Health Information Technology in the United States:
Where We Stand, 2008

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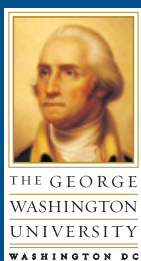
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Chapter 1: Introduction

Health information technology (HIT) and electronic health records (EHRs) are topics that currently engender lively debate in our health care system. In our 2006 inaugural report, *Health Information Technology in the United States: The Information Base for Progress,* we examined the challenges related to accurately measuring HIT adoption in the United States and made recommendations both for improving existing, ongoing national surveys and for new surveys. This report expands on those efforts, reporting on new survey data among physicians generally and among those serving "vulnerable populations" and exploring methods of evaluating the effect of these technologies on the cost and quality of health care.

Purpose

This report builds on our previous work, initiated by the Office of the National Coordinator for Health Information Technology (ONC) in 2006, to design and deploy standardized measures of EHR adoption in a national physician survey. The development of this report was funded by the Robert Wood Johnson Foundation (RWJF). The Foundation has a long-standing commitment to understanding and improving the quality of American health care. This mission includes several efforts designed to address all dimensions of the quality problem, including inequities in care. The potential of EHRs to improve quality of care and improve its efficiency makes the dissemination of this technology highly relevant to RWJF's larger purposes. For this reason, the Foundation has supported this report as a way to disseminate the lessons of the work we have done on behalf of the ONC.

The report provides updated estimates on the rate of EHR adoption and how this varies by providers' practice size and patient constellations. It has a particular focus on providers serving a disproportionate share of vulnerable patients (e.g., the uninsured, those covered by Medicaid and racial and/or ethnic minorities). Using the best available survey data, the report examines whether EHRs are diffusing differentially across providers serving different patient groups and creating a disparity in access to this technology.

Recognizing that there is still considerable debate about the effect of EHRs on the cost and quality of care, this report reviews issues related to measuring the impact of EHRs, discusses options for measuring the cost of EHR adoption, and explores potential methods for assessing the impact of these systems on the quality of patient care. The widespread adoption of EHRs is expected to have far-reaching effects on health care quality, both by having a direct effect on provider and patient decisions at the point of care, as well as the indirect effects of the potential generation of richer, cheaper, and more relevant clinical information that can be used to measure performance at the practice, organizational, and regional levels. Further, this data may increase transparency in the health care system, alerting providers and patients to existing variations in performance, stimulating the former to improve and the latter to choose better performing health care practitioners and organizations. In this report, we focus on the direct effects of EHR adoption. We intend to focus on the indirect effects in greater detail in later reports.

Finally, the report provides data on several other important policy issues. These include the evolving issue of regional health information networks, the international picture of HIT adoption, and the evolution of the electronic record in a legal context, with a focus on privacy and security.

Major Content Areas

Specifically, the second chapter, "Scanning the Health Information Technology-Related Policy Environment," assesses the quality of recent survey work in this area and uses available, high-quality survey data to estimate current levels of adoption. Further, the chapter reviews changes in the federal policy landscape and the potential impact of these changes on EHR adoption rates.

In Chapter 3, "Are Physicians Serving Poor and Minority Patients Keeping Pace With Electronic Health Record Adoption?", we further define methods for measuring disparities in EHR adoption among providers serving vulnerable populations and provide estimates of adoption among this group of providers.

In Chapter 4, "Consumers, EHRs and PHRs: Measures and Measurement," we review what is known about the adoption of personal health records by consumers and their perceptions of adoption of EHRs by their doctors. This chapter provides guidance on the challenges of measuring adoption of PHRs and EHRs using perceptions from among the general population.

Chapter 5, "Regional Health Information Organizations and Health Information Exchange," reports the results of a national survey of RHIOs, the extent to which these organizations are exchanging health information and the obstacles to wider implementation of health information exchange.

In Chapter 6, "Emerging Privacy Issues in Health Information Technology," we examine the evolution of legal issues related to EHRs, focusing on issues of privacy and security.

Chapter 7, "International Adoption of Electronic Health Records," we turn to the global community, detailing efforts in other nations to implement widespread EHR use.

Finally, Chapters 8 ("Economic Analyses of Health Information Technology") and 9 ("A Framework for Measuring the Effects of Health Information Technology on Health Care Quality") discuss methods of measuring the value of EHR adoption both in terms of the cost (Chapter 8) and quality of care (Chapter 9). These chapters review what is known about the value of adoption and make recommendations for measurement in the future.

Previous Work

Our team draws from several institutions with relevant expertise: The George Washington University School of Public Health and Health Services' Department of Health Policy; the Institute for Health Policy at Massachusetts General Hospital/Partners HealthCare System; the Harvard School of Public Health; and Weill Cornell Medical College. Previous projects of this group include our RWJF-funded inaugural 2006 report, *Health Information Technology in the United States: The*

Information Base for Progress, as well as studies of the costs of developing a national health information network, an RWJF colloquium on measuring the diffusion of health care technology, and an RWJF analysis of the legal barriers to widespread adoption of electronic health information reporting.

Our Expert Consensus Panel (ECP) continues to play a critical role in our research process. This panel, composed of national experts in relevant areas, helps guide our development of definitive judgments and methodologies for measuring the adoption of EHRs, including survey design and interpretation, statistics, meta-analysis, EHR development and use, technology diffusion, qualitative research methods, economics, sociology, psychology, physician and hospital behavior, health care disparities and health care quality. These leaders represent agencies of the federal government currently conducting surveys that could be used for the purposes of this work, private sector consumers of the resulting data and other potential funders of efforts to measure diffusion of HIT. The ECP met three times during the preparation of this report and addressed issues related to survey methods, quality measurement and assessing the value of HIT adoption.

We continue to be grateful to these individuals for their enormous contributions to this effort and for their generosity in donating their time. We hope that their effort will contribute to an improved understanding of the pace and determinants of HIT adoption and to the subsequent development of policies that optimize the adoption and employment of innovative electronic technologies in medicine. We are also grateful to the Office of the National Coordinator of Health Information Technology, the Robert Wood Johnson Foundation and their staff, who have worked collaboratively and collegially in the preparation of this report and the work on which it draws.

Chapter 2: Scanning the Health Information Technology-Related Policy Environment

Catherine M. DesRoches, Dr.P.H. and Sara Rosenbaum, J.D.

This chapter provides an overview of important developments in health information policy and health information technology research that have taken place since the 2006 publication of *Health Information Technology in the United States: The Information Base for Progress*. These developments fall into two major categories. The first consists of policy-relevant research, and this chapter highlights some of the most prominent advances that have taken place over the 2006–2007 time period. The second category consists of policy developments related to health information and the diffusion of health information technology. For the purposes of this report, developments in law and policy, which can be expected to affect the rate and speed with which various entities within the health care sector advance technologically, are of particular interest. This includes these entities' adaptation to a health care system that more than ever turns on the broad use of health information to achieve fundamental goals in the areas of quality, safety, cost control and transparency.

1. Developments in HIT-Related Research: National Surveys

Overview

A basic purpose of this project is to establish an estimate of the national EHR adoption rate. In 2006 we published an environmental scan that included an assessment of all formal surveys of adoption among physicians, group practices and hospitals.[1] This chapter updates that work by including data published or made available since that time. In examining these new national survey efforts, we utilized quality assessment methods that were described in our earlier study, and that are summarized in Table 1.

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1 Blumenthal D, DesRoches C, Donelan K, Ferris T, Jha AK and Kaushal R. *Health Information Technology in the United States: The Information Base for Progress.* Robert Wood Johnson Foundation, 2006.

Table 1: **Dimensions of Survey Quality**

Quality of Survey Administration	Representativeness: Was the survey designed and conducted in such a way that the collected data well represents the stated population of interest?
	Response Rate Effort: Were diligent efforts made to enhance response rate and reduce response bias?
	Questionnaire Development: Were individual items assessed and tested for validity and reliability? Was the instrument pretested? Were diligent attempts made to reduce bias and response order effects in wording and context?
	Sample Size: Was the sample size sufficient to minimize sampling error and achieve analytical objectives?
Quality of Survey Content	Were the following domains included in the survey: a. Whether the practice or organization has an EHR? b. Nature of EHR functionalities? c. Whether the survey distinguishes between EHR acquisition, installation and use? d. Measures of incentives for EHR adoption? e. Measures of barriers to EHR adoption? f. Ability to identify disparities in adoption among different at-risk populations?

Three members of the project team, all experienced researchers, examined each survey, discussed their assessments, reconciled discrepancies and arrived at a consensus regarding the quality of both the methods and content of each survey that was reviewed.

A total of nine surveys were identified, and for each, the team was able to obtain both the survey instruments and complete results. Of these surveys, three were found to be regional in scope and thus excluded from further analysis. Of the six remaining surveys, four were of physicians and two were of hospitals.

In addition to the surveys discussed above, we present data from the National Survey of EHR Adoption, conducted by the research team at the Institute for Health Policy, George Washington University and the Harvard School of Public Health. This survey, funded by the Office of the National Coordinator for Health Information Technology (ONC), was developed to provide definitive estimates of EHR adoption by U.S. physicians.

In addition to the surveys discussed above, we summarize the results of a 2006 HIMSS (Healthcare Information and Management Systems Society) Analytics report that examines the link between HIT and quality. This report is based on the HIMSS Analytics database, which is comprised of data from several sources including the American Hospital Association Annual Survey and HIMSS Analytics' own surveys.

Results

We rated the two physician surveys high on methodology. One received a high content rating in assessing functionalities, while the other received a medium content rating in identifying and assessing functionalities. Neither of the two hospital surveys received a high methodology rating: one received a medium rating while the other received a low rating. However, we gave both hospital

surveys a high content rating in EHR functionalities. One survey also received a high content rating in barriers to EHR implementation.

National Physician Surveys:

The Commonwealth Fund 2006 International Survey of Physicians found that 28 percent of U.S. physicians use an electronic, patient medical record in their practice.[2] Among those using an EHR, 42 percent reported that their system allowed them to share patients' medical records with clinicians outside their practice, 34 percent used systems that allowed patients to access their own records, and 76 percent reported being able to access patient records when they were out of the office. In addition to asking a global question on EHR adoption, this survey included a module of items assessing the use of specific EHR functionalities. The findings suggest that between one-quarter and one-half of physicians routinely use the following functionalities in their practice: electronic ordering of tests (22 percent), electronic prescribing (20 percent), electronic access to test results (48 percent) and electronic access to patient's hospital records (40 percent).

The Community Tracking Study Physician Survey, also given a high quality methodology rating, asked about their use of information technology (IT) for specific clinical functions rather than using a global EHR measure.[3] The survey used a fairly broad question to do this, asking about the use of "computers or other forms of information technology." Using this definition, the survey found that physicians' IT use ranged from 22 percent for writing prescriptions to 65 percent for obtaining clinical guidelines. Other clinical activities included in the survey were the generation of reminders (29 percent), accessing patient notes (50 percent) and exchanging clinical data with other physicians (50 percent). The relatively high estimates are likely attributable to the broad definition used to pose the question. Regardless of question wording, the findings from this survey suggest that the gap in adoption between small and large group practices is widening, with 64 percent of physicians in large group practices (defined as more than 50 physicians) reporting the use of IT for at least three of the five clinical activities, compared to 26 percent of physicians in small or solo practices (defined as one to nine physicians). In 2001 these estimates were 46 percent and 19 percent, respectively.

The National Ambulatory Medical Care Survey, conducted by U.S. Census Bureau for the National Center for Health Statistics, asked questions about both a global measure of EHR adoption and the availability of specific functionalities. The survey was rated high for both methodology and content. The survey found 29 percent of physicians reporting the use of either a full (14.5 percent) or partial (14.7 percent) EHR system in their office-based practice.[4] Using a functionality-based definition that included computerized orders for prescriptions, test results (lab or imaging) and clinical notes, the survey found 12.4 percent of physicians reporting the use of an EHR system containing these functionalities. This estimate remained unchanged from the prior year.[5]

2   Schoen C, Osborn R, Huynh PT, Doty M, Peugh J, Zapert K. "On the Front Lines of Care: Primary Care Doctors' Office Systems, Experiences, and Views in Seven Countries." *Health Affairs* (Millwood), 25: w555–571, 2006.

3   Grossman J, Reed M. *Clinical Information Technology Gaps Persist Among Physicians. Issue Brief.* Center for Studying Health System Change, 106: 1–4, 2006.

4   Hing ES, Burt CW, Woodwell DA. „Electronic Medical Record Use by Office-Based Physicians and Their Practices: United States." *Adv Data 2007*, 393: 1–7, 2006.

5   Blumenthal et al.

The National Survey of EHR Adoption

This survey was developed to provide definitive estimates of the proportion of U.S. physicians who have adopted a fully functional EHR. The survey was developed with guidance from an Expert Consensus Panel (ECP), comprised of experts in the fields of survey research, health information technology and health care management and policy, and representatives from hospital and physician groups and organizations.

Based on the advice of the ECP, we first defined the key functionalities that constitute an EHR and asked respondents to report the availability and use of those functions. As described in an earlier *Annual Report*, we used a modified Delphi process to reach consensus on which of the possible functionalities should be present to qualify the technology as fully functional.[6] As shown in Table 2, these functionalities generally fall into four domains: recording patient information and demographics, results viewing and management, order entry management (including e-prescribing) and clinical decision support. Physicians were asked if their main practice site had a computerized system for each functionality shown in Table 2.

Recognizing that comparatively few physicians might have a fully functional EHR, and that less complete electronic records might convey some benefits for patient care, we developed a second definition. Called a basic EHR, its components, as displayed in Table 2, constitute a minimum set of functionalities that might merit using the term "electronic health record." The principal differences between a fully functional and basic EHR are the absence of certain order entry capabilities and clinical decision support in the latter.

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6   Ibid.

