computerized system for…	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Public health reporting								
Yes	42	**6.8**	23	**11.4**	15	**5.7**	25	**9.5**
No	408	66.2	99	49.0	186	70.4	159	60.2
Don't know	135	21.9	66	32.7	48	18.2	67	25.4
Missing	31	5.0	14	6.9	15	5.7	13	4.9
If yes, are notifiable disease reports sent electronically								
Yes	11	26.2	7	30.4	7	46.7	6	24.0
No	19	45.2	7	30.4	6	40.0	14	56.0
Don't know	10	23.8	3	13.0	0	0.0	3	12.0
Missing	2	4.8	6	26.1	2	13.3	2	8.0

Note. Values in bold text represent statistically significant differences between 2011 and 2013 (p<0.05)

Support for creating or receiving information related to continuity of care was also relatively uncommon, but tended to increase from 2011 to 2013 (Table 11).

Table 11. Available functions of computerized systems related to continuity of care

Does your main practice site have a computerized system for…	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Generating CCDs								
Yes	72	**11.7**	53	**26.2**	35	13.3	45	17.1
No	347	56.33	65	32.2	154	58.3	133	50.4
Don't know	165	26.8	71	35.2	61	23.1	73	27.6
Missing	32	5.2	13	6.4	14	5.3	13	4.9
Receiving CCDs								
Yes	42	**6.8**	39	**19.3**	20	7.6	24	9.1
No	349	56.7	56	27.7	159	60.2	123	46.6
Don't know	182	29.6	76	37.6	66	25.0	75	28.4
Missing	43	7.0	31	15.4	19	7.2	42	15.9
Generating CCRs								
Yes	54	**8.8**	43	**21.3**	28	**10.6**	37	**14.0**
No	340	55.2	63	31.2	152	57.6	129	48.9
Don't know	184	29.9	78	38.6	65	24.6	76	28.8
Missing	38	6.2	18	8.9	19	7.2	22	8.3
Receiving CCRs								
Yes	37	**6.0**	34	**16.8**	18	**6.8**	26	**9.9**
No	351	57.0	59	29.2	157	59.5	120	45.4
Don't know	190	30.8	78	38.6	68	25.8	77	29.2
Missing	38	6.2	31	15.3	21	7.9	41	15.5

Note. Values in bold text represent statistically significant differences between 2011 and 2013 ($p<0.05$)

Computerized systems that generated reminders for guideline-based interventions and screenings increased significantly from around 25% in 2011 to 33-41% in 2013 (Table 12). Over a third of physicians reported that their computerized systems were capable of providing patients with electronic copies of health information and clinical summaries of visits.

Table 12 Available functions of computerized systems related to patient-centered practice

Does your main practice site have a computerized system for…	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Generating reminders for guideline-based interventions								
Yes	151	**24.5**	82	**40.6**	71	**26.9**	87	**32.9**
No	367	59.6	64	31.7	161	61.0	126	47.7
Don't know	63	10.2	39	19.3	17	6.4	32	12.1
Missing	35	5.7	17	8.4	15	5.7	19	7.2
Providing patients with an electronic copy of health info.[1]								
Yes			94	46.5			91	34.5
No			57	28.2			103	39.0
Don't know			23	11.4			16	6.1
Missing			28	13.9			54	20.4
Providing patients with clinical summaries at each visit[1]								
Yes			97	48.0			102	38.6
No			54	26.7			94	35.6
Don't know			20	9.9			13	4.9
Missing			31	15.3			55	20.8

[1]Question added in second round of survey.

Note. Values in bold text represent statistically significant differences between 2011 and 2013 (p<0.05)

However, *having* a computerized system that is capable of a particular clinical function is not the same as *using* that function. The following figures summarize the extent to which physicians used each clinical function available in their computerized systems. The length of the bars is a general indicator of the proportion of physicians with computerized systems that were capable of each function. (Note that these proportions do not align exactly with the percentages in Table 12, because some physicians who reported that their practice had a computerized system that supported each clinical function did not always answer the subsequent question about frequency of use.)

The segments within each bar represent the proportion of physicians using each function most or all of the time, some of the time, none of the time, or felt it was not applicable to their practice. Comparing the 2011 and 2013 bars, we can see that the proportion of physicians who reported using each clinical function "most or all of the time" increased over time. For the 2011 baseline and 2013 follow-up samples (Figure 8), the prevalence of five clinical functions increased by 10 or more percentage points: medication lists (37% to 51%), record clinical notes (39% to 50%), order radiology tests (20% to 31%), and patient problem lists (35% to 45%).

Figure 7. Use of each clinical function within physicians' current computer systems (2011 Cohort 1, N=616 and 2013 Cohort 2, N=202)

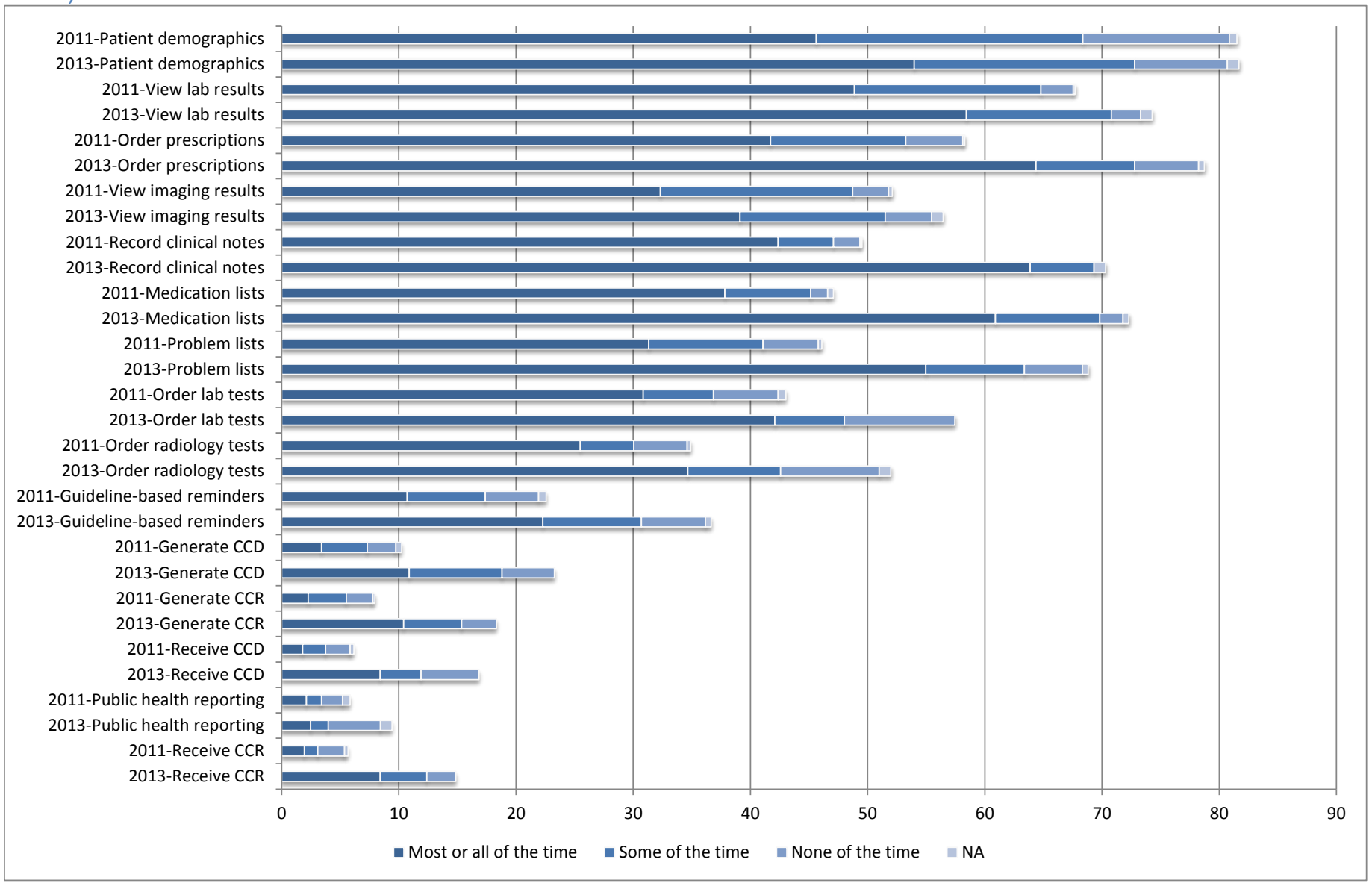
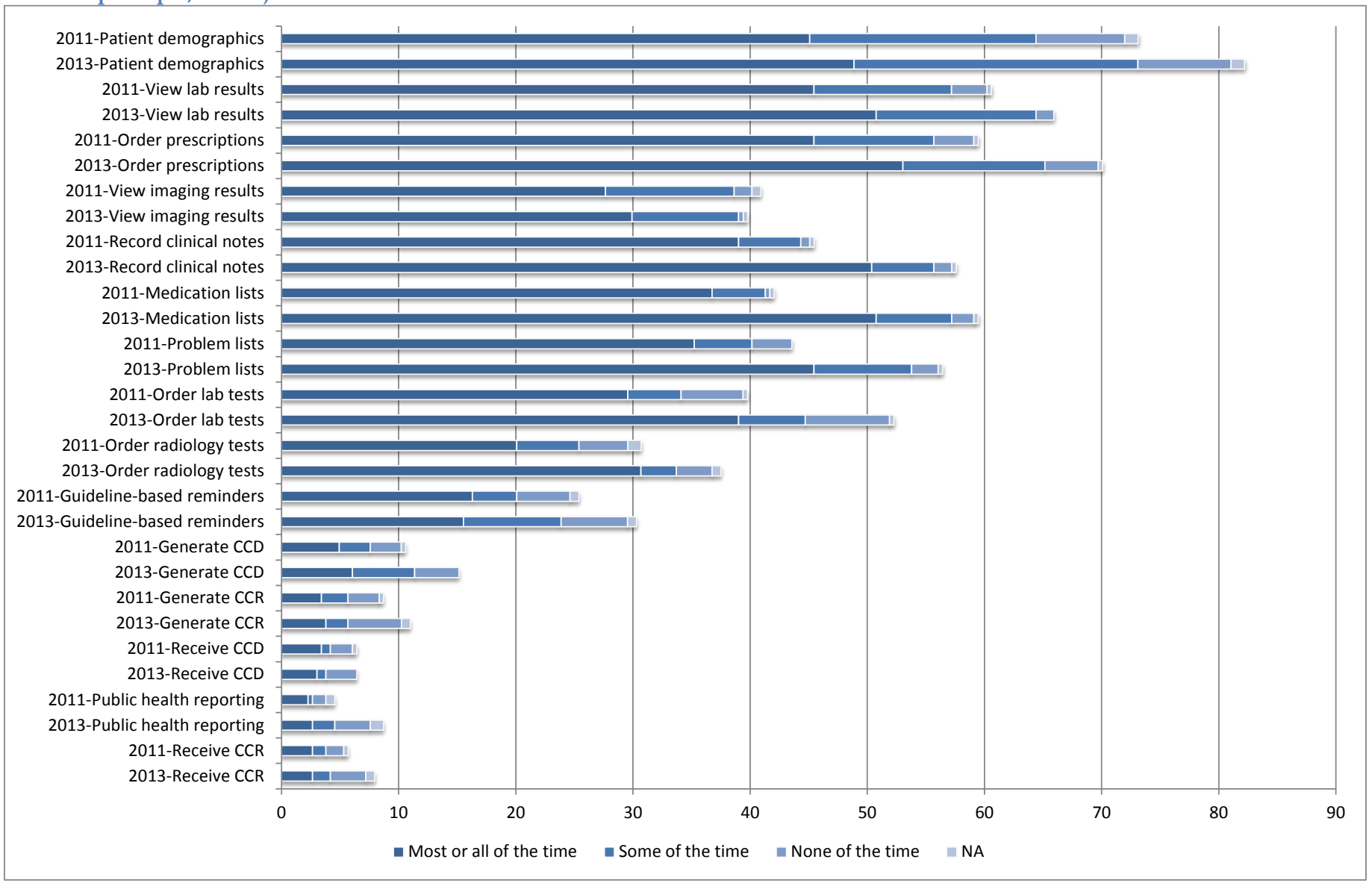


Figure 8. Use of each clinical function within physicians' current computer systems (2011 Baseline sample, N=264 and 2013 Follow-Up sample, N=264)



Acquisition and implementation of EHR system

Table 13 shows that, in the 2011 survey, 38-40% of physicians said their practice had fully implemented an EHR system. In the 2013 survey, the proportion of practices with fully-implemented EHR systems increased significantly to 62% for the Cohort 2 sub-sample and to 53% for the follow-up sub-sample. Of those physicians whose practices had acquired or were in the process of implementing their EHR system, around one half expected to have completed their implementation within the next 12 months. Among physicians whose practices were in the process of implementing or had fully implemented their EHR system, between 20-30% had been using the system for more than five years and the phased implementation approach was the most common.

Table 13. EHR system acquisition and implementation

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
EHR adoption	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Fully implemented	227	**37.8**	126	**62.4**	105	**39.8**	141	**53.4**
Implementation in process	111	18.0	23	11.4	34	12.9	39	14.8
Acquired but not implemented	36	5.8	12	5.9	11	4.2	6	2.3
Plan to acquire in next year	61	9.9	8	4.0	26	9.9	6	2.3
Plan to acquire in next 2 years	60	9.7	8	4.0	19	7.2	12	4.5
No plans to acquire	102	16.6	20	9.9	64	24.2	56	21.2
Missing	19	3.1	5	2.5	5	1.9	4	1.5
If you have purchased or are in the process of implementing an EHR system, within how many months do you expect to have completed implementation?								
	(*N*=147)		(*N*=35)		(*N*=45)		(*N*=45)	
Within 6 months	53	36.0	11	31.4	17	37.8	11	24.4
Within 7-12 months	37	25.2	8	22.9	11	24.4	9	20.0
Not for a year or more	28	19.1	3	8.6	7	15.6	5	11.1
Missing	29	19.7	13	37.1	10	22.2	20	44.4
If you are in the process of implementing or have fully implemented an EHR system…								
	(*N*=338)		(*N*=149)		(*N*=139)		(*N*=180)	
How many years have you been using an EHR								
Less than one year	24	7.1	23	15.4	8	5.8	24	13.3
One year	26	7.7	13	8.7	12	8.6	14	7.8
Two years	28	8.3	21	14.1	10	7.2	19	10.6
Three years	30	8.9	23	15.4	24	17.3	23	12.8
Four years	23	6.8	9	6.0	10	7.2	11	6.1
Five years	17	5.0	13	8.7	11	7.9	9	5.0
Greater than five years	76	22.5	38	25.5	28	20.1	52	28.9
Missing	114	33.7	9	6.0	36	25.9	28	15.6
How did you implement your EHR								
Phased	108	31.9	84	56.4	58	41.7	90	50.0
All at once	100	29.6	48	32.2	38	27.3	63	35.0
Neither phased nor all at once	13	3.8	7	4.7	3	2.2	2	1.1
Missing	117	34.6	10	6.7	40	28.8	25	13.9

Note. Values in bold text represent statistically significant differences between 2011 and 2013 ($p<0.05$)

Twelve month period prevalence of EHR implementation

Another way to measure the prevalence of EHR implementation involves specifying a particular period of time during which physicians' implementation of EHR is assessed. Considering the calendar year 2013, we calculated the prevalence of EHR implementation among the 465 unique physicians who completed a survey during 2013 (which included physicians who participated in the first round of data collection that extended into 2013 and physicians who participated in the second round of data collection that began in July 2013). We combined these two groups in order to measure prevalence of EHR implementation rather than to identify change in the prevalence of implementation over time. During 2013, 57.2% of physicians reported their main practice site had fully-implemented EHR systems and 13.3% were in the process of implementing an EHR.