Table 2: **EHR Survey Items**

Does your main practice site have a computerized system for any of the following:	Basic EHR	Fully Functional EHR
Health information and data		
Patient demographics	X	X
Patient problem lists	X	X
Electronic lists of what medications each patient takes	X	X
Clinical notes	X	X
Notes include medical history and follow-up notes		X
Order entry management		
Orders for prescriptions	X	X
Orders for laboratory tests		X
Orders for radiology tests		X
Prescriptions sent electronically		X
Orders sent electronically		X
Results management		
Viewing lab results	X	X
Viewing imaging results	X	X
Electronic images returned		X
Clinical decision support		
Warnings of drug interactions or contraindications provided		X
Out-of-range levels highlighted		X
Reminders for guideline-based interventions and/or screening		X
Population Health Management		
Public health reporting		
Notifiable diseases are sent electronically		

Results From the National Survey of EHR Adoption

Four percent of respondents reported having a fully functional EHR and 13 percent had a basic EHR (Figure 1). Among the 83 percent of respondents lacking an EHR, 17 percent reported that their practice had purchased but not yet implemented an EHR at the time of our survey. An additional 26 percent said that their practice intended to purchase an EHR within the next two years.

Figure 1: **Physician Reports of Availability of Electronic Health Records**

Fully Functional EHR 4%

No EHR 83%

Basic EHR 13%
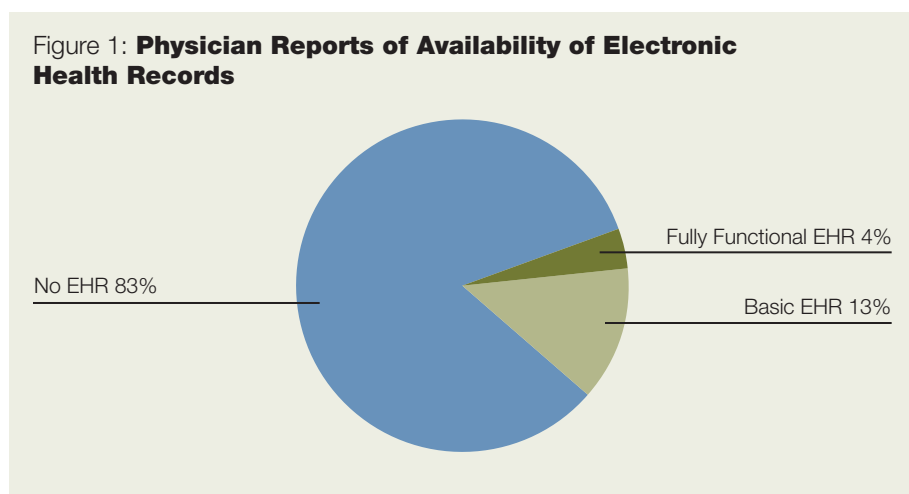
Factors Associated with EHR Availability

In multivariate analyses, having an EHR was significantly associated with several individual and practice characteristics (Table 2). For example, primary care physicians were significantly more likely than specialists to have a basic EHR (14 percent versus 10 percent). Among physicians in small practices (those with one to three doctors), 2 percent had a fully functional EHR compared to 5 percent in practices of between six to 10 physicians and 16 percent in practices with more than 50 physicians. For a basic EHR, comparable numbers were 6 percent, 16 percent and 31 percent, respectively. Physicians practicing in hospitals or medical centers in the Western part of the United States also reported greater availability of EHRs. Physicians in practice for more than 30 years were significantly less likely (9 percent) to report having a basic EHR than physicians in practice 19 years or less (13 percent).

Table 3: **Regression-Adjusted Percentage of EHR Adoption by Physician and Practice Characteristics***

	Fully Functional EHR		Basic EHR		No Basic or Fully Functional EHR		
	N = 117 %	Standard Error %	N = 330 %	Standard Error %	N = 2160 %	Standard Error %	p-value
Overall	**4**	**0.4**	**13**	**0.7**	**83**	**0.7**	
Gender							**0.76**
Male	4.5	0.5	13.0	0.8	82.5	0.9	
Female	4.3	0.6	12.7	1.1	83.0	1.5	
Ethnicity							**0.99**
Hispanic or Latino	4.4	1.1	12.9	2.3	82.7	3.3	
Not Hispanic or Latino	4.5	0.4	12.9	0.7	82.6	0.8	
Race±							
White	4.5	0.5	13.1	1.0	82.4	1.3	0.84
Black / African American	5.2	2.2	14.4	4.2	80.4	6.4	0.72
Asian	4.8	1.6	13.6	3.2	81.6	4.7	0.82
Other	3.0	1.6	9.7	4.0	87.3	5.5	0.45
Physician Specialty							**<0.001**
Primary Care	5.5	0.6	15.1	1.0	79.5	1.2	
Non-Primary Care	3.6	0.4	11.0	0.8	85.5	1.0	
Professional Age/Number of years since graduation							**0.009**
1–9 years	5.4	0.8	15.1	1.6	79.5	2.2	
10–19 years	4.8	0.6	13.9	1.0	81.3	1.4	
20–29 years	4.7	0.6	13.5	1.1	81.8	1.4	
> 30 years	3.1	0.5	9.8	1.0	87.2	1.4	
Practice Size							**<0.001**
1–3 physicians	1.8	0.3	6.8	0.7	91.4	0.9	
4–5 physicians	3.2	0.5	11.3	1.3	85.5	1.7	
6–10 physicians	5.5	0.7	17.1	1.5	77.4	2.0	
11–50 physicians	7.7	1.1	21.6	1.9	70.7	2.6	
> 50 physicians	17.3	2.9	33.2	2.6	49.5	4.8	

continued

	Fully Functional EHR		Basic EHR		No Basic or Fully Functional EHR		
	N = 117 %	Standard Error %	N = 330 %	Standard Error %	N = 2160 %	Standard Error %	p-value
Setting							0.008
Hospital, Medical Center	5.4	0.6	15.1	1.1	79.5	1.4	
Physician Office not attached to a hospital, or on a medical center campus	3.7	0.4	11.6	0.8	84.7	1.0	
Other	4.3	1.3	12.9	2.9	82.7	4.1	
Urban/Rural							0.92
Urban	4.5	0.4	12.9	0.7	82.6	0.8	
Rural	4.4	0.6	12.8	1.3	82.8	1.8	
Region of the Country							0.003
Northeast	3.5	0.5	10.8	1.2	85.7	1.6	
Midwest	4.2	0.6	12.6	1.1	83.1	1.5	
South	4.0	0.5	12.0	1.0	84.0	1.3	
West	6.0	0.8	16.2	1.2	77.7	1.7	

* Percentages were obtained from a multivariable analysis applying a cumulative logit model to predict EHR adoption adjusting for all the other variables listed in the table above. The analysis was adjusted for non-response.

± Respondents were allowed to select more than one race.

Frequency of EHR Use

The survey asked physicians with EHR functionalities available in their practice to indicate whether they used them. Among the 4 percent of doctors with a fully functional EHR, 97 percent reported using all of the functionalities at least some of the time. Among the 13 percent of doctors with a basic EHR, more than 99 percent reported using all of the functionalities at least some of the time.

National Hospital Surveys

Two national hospital surveys were conducted in 2006, neither of which received high quality ratings according to our assessment. The American Hospital Association's (AHA) Forward Momentum Survey, which received a medium quality rating for its methodology, found that 11 percent of hospitals have fully implemented an EHR, with an additional 57 percent of hospitals reporting a partially implemented EHR.[7] Larger hospitals, teaching hospitals and hospitals in urban areas were more likely to have a fully implemented EHR. The AHA survey also assessed the use of specific EHR functionalities. As shown in Figure 2, among those hospitals with a fully or partially implemented EHR, majorities reported the ability to view test results electronically and place orders electronically. Fewer hospitals with fully or partially implemented EHRs reported the use of decision support, including back-end drug alerts, real-time drug alerts, or clinical guidelines and pathways. Finally, the survey assessed the actual use of computerized physician order entry (CPOE), that is, the direct entry of medical orders into the computer system. The findings suggest that, in 2006, a majority of physicians routinely order medications electronically in 10 percent of hospitals. Further, the majority of treating physicians routinely order tests electronically in 16 percent of hospitals.

The 2006 HIMSS Leadership Survey found a higher rate of EHR adoption, with 24 percent of hospitals reporting a fully functional EHR and an additional 36 percent reporting that they had initiated the installation process.[8] However, the discrepancy between the HIMSS and AHA estimates is likely attributable to differences in survey question wording and methodology. The AHA survey is based on a national probability sample, with every hospital in the country having a known probability of selection into the study; whereas the HIMSS database is not probability-based and may be affected by selection bias. These methodological differences suggest that the AHA estimate is likely to be a more accurate reflection of the actual rate of EHR adoption among hospitals.

Studies Using National Survey Data to Examine the Relationship Between EHR Use and Quality of Care

HIMSS Analytics, a wholly owned, nonprofit subsidiary of HIMSS, issued a report in 2006 examining the relationship between hospital quality indicators and an institution's level of EHR sophistication.[9] The report presents a detailed model of EHR adoption, with seven stages ranging from having no IT capability (Stage 0) to having a fully electronic medical record where "clinical information can be readily shared via electronic transactions or exchange of electronic records with all entities within a regional health network." It analyzed the effectiveness of clinical IT use

Figure 2: **AHA Annual Forward Momentum Survey**

Hospitals with a fully or partially implemented EHR	
Results viewing	
Laboratory results	78%
Radiology reports	77%
Radiology images	64%
Electronic order entry	**72%**
Laboratory orders	72%
Radiology orders	70%
Prescription ordering	61%
Decision Support	
Back-end alerts	56%
Real time alerts	51%
Electronic clinical guidelines or pathways	36%

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7   American Hospital Association. *Continued Progress: Hospital Use of Information Technology*, 2007.

8   HIMSS Foundation. *2006 HIMSS Leadership Survey*.

9   HIMSS Analytics. *EMR Sophistication Correlates to Hospital Quality Data*. White Paper, 2006.

among 107 University HealthSystem Consortium (UHC) hospitals, basing the findings on 63 evidence-based, health care quality measures defined by the Agency for Healthcare Research and Quality (AHRQ). These indicators were correlated with the institution's EHR adoption level, based on the HIMSS Analytics adoption model. The study found that EHR sophistication may be correlated with improved care on these AHRQ measures; however, the findings did not show a consistent pattern. This lack of consistency may be the result of the small sample of UHC hospitals, the generally low level of EHR sophistication as defined by the HIMSS Analytics adoption model, or some combination of the two.

A second study by Linder and colleagues, which was recently reported in the *Archives of Internal Medicine*, used the 2004 National Ambulatory Medical Care Survey (NAMCS) to assess the relationship between EHR use and quality.[10] The 2004 NAMCS survey instrument includes the question, "Does your practice use electronic medical records (not including billing records)?" to measure EHR use.[11] The authors examined associations between EHR use and patient demographics, physician specialty, office characteristics, and patient race and ethnicity. They further created quality indicators around the medical management of common diseases, recommended antibiotic use, preventive counseling, screening and potentially inappropriate prescribing in elderly patients, with performance on quality indicators measured as the percentage of applicable visits receiving recommended care. The study found no consistent association between EHR use and ambulatory care quality. These findings may be related to the use of a global EHR measure, rather than assessing specific EHR functionalities that, theoretically, could affect specific quality indicators. Further analysis using future NAMCS surveys, which measure the adoption of specific functionalities, may enable a more detailed examination of these relationships.

Summary of Findings Related to 2006 Surveys and Research Results Into the Link Between EHRs and Health Care Quality

All of the surveys, both of physicians and hospitals, show an increase in their estimates of EHR use in the inpatient and outpatient setting when compared to surveys from prior years. Despite this encouraging finding, several troubling issues must be noted. The adoption gap between small and large physician practices and small and large hospitals continues to widen. Thus, there is room for significant improvement in this area. In addition, the failure to find a significant association between EHR use and improved quality of care suggests that either better measures are needed or the quality benefits of EHR adoption are further out on the adoption timeline. Chapter 9 recommends new methods for examining the relationship between EHR use and improved quality of care.

Our analysis of available survey data found a wide range of estimates for the use of specific EHR functionalities, particularly between the two hospital surveys. This is likely to be due to differences in the methodologies used to generate these estimates. The disparity in survey findings reinforces the need for reliable, valid and consistent measures of HIT adoption, particularly in the inpatient setting.

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10 Linder JA, Ma J, Bates DW, Middleton B, Stafford RS. "Electronic Health Record Use and the Quality of Ambulatory Care in the United States." *Archives of Internal Medicine*, 167(13): 1400–1405, 2007.

11 The 2004 NAMCS was reviewed for the 2006 Annual Report on HIT Adoption and given a high quality rating for survey methodology.

2. Policy Developments

The Promulgation of "Safe Harbor" Regulations to Incentivize Technology Adoption

Overview

Public policy offers two basic strategies for encouraging a desired result. The first strategy involves the use of financial incentives to encourage a desired course of action. The second essentially offers what might be thought of as permissive rewards, that is, the lifting of a sanction against otherwise prohibited conduct in order to achieve a desired outcome. As budget constraints have stalled federal legislative efforts to use positive financial incentives to spur a more rapid transformation to an information-based health care system, the use of permissive rewards has taken on added importance.

This type of permissive reward strategy can be seen in the promulgation of federal regulations during 2006 that relaxed constraints against private conduct that otherwise would be considered health care fraud. The purpose of these regulations, which implement legislation passed in 2003, is to make possible significant HIT donations to clinical health care professionals by larger health care entities such as hospitals, group practices and health systems with an obvious property interest in the professionals' financial decisions. This relaxation of federal fraud laws makes possible two types of conduct considered impermissible in their absence: bribes and kickbacks that involve giving of something of value in order to gain a "quid pro quo," and self-dealing conduct resulting in unjust enrichment.

Health care fraud has been of major concern to the federal government for well over a generation.[12] Of particular concern are donations calculated to induce referrals, as well as self-dealing by medical practice groups that maximize their investments and induce waste and overuse. At the same time, the prohibitive cost of acquiring, installing and maintaining the technology that can advance health information means that, in the absence of public financing, private investment by interested parties becomes important. Thus, despite concerns over the potential for abuse, financial considerations led Congress, as part of the Medicare Prescription Drug Improvement and Modernization Act of 2003 (MMA),[13] to instruct the Secretary of the U. S. Department of Health and Human Services (HHS) to develop an HIT-related exception to the physician anti-self-referral statute (known as the Stark law), as well as a "safe harbor" from criminal and civil sanctions under the federal anti-kickback laws.[14]

Whether and how the 2006 regulations actually increase the speed of HIT diffusion than otherwise would be the case is a matter of high interest in health services research, which has seldom, if ever, formally considered the impact of relaxed federal standards on provider conduct. The 2006 regulations are of particular interest because to a considerable degree, they appear to permit the private sector to selectively invest in the most remunerative physicians, that is,

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12 Bartlett D and Steele J. *Critical Condition: How Health Care in America Became Big Business and Bad Medicine.* Doubleday, New York, 2004. See esp. Chapters 2 and 3.

13 Publication L., 108–173, 108th Congress, 1st Session.

14 SSA §§ 1860D-4(e)(4) and (e)(6); SSA §1128B(b), 42 U.S.C. 1320a–7b(b).

physicians whose practices might be expected to yield a substantial return. Thus, it remains to be seen whether the regulations will advance diffusion and, if so, whether they will do so in an equitable manner that reduces rather than widens racial, ethnic and socioeconomic disparities in health and health care.

Key Elements of the Self-Referral and Safe Harbor Rules

The August 2006 final regulations[15] establish certain exceptions to the physician anti-self-referral statute[16] and a "safe harbor" under federal anti-kickback law for investments in certain HIT.[17] As with safe harbor and exceptions regulations generally, which tend to be carefully tailored to avoid excessive inducement, the HIT regulations are highly technical and apply only to permissibly structured donations of certain types of health information technology under carefully defined conditions.[18] Thus, the regulations permit only "certain arrangements in which a physician receives ...'nonmonetary remuneration' that is necessary and used solely to receive and transmit electronic prescription information [as well as] ...nonmonetary remuneration in the form of electronic health records software or information technology and training services necessary and used predominantly to create, maintain, transmit or receive electronic health records."[19]

The rules are highly detailed and carefully tailored to ensure that the public benefit outweighs the risk of fraud. Perhaps inevitably, therefore, the regulations introduce a level of complexity that is viewed by some legal experts as potentially undermining the basic purpose of the law.[20]

The e-prescribing exception to the physician anti-self-referral regulations applies only when all applicable conditions set forth in the exception are met.[21] Fundamentally, these conditions rest on the purpose for which the technology is to be used, prohibit the donor or recipient of the items and services from conditioning their financial relationship on the donations, and require that the systems be interoperable.[22] These arrangements must be in writing, and donations must be made without reference to other donor/donee relationships that may exist.

In the case of electronic health records,[23] the exception rule is similarly designed to operate in a narrow and constrained fashion, with qualification for the exception conditioned on the ability to demonstrate that the donation arrangement

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15 The 2006 regulations are under the purview of two separate parts of the U.S. Department of Health and Human Services (HHS): the Centers for Medicare and Medicaid Services (CMS), which has enforcement authority over the physician anti-self-referral law; and the Office of the Inspector General (OIG), which administers and enforces the federal health care anti-kickback statute.

16 71 Fed. Reg. 45140 (Aug. 8, 2006). See HHS News Release Aug. 1, 2006. www.hhs.gov/news/press/2006pres/20060801.html.

17 71 Fed. Reg. 45110–45134 (Aug. 8, 2006). See HHS News Release Aug. 1, 2006. www.hhs.gov/news/press/2006pres/20060801.html.

18 71 Fed. Reg. 45140 (Aug. 8, 2006). See HHS News Release Aug. 1, 2006. www.hhs.gov/news/press/2006pres/20060801.html.

19 71 Fed. Reg. 45140 (Aug. 8, 2006).

20 *Girardeau JM*. Final Stark Exception And Anti-Kickback Safe Harbor For Electronic Health Records And E-Prescribing, American Health Lawyers Association, Sept. 1, 2006.

21 42 C.F.R. §411.357(v).

22 The term "interoperable" is defined as "able to communicate and exchange data accurately, effectively, securely and consistently with different information technology systems, software applications and networks in various settings; and exchange data such that the clinical or operational purpose and meaning of the data are preserved and unaltered." 42 C.F.R. §411.351.

23 The regulation defines an EHR as follows: Electronic health record means a repository of consumer health status information in computer processable form used for clinical diagnosis and treatment for a broad array of clinical conditions. 42 C.F.R. §411.351

meets certain basic requirements. The rule allows compensation "in the form of software or information technology and training services[24] necessary and used predominantly to create, maintain, transmit or receive electronic health records"[25] only if the requirements set forth in the regulation are met. The donation cannot include hardware; it is limited to software and services. As with the e-prescribing rule, the conditions focus on the absence of specific "quid pro quo" or financial remuneration considerations, the presence of interoperability, and certain indicia that symbolize the presence of an arms-length transaction, such as an expectation of a certain volume of referrals or evidence of specific financial gain.

The anti-kickback safe harbor regulations are substantially similar to the exception rules; most notably, the range of donors and recipients is broader under the anti-kickback rule, given its broader sweep.[26] That is, while the "Stark" anti-self referral exceptions regulations apply specifically to physicians, the safe harbor rules reach a range of health care practices.

1. Interoperability

Interoperability is one of the rule's fundamental policy goals. The preamble underscores HHS' view that achieving an interoperable health information network justifies exceptions to self dealing and safe harbors, conduct that otherwise would be considered to constitute a kickback arrangement:

> The implementation of electronic health information technology is a national priority that has the potential to improve our health care system. Interoperable electronic health information technology would allow patient information to be portable and to move with consumers from one point of care to another. This would require an infrastructure that can help clinicians gain access to critical health information when treatment decisions are being made, while keeping that information confidential and secure. * * *

> * * * [W]e believe that interoperable electronic health records technology, once implemented, has the potential to increase health care quality and improve efficiency, which are outcomes consistent with our goals in exploring pay-for-performance options. We also believe it is important to promote these open, interconnected, interoperable electronic health records systems that help improve the quality of patient care and efficiency in the delivery of health care to patients, without protecting arrangements that hinder marketplace competition, serve as marketing platforms, or are mechanisms to influence clinical decision-making inappropriately.[27]

As a result, the rule sets forth two requirements. First, "once interoperability and other product criteria have been recognized, electronic health records technology should be certified in accordance with standards adopted by the Secretary." Second, the rule prohibits donors from restricting "the use of the technology with other electronic prescription or health records systems, or otherwise impose barriers to compatibility."[28]

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24 Multi-functional hardware is specifically excluded. 71 Fed. Reg. at 45149.
25 42 C.F.R. §411.357(w).
26 Final Stark Exception and Anti-Kickback Safe Harbor, op. cit.
27 71 Fed. Reg. at 45156.
28 Ibid.

2. A Broad Definition of an Electronic Health Record

Second, the regulations adopt a very broad EHR definition to encompass functionalities identified as critical by the Medicare Payment Advisory Commission and others such as the American Health Information Community. In the preamble to the final rule, HHS notes that its definition is meant to cover applications that permit patient tracking over time, electronic ordering and access to test results; provide alerts and reminders; and produce and transmit prescriptions electronically. By adopting a broad definition of an EHR, the regulation seeks to spur the donation of software applications with the broadest possible functionalities.

3. Selective Donation

Notably, HHS allowed donations to be selective. That is, while the donation cannot be conditioned on a specific quid pro quo, the donor can take a physician practice's attributes or size into account. The preamble specifically notes that "[T]his final rule permits donors to use selective criteria for choosing physician recipients" so long as they do not use criteria that directly relate to the "the volume or value of referrals or other business generated between the parties (e.g., a determination based on the total number of hours that the physician practices medicine or a determination based on the size of the physician's medical practice)." At the same time, the rules do not prohibit "selection criteria …based on the total number of prescriptions written by a physician."

In clarifying that donors can selectively target recipients, HHS notes that "this approach will ensure that donated technology can be targeted at physicians who use it the most in order to promote a public policy favoring adoption of electronic health records, while discouraging especially problematic direct correlations with Medicare referrals."[29] In other words, the department allows the targeting of high users, as long as the targeting strategies are not overly specific, that is, they do not set use or volume targets in exchange for the donation. As a result, it would apparently be possible under the rule to screen out users who are lower in the aggregate (e.g., physicians who treat a high volume of uninsured patients who use less care) while favoring with donations physicians who are mass consumers of the donor's goods or services.

This ability to be selective and to consider the aggregated volume of business that a donor might realize in relation to various possible recipients, may bear particularly careful scrutiny because of the potential that less lucrative health care practices will not receive comparable treatment with respect to permissible donated goods and services arrangements. Donations may represent a considerable outlay on the part of the donor, and the rule appears to suggest that donors can be broadly strategic, targeting or prioritizing their donations, as long as an explicit quid pro quo is not built into the equation.

Despite their ambitious goals, the regulations may have only a limited impact on HIT diffusion rates. Indeed, HHS itself appears to predict a relatively limited impact. In the preamble to the final regulations, HHS concludes that a regulatory impact statement was not necessary because the overall economic impact of the rules is not expected to exceed $100 million annually. Indeed, the department notes that:

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29   71 Fed. Reg. at 45158.

"[t]he exceptions [as well as the safe harbors] should facilitate the adoption of electronic prescribing and electronic health records technology by filling a gap rather than creating the primary means by which physicians will adopt these technologies. In other words, we do not believe that donor entities will contribute toward all of the health information technology used by physicians."[30]

In its reference to donations as a "gap filler," HHS cites evidence from a national survey of health care executives that suggests relatively few health care entities can be expected to donate significantly: 30 percent of respondents reported that they would donate nothing, another 30 percent reported that they would consider donating 20 percent or less of the cost of adoption, and less than 15 percent of those surveyed reported that they would cover 60 percent or more of the cost of donation.[31]

This view is amplified by industry experts, who believe the regulations contain several elements that will limit donation. Among these are a prohibition against the donation of hardware and the requirement of interoperability, which is viewed as undermining donors' competitive positions, particularly in the case of hospital donations to members of its medical staff.[32]

The federal government's conclusion that the rule will have a modest impact raises an immediate question: Where will the "primary" investment come from? But a second, and perhaps more important question is: Given the nature of donations as "gap fillers," which gaps (and whose gaps) will donors choose to fill, and to what extent, if any, will the interoperability requirement be seen as too steep a disincentive to a competitive private market willing to play a gap-filling role?

Particularly important to watch may be the interaction between interoperability and selective donation. Since systems must be interoperable and no specific quid pro quos can be exchanged, donors may be further incentivized to aid only their most lucrative users, leaving behind those health care practices that are most in need of donation assistance and least positioned to make good on the investment. The final rules make the broad economic, geographic and demographic characteristics of physician practices directly relevant to the receipt of compensation in the form of EHR donations. Will donors use these criteria to screen out physicians who provide a high volume of uncompensated care, or who serve publicly insured patients in large numbers? This may be the case if donors, concerned that interoperability, coupled with the inability to negotiate specific quid pro quos, will significantly limit the value of their investments in technology. In such a case, donors may be eager to use broad selection criteria to focus in on providers that display a "high-yield" profile because of their patient mix, their location and other permissible economic, financial or demographic characteristics.

Closely associated with the question of selective donation is the question of how to measure the social value of the rule. Given the modest expectations associated with the regulation, will donation in fact advance the very goal of interoperability that serves as the social good justifying the rule in the first place? In this regard, does the rule limit the potential of the federal government's broad vision of a national, interoperable health care system (and thus the very rationale

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30   71 Fed. Reg. at 45165.

31   Ibid.

32   Gosfield AG (ed). Health Law Handbook (Current through the 2007 Edition), §8.31.

that gave rise to the donation exception policy to begin with) by permitting selective donation driven by rate of return calculations on the part of the donor? These questions and others can be answered only through careful and long-term research measuring the donation policy's impact. Future reports, including future environmental scans, will consider these important policy questions.

4. Health Care Practice Network "Tiering" by Health Insurers

While they were rare as few as 25 years ago, physician networks are now the norm in health insurance coverage and health benefit service plans. Indeed, by 2006, only 7 percent of all employers offered a "conventional" plan, that is, a plan whose terms of coverage are not tied to a provider network.

Health insurers have a clear interest in encouraging their network providers to perform in a high-quality and efficient manner, and the concept of tying compensation to the quality of care is hardly a new one. Nor (as illustrated by credentialing activities among hospitals and managed care organizations) is the notion of conditioning any, or the level of, physician membership in a health care organization on the quality of care. As efforts to link practice quality to financing have increased, health plans have begun to test the use of provider network tiers, that is, network classification arrangements that rank their providers on certain quality and efficiency measures selected and calculated by the plan administrator.[33]

Physician tiering arrangements tend to focus on specialized, selected high-cost procedures; tiering techniques and methods may be tied to physician performance against evidence-based guidelines and consensus standards specified by the plan, with actual performance calculated via proprietary algorithms. Both the tiering measures and the tiering algorithms may be proprietary (and therefore opaque) with substantial variation from plan to plan.[34] Performance assessments may be limited to what can be ascertained through claims data at the individual provider level, and results may or may not be aggregated to practice group level. Plans also can vary in the proportion of network physicians designated as high performers.[35] In addition, plans may show much variation in the techniques they employ to incentivize member selection of high performing physicians.

Even though health plans have credentialed and overseen network performance for many years, new terms such as physician tiering may give rise to new legal challenges that attempt to frame the effort as a major departure from existing legal norms. This was the case during 2007 when physician groups launched challenges to health plan tiering arrangements.[36] In these challenges, the most prominent of which were a private lawsuit in Washington State[37] and a state attorney general

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33   Draper D, Liebhaber A, Ginsburg P. *High Performance Health Plan Networks: Early Experiences.* Center for Studying Health Systems Change Issue Brief 111, May 2007.

34   Ibid.

35   Ibid.

36   See, Sara Rosenbaum, Sarah Kornblet, and Phyllis Borzi. "An Assessment of Legal Issues Raised in Health Plan High Performing Health Plan Quality and Efficiency Tiering Arrangements: Can the Patient Be Saved?" *BNA Health Law Reporter* (Oct 9, 2007). Available at www.rwjf.org/files/research/physiciantiering102007.pdf (Accessed May 12, 2008).