Factors associated with EHR adoption

We examined factors that were associated with EHR adoption (defined as being in the process of implementing or having fully implemented an EHR system), estimating separate models for each sub-sample. Factors that were significantly associated ($p<.05$) with having an EHR in the bivariate analyses were included in multivariable logistic regression models. These factors included demographic characteristics (sex, age, years practicing medicine, practice specialty, and self-rated computer experience), practice characteristics (number of physicians in the practice, practice type) and perceived barriers to EHR adoption (amount of capital needed to acquire and implement an EHR system, concern about inappropriate disclosure of patient information, and concern about illegal record tampering).

In 2011, the odds of EHR adoption were higher among Cohort 1 physicians who reported they had "a lot" of computer experience (OR=1.65), who worked in larger practice groups compared with physicians in solo practice (4-6 physicians OR=2.46; 7+ physicians OR=2.39), or who characterized their practice setting as "other" (OR 2.97) compared with solo practice. Please see Appendix C, Table C 1 for detailed results from the logistic regression analysis. Similarly, the odds of EHR adoption were higher among 2011 baseline sub-sample physicians who reported they had "a lot" of computer experience (OR=3.6) compared with "some, a little or no experience," or who worked in larger practice groups compared with physicians in solo practice (7+ physicians OR=5.32). In addition, the odds of EHR adoption were higher among these physicians who thought concerns about inappropriate disclosure of patient information represented a "minor" barrier to adoption (OR=3.83) (versus "not a barrier") or who characterized their practice setting as "other" (OR 8.74) compared with solo practice. Please see Appendix C, Table C 3 for detailed results from the logistic regression analysis.

In 2013, the odds of EHR adoption were higher among Cohort 2 primary care (versus specialty care) physicians (OR=3.59). Please see Appendix C, Table C 2 for detailed results from the logistic regression analysis. Follow-Up sub-sample physicians who worked in larger practice groups had higher odds of EHR adoption compared with physicians in solo practice (4-6 physicians OR=3.55; 7+ physicians OR=12.96). In addition, physicians in this sub-sample who thought concerns about inappropriate disclosure of patient information represented a "major" barrier to adoption (versus "not a barrier") had lower odds of EHR adoption (OR=0.14). Please see Appendix C, Table C 4 for detailed results from the logistic regression analysis.

EHR system provider

Allscripts was the EHR provider used by around 1 in 5 physicians in the 2011 Baseline and 2013 Follow-Up sub-samples, and by around 1 in 4 physicians in Cohort 1 and Cohort 2 (Table 14). Approximately 30-40% of physicians named another EHR system provider. We examined the write-in responses for the "other" category and found the most common EHR system providers were: (a) CPRS (mentioned 4 times by 1.8% of the 2011 Cohort 1 sub-sample), (b) Athena and SRS (both mentioned 3 times by 2.4% of the 2013 Cohort 2 sub-sample), (c) CPRS, Greenway, Igenix Caretracker, McKesson Practice Partner, Medinotes, and SRS (each mentioned 2 times by 1.9% of the 2011 Baseline sub-sample), and (d) Greenway (mentioned 5 times by 3.5% of the 2013 Follow-Up sub-sample).

Table 14. EHR system provider

	2011 Cohort 1 (*N*=227)		2013 Cohort 2 (*N*=126)		2011 Baseline (*N*=105)		2013 Follow-Up (*N*=141)	
EHR provider	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Allscripts	53	23.3	32	25.4	19	18.1	26	18.4
eClinicalWorks	18	7.9	6	4.7	12	11.4	14	9.9
Sage/Vitera	10	4.4	5	4.0	4	3.8	6	4.3
GE	9	4.0	2	1.6	6	5.7	4	2.8
Meditech	9	4.0	4	3.2	3	2.9	2	1.4
NextGen	9	4.0	17	13.5	8	7.6	13	9.2
Eclipsys	6	2.6	0	0.0	2	1.9	1	0.7
Cerner	5	2.2	1	0.8	3	2.9	3	2.1
Epic	2	0.9	16	12.7	0	0.0	14	9.9
eMDs	0	0.0	0	0.0	0	0.0	1	0.7
MED3000	0	0.0	3	2.4	0	0.0	2	1.4
Other	93	41.0	37	29.4	43	40.9	52	36.9
Unknown	8	3.5	1	0.8	1	0.9	2	1.4
Missing	5	2.2	2	1.6	4	3.8	1	0.7

Effects of EHR system on clinical practice

Physicians whose practices had fully implemented an EHR system were asked to assess the effect that the EHR system had on various aspects of health care. In terms of quality of care, Table 15 shows the percentage of physicians who felt that their EHR system had a positive effect on the quality of clinical decisions ranged from 36% to 52% across the sub-samples. However, 38-51% of physicians felt that their EHR system had no effect on the quality of clinical decisions. The majority of physicians said that their EHR system had a positive effect on timely access to medical records. More than half of physicians said their EHR system had a positive effect on preventing medication errors. Notably, few physicians felt their EHRs had a negative effect on quality of care.

We caution against comparing these percentages across time because physicians whose practices had not fully implemented an EHR in the first round of data collection (and were not included in the calculation of percentages for that period) may have implemented an EHR by the second round (and were included in the calculation of percentages for that period for the

first time). Because the composition of the groups varied over time, it is not possible to infer patterns of change based on differences in percentages.

Table 15. Effect of EHR system on quality of care

	2011 Cohort 1 (*N*=227)		2013 Cohort 2 (*N*=126)		2011 Baseline (*N*=105)		2013 Follow-Up (*N*=141)	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Quality of clinical decisions								
Major positive effect	31	13.7	10	7.9	15	14.3	13	9.2
Positive effect	89	39.2	43	34.1	35	33.3	39	27.7
No effect	87	38.3	58	46.0	48	45.7	72	51.1
Negative effect	7	3.1	5	4.0	4	3.8	6	4.3
Major negative effect	2	0.9	2	1.6	0	0.0	3	2.1
Not applicable	4	1.8	1	0.8	0	0.0	2	1.4
Missing	7	3.1	7	5.6	3	2.9	6	4.3
Timely access to medical records								
Major positive effect	114	50.2	58	46.0	61	58.1	60	42.5
Positive effect	86	37.9	50	39.7	28	26.7	57	40.4
No effect	11	4.8	10	7.9	12	11.4	18	12.8
Negative effect	6	2.6	2	1.6	2	1.9	1	0.7
Major negative effect	1	0.4	1	0.8	0	0.0	1	0.7
Not applicable	2	0.9	1	0.8	0	0.0	0	0.0
Missing	7	3.1	4	3.2	2	1.9	4	2.8
Avoidance of medication errors								
Major positive effect	31	13.7	20	15.9	26	24.8	16	11.3
Positive effect	107	47.1	55	43.6	35	33.3	60	42.5
No effect	60	26.4	38	30.2	35	33.3	49	34.7
Negative effect	10	4.4	4	3.2	3	2.9	8	5.7
Major negative effect	1	0.4	0	0.0	1	0.9	0	0.0
Not applicable	10	4.4	3	2.4	1	0.9	3	2.1
Missing	8	3.5	6	4.8	4	3.8	5	3.5

Between 64-74% of physicians reported that their EHR system had a positive effect on prescription refills (Table 16). EHR systems appeared to have limited effects on the delivery of preventive and chronic disease care meeting practice guidelines. Relatively few physicians felt their EHR had a negative effect on the delivery of care.

Table 16. Effect of EHR system on delivery of care

	2011 Cohort 1 (*N*=227)		2013 Cohort 2 (*N*=126)		2011 Baseline (*N*=105)		2013 Follow-Up (*N*=141)	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Prescription refills								
Major positive effect	85	37.4	50	39.7	50	47.6	54	38.3
Positive effect	60	26.4	39	31.0	28	26.7	50	35.5
No effect	42	18.5	21	16.7	14	13.3	22	15.6
Negative effect	3	1.3	3	2.4	5	4.8	3	2.1
Major negative effect	2	0.9	1	0.8	0	0.0	1	0.7
Not applicable	26	11.4	8	6.3	3	2.9	7	5.0
Missing	9	4.0	4	3.2	5	4.8	4	2.8
Delivery of preventive care that meets guidelines								
Major positive effect	19	8.4	12	9.5	16	15.2	9	6.4
Positive effect	54	23.8	41	32.5	25	23.8	36	25.5
No effect	108	47.6	52	41.3	51	48.6	73	51.8
Negative effect	2	0.9	2	1.6	0	0.0	0	0.0
Major negative effect	1	0.4	1	0.8	0	0.0	0	0.0
Not applicable	35	15.4	14	11.1	10	9.5	19	13.5
Missing	8	3.5	4	3.2	3	2.9	4	2.8
Delivery of chronic illness care that meets guidelines								
Major positive effect	17	7.5	13	10.3	13	12.4	10	7.1
Positive effect	63	27.7	34	27.0	22	20.9	29	20.6
No effect	100	44.0	56	44.4	53	50.5	75	53.2
Negative effect	2	0.9	1	0.8	0	0.0	1	0.7
Major negative effect	1	0.4	1	0.8	0	0.0	0	0.0
Not applicable	37	16.3	17	13.5	12	11.4	21	14.9
Missing	7	3.1	4	3.2	5	4.8	5	3.5

The majority of physicians indicated that their EHR system had improved communication with other providers (Table 17). However, around 4 in 10 physicians said their EHR system had no effect on their communication with patients.

Table 17. Effect of EHR system on communication

	2011 Cohort 1 (*N*=227)		2013 Cohort 2 (*N*=126)		2011 Baseline (*N*=105)		2013 Follow-Up (*N*=141)	
	N	%	N	%	N	%	N	%
Communication with other providers								
Major positive effect	54	23.8	20	15.9	21	20.0	20	14.2
Positive effect	110	48.5	54	42.9	52	49.5	69	48.9
No effect	46	20.3	39	31.0	26	24.8	36	25.5
Negative effect	11	4.8	7	5.6	2	1.9	10	7.1
Major negative effect	1	0.4	1	0.8	0	0.0	1	0.7
Not applicable	2	0.9	1	0.8	1	0.9	1	0.7
Missing	3	1.3	4	3.2	3	2.9	4	2.8
Communication with patients								
Major positive effect	22	9.7	10	7.9	12	11.4	11	7.8
Positive effect	73	32.2	38	30.2	41	39.1	59	41.8
No effect	102	44.9	58	46.0	46	43.8	56	39.7
Negative effect	12	5.3	9	7.1	3	2.9	8	5.7
Major negative effect	5	2.2	2	1.6	0	0.0	1	0.7
Not applicable	7	3.1	3	2.4	1	0.9	2	1.4
Missing	6	2.6	6	4.8	2	1.9	4	2.8

Satisfaction with EHR system

More than half of physicians whose practices had fully-implemented EHR systems were satisfied their systems (Table 18). Although the proportion of physicians who were satisfied with their EHR systems appeared to decline slightly between 2011 and 2013, it is difficult to make direct comparisons between these values because answering this question depended on the physician's practice having a fully-implemented EHR system, and that condition may have changed between 2011 and 2013.

Table 18. Satisfaction with EHR system

Satisfaction with EHR system at main practice site	2011 Cohort 1 (*N*=227)		2013 Cohort 2 (*N*=126)		2011 Baseline (*N*=105)		2013 Follow-Up (*N*=141)	
	N	%	N	%	N	%	N	%
Very satisfied	36	15.9	17	13.5	16	15.2	18	12.8
Satisfied	109	48.0	53	42.1	45	42.9	55	39.0
Neutral	34	15.0	20	15.9	17	16.2	28	19.9
Unsatisfied	27	11.9	21	16.7	14	13.3	29	20.6
Very Unsatisfied	18	7.9	9	7.1	9	8.6	5	3.5
Missing	3	1.3	6	4.8	4	3.8	6	4.3

Physicians' comments about their EHR system (Figure 9 and Figure 10) cited the convenience of being able to access records from multiple locations and share information with other providers as benefits. However problems with their systems' usability, the learning curve required to use the system, decreased productivity, the amount of time that using the system has added to their work day, and the subsequent decrease in time spent seeing patients, were noted as challenges.

Figure 9. Comments from physicians who were satisfied/neutral about their EHR system

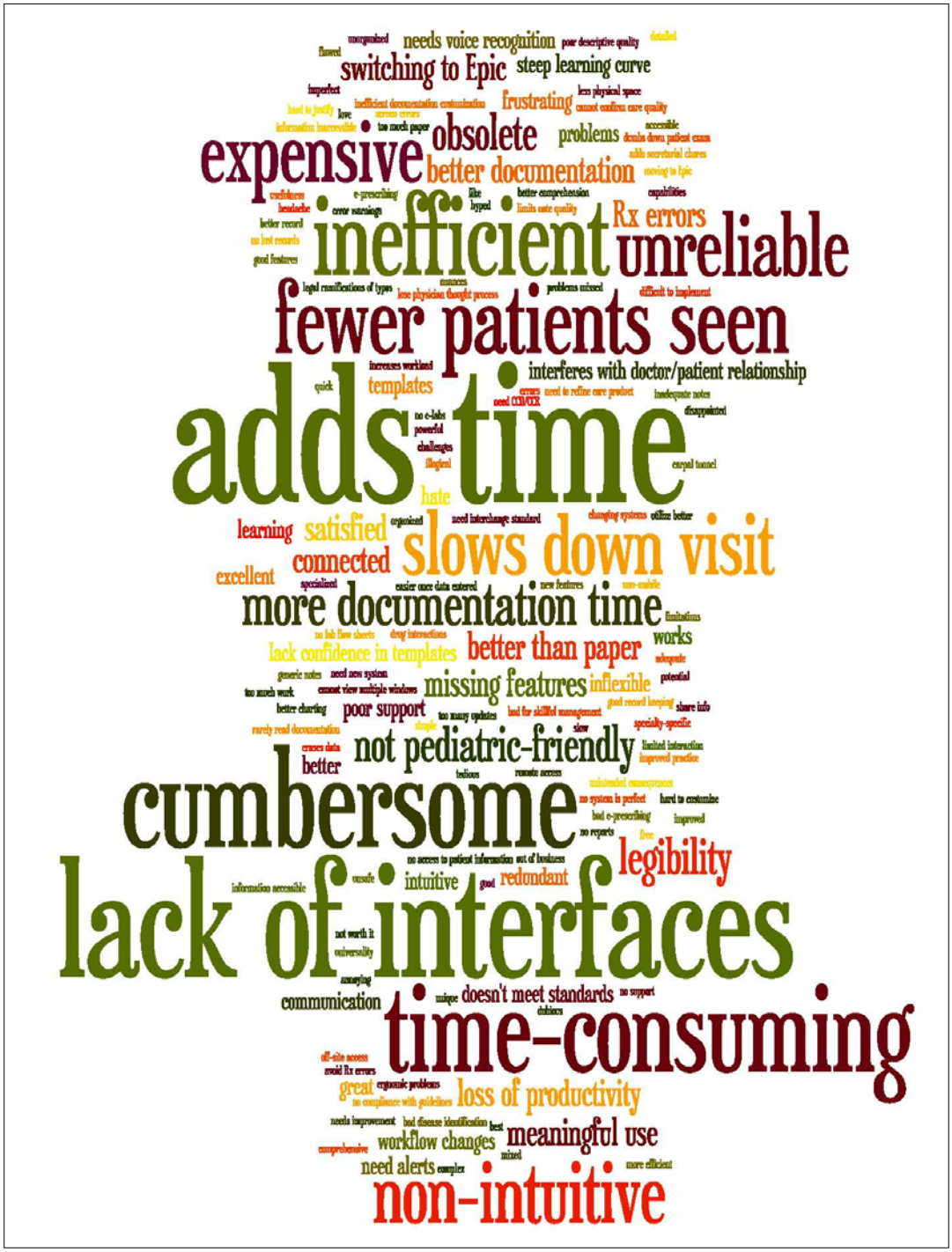


Figure 10. Comments from physicians who were dissatisfied with their EHR system

It is interesting to note that physicians who were satisfied and neutral about their EHRs (Figure 9) and those who were dissatisfied with their EHRs (Figure 10) had very similar comments, suggesting that the process of using an EHR was time-consuming, reduced the amount of time available to see patients, was cumbersome to use, and expensive, to name a few. It is important to understand that even though physicians support the use of EHRs, the current EHR technologies are not user-friendly and mostly inefficient.