37   See Washington State Medical Assoc., et. al. v Regence BlueShield (No. 06-2-30665-1SEA, filed Nov. 29, 2006, Seattle WA Superior Court) (settlement announced August 2007, BNA Health Law Reporter 12:153, August 9, 2007). Another example occurred in St. Louis, Missouri, where United HealthCare attempted to introduce a high-performance network in 2005. Providers rebuffed the plan, alleging design flaws, deceptive representations regarding the cost of care, and exclusion of certain groups of providers from the rankings system.

investigation,[38] allegations focused on: (1) secrecy in both the standards used and the weights used to perform rankings; (2) the absence of a transparent rational basis for the methods chosen; (3) the absence of a process by which physicians can examine the data on which their rankings rest and challenge errors in data or methodology; and (4) charges of defamation, interference with business practice, and restraint of trade.

In view of the fact that physician tiering in fact is another name for the long-standing practice of conditioning physician membership in health care organizations on performance, it is perhaps not surprising that settlements ultimately were reached. These settlements aim to balance physician concern against the desire for more and better information about physician performance. One recent settlement illustrates the nature of the accommodations that are being reached:

1. Prior to implementing any new or revised performance measurement program, the plan will give physicians an opportunity of meaningful input, including input on the data to be used, the methods used to compare physician performance, and the methods of communicating ratings and scores.

2. The insurer will make efforts to offer actual, advance notice (10 days) to physicians that new scores are forthcoming.

3. Physician scores will be posted in an electronic format, along with an explanation of the methodology, an explanation of the data relied on to calculate the score, and a means to identify the types of patients included in the calculation of the score.

4. Physicians will have the opportunity to make a timely appeal of their scores; where a score is challenged on a timely basis, it will be withheld until the appeal is completed. Where a physician's challenge is outside of the time limits permitted for an appeal, the score will be posted but with a clear notation that a challenge is underway.

5. Determinations by the insurer regarding the accuracy of its scoring will be appealable to an independent external reviewer based on the same materials used in the external review.[39]

This settlement illustrates a basic aspect of law, namely that, even while permitting a broad array of conduct, the legal system places a premium on rational conduct that is visible to affected populations and allows their input. In short, it is not classification based on quality that raises legal questions, nor is it the publication of information regarding health care quality; rather, the law reacts when efforts to rank and measure are conducted in an opaque manner. Thus, as challenges to early tiering arrangements are resolved, one may expect to see their spread in coming years, a development made possible by HIT.

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38 "Doctors Rated", op. cit., reporting on a New York State investigation. See letter dated July 13, 2007 from Attorney General Cuomo to United Healthcare indicating plans to seek an injunction against tiering on the basis of potential violations of consumer fraud laws.

39 Washington State Medical Assoc., et. al. v Regence BlueShield (No. 06-2-30665-1SEA, filed Nov. 29, 2006, Seattle WA Superior Court) (settlement announced August 2007, BNA Health Law Reporter, 12:153, August 9, 2007).

Chapter 3: Are Physicians Serving Poor and Minority Patients Keeping Pace With EHR Adoption?

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Monitoring the potential impact of health information technology (HIT) on health disparities remains a high priority for policy-makers. The 2001 Institute of Medicine (IOM) report, *Crossing the Quality Chasm*, emphasized the elimination of health disparities as one of its six national quality goals and advocated for "the provision of equitable health care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographical location and socioeconomic status."[1]

One of the great benefits of enhanced HIT adoption, assuming that this facilitates recording of data on patient race and ethnicity, will be to promote reporting on disparities of all kinds. Making that data publicly available cheaply and quickly could have a galvanizing effect on efforts to reduce inequities in U.S. health care. In addition, there is broad consensus that HIT—and electronic health records (EHRs) in particular—can significantly improve health care quality, safety and efficiency.[2–4] To the extent that EHRs significantly improve health care by enhancing the clinical quality and effective management of care,[5–22] ensuring equal access to HIT-enhanced health care will be an important component of any comprehensive strategy to eliminate health disparities. The IOM has emphasized the potential of EHRs to produce care that is more equitable,[23] and the American Medical Informatics Association (AMIA) has noted that underserved and vulnerable populations are "particularly in need of health information support," due to their members' increased risk for adverse outcomes.[24] Efforts to track the ultimate impact of HIT adoption on health disparities, however, are somewhat limited by a lack of data on HIT adoption rates among providers who disproportionately serve low-income, uninsured, minority or other underserved patients.

In our inaugural 2006 report on HIT adoption in the United States, we reviewed the current state of knowledge regarding EHR adoption among providers of underserved populations, addressed conceptual frameworks and analytic approaches for studying EHR adoption among such providers, and presented new analyses pertinent to these issues. In this chapter, we briefly summarize that discussion and provide newly available data on EHR adoption among three groups of providers: community health centers, public hospitals and physicians. We also present new data from the National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS) that provide the first glimpse into patient access to HIT-enhanced health care according to patient characteristics. We then discuss important data gaps that need to be addressed in order to allow policy-makers to monitor HIT diffusion among providers who serve poor and minority patients, and to assess the potential impact of differential diffusion on health disparities.

A Note on Definitional Issues

Analyses of EHR adoption have had to grapple with inconsistent definitions of what constitutes an EHR; as a result, recent estimates of EHR adoption among physicians range from 9 percent to close to 30 percent, depending on the level of functionality achieved.[25, 26] Our recent environmental scan conducted for the national HIT Adoption Initiative concluded the best estimate of EHR adoption among physicians in 2004 was 17 percent.[27] According to our most recent national survey of physicians, 13 percent have a basic EHR and 4 percent have a fully functional EHR.[28]

Many HIT adoption studies use self-reported global measures of adoption, along with additional questions to assess the presence and use of specific functionalities. The NAMCS summary measure, for example, asks physicians, "Does your practice use electronic medical records (not including billing records)?" Available responses are: "yes, all electronic;" "yes, part paper and part electronic;" "no;" and "don't know."[29] Additional questions focus on EHR functionalities (e.g., "Does your health center's electronic medical record system include: computerized orders for prescriptions; lab results; imaging results…"). In our analysis, we review estimates of EHR adoption according to the definition developed by the national HIT Adoption Initiative's Expert Consensus Panel (ECP) in 2006. The ECP determined that, at a minimum, an EHR system must include patient demographics, computerized orders for prescriptions, computerized orders for tests and lab results, and computerized decision support.[30] Where construction of this definition is not possible, we report the question used in the respective survey instrument.

With respect to clarifying what we mean by "disparities," the most often used categories for documenting health disparities are patients' race[31–41] and insurance status (as a proxy for socioeconomic status).[42–44] The ECP identified racial/ethnic minorities and low-income patient populations as the highest priority groups with respect to tracking access to HIT-enhanced medical care and its potential implications for health disparities.[45]

Strategies for Monitoring EHR Diffusion Among Providers Who Serve Vulnerable Populations

Ultimately, the policy relevant questions we want to address are: (1) Do poor, minority and other underserved patients have reduced access to HIT-enhanced health care? and (2) To what extent does reduced access have a negative impact on health outcomes and health disparities? The effect of HIT-enhanced care on outcomes and disparities in outcomes is not measurable with available data and may not be observable for a considerable period of time; therefore, we will confine our focus to the first question.

Consumers often are not in a position to report reliably on their health providers' use of HIT to guide clinical care. The ideal approach for assessing consumer access to EHR-enhanced health services is to sample patients and then query their primary providers regarding their use of an EHR system. Another strategy for monitoring patient access is to monitor EHR use among providers who disproportionately serve specific subpopulations of patients as a proxy for such access. As described in our inaugural report, there are several possible analytic strategies for monitoring EHR adoption rates among providers who

disproportionately serve minority, poor or other underserved patient populations. Each approach has strengths and limitations and variable data requirements.

One approach is to focus on safety-net providers, whose patient populations are overwhelmingly comprised of low-income, Medicaid, minority and uninsured (e.g., more than three-fourths of community health center (CHC) patients are uninsured or on Medicaid).[46] The IOM report, *The Health Care Safety Net: Intact but Endangered*,[47] defines safety-net providers as "those providers that organize and deliver a significant level of health care and other related services to uninsured, Medicaid and other vulnerable patients."[48] The study further defines core safety-net providers as those providers who: (1) either by legal mandate or explicitly adopted mission maintain an "open door," offering access to services for patients regardless of their ability to pay; or (2) for whom a substantial share of their patient mix is uninsured, Medicaid and other vulnerable populations.

Although safety-net providers do not serve the majority of poor or minority patients nationally, the vast majority of their patients are poor, minority or uninsured. These "high-mission" providers are typically located in underserved areas and, unlike other not-for-profit providers, are often legally mandated to serve all patients seeking services regardless of their ability to pay. Yet, focusing only on safety-net providers to study EHR adoption among vulnerable patient groups has important limitations. Most notably, this approach does not capture patients' experiences in a nationally representative way. Private, not-for-profit hospitals, for example, account for the majority (about 56 percent) of all free care provided,[49] even though the proportion of patients served by public hospitals that are uninsured is far higher.

Thus, another approach is to focus on providers who serve large numbers of patients from designated subpopulations, or "high-volume" providers. Due to their size, these providers may account for the majority of services provided to minority or uninsured patients in their service area—even though these patient subgroups may only account for 10 percent or less of their total patient panel. It is likely that a multi-pronged approach will be necessary to capture patterns of EHR use in the care of poor, minority, uninsured or other vulnerable patient populations.

In this year's report, we present data that reflect both analytic approaches. We first summarize new data on EHR adoption among CHCs and public hospitals, two important safety-net provider groups with patient panels overwhelmingly comprised of poor, uninsured and minority patients. We then report several new analyses that address primary care provider use of EHRs from NAMCS and NHAMCS, the HIT Adoption Initiative's recent survey of U.S. physicians, and the 2005 Medical Group Management Association (MGMA) Survey. These surveys investigate whether there are differential rates of EHR adoption among physicians who disproportionately serve minority, low-income or other underserved patients, or among physicians whose practices are located in areas that have a disproportionate share of poor or minority residents.

HIT Adoption Among Community Health Centers

CHCs are an important part of the health care safety net,[50] providing medical, dental and behavioral health care for people with low incomes, the uninsured, the homeless, migrant farmers and others in need of medical assistance.[51, 52] Nearly two-thirds of CHC patients are racial or ethnic minorities, and 30 percent are not fluent in English.[53] Three-quarters of CHC patients are uninsured or covered by Medicaid. Nationally, CHCs serve more than 16 million patients, including one in four persons with a family income at or below the federal poverty level, one in seven uninsured Americans, one in nine Medicaid beneficiaries, one in 10 minorities and one in nine rural residents.[54, 55] Since 1999 the number of patients served by CHCs has increased more than 50 percent.[56] This is largely due to federal initiatives aimed at increasing the number of community health centers through the addition of 630 new sites to serve up to 1,200 new communities.[57] CHCs are thus expected to serve an even greater number of poor and uninsured patients in the coming years.

Until recently, available data on HIT adoption among CHCs were limited to reports from the California-based Community Clinics Initiative[58, 59] and a qualitative study of seven health center networks identified as being CHC leaders, which emphasized the role of networks in facilitating HIT access.[60] This past year, data from the first national survey assessing HIT adoption among the universe of federally-funded CHCs (N=914; response rate: 79.5%)[61] were released. The study assessed EHR adoption using two measures: The first was drawn from the 2006 NAMCS questionnaire and asked respondents whether they had a fully electronic EHR, a partial EHR that was "part electronic and part paper" or no EHR capacity. Those reporting a full or partial EHR were asked to describe specific functionalities of their EHR system. These responses were used to construct a second measure of EHR capacity reflecting the minimal set of functionalities the national HIT Adoption Initiative's ECP deemed to comprise a functional EHR in 2006.

The National CHC HIT Survey included other HIT-related measures that assessed the maintenance of disease-specific registries; existence of patient registries funded through Health Resources and Services Administration's (HRSA) Health Disparities Collaboratives; presence of a dedicated information technology staff person; and plans to install a new EHR system or replace an existing system within the next three years. Survey data were linked by a unique provider identification number to the 2004 Bureau of Primary Health Care's Uniform Data System (UDS) data file, which includes information collected by HRSA each year to monitor and evaluate health center performance, providing a range of important covariates.

Although nearly 25 percent of CHCs reported having either full or partial EHR systems, according to the NAMCS global item, only 13 percent of CHCs had the minimum set of functionalities defined by the ECP to comprise a functional EHR (Table 1). Only 60 percent of those who self-reported that they had a full EHR, and only 47 percent of those reporting that they had a partial EHR, met these minimal criteria.

Nationally, 86 percent of CHCs maintain at least one disease-specific registry, 80 percent maintain patient registries as part of the HRSA-sponsored Health Disparities Collaboratives, 59 percent have a dedicated information technology staff person, and 60 percent report having plans to install a new EHR system or

replace an existing EHR system within the next three years (Table 2). Among those that have full or partial EHRs, virtually all have electronic patient demographics, 85 percent have computerized orders for prescriptions, 83 percent have electronic clinical notes, 71 percent have computerized orders for tests, and 71 percent have computerized laboratory results (data not shown).[62]

Among CHCs, there was significant variability in EHR adoption according to their patient mix (Table 3). Controlling for location (region, urban/rural location); size (number of unique patients served, number of sites); medical personnel (number of physician, mid-level and technical staff per patient); payer mix (proportion of patients who are privately insured, on Medicaid, Medicare or uninsured); percentage of patients enrolled in managed care, revenue-to-cost ratio and patient demographic characteristics (age, race/ethnicity, family income); CHCs serving a greater proportion of uninsured patients (above the median) were significantly less likely [adjusted odds ratio (O.R.): 0.47; 95% CI: 0.25–0.91; p<.03] to have a functional EHR compared to those centers whose uninsured patient load was below the median. Those centers ranking above the median in the proportion of patients with family income below the federal poverty line were also significantly less likely to have a functional EHR (adjusted O.R.: 0.44; 95% CI: 0.26–0.76; p<.01) compared to those serving fewer poor patients.

CHCs that do not have a functional EHR rated the lack of capital to invest in EHRs as the top barrier to adoption, with 91 percent rating this barrier as important or very important. Among other barriers to adoption, 81 percent cited their inability to integrate EHRs with the practice's current billing or claims submission system, and 76 percent cited concerns about the loss of productivity or income during the transition to EHRs (Table 4).