EHR system integration and certification standards

Around one-third of physicians said that their EHR was integrated with a hospital system and the majority said their system met federal certification standards (Table 19). A sizable minority (14-29%) of physicians did not know if their EHR system met federal certification standards, however.

Table 19. EHR system integration and certification standards

	2011 Cohort 1 (*N*=227)		2013 Cohort 2 (*N*=126)		2011 Baseline (*N*=105)		2013 Follow-Up (*N*=141)	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
EHR integrated with a hospital system								
Yes	75	33.0	44	34.9	32	30.5	53	37.6
No	147	64.8	77	61.1	70	66.7	83	58.9
Don't know	2	0.9	1	0.8	1	0.9	1	0.7
Missing	3	1.3	4	3.2	2	1.9	4	2.8
EHR meets federal certification standards								
Yes	144	63.4	100	79.4	77	73.3	116	82.3
No	14	6.2	2	1.6	4	3.8	4	2.8
Don't know	65	28.6	23	18.2	22	20.9	20	14.2
Missing	4	1.8	1	0.8	2	1.9	1	0.7

Centers for Medicare and Medicaid EHR incentive programs

Survey items pertaining to EHR incentive programs were added in 2013. Over a third of physicians did not know if they qualified for the Centers for Medicare and Medicaid EHR incentive programs (Table 20).

Table 20 EHR incentive program qualification

Per the standards set forth in the CMS EHR incentive programs, do you…	**2013 Cohort 2 (*N*=202)**		**2013 Follow-Up (*N*=264)**	
Qualify for Medicaid EHR incentive program	29	14.4	33	12.5
Qualify for Medicare EHR incentive program	74	36.6	71	26.9
Don't know if qualified for EHR incentive program	91	45.0	100	37.9

Among the small number of physicians who used an EHR system and qualified for the Medicaid EHR incentive program, most of the physicians who applied for a CMS AIU incentive payment were approved (Table 21). Between 4-5 in 10 physicians had attested to Medicaid Stage 1 meaningful use of an EHR and had been approved for an incentive payment. Far fewer physicians had done so for Stage 2 meaningful use, however.

Table 21. Medicaid EHR incentives

If you use an EHR system and qualify for the Medicaid EHR incentive program, have you…	2013 Cohort 2 (*N*=24)		2013 Follow-Up (*N*=26)	
Applied for a CMS Adopt, Implement, Upgrade (AIU) incentive payment				
Yes	6	25.0	12	46.1
No	1	4.2	0	0.0
Don't know	7	29.2	11	42.3
Missing	10	41.7	3	11.5
Been approved for a CMS Adopt, Implement, Upgrade (AIU) incentive payment				
Yes	6	25.0	10	38.5
No	0	0.0	1	3.9
Don't know	8	33.3	12	46.1
Missing	10	41.7	3	11.5
Attested to Medicaid Stage 1 Meaningful Use of an EHR				
Yes	10	41.7	14	53.9
No	0	0.0	1	3.8
Don't know	5	20.8	9	34.6
Missing	9	37.5	2	7.7
Been approved for Medicaid Stage 1 Meaningful Use of an EHR incentive payment				
Yes	11	45.8	14	53.8
No	0	0.0	0	0.0
Don't know	5	20.8	10	38.5
Missing	8	33.3	2	7.7
Attested to Medicaid Stage 2 Meaningful Use of an EHR				
Yes	2	8.3	6	23.1
No	2	8.3	5	19.2
Don't know	9	37.5	11	42.3
Missing	11	45.8	4	15.4
Been approved for Medicaid Stage 2 Meaningful Use of an EHR incentive payment				
Yes	4	16.7	5	19.2
No	2	8.3	4	15.4
Don't know	9	37.5	12	46.2
Missing	9	37.5	5	19.2

Among the physicians who used an EHR system and qualified for the Medicare EHR incentive programs, more than half had attested to Medicare Stage 1 meaningful use of an EHR and had been approved for an incentive payment (Table 22). Between 20-38% of physicians had attested to Medicare Stage 2 meaningful use of an EHR and 15-24% had been approved for the Stage 2 MU EHR incentive payment.

Table 22. Medicare EHR incentives

If you use an EHR system and qualify for the Medicare EHR incentive program, have you…	2013 Cohort 2 (*N*=61)		2013 Follow-Up (*N*=58)	
Attested to Medicare Stage 1 Meaningful Use of an EHR				
Yes	33	54.1	43	74.1
No	5	8.2	1	1.7
Don't know	6	9.8	7	12.1
Missing	17	27.9	7	12.1
Been approved for Medicare Stage 1 Meaningful Use of an EHR incentive payment				
Yes	31	50.8	39	67.2
No	6	9.8	1	1.7
Don't know	7	11.5	11	19.0
Missing	17	27.9	7	12.1
Attested to Medicare Stage 2 Meaningful Use of an EHR				
Yes	12	19.7	22	37.9
No	17	27.9	19	32.8
Don't know	10	16.4	9	15.5
Missing	22	36.1	8	13.8
Been approved for Medicare Stage 2 Meaningful Use of an EHR incentive payment				
Yes	9	14.8	14	24.1
No	16	26.2	19	32.8
Don't know	14	22.9	15	25.9
Missing	22	36.1	10	17.2

Incentives for EHR adoption

Apart from the EHR incentives offered by the Centers for Medicaid and Medicare Services, physicians were asked to rate the effect various policy changes would have on their decision to adopt an EHR system (Table 23). If their main practice site had already implemented an EHR system, physicians were asked to rate the effect of these policy changes for physicians in general.

Around half of physicians said that incentives and additional payments would have a major positive effect on the decision to adopt an EHR system. Around 40% of physicians felt that legal protection from personal liability in the event of privacy and security breaches would have a major positive effect on EHR adoption decisions. More than half of physicians felt that certification standards could have a major or minor positive effect on the decision to adopt an EHR. Finally, around 20% of physicians said that the decision to adopt an EHR could be motivated by legal liability arising from not using the latest technology.

Table 23. Effect of policy changes on decision to implement an EHR system

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
LEGAL OR REGULATORY INCENTIVES								
Change the law to protect physicians from personal liability for record tampering by external parties or for privacy and security breaches								
Major positive effect	254	41.2	73	36.1	95	36.0	101	38.3
Minor positive effect	195	31.7	62	30.7	92	34.8	78	29.6
No effect	91	14.8	31	15.4	49	18.6	50	18.9
Minor negative effect	2	0.3	2	1.0	2	0.8	4	1.5
Major negative effect	6	1.0	2	1.0	2	0.8	3	1.1
Missing	68	11.0	32	15.8	24	9.1	28	10.6
Legal liability as a result of not using the latest technology								
Major positive effect	121	19.6	39	19.3	54	20.5	45	17.0
Minor positive effect	141	22.9	52	25.7	61	23.1	68	25.8
No effect	112	18.2	42	20.8	54	20.5	64	24.2
Minor negative effect	65	10.6	20	9.9	27	10.2	31	11.7
Major negative effect	107	17.4	18	8.9	36	13.6	26	9.9
Missing	70	11.4	31	15.4	32	12.1	30	11.4
STATE OF THE TECHNOLOGY								
Published certification standards that indicate whether an EHR has the necessary capabilities and functions								
Major positive effect	213	34.6	56	27.7	76	28.8	80	30.3
Minor positive effect	209	33.9	62	30.7	86	32.6	91	34.5
No effect	102	16.6	44	21.8	61	23.1	54	20.4
Minor negative effect	13	2.11	4	2.0	9	3.4	6	2.3
Major negative effect	10	1.6	3	1.5	4	1.5	5	1.9
Missing	69	11.2	33	16.3	28	10.6	28	10.6
FINANCIAL INCENTIVES								
Incentives for the adoption of an EHR								
Major positive effect	304	49.3	105	52.0	123	46.6	125	47.4
Minor positive effect	164	26.6	41	20.3	68	25.8	73	27.6
No effect	65	10.6	21	10.4	36	13.6	36	13.6
Minor negative effect	6	1.0	1	0.5	3	1.1	0	0.0
Major negative effect	3	0.5	3	1.5	3	1.1	1	0.4
Missing	74	12.0	31	15.3	31	11.7	29	11.0
Additional payment for the use of an EHR								
Major positive effect	328	53.3	106	52.5	132	50.0	120	45.5
Minor positive effect	138	22.4	35	17.3	60	22.7	70	26.5
No effect	60	9.7	20	9.9	33	12.5	33	12.5
Minor negative effect	5	0.8	3	1.5	5	1.9	4	1.5
Major negative effect	12	1.9	7	3.5	5	1.9	6	2.3
Missing	73	11.9	31	15.3	29	11.0	31	11.7

Barriers to EHR adoption

Physicians evaluated a variety of barriers to EHR adoption, whether or not their practice had implemented an EHR. As shown in Table 24, EHR-related costs were seen as a significant barrier by the majority of physicians. Around half of physicians cited uncertainty about the return on their investment in an EHR as a major barrier to adoption.

Table 24. Financial barriers related to EHR adoption

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
The amount of capital needed to acquire/implement an EHR								
Major barrier	410	66.6	131	64.9	184	69.7	173	65.5
Minor barrier	112	18.2	30	14.8	45	17.1	47	17.8
Not a barrier	46	7.5	18	8.9	13	4.9	25	9.5
Missing	48	7.8	23	11.4	22	8.3	19	7.2
Uncertainty about the return on investment								
Major barrier	295	47.9	105	52.0	155	58.7	144	54.5
Minor barrier	171	27.8	42	20.8	47	17.8	58	22.0
Not a barrier	82	13.3	23	11.4	35	13.3	35	13.3
Missing	68	11.0	32	15.8	27	10.2	27	10.2

Concern about having the capacity to undertake all phases of EHR implementation (i.e., to select, contract, install, and implement an EHR system) was mentioned by 37-47% of physicians (Table 25). Between 30% and 37% of physicians mentioned physician resistance as a major barrier to EHR adoption.

Table 25. Organizational barriers related to EHR adoption

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Resistance to adoption among physicians								
Major barrier	184	29.9	55	27.2	97	36.7	94	35.6
Minor barrier	266	43.2	81	40.1	86	32.6	107	40.5
Not a barrier	114	18.5	36	17.8	54	20.5	44	16.7
Missing	52	8.4	30	14.8	27	10.2	19	7.2
Capacity to select, contract, install, and implement an EHR								
Major barrier	273	44.3	75	37.1	117	44.3	123	46.6
Minor barrier	221	35.9	67	33.2	84	31.8	79	29.9
Not a barrier	75	12.2	29	14.4	40	15.2	38	14.4
Missing	47	7.6	31	15.3	23	8.7	24	9.1
Concern about the loss of productivity during transition to the EHR								
Major barrier	325	52.8	112	55.4	149	65.4	163	61.7
Minor barrier	177	28.7	46	22.8	69	26.1	54	20.5
Not a barrier	65	10.5	14	6.9	21	8.8	23	8.7
Missing	49	7.9	30	14.8	25	9.5	24	9.1

Physicians appeared relatively unconcerned about legal barriers to EHR adoption (Table 26). Between two-thirds and three-quarters of physicians said concerns about inappropriate disclosure of patient information, illegal record tampering, or legal liability resulting from patients' access to medical records were minor barriers or not barriers at all to EHR adoption. The majority (around 90%) did not think that adoption would be constrained by concerns about the legality of a hospital-donated EHR.

Table 26. Legal or regulatory barriers related to EHR adoption

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Concerns about inappropriate disclosure of patient information								
Major barrier	111	18.0	34	16.8	57	21.6	62	23.5
Minor barrier	235	38.1	73	36.1	101	38.6	107	40.5
Not a barrier	221	35.9	68	33.7	94	31.8	77	29.2
Missing	49	7.9	27	13.4	22	8.2	18	6.8
Concern about illegal record tampering								
Major barrier	101	16.4	31	15.3	51	19.3	52	19.7
Minor barrier	223	36.2	68	33.7	98	37.1	99	37.5
Not a barrier	242	39.3	76	37.6	93	35.2	92	34.8
Missing	50	8.1	27	13.4	22	8.3	21	8.0
Concern about physicians' legal liability if physicians have more access to information in their medical records								
Major barrier	82	13.3	23	11.4	38	14.4	42	15.9
Minor barrier	217	35.2	73	36.1	105	39.8	97	36.7
Not a barrier	259	42.0	77	38.1	96	36.4	103	39.0
Missing	58	9.4	29	14.4	25	9.5	22	8.3
Concern about the legality of accepting an EHR that is donated from a hospital								
Major barrier	67	10.9	20	9.9	26	9.9	27	10.2
Minor barrier	164	26.6	48	23.8	88	33.3	71	26.9
Not a barrier	321	52.1	99	49.0	122	46.2	140	53.0
Missing	64	10.4	34	17.3	28	10.6	26	9.8

Finding an EHR system that meets providers' needs was mentioned as a barrier by more than half of physicians (Table 27). Between 41-46% of physicians expressed concerns that the EHR system would become obsolete.

Table 27. Technology barriers related to EHR adoption

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Finding an EHR system that meets providers' needs								
Major barrier	346	56.2	102	50.5	143	54.2	153	58.0
Minor barrier	159	25.8	48	23.8	66	25.0	64	24.2
Not a barrier	56	9.1	24	11.9	30	11.4	28	10.6
Missing	55	8.9	28	13.9	25	9.5	19	7.2
Concerns that the system will become obsolete								
Major barrier	262	42.5	82	40.6	115	43.6	122	46.2
Minor barrier	225	36.5	66	32.7	92	34.9	89	33.7
Not a barrier	76	12.3	25	12.4	33	12.5	32	12.1
Missing	53	8.6	29	14.4	24	9.1	21	8.0

Health information exchange and personal health records

As shown in Table 28, most (60-64%) physicians were not familiar with the Connecticut Health Information Exchange (CT-HIE). Questions added during the 2013 survey revealed a similar pattern, with more than half of physicians saying they had not heard of CT-HIE. A few physicians reported having used the CT-HIE in 2013, but these responses likely reflect physicians' misunderstanding the question or data entry error, as the CT-HIE is still not operational. More than three-quarters of physicians had not heard of Connecticut's Regional Extension Center (REC) (eHealthConnecticut) and the majority (63-73%) had not used REC services. Although the majority of physicians' write-in comments echoed the lack of awareness of the CT-HIE, other comments suggested physicians were interested in learning more about the CT-HIE or looking forward to using it when it is established (Figure 11).

Figure 11. Physicians' comments about the Connecticut Health Information Exchange

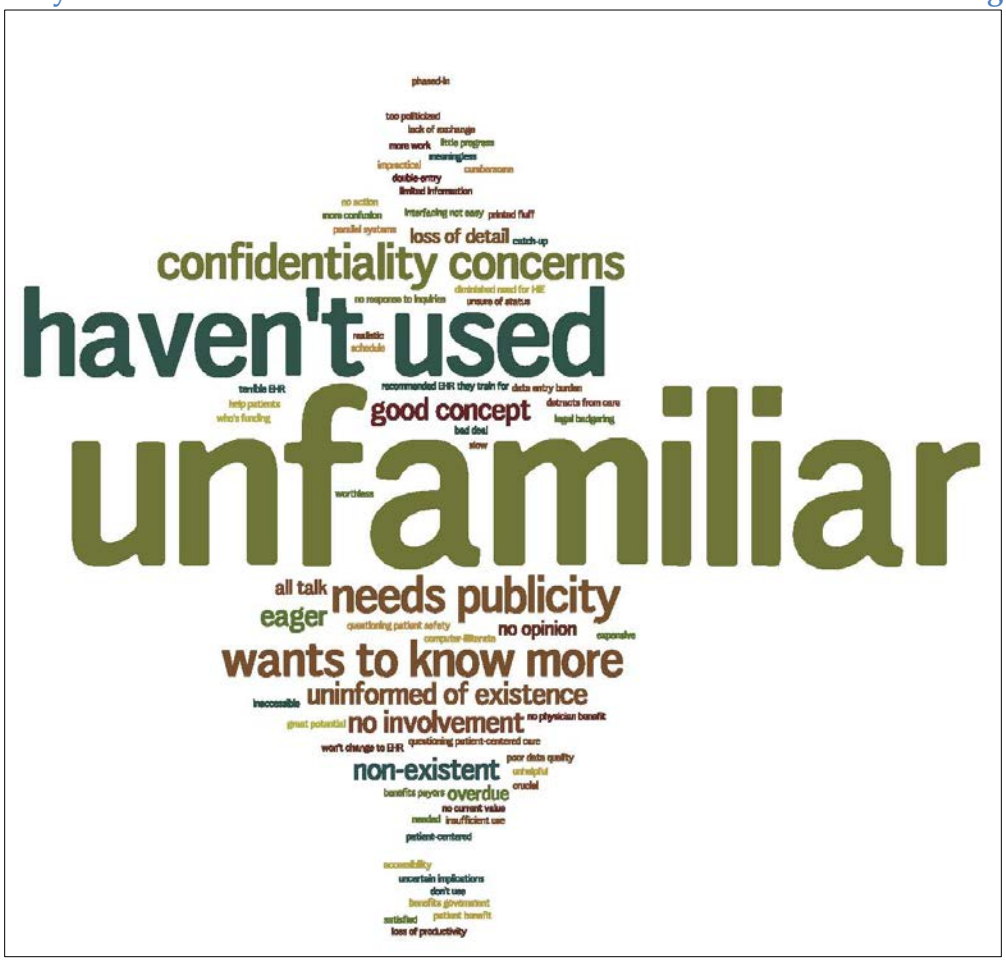


Table 28. Perceptions and use of health information exchange and personal health records

	2011 Cohort 1 (*N*=616)		2013 Cohort 2 (*N*=202)		2011 Baseline (*N*=264)		2013 Follow-Up (*N*=264)	
	N	%	N	%	N	%	N	%
Familiarity with the Connecticut Health Information Exchange								
Very familiar	11	1.8	7	3.5	5	1.9	2	0.8
Somewhat familiar	65	10.5	31	15.3	33	12.5	42	15.9
A little familiar	90	14.6	32	15.8	37	14.0	48	18.2
Not familiar	396	64.3	122	60.4	159	60.2	165	62.5
Missing	54	8.8	10	5.0	30	11.4	7	2.6
Heard of the Connecticut Health Information Exchange[1]								
Yes			68	33.7			69	26.1
No			114	56.4			147	55.7
Missing			20	9.9			48	18.2
Used the Connecticut Health Information Exchange[1]								
Yes			4	2.0			4	1.5
No			137	67.8			133	50.4
Missing			61	30.2			127	48.1
Satisfaction with the Connecticut Health Information Exchange								
Very satisfied	1	0.2	0	0.0	0	0.0	0	0.0
Satisfied	9	1.5	2	1.0	4	1.5	2	0.8
Neutral	104	16.9	41	20.3	52	19.7	51	19.3
Unsatisfied	16	2.6	1	0.5	2	0.8	3	1.1
Very unsatisfied	4	0.6	2	1.0	2	0.8	3	1.1
Missing	482	78.2	156	77.2	204	77.3	205	77.7
Heard of the Regional Extension Center[1]								
Yes			17	8.4			15	5.7
No			163	80.7			197	74.6
Missing			22	10.9			52	19.7
Used the Regional Extension Center[1]								
Yes			1	0.5			8	3.0
No			147	72.8			166	62.9
Missing			54	26.7			90	34.1
Support for widespread adoption of PHR for patients								
Yes	293	47.6	92	45.5	104	39.4	105	39.8
No	58	9.4	17	8.4	31	11.7	32	12.1
Don't know	234	38.0	81	40.1	120	45.4	111	42.0
Missing	31	5.0	12	5.9	9	3.4	16	6.1

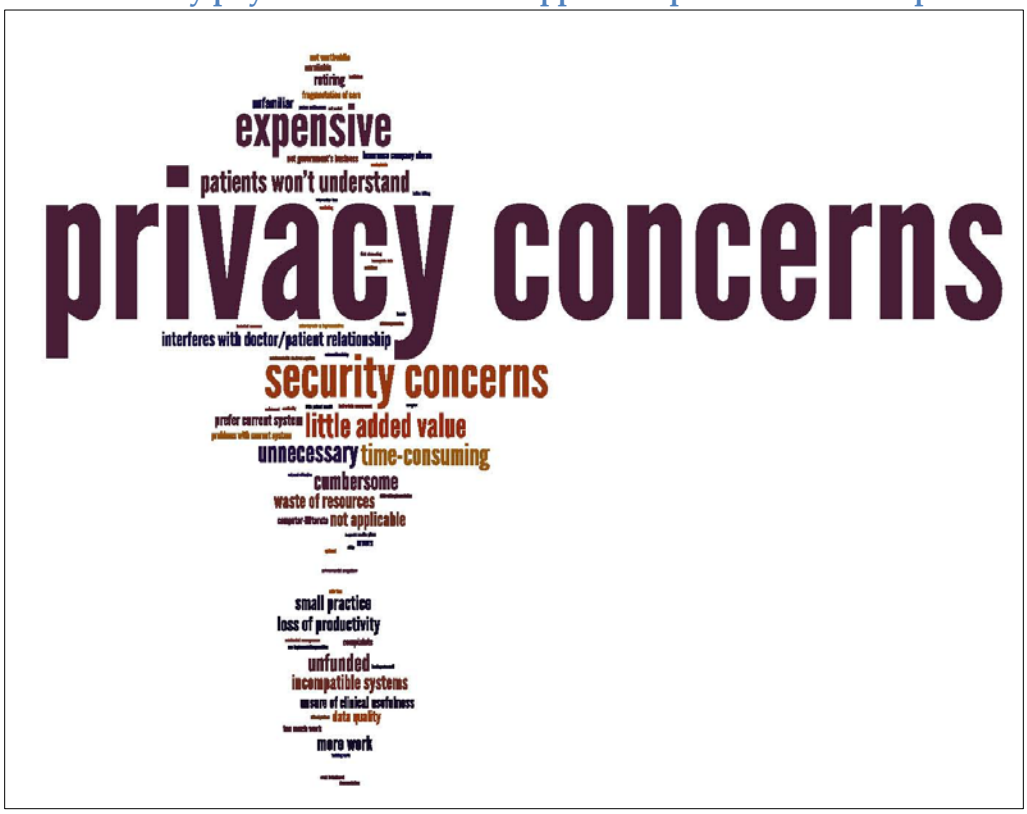
[1]Question added in second round of survey.

Support for the adoption of personal health records (PHRs) for their patients was endorsed by 40% or more of physicians. When asked why they supported adoption of PHRs, physicians offered a variety of reasons related to improvements in health care quality, safety, efficiency, and patient empowerment. Figure 12 provides a word cloud that represents some of the reasons why physicians supported adoption of PHRs by patients.

Figure 12. Reasons why physicians support adoption of PHRs for patients

Conversely, 38-40% of physicians said they did not know if they would support such systems. Physicians were also asked why they would not support PHRs for their patients. Reasons given for lack of support for PHRs included concerns about privacy and security, lack of interest or technology skills, perceived lack of benefit to patients, and cost (both in terms of time and money) (Figure 13).

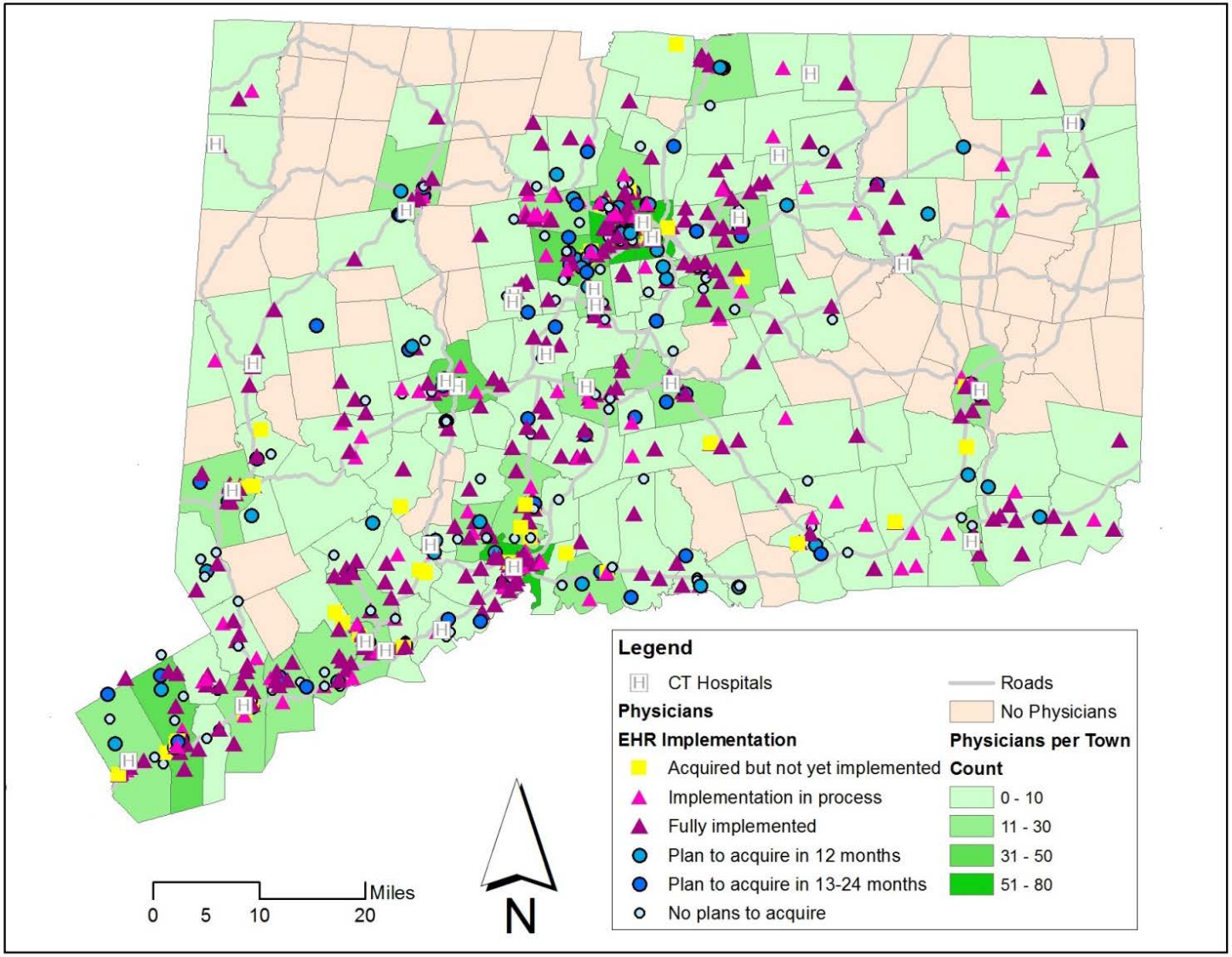
Figure 13. Reasons why physicians would not support adoption of PHRs for patients



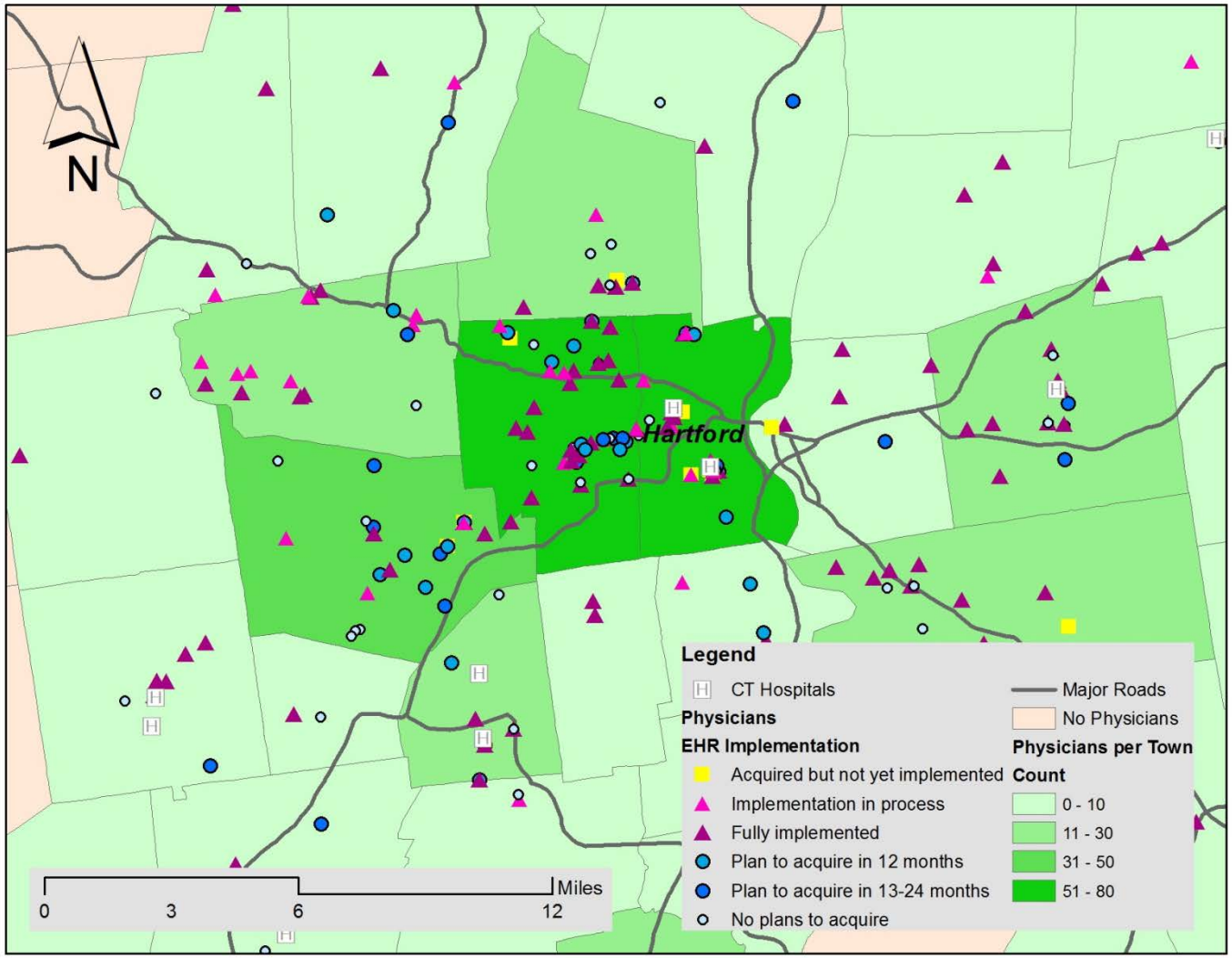
Location of Physicians in Connecticut

Using address information obtained from Connecticut's Department of Public Health licensure database and the Department of Social Services' Medicaid Provider Enrollment list, unique physicians (N=1082) were mapped to evaluate clustering versus dispersion of physicians by location. The number of physicians by town varied from 0-80. Eighty physicians were located in Hartford, followed by 66 in New Haven and 52 in West Hartford. We did not have any physician responses from 50 towns. Seven out of ten (N =759) physicians were located within five miles of a hospital. There were 271 (25%) physicians who were within five miles of I-95, west of New Haven. Consequently, physicians have easy access to hospitals for referrals and care-coordination. There were very few physicians responding to our survey from Northeast Connecticut and Litchfield County. Map 1 on the following page depicts the physicians who have adopted EHRs, those who have purchased but not implemented, and those who have not acquired EHRs. Map 2 provides a detailed view of EHR adoption among physicians in the Hartford metropolitan area.