About 13 percent of all CHCs had a functional EHR in 2006; 12.4 percent of office-based physicians had a functional EHR during the same period.[63] However, these aggregate comparisons of EHR adoption among CHCs and private physician practices miss the fact that CHCs lag behind physicians in EHR adoption within every category of practice size (Table 5). The lower average rate of adoption among physicians in the NAMCS sample is driven by the 46.4 percent of physicians that are in solo or two-physician practices, while the majority of CHCs have six to 10 providers.

CHCs that serve the highest proportion of poor and uninsured patients, and thus have comparatively lower third-party revenues, are significantly less likely to have an EHR. This is not surprising, given the substantial costs associated with the adoption of EHR systems, including hardware and software evaluation and implementation, staff training and ongoing operational support.[64] CHCs' average annual operating margin of less than one percent leaves them poorly equipped to make substantial capital investments,[65, 66] thus increased EHR adoption among CHCs is largely a financial concern. These centers' reliance on public grants and Medicaid payments, which together account for nearly 70 percent of all operating revenues, means that public financing for EHR adoption and operational support effectively will determine the extent to which CHC providers and their patients benefit from these technological advances.

Health centers cannot shift the cost of adoption to private payers, nor do they have the same level of access to private lending capital as private health care providers with robust operations. This is even more evident for CHCs

serving the greatest number of poor and uninsured patients, who lag behind their peers in EHR adoption. CHCs will need significant up-front investment to facilitate adoption, as well as ongoing assistance to support IT staffing and ongoing maintenance. Fiscella and Gieger[67] recently called for substantial federal investment in research to identify the most appropriate models for accelerating the adoption of EHR systems among CHCs and for the necessary funding and technical support to facilitate such adoption. Miller and West have estimated that CHCs will need $550 million to $1.1 billion over the next 10 years to pay for EHRs, including technical and organizational assistance.[68] Monitoring progress toward the full implementation of EHRs among CHCs is one strategy for ensuring that 10 percent to 15 percent of poor, minority and uninsured patients nationwide will have access to HIT-enhanced health care.

HIT Adoption Among Public Hospitals

Another important group of safety-net providers is public hospitals. Public hospitals provide more than 35 million ambulatory care visits each year[69] while working within an average operating margin of less than one percent.[70] On average, 32 percent of public hospital patients are on Medicaid, 26 percent are uninsured and 54 percent are minorities.[71] There are relatively few data on the EHR adoption rates among public hospitals as compared to other not-for-profit hospitals. The most recent survey, conducted in 2004, compared adoption rates at public hospitals to rates at academic medical centers during 2004. Fielded by the University HealthSystem Consortium (UHC), an alliance of academic health centers, the survey assessed HIT adoption among its members and that of National Association of Public Hospitals and Health Systems (NAPH) organizations. Hospitals were asked whether they had an electronic medical record (EMR), defined as "a computer-based, electronic file that includes personal and medical history information about a patient. It is also referred to as an electronic health record, automated patient record, or computer-based patient record, among other names,"[72] within several key departments. Possible responses included: "fully implemented," "partially implemented" or "not at all." While more than 90 percent of NAPH hospitals rated having an EHR as "highly important" for inpatient, ambulatory and emergency department care, only 64 percent of inpatient, 55 percent of ambulatory, and 55 percent of emergency department care settings reported having fully or partially implemented EHRs. In the UHC comparison group, 97 percent of inpatient care settings, 81 percent of ambulatory departments, and 72 percent of emergency care departments had fully or partially implemented EHRs[73] (Figure 1).

This survey found that public hospitals' adoption of EHR systems, including those with fully implemented EHRs or those in the process of implementing an EHR, lagged behind that of UHC hospitals across all departments. These results highlight the financial vulnerability of public hospitals and their reduced capacity for capital investments. While the NAPH hospitals in this sample had an average operating margin of 0.4 percent, UHC respondents reported an average margin of 4.9 percent. The NAPH has appealed to the federal government for funding to support the acquisition of HIT by public hospitals and other safety-net providers.[74] Public hospitals, like CHCs, will not be able to keep pace with hospitals that have healthier margins unless they receive targeted support.

A 2007 American Hospital Association survey (N=4,977 community hospitals, response rate: 31%) found that among the 11 percent of hospitals nationwide with a fully implemented EHR system, certain hospital subsets were more likely than others to have adopted HIT. In the survey, an EHR was defined as "a system that integrates electronically originated and maintained patient-level clinical health information, derived from multiple sources, into one point of access. An EHR replaces the paper medical record as the primary source of patient information." Although the report does not stratify respondents by their public or private status, they do document that larger, urban and teaching hospitals are far more likely to have a fully implemented EHR. Specifically, 16 percent of urban hospitals have EHR systems, compared to only 5 percent of rural hospitals. This disparity is important because rural hospitals disproportionately serve low-income patients,[75] and several studies have found that rural residents have reduced access to health service and poorer quality care.[76–81] The survey also found that rural hospitals and smaller hospitals cited the ongoing costs associated with maintaining a system as a significant barrier to adoption more frequently than other hospitals (Figure 2). Even though urban teaching hospitals care for substantially larger numbers of patients, reduced access to EHR-enhanced health care may adversely affect rural residents, who often have limited choice in where they receive their care.

With respect to our interest in hospitals that serve large numbers of low-income and minority patients, more refined analyses—comparing HIT capacity at these institutions relative to other hospitals—are needed. Analyses that compare public hospitals to each other—for example, those serving large numbers of minority patients to those serving a disproportionate share of uninsured patients—are needed to assess the extent to which hospitals serving poor and minority patients are keeping pace with peer institutions.

HIT Adoption Among Physicians Who Disproportionately Serve Vulnerable Patients

Several recent analyses provide insight into EHR adoption patterns as they relate to characteristics of a provider's patient panel. The most recent national data on HIT adoption according to physicians' patient mix characteristics comes from the 2008 national survey of U.S. physicians conducted by the national HIT Adoption Initiative. In this survey (N=2,661; response rate: 59%), physicians were asked a variety of questions regarding specific functionalities of their EHR systems, barriers to EHR adoption, and characteristics of their practices and the patients they serve. In order to ascertain whether there were signs of differential HIT adoption among physicians who disproportionately serve minority or poor patients relative to those serving other patient populations, we assessed rates of EHR adoption using both the "basic EHR" and "fully functional EHR" definitions adopted by the HIT Adoption Initiative.

Respondents were asked to estimate the percentage of patients in their main practice site that were uninsured, covered by Medicaid, African American or Black, Hispanic or Latino, and have a primary language other than English. Response categories included less than 10 percent, 10 percent to less than 25 percent, 25 percent to less than 50 percent or 50 percent or more. For this analysis, we designated physicians reporting 25 percent or more of their patient populations from any particular group as "high-proportion" providers, and then assessed EHR adoption among these high-proportion providers. Among survey respondents,

9 percent reported that 25 percent or more of their patients were uninsured; 25 percent of respondents reported that 25 percent or more of their patients were Medicaid; 24 percent reported that 25 percent or more of their patients were African American or black; 18 percent reported that 25 percent or more of their patients were Hispanic or Latino; and 13 percent reported that 25 percent or more of their patients had a primary language other than English.

As seen in Figures 3 and 4, there are no significant differences in EHR adoption among physicians who serve a high proportion of uninsured, Medicaid or minority groups compared to physicians serving relatively fewer such patients. These preliminary results suggest that black, Hispanic or Latino, uninsured and Medicaid patients do not currently have differential access to the benefits of HIT-enhanced health care. Further research is needed to determine the accuracy of physicians' self-reported patient-mix variables, as well as the relationship between these patient-mix variables and other factors known to be associated with EHR adoption. In bivariate analyses, for example, physicians who reported a high uninsured patient load (p<.0001), a high Medicaid patient load (p<.0001), and a high black/African American patient load (p<.0023) were also more likely to have a hospital or medical center as their primary practice setting than the national average. Approximately 47 percent of high-proportion uninsured physicians, 44 percent of high-proportion Medicaid physicians and 38 percent of high-proportion black/African American serving physicians were located in hospitals or medical centers. These facilities serve a high number of minority, uninsured and Medicaid patients and have also been shown to have a higher likelihood of EHR adoption.[82]

NAMCS/NHAMCS Analysis of Patient Access to HIT-Enhanced Health Care

To date, there are few data that assess differential access to HIT-enhanced health care among subsets of patients directly. Data from the 2005 NAMCS and outpatient department (OPD) component of the 2005 NHAMCS, which included an analysis of 18,419 individual patient encounters and represents a weighted sample of 158,728,000 unique patients in the United States, provides some initial information.[83]

The NAMCS is an annual nationally representative probability survey of visits to non-federal office-based physicians; excluding radiologists, anesthesiologists, and pathologists, while the NHAMCS is the counterpart of the NAMCS in non-Federal, general and short-stay hospitals, including children's general hospitals. The NHAMCS samples hospitals and emergency and outpatient department clinics and their visits within hospitals. Both surveys are conducted by CDC's National Center for Health Statistics (NCHS).

Based on visits to the patient's primary care providers (PCPs) in physician offices and hospital OPDs, NCHS analysts estimated annual number of patients by adjusting sample visit weights by a factor accounting for the increased likelihood of selection among patients with multiple visits during the last 12 months. NCHS analysts assessed the proportion of patients whose PCP reported having a fully functional EHR according to key patient characteristics (Figure 5). Controlling for a variety of patient characteristics (age; gender; race and ethnicity; expected payment sources; and 2000 Census income data for the patient's neighborhood) and provider characteristics (type and size of PCP's practice; region; and urban

status), Hispanic and Non-Hispanic black patients were significantly less likely to have a PCP that used an EHR system, with a regression-adjusted average of 6 percent of Hispanic patients seeing a PCP who uses an EHR and 10 percent of black patients seeing a PCP who uses an EHR. Fewer Medicaid and Medicare patients had a PCP who used an EHR compared to privately insured patients, as did rural patients compared to patients living in urban areas.

These results are based on 2005 patient-level data only; 2006 data are pending, but suggest that these differences may have been mitigated by the growth in adoption rates from 2005 to 2006. For example, the NAMCS data show increased EHR adoption by physicians with 20 percent or more of revenue from Medicaid between 2005 (5.5 percent) and 2006 (13.6 percent).[84, 85] And although estimates of 2006 adoption rates for hospital OPDs are not available yet (6.6% of patients saw their PCP in a hospital OPD), the 2007 AHA survey indicated 11 percent of hospitals in 2006 had fully implemented EHRs; prior to this estimate, the best estimate of EHR adoption in hospitals was 5 percent.[86] Thus, differences in time period of data collection is the most likely explanation for the differences in the NAMCS/NHAMCS data analyses and our preliminary analyses from the HIT Adoption Initiative's 2008 Physician Survey. The difference in sampling frames also makes comparisons challenging. For instance, the NAMCS and NHAMCS analyses build from patient-level encounter data to identify individual patients and then assessed EHR adoption of their PCPs (including mid-level providers and primary care physicians), while the HIT Adoption Initiative study surveyed all physicians in the frame directly.

Finally, the weighting algorithm used in the NAMCS analysis takes into account the total volume of patients from various subpopulations a physician serves, while the analyses from the HIT Adoption Initiative Physician Survey focus on the proportion of a physician's patient panel that come from various patient subpopulations and do not address volume of patients served. Further research is needed to disentangle the effects of patient mix, payer mix, practice setting and practice size on patient access to HIT-enhanced health care.

HIT Adoption Among Medical Group Practices Located in Minority Communities

Analyzing HIT adoption according to geographical areas with high concentrations of patient subpopulations of interest may also be informative. Studies have found that community-level poverty is a significant determinant of access to health services, with those living in low-income neighborhoods less likely to receive needed care.[87] Areas of extreme poverty, for example, have been shown to have significantly higher premature adult mortality rates.[88] Other studies document that people living in communities with greater concentrations of minority residents have less access to health services and receive poorer quality care.[89, 90] We were unable to identify any extant studies that assess HIT adoption rates among providers located in communities with high concentrations of poor or minority residents compared to other communities.

In new analyses conducted for this report, we reviewed data from a 2005 MGMA survey of 3,629 medical group practices nationwide[91] to determine whether practices located in counties with a disproportionate number of poor and minority residents are less likely to report having an EHR than practices located in areas

with fewer minority and low-income residents. The MGMA survey was designed to assess whether practices had implemented an EHR, with responses ranging from "not implemented" to "fully implemented." The survey further asked respondents to identify specific functionalities of their practices' EHR system, including patient appointment systems, clinical laboratory order entry, referral tracking, radiology/imaging order entry, prescription writing and drug interaction warnings, and to assess barriers to implementation. Further details of the MGMA survey instrument are available elsewhere.[92]

Addresses of the 3,629 medical group practices in the final study sample were geo-coded to the U.S. Census by a commercial geo-coding firm, Mapping Analytics (www.mappinganalytics.com), to ascertain county-level population characteristics, with 87 percent of cases successfully matched. These included: percentage of the population from different racial/ethnic minority groups, percentage with a family income below the federal poverty level, percentage owning their own home and median family income, according to data from the 2000 Census. As seen in Table 6, medical group practices in this sample are located in counties that tend to be, on average, less poor compared to other counties nationally. The proportion of residents who owned their own home and identified themselves as minorities, however, was roughly approximate. All analyses were adjusted to account both for sampling design and non-response.

The main dependent variable for this analysis was having a functional EHR, based on matching the specific functionalities addressed in the MGMA survey to the functionalities deemed to comprise a functional EHR according to the national HIT Adoption Initiative's ECP (Table 7).[93] To be coded as having a functional EHR, group practices were required to have electronic capacity for at least one of the tasks listed under each of the four functionality domains. County level variables indicating the percentage of population by race/ethnicity were included in the analyses as continuous variables.

The survey instrument also assessed 15 perceived barriers to EHR implementation. Physicians were asked to rate the importance of each barrier on a scale from 1 to 5 (1 = not a problem; 2 = minor impact on implementation; 3 = complicates implementation to some degree; 4 = makes implementation difficult; 5 = makes implementation extremely difficult). We analyzed these barriers by combining responses to 4 and 5 among medical group practices that currently did not have a fully implemented EHR (N=2,720). The seven barriers cited most frequently as presenting an important or extremely important barrier to implementation were analyzed further using separate logistic regression models.