Map 1. Location of Physicians by EHR Adoption



Map 2. Location of Physicians in Hartford by EHR Adoption



Discussion

Physicians' use of HIT

This survey documented Connecticut physicians' awareness and use of a variety of health information technologies. By 2013, more than half of physicians reported their practices had implemented an EHR system, over 87% of physicians who had computerized systems capable of ordering prescriptions were submitting prescriptions electronically, over 71% of physicians who had computerized systems capable of ordering lab tests were submitting lab orders electronically, and more than 60% of physicians were submitting claims electronically.

These results are encouraging, and provide evidence that Connecticut physicians are doing well in some important areas of HIT use. National estimates from 2011 (published in 2013) indicated that 55% of office-based physicians were able to send prescription orders electronically (versus 87-88% of the physicians in our 2013 sub-samples) and 35% were able to send lab orders electronically (versus 71-75% of the physicians in in our 2013 sub-samples).[93]

Yet there is also room for improvement. Despite the fact that the proportion of Connecticut physicians with fully-implemented EHR systems has grown over time (and over 80% of EHR systems in the 2013 sub-samples met federal certification standards for EHRs set by ONC), the state still lags the nation on this measure. The most recent estimates of EHR implementation obtained from our survey (53-62% in the 2013 sub-samples) were lower than the national estimate reported in the NAMCS, where "78% of office-based physicians used any type of EHR system in 2013."[48] Unlike the NAMCS, our sample also included physicians who practiced in a hospital or medical center. However, more than two-thirds of our respondents were office-based physicians and, among office-based physicians in our 2013 sub-samples, the prevalence of EHR implementation was still lower than the national level (58-64%). A variety of factors (e.g., physician attitudes and preferences, market factors, state laws and policies) may contribute to this gap. In the next sections, we discuss survey results that may help to explain why EHR implementation in Connecticut remains below the national trends.

Physicians' attitudes toward EHR systems

Although more than half of physicians whose practices had fully-implemented EHR systems said they were satisfied with their systems and commented on benefits such as the convenience of being able to access records from multiple locations and share information with other providers, around 1 in 5 physicians reported they were not satisfied with their EHR systems. Problems with EHR systems' usability, the learning curve required to use the system effectively, decreased productivity, the amount of time that using the system added to the work day, and the subsequent decrease in time spent seeing patients were noted as challenges by physicians in their write-in comments. These results suggest the need to improve EHR systems' ease of use and functionality to motivate widespread adoption[38] and to deliver the gains in efficiency promised by EHR proponents. As Ash and Bates observed, "physicians are not resistant to technology; they have embraced many new medical technologies with no hesitation….however, they are reluctant to adopt new ways of doing things that interfere with their workflow and that they perceive take time away from their patient care work."[94]

Between 10% and 24% of physicians in Connecticut declared they had no plans to acquire an EHR system. Nearly 3 in 10 (28%) of physicians in this group were psychiatrists. Unfortunately, our survey did not ask physicians to explain why they did not plan to introduce an EHR system into their practice, so we can only speculate that the potential advantages of EHR systems may hold varying degrees of appeal to physicians in different practice specialties. Also, much of the increase in EHR adoption can be attributed to the participation of practitioners in the *EHR Incentive Program* that is being administered by the Centers for Medicare and Medicaid (CMS). Smaller practices maybe less likely to adopt certified technologies as they may not be eligible for these federal incentives that can help offset costs associated with adoption of certified technologies.

In terms of EHR systems' influence on clinical practice, the positive effects cited by physicians were related to providing timely access to medical records, refilling prescriptions, and communicating with other providers. In contrast, EHR systems were perceived by physicians as having little effect on the quality of clinical decisions, delivery of preventive care, or communicating with patients. It appears that physicians appreciate the ways in which EHR systems can improve those processes that are more efficient when conducted electronically (e.g., prescription refills) at the same time they recognize EHR systems' limitations when it comes to practices that require greater human interaction to be effective (e.g., clinical decision making). As DesRoches et al. point out, "The quality and cost effects of electronic health records need to be confirmed by direct studies of clinical outcomes. Considerable controversy continues about the overall effect of electronic health records, and further research needs to clarify the effects of this technology on our health care system."[38]

Incentives and barriers related to EHR adoption

Consistent with results reported in a national survey,[38] policy changes that Connecticut physicians indicated would have a positive effect on the decision to implement an EHR included incentives for adoption and additional payments for using an EHR system. Yet, when physicians were asked if they qualified for any EHR incentive programs managed by CMS, 38-45% of physicians said they did not know if they qualified. Given physicians' responses indicating that incentives and payments would motivate their decision to adopt and use EHR systems, this result implies that there is an opportunity for extended outreach and education aimed at ensuring that physicians understand whether or not they are eligible to take advantage of these programs.

In light of these findings regarding financial incentives, it is not surprising that EHR-related costs and the uncertainty about realizing a return on their investment were seen as significant barriers to EHR adoption by many physicians. Financial barriers were also cited commonly by physicians in state[95] and national[38] studies. Although previous research has suggested that EHR implementation costs pose a greater barrier for smaller versus larger medical practices,[96] post-hoc analyses of our survey data (available on request) revealed that practice size was not associated with the likelihood of physicians' endorsing financial barriers to implementation. However, physicians from smaller practices *were* more likely to identify legal issues (e.g., inappropriate disclosure of or unauthorized access to patients' health information, concerns about the legality of accepting a system donated by a hospital) as major barriers to EHR adoption compared with physicians from larger practices. Other EHR-related costs pertained to

the associated learning curve and workflow changes that result from converting from a paper-based system to an EHR system. Concern about the potential loss of productivity during the transition to an EHR system has been reported as another adoption barrier by physicians in national[38] and state[95] studies, and our results agreed with those findings.

It seems apparent that physicians are concerned about both the direct and indirect costs that EHR adoption may impose on their practice and earnings. Although the CMS incentive programs address the issue of direct costs for some physicians, the concern about indirect costs points to the need for technical assistance that will support physicians' making the transition to EHR systems with minimal effects on the productivity of their practice.

As was true of physicians surveyed nationally[38], physicians in this study also highlighted the challenge of finding an EHR system that meets their needs as a barrier to adoption. Despite commercial availability of a variety of EHR systems, the specific needs of different practices and specialties are unlikely to be accommodated by a generic EHR system unless it incorporates sufficient flexibility to permit end-user customizations that are relatively easy for non-programmers to implement. As one physician commented:

> I want so much to be able to be positive, but I've been through 3 EHRs and none have really done any of the things I wanted. My current EHR helps with streamlining patient charting, but isn't much help in reminding me that certain labs ought to be checked at a certain frequency for example and the integrated e-prescribing is so bad I got rid of it for a stand-alone e-prescribing system.

Physician and practice characteristics related to EHR adoption

In terms of physician characteristics, younger age has been associated with EHR adoption in previous research, [53,58,59] whereas evidence has been mixed with respect to gender[38,55,56] and practice type (i.e., primary versus specialty care practice). [38,44] We found no support for age or gender differences in the odds of EHR adoption, but we did identify a positive association with primary care practice. After adjusting for other demographic and practice characteristics, the odds of EHR adoption among primary care physicians were 3.6 times greater than the odds of adoption by specialty care physicians.

Differences in measurement and methodology may explain our discrepant findings in terms of gender and age. For example, among those studies that found an association with younger age and EHR adoption, one study examined age without controlling for other physician and practice characteristics[53] (whereas our models controlled for several physician and practice characteristics), another study evaluated *imminent* EHR adoption as an outcome[58] (whereas our outcome variable measured EHR adoption that was underway or completed), and another study examined whether age was associated with change in EHR adoption over the course of a two-wave panel study[59] (whereas we investigated the association between age and EHR adoption in a cross-sectional context). It is also possible that including both the number of years in practice and age in the multivariable model suppressed the association between age and EHR adoption because of the correlation between age and number of years in practice.

Several practice characteristics have been linked with EHR adoption in previous studies, including clinical setting (i.e., outpatient primary care versus hospital-based),[38] practice type (i.e., single specialty, multi-specialty, solo practice),[44,46] and practice size.[38,95] Due to the extent of missing data (10-13%) in our survey responses, it was not possible to determine if clinical setting was associated with EHR adoption. We did observe a positive relationship between practice type and EHR adoption, but it was difficult to interpret as it indicated that physicians who reported their practice type as "other" had higher odds of EHR adoption than physicians in solo practice. Finally, in line with results reported by national[38] and state[95] surveys, we found that practice size was positively associated with EHR adoption. After adjusting for other demographic and practice characteristics, the odds of EHR adoption among physicians from larger (7+ physicians) practice groups were 2.4 to 5.3 times greater than the odds of adoption in a solo practice. Burt and Sisk speculated that this practice size differential reflects the ability of larger practices to distribute the costs of acquiring and implementing an EHR system across multiple physicians,[96] an option not available to smaller or solo practices. In addition, many smaller practices do not have fully staffed IT departments, and EHR implementations typically need IT infrastructure and support to be successful.

Computer experience was also positively associated with EHR adoption in this study. The odds of EHR adoption among physicians who described themselves as having "a lot" of computer experience were 1.6 to 3.6 times the odds of adoption for physicians who characterized their computer experience as "some, a little, or none." Because both computer experience and EHR adoption were assessed at the same time, it is not possible to determine whether physicians with greater technological expertise were more inclined to have an EHR system or if physicians developed greater confidence in their computer skills as a result of working with their EHR system. We plan to explore this question in the future using the surveys completed by the 264 physicians who participated in both rounds of data collection.

Health information exchange and personal health records

Over 60% of physicians were not familiar with the Connecticut Health Information Exchange, suggesting there is a great need to market and promote the work being done by the CT-HIE. Many physicians commented that they had never heard of the CT-HIE prior to taking the survey. Others expressed interest in learning more about the CT-HIE or were looking forward to using it once it existed. A few physicians who *had* heard of the CT-HIE felt it was "too politicized," represented "another blow to patient privacy," "has been all talk and no action," and was "worthless…I tried for a month to access this for help but gave up." Although these sentiments were relatively infrequent, they suggest that some of those physicians who *were* acquainted with the CT-HIE have developed a negative impression of its value or potential.

The fact that many states struggled to build query-based exchanges may have a lot to do with how the funds were made available to the states to increase both EHR adoption and stand up HIEs at the same time. It would have been beneficial to sequence the funding so that increasing adoption of EHRs was the initial goal, followed by building HIEs to facilitate exchange of health information. This approach would also have been in sequence with the implementation of meaningful use 1 and 2. Instead, physicians and hospitals were expected to start exchanging standards-based patient documents at the same time they were trying to implement health information technologies.

Physician support for widespread adoption of PHRs for patients varied, with 39-48% of physicians endorsing the idea and 38-45% expressing uncertainty. Physicians who supported PHRs offered a variety of reasons related to improvements in health care quality, safety, efficiency, and patient empowerment. Those who did not support PHRs cited concerns about privacy and security, lack of interest or technology skills, perceived lack of benefit to patients, and cost (both in terms of time and money). These results highlight the divergent attitudes held by physicians and health care consumers toward PHRs. In a nationally-representative survey conducted in 2011, Gaylin and colleagues reported that more than two-thirds (68%) of US adults were interested in using a PHR.[97] Perhaps consumer demand will persuade those physicians who harbor doubts about the utility of PHRs to reevaluate their positions. On the other hand, it is also possible that consumers' interest may wane as they acquire more direct experience with PHRs that are publicly available now (e.g., Microsoft's HealthVault), and they are able to compare the purported benefits of PHRs with what they are actually able to deliver.

Limitations

There are several limitations to this study that should be noted. Our findings are based on physicians' self-reports, which we did not verify independently. We chose physicians rather than practices as the unit of analysis because the CMS EHR incentive programs are offered to physicians rather than practices. As a result of that choice, it is possible that more than one physician from the same practice completed a survey, and the correlation between their responses may overstate the prevalence of various measures that are unique at the practice level (e.g., EHR implementation). We also did not account for the possibility that the physicians who participated in both rounds of data collection may have experienced a change in clinical setting (e.g., moving from an outpatient primary care setting to a hospital setting) that could have contributed to changes in their responses.

We were unable to confirm previous findings suggesting an association between EHR adoption and patients' method of payment (i.e., Medicare, Medicaid, private insurance, or self-pay) because of substantial amounts of missing data (14-28%) among those survey items. Rather than relying on physicians' self-report, future research might benefit from developing measures of patients' payment mix from claims data.

Although our sample was fairly large, the physicians who responded to our survey differed from those who did not in terms of age, race, practice type, and methods used to store patients' health records. It is also possible that survey respondents and non-respondents may have differed along other dimensions, but we were only able to compare those variables that were collected by both the postcard survey and the in-depth survey. We were able to control for age and practice type in our multivariable models, but not for race because the majority of physicians who responded to this survey were white. Because of this potential response bias, our results may not describe the general population of physicians practicing in Connecticut.

Our measure of EHR implementation was fairly generic and the survey item did not provide physicians with an explicit definition of what constituted an EHR system. As a result, physicians' responses to EHR-related questions may reflect systems with very different levels of functionality. Other studies[38,45] have distinguished EHR systems in terms of their capabilities (i.e., as basic or fully-functional systems). We investigated applying those criteria to physicians'

EHR systems in our study, but found that 44-56% of the systems could not be characterized as either basic or fully-functional, either because the system did not offer all of the required functions or because the physician did not answer all of the questions needed to classify the EHR system.

Conclusion

This study provided benchmark estimates of levels of EHR implementation and HIE awareness among Connecticut physicians between 2011 and 2013. Our results mirrored the gains made in EHR adoption that have been observed on the state and national levels. These findings also revealed that more remains to be done to address barriers to EHR implementation, to increase awareness of implementation incentives and their qualification criteria, to support physicians during the transition from paper-based to electronic medical systems, and to ensure that once an EHR system has been implemented, it enhances rather than detracts from patient care.

There is no clearly identified return on investment with respect to EHR adoption and no certified systems stand out as meeting even the most basic needs of the physicians. In particular, issues of EHR usability and the ability to accommodate various physicians' needs, along with the potentially negative effects on physician productivity should be addressed. Additionally, a better understanding of the different value and barriers that EHR systems may hold for particular practice specialties or clinical functions is needed. Our findings also emphasized the need for better communication with physicians regarding the activities of the CT-HIE and highlighted opportunities for improving physicians' perceptions of the value of the CT-HIE.

Describing Connecticut physicians' self-reported attitudes about EHRs and HIE represents a first step toward understanding their perspectives and identifying areas where incentives, technical support, outreach, and education might be worthwhile. An important next step involves examining what effects (if any) EHR systems and HIE have on patients' clinical outcomes in order to identify areas where the promises to improve health care quality and efficiency are being kept by these health information technologies, and where additional work remains.

Lastly, we would be remiss if we did not emphasize and underscore that the adoption of certified EHRs is only a means to an end: that of delivering safe, timely, effective, efficient, and person-centered care. The rate of EHR adoption is a measure of change, but we still need to demonstrate true *meaningful use* of information that is captured in these EHRs. If we attribute too much meaning to increasing EHR adoption rates, we will fall short of the true goal of realizing the triple aim of better patient experience, reduced costs, and improved health outcomes.