Results

While 23 percent of medical group practices reported having a fully implemented EHR, only 8 percent had a functional EHR according to the definition proposed by the National HIT Adoption Initiative (Table 8). Close to 43 percent of practices had order-entry management, 64 percent had results management, 35 percent had decision support software, and virtually all had access to health information and data electronically.

As in other analyses, after controlling for a wide range of variables, EHR adoption was largely driven by practice size (p=0.002) (Table 9). The likelihood that a physician practice had a functional EHR decreased in a linear fashion as the

number of physicians in the group decreased. For example, practices with three to five physicians were significantly less likely to have a functional EHR (O.R.: 0.61; 95% CI: 0.44–0.84) compared to practices with 11 or more physicians; while practices with fewer than three physicians were even less likely to have a functional EHR (O.R.: 0.43; 95% CI: 0.26–0.72). Neither the percentage of minority population in the county nor the percentage of population living in poverty was significantly associated with having a functional EHR.

Study Implications

Study results did not find a significant association between the percentage of the population who were minority or living in poverty and the likelihood of EHR adoption. Previous bivariate analyses of the 2005 NAMCS survey (N=1,281, of whom 50 percent were solo or two-physician practices rather than group practices), found significant differences in EHR adoption based on the percentage of revenue from Medicaid, but no pattern based on the county level racial/ethnic distribution of the patients' neighborhoods.[94] The association by percentage of Medicaid revenues was not found, however, in the 2006 NAMCS data.[95] Results of our MGMA analyses suggest that area-level studies of HIT adoption based on racial/ethnic or socioeconomic status of the local community may not be an optimal strategy for tracking the diffusion of HIT among providers that disproportionately serve minority or low-income patients. Tracking HIT adoption using more proximate measures of patient mix, such as physicians' self-reported patient mix by race or insurance status (as a proxy for income) or, even better, empirically assessed patient mix using claims or other data, would be a more useful strategy.

Looking to the Future

To the extent that EHRs do measurably improve quality of care, lower rates of EHR adoption among providers that serve a large proportion of low-income or minority patients would further exacerbate health disparities. To date, there is little evidence that providers who serve high numbers of poor, minority or other underserved patient populations are less likely to provide HIT-enhanced health care. Ongoing data collection efforts should soon allow more nuanced study of these dynamics. In analyses of barriers to adoption, virtually all available data document that the financial burden associated with purchasing, implementing and/or maintaining an EHR system is the major barrier to adoption among small and under-resourced subsets of providers who are more likely to serve poor, minority or other vulnerable patients (e.g., solo or very small physician practices, rural hospitals and community health centers).[96–98] Should a gap in EHR adoption emerge, targeted initiatives and financial resources will likely be needed to close such a gap. One of the only venues in which we have seen well-documented, positive progress towards HIT adoption among providers in underrepresented communities is the Indian Health Service.[99] While this may be considered a success story, it is also a fairly unique situation, as the centralized organization of the Indian Health Service makes the implementation of EHRs far easier than dealing with small, geographically scattered and organizationally disparate entities that continue to have limited or no electronic capacity.

The field of HIT research, in many ways, is still in its infancy. Extant research is limited by inconsistent definitions and variable survey design quality. The field is only beginning to coalesce around standardized definitions, spurred by national

efforts to produce reliable EHR adoption estimates across major segments of the health care system on a regular basis. The fundamental work of understanding adoption rates among various health care sectors and subcultures, and departments within health care organizations, is a daunting task in itself. The future work of systematically investigating the impact of HIT-enhanced health care on health care quality and on health disparities is the next critical step.

Ongoing and future work of the national HIT Adoption Initiative will help address some of these foundational gaps in information and begin laying the groundwork for large national studies addressing the impact of HIT on health outcomes and health disparities. Future analyses of the HIT Adoption Initiative's Physician Survey may provide further insight into the dynamics of EHR adoption and barriers to adoption among physicians who report serving high numbers of minority, low-income and low English-proficiency patients. Future NAMCS/NHAMCS analyses are expected to provide more nuanced data on EHR adoption from the perspective of the patient and his/her primary care provider. A forthcoming hospital survey, also in the field, includes items that will allow for a more detailed analysis of a hospital's HIT adoption level and its relationship to patient and payer mix. Finally, a planned consumer survey will provide new data on access to HIT-enhanced health care along dimensions that are visible to patients. All of these efforts are being designed with an express commitment to assessing whether there is differential diffusion among providers who disproportionately serve vulnerable populations. These data will provide comparable estimates of HIT adoption across subsets of providers relevant to meeting the needs of vulnerable populations.

The next generation of HIT research will focus on the impact of EHRs on health care quality and costs. Ultimately, this, along with reliable and consistent data to identify minority, Medicaid, low-income or uninsured patients, will enable us to determine the impact of HIT on vulnerable populations and health disparities. Although the inclusion of race/ethnicity data in EHR systems was not recommended in the Certification Commission for Healthcare Information Technology's (CCHIT) 2007 standards for certifying the functionality of ambulatory EHR systems, this information is critical.[100] To that extent that tracking the diffusion of HIT and its impact on health disparities is a public policy priority, additional steps—in the form of powerful incentives or legal mandates—will need to be taken in order to ensure that race/ethnicity are consistently recorded in EHRs and the impact of HIT on health outcomes among minority populations can be evaluated. Our concern lies with the impact of health system change at the individual patient level— does HIT-enhanced health care improve quality? If so, do all Americans have equal access to these benefits? These are the important questions to answer going forward. Ensuring the reliability of the data needed to study these questions is critical to this process and should be a public policy priority.

Table 1: **Self-Reported EHR Use Versus Functional EHR Among CHCs***

Self-Reported EHR Adoption	Total Reporting No. (%)		Proportion Meeting Criteria for Functional EHR
Total	**725**	**(100)**	**13%**
Full EHR	62	(9)	60%
Partial EHR	115	(16)	47%
None	545	(75)	0%
Don't Know	3	(0)	0%

SOURCE: Derived from the authors' analyses. *Minimum criteria deemed to constitute an EHR include electronic patient demographics, computerized orders for prescriptions, computerized orders for tests, electronic lab results, and electronic clinical notes (Robert Wood Johnson Foundation, MGH Institute for Health Policy, and George Washington University. *Health Information Technology in the United States: The Information Base for Projects*, Robert Wood Johnson Foundation, (ed.), 2006).

Table 2: **Community Health Center Characteristics**

	Distribution of Characteristics
Health Center Characteristics	
Geographical Region	
Northeast	20%
Midwest	18%
West	28%
South	34%
Revenue to Cost Ratio	
0–.8	9%
.8–1	49%
> 1	42%
Patient Distribution by Payer	
Private Insurance	17%
Medicaid	31%
Medicare	7%
Uninsured	41%
Other	4%
Patient Characteristics	
Family Income	
Below Federal Poverty Level	52%
100%–200% of Federal Poverty Level	16%
> 200% of Federal Poverty Level	7%
Unknown	26%
Race and Ethnicity	
White	43%
Black	21%
Asian	3%
Native American	2%
Latino	25%
Unknown	6%

	Distribution of Characteristics
Health IT Characteristics	
Self-Reported EHR Adoption	
No EHR	75%
Full EHR	9%
Partial EHR (part paper and part electronic)	16%
EHR Functionalities	
Electronic Patient Demographics	24%
Computerized Orders for Prescriptions	21%
Computerized Orders for Tests	17%
Electronic Lab Results	18%
Electronic Clinical Notes	20%
Maintains one or More Disease-Specific Registries	86%
Maintains Patient Registries as Part of HRSA's Health Disparities Collaboratives	80%
Has Dedicated Health IT Staff Person	59%
Has Plans for Installing New EHR or Replacing System Within 3 Years	60%

SOURCE: Shields, et al. "Adoption of Health Information Technology in Community Health Centers: Results of a National Survey," *Health Affairs*, 26(5), 2007.

Table 3: **Factors Associated With EHR Adoption Among CHCs (2006) (N=672)**

	Adjusted O.R.	95% C.I.	p value
Health Center Characteristics			
Practice Setting			
Rural Area	1.00		
Urban Area	1.81	0.93–3.54	0.08
Region			
Northeast	1.00		
Midwest	0.72	0.30–1.76	0.48
West	1.77	0.81–3.89	0.15
South	2.59	1.17–5.71	0.02
Number of Health Care Delivery Sites			
One site	0.49	0.18–1.33	0.16
Two–Four Sites	0.60	0.30–1.19	0.14
Five–Ten Sites	0.69	0.34–1.41	0.31
Greater Than 10 Sites	1.00		
Number of Unduplicated Patients Served Annually			
Less Than 5,000 Patients	0.56	0.22–1.42	0.22
5,000–10,000 Patients	0.75	0.37–1.50	0.41
Greater Than 10,000 Patients	1.00		
Provider per 10,000 Patients			
> median* (4.7) Primary Care Physicians	0.76	0.46–1.25	0.28
> median (3.1) PAs, NPs and CNMs	1.36	0.82–2.27	0.23
> median (0.7) Laboratory & X-Ray Technicians	1.02	0.62–1.66	0.95
Financial Characteristics			
Revenue to Cost Ratio			
Less than 1	0.86	.53–1.39	0.53
Greater than 1	1.00		
Patients' Insurance Status			
> median (13%) Privately Insured	1.09	0.57–2.09	0.80
> median (31%) Medicaid	0.97	0.53–1.77	0.91
> median (5%) Medicare	1.60	0.92–2.77	0.09

	Adjusted O.R.	95% C.I.	p value
> median (38%) Uninsured	0.47	0.25–0.91	0.03
Managed Care			
> median (10%) Enrolled in Managed Care	1.12	0.65–1.94	0.67
Patient Characteristics			
Age			
> median (31%) Aged 0–17 yrs	1.11	0.63–1.95	0.71
> median (60%) Aged 18–64 yrs	1.36	0.73–2.56	0.34
> median (6%) Aged 65+	0.60	0.33–1.12	0.11
Family Income			
> median (53%) With Family Income Below 100% Federal Poverty Level	0.44	0.26–0.76	0.01
Race and Ethnicity			
> median (38%) White	1.11	0.62–1.96	0.73
> median (7%) Black	0.92	0.49–1.71	0.79
> median (10%) Latino	1.75	0.97–3.16	0.06
> median (5%) Other Race	1.43	0.86–2.39	0.17

SOURCE: Ibid.

*Health centers above the median of the distribution were compared to centers below the median. PA: Physician assistant; NP: Nurse practitioner; CNM: Certified nurse-midwife

Table 4: **Perceived Barriers to EHR Adoption Among Community Health Centers***

	Proportion Rating Barrier Important or Very Important
Lack of capital to invest in EHR	91%
Inability to integrate the EHR with practice's billing/claim submission system	81%
Concern about loss of productivity or income during transition to the EHR system	76%
Available software does not meet the health center's needs	56%
Inability to evaluate, compare, and select the appropriate EHR system	56%
Added value of EHR does not justify investment	50%
Lack of support from physicians	50%
Lack of support from non-physician providers	43%

Source: Ibid.

* Table summarizes results for those health centers (N=633; 87%) that do not currently have an EHR.

Table 5: **Electronic Health Record Use by CHCs Versus Private Physician Practices, 2006**

Number of Providers*	Percent Functional EHR Use (%)	
	CHCs	NAMCS Physicians
Solo	3.4	7.1
2	7.9	9.7
3–5	9.3	13.4
6–10	14.4	16.6
11 or more	21.0	26.6
All	13.0	12.4

Sources: Ibid. And Hing E, Burt C, And Woodwell D, 2007.

* Health Resource and Services Administration (HRSA) baseline productivity standards for Federally qualified health centers define the number of CHC providers as equal to the number of physician fulltime equivalents (FTEs) plus one half the number of mid-level practitioners FTEs in the practice. Mid-level practitioners include nurse practitioners, physician assistants and certified nurse-midwives. HRSA calculates mid-level practitioner productivity as half that of physicians (HRSA, "Comparison of Rural Health Clinics and Federally Qualified Health Center Programs", Sterling, VA, 2006.

NOTE: These figures exclude radiologists, anesthesiologists and pathologists.

Figure 1: **Percentage of NAPH Versus UHC Respondents With Departmental EHRs Installed or in Process**
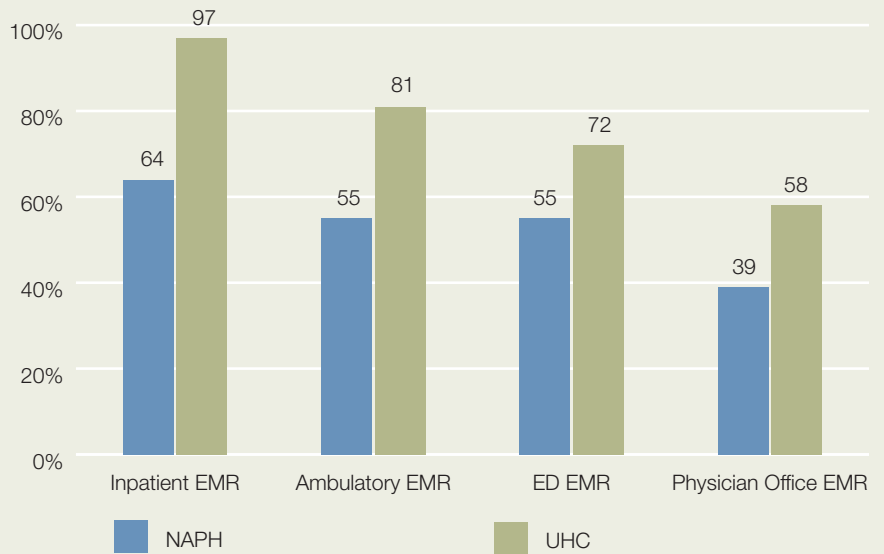
Source: NAPH Health Information Technology Source Book, NAPH, 2005.

Note: University HealthSystem Consortium (UHC) is an alliance of academic health centers. It has 90 full members and 123 associate members.

Figure 2: **Rural and Smaller Hospitals More Likely to List Cost as a Significant Barrier to HIT Adoption**

Rural hospitals more likely to see ongoing costs as a significant barrier

Percentage of hospitals indicating ongoing costs are a "significant barrier" or "somewhat of a barrier" by location, 2006
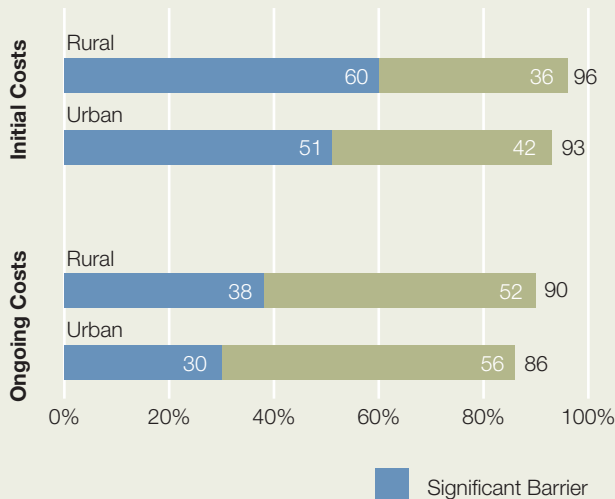
While a barrier for all, smaller hospitals were most likely to see ongoing costs as a significant barrier

Percentage of hospitals indicating ongoing costs are a "significant barrier" or "somewhat of a barrier" by bed size, 2006
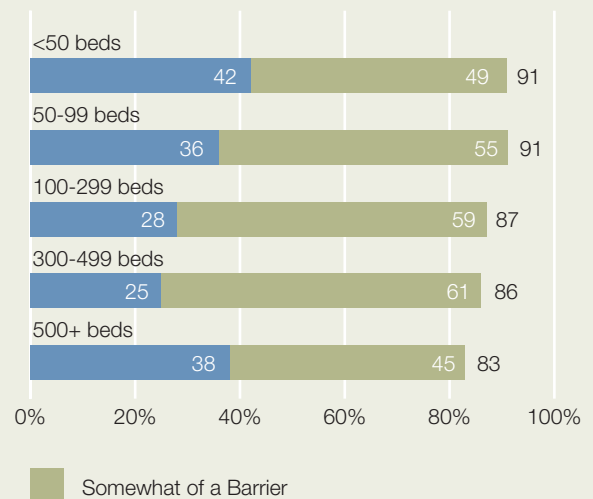
Source: "Continued Progress: Hospital Use of Information Technology", AHA , Feb 2007.

Figure 3: **EHR Adoption Among Providers Who Serve High Proportions of Uninsured and Medicaid Patients Relative to Peer Physicians (2008)**
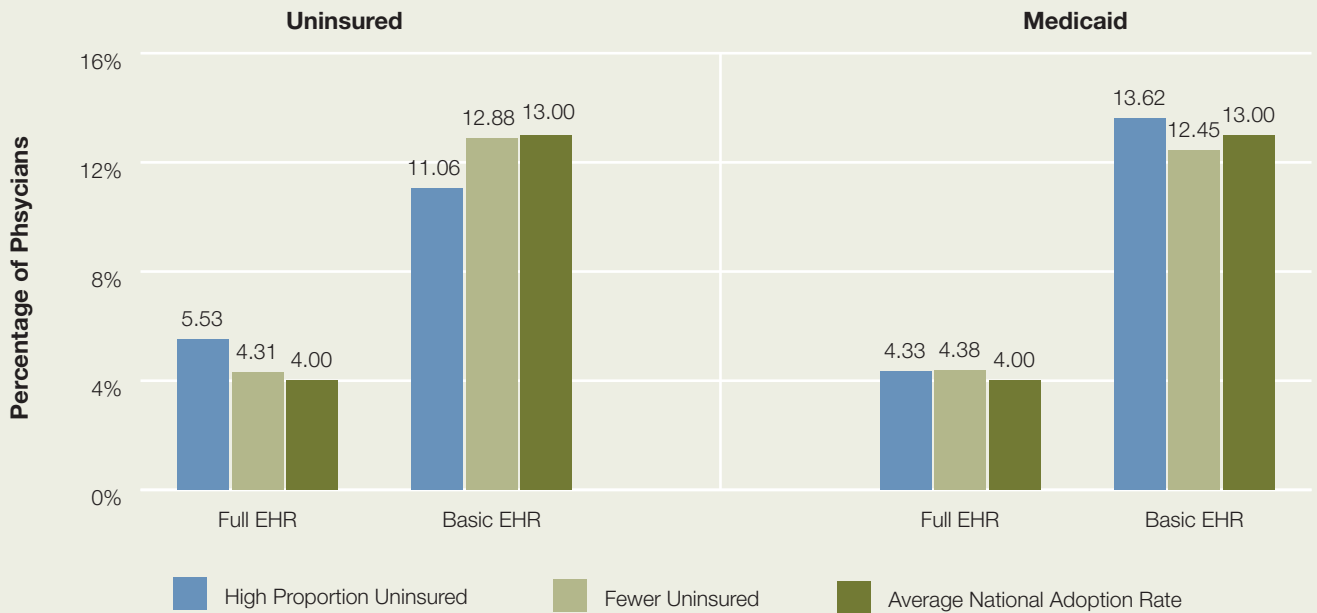
Source: Analyses of the HIT Adoption Initiative's 2008 Physician Survey

Figure 4: **EHR Adoption Among Providers Who Serve High Proportions of Black and Latino Patients Relative to Peer Physicians**
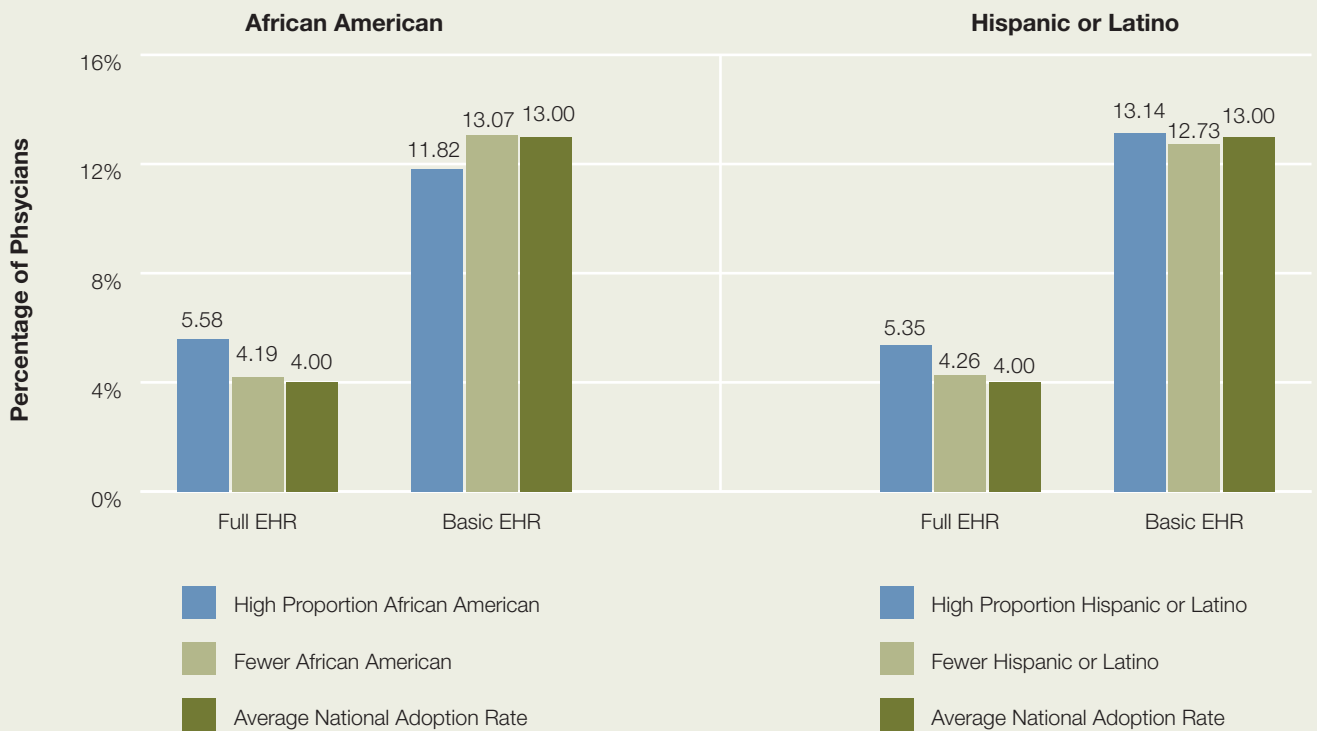
Source: Analyses of the HIT Adoption Initiative's 2008 Physician Survey

Figure 5: **Percentage of Patients Whose Physicians Use an EHR, by Patient Characteristics (2005)**

Adjusted Percentage of Patients Whose Primary Care Providers Used Comprehensive EMRs

Percentage of Patients
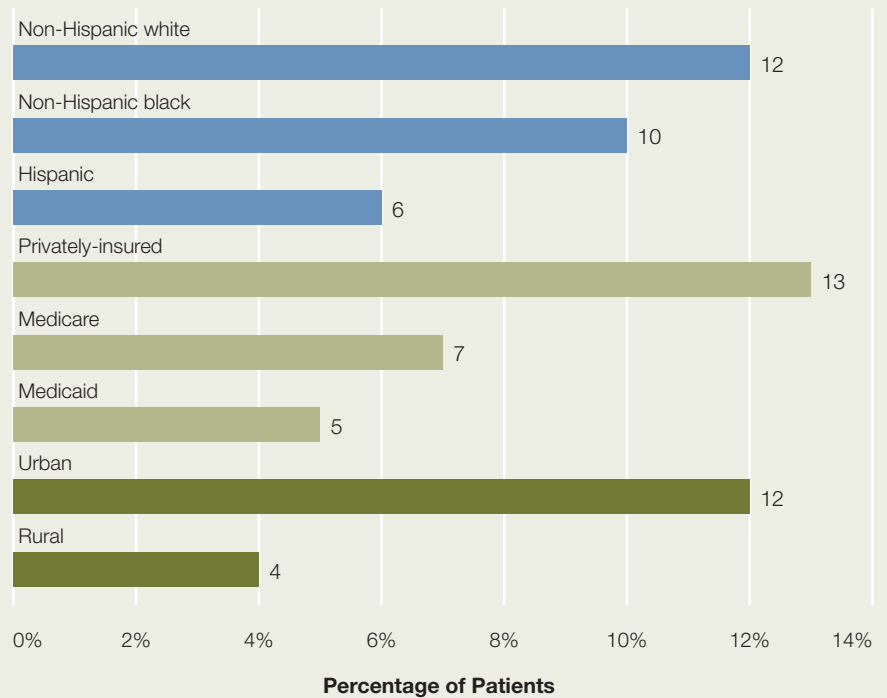
Source: National Ambulatory Medical Care Survey, 2005 and National Hospital Ambulatory Medical Care Survey, 2005 data presented by Dr. Jane E. Sisk at American Health Information Community: Tracking Use of Electronic Medical Records. November 13, 2007. Presentation available at www.hhs.gov/healthit/documents/m20071113/sisk_files/800x600/index.html

Table 6: **Distribution of Minority Characteristics at the County Level in the MGMA Sample and All U.S. Counties**

	MGMA Sample[*] (N=978) N (%)	All U.S. Counties (N=3141) N (%)
Below 100% Federal Poverty Level >20%	**79 (8.08)**	**496 (15.79)**
Home Ownership <50%	**69 (7.06)**	**222 (7.07)**
Race		
Black >20%	155 (15.85)	498 (15.85)
Asian>20%	7 (0.72)	10 (0.32)
American Indian>20%	8 (0.82)	54 (1.72)
Hawaiian Islander>20%	—	1 (0.03)
Mixed>20%	2 (0.20)	3 (0.10)
Other>20%	19 (1.94)	55 (1.75)
Hispanic>20%	74 (7.57)	245 (7.80)

* 490 counties excluded due to missing data on geo-coding

Table 7: **Defining a Functional EHR**

EHR Function	Specific tasks of the function
Health information and data	■ Medical and nursing diagnoses ■ Medication lists ■ Allergies ■ Demographics ■ Clinical narratives ■ Test results
Results management	■ Computerized laboratory test results and radiology procedure result reports ■ Automated display of previous and current test results
Order entry management	■ Computerized physician order entry (CPOE) ■ Patient laboratory, microbiology, pathology, radiology orders ■ Electronic prescribing of medication orders ■ Nursing orders ■ Ancillary service and consult referrals
Decision support	■ Screening for correct drug selection, dosing and interactions with other medications ■ Preventive health reminders for vaccinations, breast cancer screening, colorectal screening and cardiovascular risk detection ■ Clinical guidelines and pathways for patient treatment ■ Management of chronic diseases

Table 8: **Characteristics of MGMA Sample**

Practice Characteristics	Distribution of Characteristics N (%)[+][*]
Practice Location (regions)	
Eastern	823 (31.38)
Midwest	682 (21.66)
Southern	865 (30.12)
Western	611 (16.83)
Practice Specialty	
Multi-specialty	830 (22.50)
Single specialty	2151 (77.50)
Group Practice Size	
1–<3	354 (15.21)
3–<6	1076 (45.76)
6–<11	718 (23.20)
11+	817 (15.82)
Physician-Owned	
Yes	2336 (80.32)
No	645 (19.68)
Practice Type	
Free standing, independent medical group	1872 (86.38)
Med. group, component of IDS	153 (6.11)
FQHC, CHC, or similar	80 (3.25)
Medical School, other academic practice	62 (2.01)
Other	47 (2.26)
Status of EHR Use	
Use of EHR	
Yes	426 (13.36)
No	2543 (86.64)
Degree of EHR Implementation	
Fully implemented	758 (23.44)
Partially implemented	1037 (34.01)
Not implemented	1157 (42.55)
Use of Order Entry Management	
Yes	1340 (42.63)
No	1641 (57.37)
Use of Results Management	
Yes	1470 (64.07)
No	756 (35.93)
Access to Decision Support Software	
Yes	828 (35.28)
No	1390 (64.72)
Health Information and Data	
Yes	458 (99.50)
No	2 (0.50)
Functional EHR	
Yes	261 (8.12)
No	2720 (91.88)

+ Weighted for sample design and non-response
* Percentages do not always add up to 100 as a result of missing values.