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Appendix A

Physician Postcard

Please complete the following survey and mail the postcard

1. Do you currently practice in the state of Connecticut? O Yes O No	ID
2. Your main practice site is : O Single specialty group/partnership O Multi specialty group/partnership O Solo practice	8. Roughly what percent of your patient revenue comes from the following? (Percentage should total 100%) _____% Medicare _____% Medicaid (including Husky. SAGA Medicaid LIA & Title 19) _____% Private insurance _____% Patient payments _____% Other (please specify)
3. How does your main practice site store patient information? O Paper medical records/charts stored in cabinets O Computerized system which stores scanned copies of paper records (DIMS) O Electronic Health Record O Both –paper and computerized O Other please specify: _____	
4. What is the year of your birth? _____	9. Which method of survey administration do you prefer? O Web-based(we will email you a survey link) O Regular mail O Telephone interview O In Person interview
5. What is your gender? O Male O Female	
6. What is your ethnicity? O Hispanic or Latino O Not Hispanic or Latino	
7. What is your race? O White O Black/African American O Asian O Native Hawaiian/Other Pacific Islander O American Indian/Alaska Native	Please supply us with the following information Email address: Telephone number:

University of Connecticut Health Center
Dept. of Community Medicine & Health Care
263 Farmington Avenue
Farmington, CT 06030-6325

FIRST CLASS
AUTO
US POSTAGE
PAID
PERMIT #13
FARMINGTON, CT

The UCHC HIE survey

Dear Doctor,

The University of Connecticut, under contract from the Department of Public Health, is conducting an evaluation of the development and implementation of the Health Information Exchange (HIE) in Connecticut. As a physician, you are an important stakeholder in this process and your support for this endeavor is essential for its success. We would greatly appreciate your help in filling out this brief introductory survey which will help us gather basic demographic information on the state of health information technology use in Connecticut. Additionally, you can expect to receive two more surveys over the next two years. We would like to make this as convenient for you as possible; therefore, please let us know which method of survey administration you would prefer: telephone, email, regular mail or an in-person interview. [This study has been approved by the University of Connecticut Health Center Institutional Review Board (IRB # 11-120-2).]

Instructions for completing the survey:

Please check the boxes which apply to you. Once you fill in the survey just drop it into the mailbox. No postage is necessary. At the end of the survey we have requested an email ID or a telephone number. This is optional.

We hope you will participate in this survey. If you have any questions, please contact me at:

Dr. Minakshi Tikoo, Ph.D.
Assistant Professor, Dept. of Community Medicine & Health Care
University of Connecticut Health Center
263 Farmington Avenue, CT 06030-6325
tikoo@uchc.edu (860-679-5559)

Baseline survey instrument

ID Number:_____

PHYSICIAN SURVEY: BASELINE
Health Information Technology Exchange of Connecticut: UCHC Evaluation

I. Practice Characteristics

1. At approximately how many practice sites do you encounter, communicate with, or treat patients?

   ☐ None
   ☐ One
   ☐ Two
   ☐ Three (or more, please fill in number: _____)

The following questions refer to characteristics of your main practice site, with your main practice site being the location at which you see the majority of your patients.

2. At what location do you see the majority of your patients?
   ☐ Hospital or medical center
   ☐ Long-term care facility (nursing homes, specialty care hospitals, specialized rehabilitation units)
   ☐ Outpatient (primary care clinics, subspecialty clinics, medical and surgical specialties)
   ☐ Outpatient laboratories, radiological services and ancillary services
   ☐ Other: _____

3. What type of practice is your main practice site?
   ☐ Single specialty group or partnership
   ☐ Multi-specialty group or partnership
   ☐ Solo practice
   ☐ Other

4. Approximately, what percent of your patient visits occur at your main practice site?

   _____ (percent)

5. How many physicians, including you, are based within this practice site?

   _____

6. What type of setting characterizes the location of your main practice site?
   ☐ Urban
   ☐ Rural
   ☐ Neither urban nor rural

7. Are you or your practice affiliated with the VA system?

   ☐ Yes

   (Please explain)

   _____

   _____

   _____

   ☐ No

8. During your last full week of work, approximately how many patient visits took place at your main practice site?

   _____.

9. How much experience do you have with computers?

   ☐ A lot
   ☐ Some
   ☐ A little
   ☐ None

10. Does your main practice site have a computerized system for any of the following? *Please indicate whether the feature is available to you, and if the feature is unavailable, please skip the "use" portion of the question.*

	Availability			**Use**			
	Yes	No	Don't know	I do not use	I use some of the time	I use most or all of the time	Not applicable to my practice
a) Patient demographics	☐	☐	☐	☐	☐	☐	☐
b) Patient problem lists	☐	☐	☐	☐	☐	☐	☐
c) Orders for prescriptions	☐	☐	☐	☐	☐	☐	☐
d) If yes, are there warnings of drug interactions or contraindications provided?	☐	☐	☐	☐	☐	☐	☐
e) If yes, are prescriptions sent electronically to the pharmacy?	☐	☐	☐	☐	☐	☐	☐
f) Orders for laboratory tests?	☐	☐	☐	☐	☐	☐	☐
g) If yes, are orders sent electronically?	☐	☐	☐	☐	☐	☐	☐
h) Orders for radiology tests?	☐	☐	☐	☐	☐	☐	☐
i) If yes, are orders sent electronically?	☐	☐	☐	☐	☐	☐	☐
j) Viewing lab results?	☐	☐	☐	☐	☐	☐	☐
k) If yes, are electronic images returned?	☐	☐	☐	☐	☐	☐	☐
l) Viewing imaging results?	☐	☐	☐	☐	☐	☐	☐
m) If yes, are electronic images returned?	☐	☐	☐	☐	☐	☐	☐
n) Clinical notes?	☐	☐	☐	☐	☐	☐	☐
o) If yes, do they include medical history and follow up notes?	☐	☐	☐	☐	☐	☐	☐
p) Electronic lists of what medications each patient takes?	☐	☐	☐	☐	☐	☐	☐
q) Reminders for guideline-based interventions and/or screening tests?	☐	☐	☐	☐	☐	☐	☐
r) Public health reporting?	☐	☐	☐	☐	☐	☐	☐
s) If yes, are notifiable diseases sent electronically?	☐	☐	☐	☐	☐	☐	☐
***t)* Generating Continuity of Care Documents (CCD)?**	☐	☐	☐	☐	☐	☐	☐

u) Receiving CCD?	☐	☐	☐	☐	☐	☐	☐
v) Generating Continuity of Care Records (CCR)?	☐	☐	☐	☐	☐	☐	☐
w) Receiving CCR?	☐	☐	☐	☐	☐	☐	☐

11. Does the practice submit claims electronically (electronic billing)?
    - ☐ Yes, all electronic
    - ☐ Yes, part paper and part electronic
    - ☐ No
    - ☐ Unknown

II. Acquisition and Implementation of an EHR System

12. Describe how your health records system stores information for the majority of patients served by your practice. If your organization uses multiple technologies, choose the system used for the majority of patient health/medical records.
    - ☐ Paper medical records/charts filed in record cabinet
    - ☐ Computer-based system in which paper records/charts are scanned and scanned documents are filed electronically (DIMS)
    - ☐ An EHR system that stores patient medical and demographic information in a computer database that is accessed by computer terminals or other electronic means
    - ☐ Other: _____
13. Currently, what is your degree of electronic health record acquisition or implementation at your main practice site?
    - ☐ We have acquired an EHR system, but have not implemented it (go to Question 14)
    - ☐ Our EHR implementation is in process (go to Question 14)
    - ☐ We have fully implemented our EHR system (go to Question 15)
    - ☐ We plan to acquire an EHR system in the next 12 months (go to Question 22)
    - ☐ We plan to acquire an EHR system in the next 13-24 months (go to Question 22)
    - ☐ We have no plans to acquire an EHR system (go to Question 22)
14. If you have purchased and are in the process of implementing an EHR system, within how many months do you expect to have completed implementation?

    _____ months

If your main practice site uses paper records or is in the process of transitioning to an EHR system, please continue to Question 22. If your main practice site uses electronic health records, please continue to question 15.

III. Experience with Electronic Health Records

15. How many years have you been using an EHR in your main practice site?

- ☐ Less than one year
- ☐ One year
- ☐ Two years
- ☐ Three years
- ☐ Four years
- Five years
- ☐ More than five years

16. Please choose which word best describes the implementation of the EHR in your practice:

☐ Phased ☐ All at once ☐ Neither phased nor all at once

17. To what extent has the EHR system affected the following areas at your main practice site?

	Major positive impact	**Positive impact**	**No impact**	**Negative impact**	**Major negative impact**	**Not applicable**
a) The quality of clinical decisions	☐	☐	☐	☐	☐	☐
b) Communication with other providers	☐	☐	☐	☐	☐	☐
c) Communication with your patients	☐	☐	☐	☐	☐	☐
d) Prescription refills	☐	☐	☐	☐	☐	☐
e) Timely access to medical records	☐	☐	☐	☐	☐	☐
f) Avoiding medication errors	☐	☐	☐	☐	☐	☐
g) Delivery of preventive care that meets guidelines	☐	☐	☐	☐	☐	☐
h) Delivery of chronic illness care that meets guidelines	☐	☐	☐	☐	☐	☐

18. Overall, please rate your level of satisfaction with the EHR system at your main practice:

Very unsatisfied Unsatisfied Neutral Satisfied Very satisfied

Comment:

19. Is the electronic health record system at your main practice site integrated with a hospital system?

- ☐ Yes
- ☐ No
- ☐ Don't know

20. If you use an electronic health record system, does it meet federal certification standards?

- ☐ Yes
- ☐ No
- ☐ Don't know

21. What is the name of your current EHR system?

- ☐ Allscripts
- ☐ Eclipsys
- ☐ HealthPort
- ☐ Cerner
- ☐ MED3000
- ☐ Epic
- ☐ NextGen
- ☐ Meditech
- ☐ eMDs
- ☐ eClinicalWorks
- ☐ CHARTCARE
- ☐ Sage/Vitera
- ☐ GE
- ☐ Unknown
- ☐ Other:_____

22. How familiar are you with the Connecticut Health Information Exchange (HIE) Initiative?

- ☐ Very familiar
- ☐ Somewhat familiar
- ☐ A little familiar
- ☐ Not familiar at all

23. Overall, please rate your level of satisfaction with the Connecticut Health Information Exchange (HIE) Initiative:

Very unsatisfied Unsatisfied Neutral Satisfied Very satisfied

Comment:

_____

_____

_____

_____

_____

24. Would you support the widespread adoption of the personal health record (PHR) for your patients?

- ☐ Yes
- ☐ No
- ☐ Not sure

25. If yes, please describe why:

_____

_____

_____

_____

26. If no, please describe why not:

_____

_____

_____

IV. Barriers to EHR Adoption

27. Please answer the following questions regardless of whether your main practice site has an established EHR system or not.

	Major barrier	Minor barrier	Not a barrier
FINANCIAL BARRIERS			
a) The amount of capital needed to acquire/implement EHR	☐	☐	☐
b) Uncertainty about the return on investment	☐	☐	☐
ORGANIZATIONAL BARRIERS			
c) Resistance to adoption among physicians	☐	☐	☐
d) Capacity to select, contract, install, and implement an EHR	☐	☐	☐
e) Concern about the loss of productivity during transition to the EHR	☐	☐	☐
LEGAL OR REGULATORY BARRIERS			
f) Concerns about inappropriate disclosure of patient information	☐	☐	☐
g) Concerns about illegal record tampering	☐	☐	☐
h) Concerns about the legality of accepting an EHR that is donated from a hospital	☐	☐	☐
i) Concerns about physicians' legal liability if patients have more access to information in their medical records	☐	☐	☐
STATE OF THE TECHNOLOGY			
j) Finding an EHR system that meets providers' needs	☐	☐	☐
k) Concerns that the system will become obsolete	☐	☐	☐

V. Incentives for EHR Adoption

28. Please rate the impact that the following policy changes would have on your decision to adopt an EHR system. If your main practice has previously implemented an EHR system, please rate the impact of these possible policy changes for physicians in general.

	Major positive impact	Minor positive impact	No impact	Minor negative impact	Major negative impact
LEGAL OR REGULATORY INCENTIVES					
a) Change the law to protect physicians from personal liability for record tampering by external parties or for privacy and security breaches	☐	☐	☐	☐	☐
b) Legal liability as a result of NOT using the latest technology	☐	☐	☐	☐	☐
STATE OF THE TECHNOLOGY					
c) Published certification standards that indicate whether an EHR has the necessary capabilities and functions	☐	☐	☐	☐	☐
FINANCIAL INCENTIVES					
d) Incentives for the adoption of an EHR	☐	☐	☐	☐	☐
e) Additional payment for the use of an EHR	☐	☐	☐	☐	☐

VI. Practice Characteristics

29. What is the year of your birth?

19_____

30. What is your gender?

☐ Male

☐ Female

31. What is your ethnicity?

☐ Hispanic or Latino

☐ Not Hispanic or Latino

32. What is your race?

☐ White

☐ Black/African American
☐ Asian
☐ Native Hawaiian/Other Pacific Islander

☐ American Indian/Alaska Native

33. In what area are you board certified?

_____

34. In what year did you first practice medicine, after completing residency or fellowship?

19_____

35. Roughly, what percentage of your patient revenue comes from the following? (Percentage should total 100%).

_____ Medicare
_____ Medicaid (including Husky A, SAGA Medicaid LIA and Title 19)
_____ Private Insurance
_____ Patient payments
_____ Other: _____

36. What type of internet access does your organization have?

- ☐ No internet access
- ☐ Dial-up/non-broadband
- ☐ T-1
- ☐ Broadband – cable or digital subscriber line (DSL)
- ☐ Broadband – satellite
- ☐ Other

37. Does your organization need additional high speed internet access at any of its locations?

- ☐ Yes
- ☐ No
- ☐ Unsure

38. Who completed this survey?

- ☐ The physician to whom it was addressed
- ☐ Office staff
- ☐ Other: _____

Adapted from DesRoches C.M., Campbell E.G., Rao S.R., et al. (2008). Electronic health records in ambulatory care — A national survey of physicians. *N Engl J Med*, 359, 50-60.

Follow-Up survey instrument

ID Number:_____

PHYSICIAN SURVEY: FOLLOW-UP
Health Information Technology Exchange of Connecticut: UCHC Evaluation

I. Practice Characteristics

1. Do you currently practice within the state of Connecticut? *Only continue the survey if you practice in CT. If you no longer practice in CT, please simply send back the survey with that information specified.*

- ☐ Yes
- ☐ No

2. At approximately how many practice sites do you encounter, communicate with, or treat patients?

- ☐ None, I do not see any patients.
- ☐ One
- ☐ Two
- ☐ Three (or more, please fill in number: _____)

The following questions refer to characteristics of your main practice site, with your main practice site being the location at which you see the majority of your patients.

3. At what location do you see the majority of your patients?

- ☐ Hospital or medical center
- ☐ Long-term care facility (nursing homes, specialty care hospitals, specialized rehabilitation units)
- ☐ Outpatient (primary care clinics, subspecialty clinics, medical and surgical specialties)
- ☐ Outpatient laboratories, radiological services and ancillary services
- ☐ Other: _____

4. What type of practice is your main practice site?

- ☐ Single specialty group or partnership
- ☐ Multi-specialty group or partnership
- ☐ Solo practice
- ☐ Other: _____

5. Approximately what percent of your patient visits occur at your main practice site?

_____ (percent)

6. How many physicians are based within this practice site?

_____

7. What type of setting characterizes the location of your main practice site?

☐ Urban
☐ Rural
☐ Neither urban nor rural

8. Are you or your practice affiliated with the VA system?

☐ Yes
(Please explain)

_____
_____
_____

☐ No

9. During your last full week of work, approximately how many patient visits took place at your main practice site?

_____.

10. How much experience do you have with computers?

☐ A lot
☐ Some
☐ A little
☐ None

11. Does your main practice site have a computerized system for any of the following? *Please indicate whether the feature is available to you, and if the feature is unavailable, please skip the "use" portion of the question.*

	Availability			**Use**			
	Yes	No	Don't know	I do not use	I use some of the time	I use most or all of the time	Not applicable to my practice
a) Patient demographics	☐	☐	☐	☐	☐	☐	☐
b) Patient problem lists	☐	☐	☐	☐	☐	☐	☐
c) Orders for prescriptions	☐	☐	☐	☐	☐	☐	☐
d) If yes, are there warnings of drug interactions or contraindications provided?	☐	☐	☐	☐	☐	☐	☐
e) If yes, are prescriptions sent electronically to the	☐	☐	☐	☐	☐	☐	☐

pharmacy?							
f) Orders for laboratory tests?	☐	☐	☐	☐	☐	☐	☐
g) If yes, are orders sent electronically?	☐	☐	☐	☐	☐	☐	☐
h) Orders for radiology tests?	☐	☐	☐	☐	☐	☐	☐
i) If yes, are orders sent electronically?	☐	☐	☐	☐	☐	☐	☐
j) Viewing lab results?	☐	☐	☐	☐	☐	☐	☐
k) If yes, are electronic images returned?	☐	☐	☐	☐	☐	☐	☐
l) Viewing imaging results?	☐	☐	☐	☐	☐	☐	☐
m) If yes, are electronic images returned?	☐	☐	☐	☐	☐	☐	☐
n) Clinical notes?	☐	☐	☐	☐	☐	☐	☐
o) If yes, do they include medical history and follow up notes?	☐	☐	☐	☐	☐	☐	☐
p) Electronic lists of what medications each patient takes?	☐	☐	☐	☐	☐	☐	☐
q) Reminders for guideline-based interventions and/or screening tests?	☐	☐	☐	☐	☐	☐	☐
r) Public health reporting?	☐	☐	☐	☐	☐	☐	☐
s) If yes, are notifiable diseases sent electronically?	☐	☐	☐	☐	☐	☐	☐
***t)* Continuity of Care Documents (CCD)?**	☐	☐	☐	☐	☐	☐	☐
u) Receiving CCD?	☐	☐	☐	☐	☐	☐	☐
v) Continuity of Care Records (CCR)?	☐	☐	☐	☐	☐	☐	☐
w) Receiving CCR?	☐	☐	☐	☐	☐	☐	☐
x) Provide patients with an electronic copy of their health information?	☐	☐	☐	☐	☐	☐	☐
y) Provide patients with clinical summaries for each visit?	☐	☐	☐	☐	☐	☐	☐

12. If the practice's EHR allows for electronic prescriptions but you do not use this feature, for what reason are you not using e-prescribing?

- ☐ E-Prescribing is unreliable
- ☐ Prescription volume is too low to switch to e-prescribing
- ☐ Not trained in how to use e-prescribing
- ☐ Not interested in using e-prescribing
- ☐ Other (Please explain)

_____

13. Does the practice submit claims electronically (electronic billing)?

- ☐ Yes, all electron
- ☐ Yes, part paper and part electronic
- ☐ No
- ☐ Unknown

II. Acquisition and Implementation of an EHR System

14. Describe how your health records system stores information for the majority of patients served by your practice. If your organization uses multiple technologies, choose the system used for the majority of patient health/medical records.

- ☐ Paper medical records/charts filed in record cabinet
- ☐ Computer-based system in which paper records/charts are scanned and scanned documents are filed electronically (DIMS)
- ☐ An EHR system that stores patient medical and demographic information in a computer database that is accessed by computer terminals or other electronic means
- ☐ Other: _____

15. Currently, what is your degree of electronic health record acquisition or implementation at your main practice site?

- ☐ We have acquired an EHR system, but have not implemented it (go to Question 14)
- ☐ Our EHR implementation is in process (go to Question 16)
- ☐ We have fully implemented our EHR system (go to Question 17)
- ☐ We plan to acquire an EHR system in the next 12 months (go to Question 24)
- ☐ We plan to acquire an EHR system in the next 13-24 months (go to Question 24)
- ☐ We have no plans to acquire an EHR system (go to Question 24)

16. If you have purchased and are in the process of implementing an EHR system, within how many months do you expect to have completed implementation?

_____ months

If your main practice site uses paper records or is in the process of transitioning to an EHR system, please continue to Question 22. If your main practice site uses electronic health please continue to question 15.

III. Experience with Electronic Health Records

17. How many years have you been using an EHR in your main practice site?

- ☐ Less than one year
- ☐ One year
- ☐ Two years
- ☐ Three years
- ☐ Four years
- Five years
- ☐ More than five years

18. Please choose which word best describes the implementation of the EHR in your practice:

☐ Phased ☐ All at once ☐ Neither phased nor all at once

19. To what extent has the EHR system affected the following areas at your main practice site?

	Major positive impact	Positive impact	No impact	Negative impact	Major negative impact	Not applicable
i) The quality of clinical decisions	☐	☐	☐	☐	☐	☐
j) Communication with other providers	☐	☐	☐	☐	☐	☐
k) Communication with your patients	☐	☐	☐	☐	☐	☐
l) Prescription refills	☐	☐	☐	☐	☐	☐
m) Timely access to medical records	☐	☐	☐	☐	☐	☐
n) Avoiding medication errors	☐	☐	☐	☐	☐	☐
o) Delivery of preventative care that meets guidelines	☐	☐	☐	☐	☐	☐
p) Delivery of chronic illness care that meets guidelines	☐	☐	☐	☐	☐	☐

20. Overall, please rate your level of satisfaction with the EHR system at your main practice:

Very unsatisfied Unsatisfied Neutral Satisfied Very satisfied

Comment:

_____

_____

21. Is the electronic health record system at your main practice site integrated with a hospital system?

- ☐ Yes
- ☐ No
- ☐ Don't know

22. If you use an electronic health record system, does it meet federal certification standards?

- ☐ Yes
- ☐ No
- ☐ Don't know

23. What is the name of your current EHR system?

☐ Allscripts	☐ Epic	☐ CHARTCARE
☐ Eclipsys	☐ NextGen	☐ Sage/Vitera
☐ HealthPort	☐ Meditech	☐ GE
☐ Cerner	☐ eMDs	☐ Unknown
☐ MED3000	☐ eClinicalWorks	☐ Other:_____

24. How familiar are you with the Connecticut Health Information Exchange (HIE) Initiative?

- ☐ Very familiar
- ☐ Somewhat familiar
- ☐ A little familiar
- ☐ Not familiar at all

25. Have you heard about or used:

	Have you heard about?		Have you used?	
The Connecticut Health Information Exchange	☐ Yes	☐ No	☐ Yes	☐ No
The Regional Extension Center	☐ Yes	☐ No	☐ Yes	☐ No

26. Overall, please rate your level of satisfaction with the Connecticut Health Information Exchange (HIE) Initiative:

Very unsatisfied — Unsatisfied — Neutral — Satisfied — Very satisfied

Comment: _____

27. Would you support the widespread adoption of the personal health record (PHR) for your patients?

- ☐ Yes
- ☐ No
- ☐ Not sure

28. If yes, please describe why:

_____

_____

29. If no, please describe why not:

_____

_____

30. Per the standards set forth in the Centers for Medicaid and Medicare Services' (CMS') Electronic Health Record (EHR) Incentive programs, do you qualify for the following:

- ☐ Medicaid Incentive Program
- ☐ Medicare Incentive Program
- ☐ Don't know

31. If you use an EHR system and qualify for the Medicaid EHR Incentive Program, have you:

	Yes	No	Don't Know
Applied for a CMS Medicaid Adopt, Implement, Upgrade (AIU) incentive payment?	☐	☐	☐
Been approved for a CMS Medicaid Adopt, Implement, Upgrade (AIU) incentive payment?	☐	☐	☐
Attested to Medicaid Stage 1 Meaningful Use of an EHR?	☐	☐	☐
Been approved for a Medicaid Stage 1 EHR Meaningful Use incentive payment?	☐	☐	☐
Attested to Medicaid Stage 2 Meaningful Use of an EHR?	☐	☐	☐
Been approved for a Medicaid Stage 2 EHR Meaningful Use incentive payment?	☐	☐	☐

32. If you use an EHR system and qualify for the Medicare EHR Incentive Program, have you:

	Yes	No	Don't Know
Attested to Medicare Stage 1 Meaningful Use of an EHR?	☐	☐	☐
Been approved for a Medicare Stage 1 EHR Meaningful Use incentive payment?	☐	☐	☐
Attested to Medicare Stage 2 Meaningful Use of an EHR?	☐	☐	☐
Been approved for a Medicare Stage 2 EHR Meaningful Use incentive payment?	☐	☐	☐

IV. Barriers to EHR Adoption

33. Please answer the following questions regardless of whether your main practice site has an established EHR system or not.

	Major barrier	Minor barrier	Not a barrier
FINANCIAL BARRIERS			
l) The amount of capital needed to acquire/implement EHR	☐	☐	☐
m) Uncertainty about the return on investment	☐	☐	☐
ORGANIZATIONAL BARRIERS			
n) Resistance to adoption among physicians	☐	☐	☐
o) Capacity to select, contract, install, and implement an EHR	☐	☐	☐
p) Concern about the loss of productivity during transition to the EHR	☐	☐	☐
LEGAL OR REGULATORY BARRIERS			
q) Concerns about inappropriate disclosure of patient information	☐	☐	☐
r) Concerns about illegal record tampering	☐	☐	☐
s) Concerns about the legality of accepting an EHR that is donated from a hospital	☐	☐	☐
t) Concerns about physicians' legal liability if patients have more access to information in their medical records	☐	☐	☐
STATE OF THE TECHNOLOGY			
u) Finding an EHR system that meets providers' needs	☐	☐	☐
v) Concerns that the system will become obsolete	☐	☐	☐

V. Incentives for EHR Adoption

34. Please rate the impact that the following policy changes would have on your decision to adopt an EHR system. If your main practice has previously implemented an EHR system, please rate the impact of these possible policy changes for physicians in general.

	Major positive impact	Minor positive impact	No impact	Minor negative impact	Major negative impact
LEGAL OR REGULATORY INCENTIVES					
f) Change the law to protect physicians from personal liability for record tampering by external parties or for privacy and security	☐	☐	☐	☐	☐

	breaches					
g)	Concerns about legal liability as a result of NOT using the latest technology	☐	☐	☐	☐	☐
STATE OF THE TECHNOLOGY						
h)	Published certification standards that indicate whether an EHR has the necessary capabilities and functions	☐	☐	☐	☐	☐
FINANCIAL INCENTIVES						
i)	Incentives for the purchase of an EHR	☐	☐	☐	☐	☐
j)	Additional payment for the use of an EHR	☐	☐	☐	☐	☐

VI. Practice Characteristics

35. What is the year of your birth?

19_____

36. What is your gender?

☐ Male

☐ Female

37. What is your ethnicity?

☐ Hispanic or Latino

☐ Not Hispanic or Latino

38. What is your race?

☐ White

☐ Black/African American
☐ Asian
☐ Native Hawaiian/Other Pacific Islander

☐ American Indian/Alaska Native

39. In what area are you board certified?

_____

40. In what year did you first practice medicine, after completing residency or fellowship?

19_____

41. Roughly, what percentage of your patient revenue comes from the following? (Percentage should total 100%).

_____ Medicare
_____ Medicaid (including Husky A, SAGA, Medicaid LIA and Title 19)
_____ Private Insurance
_____ Patient payments

_____ Other: _____

42. What type of internet access does your organization have?

- ☐ No internet access
- ☐ Dial-up/non-broadband
- ☐ T-1
- ☐ Broadband – cable or digital subscriber line (DSL)
- ☐ Broadband – satellite
- ☐ Other

43. Does your organization need additional high speed internet access at any of its locations?

- ☐ Yes
- ☐ No
- ☐ Unsure

44. Who completed this survey?

- ☐ The physician to whom it was addressed
- ☐ Office staff
- ☐ Other: _____

¤ Adapted from DesRoches C.M., Campbell E.G., Rao S.R., et al. (2008). Electronic health records in ambulatory care — A national survey of physicians. *N Engl J Med*, 359, 50-60.

Appendix B

Physician survey administration protocol

Baseline Postcard and Survey Administration

The study consisted of two instruments. Initially a brief physician postcard was mailed to capture basic data about Connecticut physicians that appeared on the CT Dept. of Public Health's Licensure list and/or the CT Dept. of Social Services' Medicaid Provider Enrollment list. This postcard was designed to collect basic demographic data, information on the percentages of patients using various methods to pay for services (e.g. Medicare, Medicaid, private insurance, etc.), and physicians' methods for storing patient information. In addition, the postcard offered physicians the option to participate in a longer survey; physicians were given the option to conduct the survey on-line, receive a hard copy survey in the mail, conduct the survey over the phone, or conduct a face-to-face survey with a member of the study team.

The physician survey instrument delved into much greater depth regarding physicians' use of health information technology. It asked the physician about his or her implementation of and satisfaction with an Electronic Health Record (EHR) system, and his or her attitudes about potential incentives for and barriers to the adoption of EHRs. It also asked questions about the physician's practice, and asked about the presence of and use of several EHR core functions (e.g. electronic prescribing, electronically-ordering lab tests and receiving lab results, generating and receiving Continuity of Care Documents and Continuity of Care Records, etc.).

Initial Postcard Mailing

In the initial postcard mailing, 18,642 postcards were sent to physicians appearing in either the CT DPH Licensure list and/or the CT DSS Medicaid list. This mailing took place in May 2011. Of these 18,642 postcards, 1,007 (5.4%) were returned as undeliverable. Of these undeliverable postcards, 830 (82.4%) had been sent to addresses in Connecticut and 177 (17.6%) had been sent to addresses outside Connecticut.

As of June 24, 2011, 1,691 physicians had responded to the initial postcard mailing. Of these, 703 (41.6%) requested to take the survey on-line. One hundred and six of these 703 physicians (15.1%) did not provide an e-mail address. Additionally, e-mails sent to 54 of these physicians (7.7%) were returned as undeliverable. Study team Research Assistants called these physicians' offices to obtain corrected e-mail addresses. In cases where the raw physician data did not contain a phone number, the Research Assistants used internet research to find the physicians' phone numbers.

Eight hundred ninety-five physicians responding to the initial postcard by June 24 (52.9%) requested a mailed hard-copy survey; this represented a slight majority of physicians who agreed to participate in the full survey. Twenty-one of the initial postcard respondents (1.2%) requested a phone survey, while 12 (0.7%) requested in-person surveys.

Sixty of the initial respondents (3.5%) did not specify a preferred method for receiving the survey. In addition, 30 (1.8%) did not specify on their postcards whether or not they practiced in Connecticut. In these cases, study team Research Assistants called the physicians' offices to

gather the missing information. The follow-up calls led to the distribution of nine additional on-line surveys, forty-three mailed hard-copy surveys, and four surveys faxed to physician offices. Four of the 30 physicians that did not initially specify whether or not they practiced in Connecticut (13.3%) were retired.

2,598 of the 18,642 postcards (13.9%) were ultimately returned by physicians with a response.

Second Postcard Mailing

Following the return of 1,007 postcards from the initial mailing as undeliverable, study team Research Assistants conducted a combination of internet and telephone research to attempt to determine the correct addresses for physicians whose postcards had been returned. This research involved looking up potential corrected addresses for each physician on the internet, then calling the listed address to verify whether or not it was correct. On November 1, 2011 a batch of 713 postcards was mailed to physicians whose initial postcards had been returned as undeliverable. Of these, 113 (15.8%) were returned as undeliverable. It is suspected that these additional undeliverable postcards arose from a combination of Research Assistants not calling to confirm certain correct addresses and vagaries in mail delivery. Sixty-one postcards sent during the second mailing (8.6%) were filled out and returned by their physicians.

Identification of Duplicate Physicians

As the study team contacted physicians to obtain corrected addresses or to determine whether or not they practiced in Connecticut, it became apparent that the raw physician data used for the initial postcard mailing contained many duplicate physician listings. In most cases these involved different practice addresses listed for the same physician. The study team decided to ascertain how many unique physicians were represented in the 18,642 records used for the initial postcard mailing.

In an attempt to identify potential duplicate physicians, the study team first captured all raw physician records sharing identical first and last names with at least one other physician record. This initial search yielded 4,035 raw physician records (21.6%) with matched first and last names.

The study team also wished to identify probable duplicate physicians based on records having similar, but not identical, first and last names. To this end, the team programmed a function to calculate probabilistic matches between physicians' first and last names using the Jaro-Winkler algorithm. The Jaro-Winkler algorithm was developed by the U.S. Census Bureau to measure the degree of similarity between character strings. The study team investigated physicians whose first names and last names both had a Jaro-Winkler score of 0.9 or greater; 2,965 of the 18,642 original physician listings (15.9%) were identified as potential probabilistic matches. In addition, 288 listings (1.5%) had identical last names and first names with Jaro-Winkler similarity scores of 0.9 or greater.

To investigate these potential duplicate physicians, three study team Research Assistants called the first listed practice site for each physician to verify if other listings flagged as potential duplicates actually pertained to the physician in question. These calls began on September 23, 2011. In cases where multiple practice listings applied to the same physician, the Research Assistants asked which address represented the physician's primary practice site. These

investigations of potential duplicate physicians yielded 2,115 matched sets of physician names covering 4,293 raw physician listings. Of these 2,115 matches, in 2,056 cases (97.2%) two records were identified as applying to the same physician. In 50 cases (2.4%) three records were identified as duplicates, in four cases (0.2%) four records were identified as belonging to the same physician, and in three cases (0.1%) five records applied to the same physician.

Changes to Survey Instrument in February 2012

In February 2012 modifications to the physician survey instrument were approved by the UConn Health Center Institutional Review Board (IRB). The study team added questions to the instrument asking physicians if they had heard of the CT Health Information Exchange (HIE) and if they had heard of the Regional Extension Center (REC); the REC is an organization that exists to help health care providers to achieve meaningful use of Electronic Health Record (EHR) technology. The revised survey also asked whether respondents have used the CT HIE or the REC.

Third Postcard Mailing

A third mailing of physician postcards occurred on March 1, 2012. This mailing targeted 6,496 physicians who had not yet responded to earlier postcard mailings. 172 postcards from this mailing (2.6%) were returned as undeliverable, while 521 responses from physicians (8.0%) were received. Study team research associates attempted to find corrected addresses for the physicians with undeliverable postcards. Follow-up phone calls to these physicians' offices revealed that one of these physicians was retired and that fifteen no longer practiced in Connecticut. The Research Assistants were unable to contact twenty-three of these physicians.

Fourth Postcard Mailing

A fourth small postcard mailing took place on April 12, 2012. This mailing targeted 117 physicians whose postcards from the third mailing had been returned as undeliverable, and for whom the study team was able to find new mailing addresses. Of these 117 postcards, 19 (16.2%) were returned as undeliverable. 12 (10.3%) were completed by physicians.

Survey Receipt

A total of 943 baseline physician surveys were received (in addition to three test surveys that were entered in REDCap). Of these, 66 were excluded from the final analytic data set for the following reasons:

- In 13 surveys the respondent did not answer any survey questions or answered only a small number of questions.
- 13 surveys could not be matched to a physician postcard.
- 11 surveys were superseded by updated surveys submitted by the same physician.
- 10 were for physicians who no longer practiced in CT.
- 7 were duplicate surveys.
- 5 physicians indicated that they do not see any patients.
- 4 were for physicians who were retired.
- 3 were test surveys.

A total of 880 baseline surveys were retained for the final analytic data set. This represents 93.0% of the baseline surveys received.

Follow-Up Postcard and Survey Administration

Originally the survey team had planned to administer a follow-up round of physician surveys after Connecticut's Health Information Exchange (HIE) became operational. This follow-up round was planned to assess the effects of the HIE on physicians' use of Health Information Technology and data sharing.

As of the summer of 2013, however, the Connecticut HIE was still not operational. After deliberation, the study team decided to proceed with the follow-up survey. Surveys from this follow-up round would be analyzed in conjunction with those from the baseline round in order to determine how physicians' attitudes toward and usage of Health IT had changed.

The physician postcard was modified for the follow-up round to include questions asking whether respondents had heard of and/or used the Connecticut HIE, and whether they had heard of or used the Regional Extension Center (REC), which is an organization intended to assist providers in attaining meaningful use of Electronic Health Record (EHR) systems.

The physician survey was modified for the follow-up round to include a question asking the physician whether or not he or she still practiced medicine in Connecticut. This question was added so that the study team could capture the current practice status for physicians who may have responded to the baseline physician postcard or survey back in 2011 or 2012.

The following additional questions were added to the follow-up physician survey:

- Does the physician have a computerized system that can provide patients with electronic copies of their health information? If so, how often is this feature used?
- Does the physician have a computerized system that can provide patients with clinical summaries of each visit? If so, how often is this feature used?
- If the physician's EHR allows for e-prescribing but the physician does not use this feature, why is this feature not being used?
- Does the physician qualify for the Medicaid and/or Medicare EHR Incentive programs?
- Has the physician applied for a Medicaid Adopt/Implement/Upgrade (AIU) incentive payment?
- Has the physician received a Medicaid Adopt/Implement/Upgrade (AIU) incentive payment?
- Has the physician applied for a Medicaid Stage 1 Meaningful Use incentive payment?
- Has the physician received a Medicaid Stage 1 Meaningful Use incentive payment?
- Has the physician applied for a Medicaid Stage 2 Meaningful Use incentive payment?
- Has the physician received a Medicaid Stage 2 Meaningful Use incentive payment?
- Has the physician applied for a Medicare Stage 1 Meaningful Use incentive payment?
- Has the physician received a Medicare Stage 1 Meaningful Use incentive payment?
- Has the physician applied for a Medicare Stage 2 Meaningful Use incentive payment?
- Has the physician received a Medicare Stage 2 Meaningful Use incentive payment?

The first steps in the follow-up postcard/survey administration were as follows:

- Mailed physician postcards on July 24, 3013 to 8,292 physicians from whom we received no response from the baseline postcard mailing. No follow-up postcards were mailed to physicians who had completed a baseline postcard.
- Distributed physician surveys beginning on July 9, 2013 to physicians who had either completed a baseline physician survey or who had indicated in their baseline postcards a willingness to take the survey. These initial survey distributions were as follows:

    - 410 links to the on-line follow-up survey were e-mailed to physicians who did not complete a baseline survey, but who indicated on their baseline postcards that they wished to take the survey on-line.
    - 278 links to the on-line follow-up survey were e-mailed to physicians who completed an on-line baseline survey.
    - 5 links to the on-line follow-up survey were e-mailed to physicians who did not complete a baseline survey, but who had indicated on their baseline postcards that they wanted to take the survey over the phone. These physicians had also provided e-mail addresses on their postcards.
    - 2 links to the on-line follow-up survey were e-mailed to physicians who completed a baseline survey, but who had originally indicated on their baseline postcards that they wanted to take the survey over the phone. These physicians had also provided e-mail addresses on their postcards.
    - 669 hard copy follow-up surveys were mailed to physicians who did not complete a baseline survey, but who indicated on their baseline postcards that they wanted to receive a mailed survey.
    - 482 hard-copy follow-up surveys were mailed to physicians who completed a baseline mail survey.
    - 6 links to the on-line survey were e-mailed to physicians who originally indicated that they wanted to take the survey in-person, but who also provided e-mail addresses.

Of the 8,292 postcards mailed, 608 (7.3%) were returned as undeliverable. Study team staff used a combination of telephone calls and internet research to attempt to find addresses for these physicians. After this research, a further 166 postcards with corrected addresses were mailed on October 22, 2013. Of these 166 postcards, four (2.4%) were again returned as undeliverable, while 11 (6.6%) were returned with a response by physicians.

462 follow-up postcards (5.6%) were returned completed by physicians. These postcards resulted in the following survey distributions:

- 146 links to the on-line survey were e-mailed to physicians who requested an on-line survey.
- 209 hard-copy surveys were mailed to physicians who requested mail delivery.

67 physicians reported on their postcards that they did not wish to take the survey. Fourteen reported that they were retired, and 3 reported that they no longer practiced medicine on Connecticut. Nineteen physicians reported on their postcards that they wished to take the survey on-line, but never provided an e-mail address for survey distribution. In these cases the

study team was unable to obtain an e-mail address. The remaining 4 postcards were for physicians who wished to conduct the survey over the phone.

For physicians who did not respond to on-line survey distributions approximately a month after they were e-mailed, the study team sent an e-mail reminder concerning the survey. The study team sent a total of 116 e-mail reminders to providers who received links for on-line surveys.

A total of 548 follow-up surveys were received. 82 follow-up surveys were excluded from the final analytic data set for the following reasons:

- On 30 surveys, the physician indicated that he or she did not still practice medicine in CT.
- 30 surveys were duplicates of other surveys entered into REDCap.
- 7 surveys could not be matched to a physician postcard.
- On 5 surveys, the respondent either answered no questions or only answered a small number of questions.
- 5 surveys were superseded by later survey responses from the same physician.
- On 3 surveys, the respondent indicated that he or she did not see any patients.
- One 1 survey, the respondent didn't indicate whether or not he or she practiced in CT.
- One 1 survey, the respondent indicated that he or she planned to leave CT within one year.

A total of 466 follow-up surveys were retained for the final analytic data set. This accounts for 85.0% of the overall follow-up surveys received.

Appendix C

Logistic regression analyses

In the following tables, variables in bold text are significantly associated with the outcome of interest at the $p < .05$ level.

Table C 1. 2011 Cohort 1 – Characteristics associated with having an EHR (being in the process of implementing or having a fully implemented EHR) ("yes" vs. "no")

N = 508	Odds Ratio	95% CI
Demographic characteristics		
Male vs. female	1.02	0.66-1.59
Age		
29-39 (reference group)	1.00	
40-49	0.64	0.27-1.51
50-59	0.52	0.17-1.58
60-69	0.29	0.08-1.09
70+	0.35	0.07-1.59
Years practicing medicine		
1-9 (reference group)	1.00	
10-19	1.69	0.75-3.81
20-29	2.16	0.76-6.11
>=30	2.63	0.77-9.00
Specialty		
Primary care	1.13	0.75-1.70
Specialty care (reference group)	1.00	
Computer experience		
A lot	**1.65**	**1.10-2.46**
Some, a little, or none (reference group)	1.00	
Practice characteristics		
Number of physicians in practice		
1 (reference group)		
2-3	1.54	0.72-3.30
4-6	**2.46**	**1.08-5.58**
7+	**2.39**	**1.08-5.29**
Type of practice		
Solo (reference group)	1.00	
Single specialty group or partnership	1.45	0.67-3.18
Multi-specialty group or partnership	2.00	0.80-4.99
Other	**2.97**	**1.07-8.23**
Barriers to EHR adoption		
Amount of capital needed to acquire/implement EHR		
Major barrier	0.74	0.34-1.58
Minor barrier	0.79	0.34-1.83
Not a barrier (reference group)	1.00	
Concern about inappropriate disclosure of patient information		
Major barrier	1.12	0.43-2.87
Minor barrier	1.95	1.00-3.78
Not a barrier (reference group)	1.00	
Concern about illegal record tampering		
Major barrier	0.54	0.21-1.39
Minor barrier	0.61	0.32-1.19
Not a barrier (reference group)	1.00	

Table C 2. 2013 Cohort 2 – Characteristics associated with having an EHR (being in the process of implementing or having a fully implemented EHR) ("yes" vs. "no")

N = 157	Odds Ratio	95% CI
Demographic characteristics		
Male vs. female	1.11	0.36-3.45
Age		
29-39 (reference group)	1.00	
40-49	0.15	0.14-1.66
50-59	0.12	0.01-1.98
60-69	0.05	0.00-1.01
70+	0.05	0.00-1.38
Years practicing medicine		
1-9 (reference group)	1.00	
10-19	1.37	0.18-10.53
20-29	1.72	0.15-19.99
>=30	3.77	0.26-53.90
Specialty		
Primary care	**3.59**	**1.34-9.57**
Specialty care (reference group)	1.00	
Computer experience		
A lot	2.35	0.90-6.12
Some, a little, or none (reference group)	1.00	
Practice characteristics		
Number of physicians in practice		
1 (reference group)		
2-3	0.28	0.03-2.50
4-6	0.41	0.05-3.47
7+	0.76	0.09-6.51
Type of practice		
Solo (reference group)	1.00	
Single specialty group or partnership	3.79	0.47-30.27
Multi-specialty group or partnership	4.76	0.49-46.22
Other	1.21	0.13-11.27
Barriers to EHR adoption		
Amount of capital needed to acquire/implement EHR		
Major barrier	0.67	0.16-2.78
Minor barrier	1.53	0.24-9.62
Not a barrier (reference group)	1.00	
Concern about inappropriate disclosure of patient information		
Major barrier	2.44	0.18-32.38
Minor barrier	3.25	0.51-20.49
Not a barrier (reference group)	1.00	
Concern about illegal record tampering		
Major barrier	0.18	0.01-2.71
Minor barrier	0.22	0.04-1.33
Not a barrier (reference group)	1.00	

Table C 3. 2011 Baseline sample – Characteristics associated with having an EHR (being in the process of implementing or having a fully implemented EHR) ("yes" vs. "no")

N = 226	Odds Ratio	95% CI
Demographic characteristics		
Male vs. female	1.30	0.59-2.88
Age		
29-39 (reference group)	1.00	
40-49	2.85	0.49-16.46
50-59	1.88	0.27-13.17
60-69	2.11	0.24-18.86
70+	1.60	0.12-21.10
Years practicing medicine		
1-9 (reference group)	1.00	
10-19	1.68	0.41-6.92
20-29	2.57	0.52-12.72
>=30	0.96	0.15-6.03
Specialty		
Primary care	0.84	0.42-1.69
Specialty care (reference group)	1.00	
Computer experience		
A lot	**3.60**	**1.75-7.39**
Some, a little, or none (reference group)	1.00	
Practice characteristics		
Number of physicians in practice		
1 (reference group)		
2-3	1.80	0.47-6.94
4-6	1.61	0.39-6.70
7+	**5.32**	**1.10-25.71**
Type of practice		
Solo (reference group)	1.00	
Single specialty group or partnership	2.21	0.55-8.87
Multi-specialty group or partnership	4.42	0.85-22.95
Other	**8.74**	**1.45-52.68**
Barriers to EHR adoption		
Amount of capital needed to acquire/implement EHR		
Major barrier	1.16	0.27-5.06
Minor barrier	4.36	0.87-21.80
Not a barrier (reference group)	1.00	
Concern about inappropriate disclosure of patient information		
Major barrier	2.40	0.55-10.48
Minor barrier	**3.83**	**1.13-12.99**
Not a barrier (reference group)	1.00	
Concern about illegal record tampering		
Major barrier	0.54	0.12-2.48
Minor barrier	0.41	0.12-1.35
Not a barrier (reference group)	1.00	

Table C 4. 2013 Follow-Up sample – Characteristics associated with having an EHR (being in the process of implementing or having a fully implemented EHR) ("yes" vs. "no")

N = 226	Odds Ratio	95% CI
Demographic characteristics		
Male vs. female	1.62	0.69-3.76
Age		
29-39 (reference group)	1.00	
40-49	0.65	0.07-6.06
50-59	1.56	0.13-19.16
60-69	1.67	0.11-25.69
70+	0.63	0.03-12.91
Years practicing medicine		
1-9 (reference group)	1.00	
10-19	0.64	0.13-3.20
20-29	0.48	0.08-2.89
>=30	0.40	0.05-3.45
Specialty		
Primary care	1.51	0.72-3.14
Specialty care (reference group)	1.00	
Computer experience		
A lot	1.41	0.68-2.94
Some, a little, or none (reference group)	1.00	
Practice characteristics		
Number of physicians in practice		
1 (reference group)		
2-3	2.53	0.82-7.85
4-6	**3.55**	**1.07-11.73**
7+	**12.96**	**2.85-58.80**
Type of practice		
Solo (reference group)	1.00	
Single specialty group or partnership	0.51	0.16-1.68
Multi-specialty group or partnership	0.62	0.12-3.16
Other	0.26	0.04-1.66
Barriers to EHR adoption		
Amount of capital needed to acquire/implement EHR		
Major barrier	0.64	0.15-2.77
Minor barrier	1.13	0.23-5.66
Not a barrier (reference group)	1.00	
Concern about inappropriate disclosure of patient information		
Major barrier	**0.14**	**0.03-0.64**
Minor barrier	0.37	0.11-1.25
Not a barrier (reference group)	1.00	
Concern about illegal record tampering		
Major barrier	1.17	0.27-5.12
Minor barrier	2.48	0.78-7.91
Not a barrier (reference group)	1.00	