Table 9: **Factors Associated With EMR Adoption Among Medical Group Practices (N=2981)**

	FEHR		O.R.	95% CI	p Value
	No (N=2720)	**Yes (N=261)**			
Group Level Characteristics	**No. (%)**	**No. (%)**			
Group Size/Number of Physicians					**0.002**
1–<3	334 (15.66)	20 (10.11)	0.43	(0.26–0.72)	
3–<6	993 (46.04)	83 (42.63)	0.61	(0.44–0.84)	
6–<11	650 (22.98)	68 (25.72)	0.76	(0.54–1.07)	
11+	727 (15.32)	90 (21.54)	1.0*		
Majority Owned by Physician					**0.12**
No	594 (19.94)	51 (16.67)	1.0*		
Yes	2126 (80.06)	210 (83.33)	1.32	(0.93–1.86)	
State/Region					**0.08**
Eastern	762 (31.72)	61 (27.63)	1.0*		
Midwest	628 (21.86)	54 (19.43)	0.95	(0.63–1.44)	
Southern	787 (30.07)	78 (30.67)	1.18	(0.81–1.73)	
Western	543 (16.35)	68 (22.27)	1.79	(1.08–2.95)	
County Level Variables	**Mean (SE)**	**Mean (SE)**			
Race					
% Black	11.85 (0.24)	10.59 (0.87)	0.99	(0.97–1.00)	0.11
% Asian	2.59 (0.06)	2.34 (0.15)	0.98	(0.92–1.05)	0.61
% American Indian	0.89 (0.07)	0.94 (0.22)	0.99	(0.95–1.03)	0.53
% Hawaiian	0.10 (0.01)	0.08 (0.01)	0.57	(0.17–1.96)	0.37
% Mixed race	2.02 (0.03)	1.98 (0.07)	0.97	(0.78–1.20)	0.77
% Other race	3.63 (0.09)	3.75 (0.32)	1.01	(0.95–1.08)	0.69
% Hispanic	8.36 (0.21)	8.43 (0.71)	0.99	(0.96–1.02)	0.41
Income					**0.24**
Below 100% Federal Poverty Level	11.63 (0.09)	11.90 (0.33)	1.02	(0.99–1.06)	

*Reference category

O.R.: Odds ratio; CI: Confidence interval; SE: Standard error

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Chapter 4: Consumers, EHRs and PHRs: Measures and Measurement

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Introduction

When President Bush announced his proposals for health information technology (HIT) in 2004, he set the ambitious goal of assuring that "most Americans" have electronic health records (EHRs) by 2014. The president's Health Information Technology Plan included a vision that "complete health care information is available for most Americans at the time and place of care, designed to share information privately and securely among and between health care providers when authorized by patients."[1]

While the federal government has developed guidelines to define and measure EHR adoption by physicians, physician group practices and hospitals,[2] no such guidelines exist to measure consumer access to and use of EHRs. One interpretation of existing policy is that the implementation of this national HIT policy initiative—to purchase, install and use EHRs to record patient health information—is the responsibility of providers. Indeed, the president made "participation by patients voluntary."[3]

Still, in a health system where many individuals' health information is likely to exist in multiple medical or personal records, it may be both prudent and empowering for individuals to maintain a personal health record or PHR.[4, 5] Tang and colleagues have described a spectrum of electronic PHR models, from *stand-alone* records created and maintained by individuals at one end of the spectrum, to a *tethered* system where an individual has access to a provider created and managed EHR at the other end of the spectrum. In the middle are models where one or more elements of the PHR and EHR might be *interconnected*.[6] More recently market developments have introduced a new model which aggregates personal health information from multiple sources on behalf of the consumer. To gain a full understanding of the number of Americans who have access to some sort of computerized, processable health record requires an assessment of data on individual access to and use of PHRs and EHRs. Technical distinctions made by experts may be difficult to capture until consumer awareness and experience grow.

While numerous surveys have measured physician adoption and use of EHRs, few have asked the same questions of patients or consumers about PHRs or EHRs. Given the recent emergence of these technologies and the limited patient understanding of physician and hospital record systems, some may wonder if it is worth the effort required to elicit information from the public. As we have noted previously, collecting this information from providers who have traditionally managed health information and records is already difficult. Improvements in surveys of providers, payers and vendors may eventually make it unnecessary to rely on population surveys for estimates of consumer access to EHRs or PHRs. One might, however, draw some analogies to surveys of the public about health insurance coverage and health services use. Estimates of these same metrics are available from payers and providers, but surveys of patients, health consumers and

the general public expand our understanding both of who does and does not have access to or use critical health resources and why. Given that the policy climate is demanding acceleration in EHR and PHR adoption and their potential impact on the delivery of health services, it is prudent to begin taking consistent and serious measure of what the public knows and does not know about these technologies.

Beyond the development of an information base on consumer use and awareness of HIT, there are additional benefits to be gained from gathering data from consumers and patients about their health experiences. Currently, most transparency initiatives are focused on sharing claims-based quality provider performance data with the public, especially insured individuals. The elicitation of patient and consumer experience data offers the promise of expanding quality data to include the perspective of those who use health care systems and services. Areas where consumer and patient interfaces with EHR and PHR systems may yield valuable data include provider (hospital and physician) performance outcomes, chronic disease monitoring, medication adherence, patient safety metrics, patient satisfaction, patient use of health information to make informed decisions, patient physician communication tracking and more. As the patient experience with these systems expands and information sharing becomes more commonplace, the promise of these technologies in enhancing the delivery of patient-centered care may be realized. While this promise may seem like a longer-term strategic objective, we can already see examples of settings where early adoption has borne fruit.

In this chapter, we review surveys of the general public that have been conducted and publicly reported over the past decade to assess their experience with and knowledge of EHRs and PHRs. Specifically, this chapter reviews: (1) current estimates of computer and Internet use in the United States; (2) estimates of EHR and PHR use and access by consumers across the United States, including the use of different core functions; (3) public attitudes toward EHRs and PHRs, including their perceived promise and concerns about this technology; (4) available data about racial, ethnic and socioeconomic status as predictors of access, use and attitudes toward these technologies, where data are available; and (5) critical information gaps and optimal approaches to addressing them.

Methods

Sources of Data

For this review, we relied on publicly reported surveys of the U.S. adult population that purport to provide national estimates of consumers' access to, use of and attitudes about EHRs and PHRs. To assemble the materials for our review, the project team identified and collected all extant surveys of the public about EHR and PHR use; developed an abstraction protocol to use in recording key elements of survey source, method and content; and constructed a time-series database of questions and metrics in key domains of interest. Our environmental scan included published and unpublished data and reports completed between 1997 and 2007. Published data were initially obtained from the peer-reviewed medical literature, based on PubMed searches. A national repository of public opinion data known as iPOLL, resident at the Roper Center for Public Opinion Research at the University of Connecticut, provided a searchable, question-level database

from which many surveys were drawn. Standard search techniques–Ovid, Google, Google Scholar, Nexis and other search engines–were then used to obtain reports and data from non-peer-reviewed sources. Our team also worked to collect full survey instruments and methodology reports where available.

As a part of this effort, we reviewed multiple federal health surveys of the general U.S. population, including the National Health Interview Survey (NHIS), the National Immunization Survey (NIS), the Medical Expenditure Panel Survey (MEPS), the Behavioral Risk Factor Surveillance System (BRFSS), the National Health and Nutrition Examination Survey (NHANES) and the Medicare Current Beneficiary Survey (MCBS). None of these surveys currently contain any items about electronic or personal health records, electronic health record functionalities or electronic patient-physician communication.[7–11]

The National Ambulatory Medical Care Survey (NAMCS) of physicians measures EHR use in physician practices and collects patient-level data on several measures. While this is not a vehicle for eliciting information directly from patients, it may provide the means to have an estimate of patient-level access to EHRs in a representative, national sample of physician practices,[12–14] although such estimates have not yet been published. The Consumer Assessment of Healthcare Providers and Systems (CAHPS) is developing a CAHPS Health Information Technology Item Set intended for use as a supplement to the CAHPS Clinician & Group Survey.[15]

We turn then to surveys and polls of the general population that have been released in other domains. While some surveys are entirely devoted to the topic of electronic health information, most are not. Many polls and surveys of the public collect one or two measures of interest to us, nested within lengthy surveys designed for other purposes. Every year, public and private interests in the United States complete thousands of surveys of the general public and no single repository assures complete access to this data. We rely most extensively on surveys that have a principle focus on the public and health information technology in general, or electronic health or medical records more specifically. Key elements for abstraction included survey organization, project title, sponsor, dates of fieldwork, population, measures of EHR or PHR access and function.

Assessing Survey Content

One challenge in assessing surveys that purport to measure individual or patient experiences with EHRs or PHRs is that these technologies and/or their component parts may not be reliably recognized. Our assessment of provider and health professional surveys first required consensus on an EHR definition. A core element of most definitions recognizes that an EHR is "a repository of information regarding the health of a subject of care, in computer processable form."[16] More comprehensive definitions include further specificity on secure storage, transmission, accessibility by multiple users, and the prospect of more integrated, efficient and higher quality care. Patients and the general public may not have ready access to information on these aspects of the medical record systems they encounter.

To elicit consistent information from physicians, our team relied on functionality-based measures that might be recognized and reportable by the providers who use them. In developing our guidelines for assessing consumer survey content, we considered questions that would provide an individual patient perspective in the

same domains—storage of health information and data, results management, order entry management, decision support, electronic communication and connectivity, patient support, administrative processes, public health reporting and population health management. While the language for describing these activities might vary in their presentation to respondents, several of the surveys we identified do elicit information about patient experiences with multiple functions of a record.

For example, a patient might know there is an EHR if their physician's office invites them to log in to view information in the record, or the electronic storage of "health information and data" might be visible to a parent who receives a computer printout of their child's annual physical and immunization record rather than a handwritten report. Other examples might include a patient, who was used to bringing a paper order form or prescription, being told that "the order was sent by computer," a patient might see a doctor or nurse typing clinical notes or vital sign measurements into a computer, or be shown test results or images on a shared computer screen. We can recognize, however, that the use of a computer to perform these functions may not actually mean there is an electronic health record system in use. Measuring consumer access, by measuring patient or consumer perceptions outside of a context where the perceptions can be validated, may be especially difficult.

The surveys and survey questions we searched for included content to measure the following (abbreviations in parentheses are shown also in Table 1 to reference corresponding estimates):

1. Whether an individual has an electronic health record maintained by any health provider (MDEHR) or health plan (PLANEHR) and whether the individual can view information in that record (PTGATEWAY).

2. Whether an individual has a personal health record (PHR) maintained by the individual in paper or electronic form, for the purpose of storing personal health information.

3. Whether an individual can access specific functions in computer form in an EHR or PHR, including health information and data, test results, medication or test orders, decision support, electronic communication and connectivity, patient support tools and processes, administrative processes, public health reporting and population health management. These functionalities have been defined as elements of a comprehensive EHR system.[17] Some questions asked of the general public do not specify EHR versus PHR use, but merely ask if functions are available or accessible to the patient. Specific question wording is provided to show variation in the measurement of these concepts.

4. Incentives for consumer use: measures of public interest in and willingness to use an EHR or PHR.

5. Barriers to consumer use: measures of public concern about privacy, security or other factors that may influence willingness to use an EHR or PHR.

6. Measures of disparities in use of, or attitudes about, EHRs or PHRs by people of different races, ethnic origins, education, age, insurance or other factors. Reported differences by race, ethnicity, age, income or education are reported for each set of the previous sets of measures.

Assessing Survey Quality

In our 2006 report, we discussed several ways of assessing survey quality through an examination of their methods and content. In brief, achieving high quality estimates in general population surveys requires attention to the relationship of the available sample and its coverage of the population, pros and cons of the data collection modes, and efforts to reduce response and non-response bias through intensive questionnaire design and fieldwork methods. Professional standards also require the disclosure of methods and measures for public inspection. A process to formally rate the quality of public surveys accessed was not accomplished as part of this review. We found few surveys met the rigorous tests for high survey quality set in our environmental scan of the physician and hospital literature. We acknowledge that conducting nationally representative surveys of the U.S. population in any modality can be challenging and costly. Given the relatively small number of surveys with the measures of interest, we do not attempt to resolve the controversies about data quality from different collection modes. We provide data from publicly reported sources, where survey dates, sample size, mode of data collection, survey organization, actual question text and survey sponsor were all reported. The vast majority of these surveys were conducted by telephone or online with samples of the general public. For most surveys, insufficient data is available to judge whether probability sampling methods were used and what efforts were made to enhance response rates and reduce response error and bias. Generally, response rates and methods for questionnaire development are unreported.

National Estimates of Computer and Internet Use, 2000–2006

Before we examine consumer use of and access to EHRs and PHRs, we should consider consumer access to and use of computers and the Internet more broadly. Table 1 shows a trend of increasing use of computers and access to the Internet over the past decade. In 2007 nearly 80 percent of U.S. adults reported the use of computers, and 70 percent access to the Internet at home, 35 percent at work and 22 percent in some other location.[18] We show the relative proportions for home and work use, because consumer ability and willingness to access private health information may vary by setting. Over the past decade, racial and ethnic differences in Internet use have largely been eliminated. As shown in Figure 1, when Internet users are compared with the U.S. population using Current Population Survey (CPS) data as a benchmark, gaps remain by age, education and income.[19]

Figure 1: **Internet Population Versus General Population**

Demographics	Internet Population			
	1995	2001	2006	CPS*
African American	1%	19%	10%	**11%**
Hispanic	9%	10%	13%	**13%**
Women	21%	49%	51%	**52%**
College educated	57%	32%	30%	**27%**
Annual earnings < $25K	15%	10%	14%	**19%**
Over 65 years old	3%	7%	8%	**16%**

Source: Harris Poll and *Current Population Survey (2005)

Figure 2: **Consumer Use of the Internet**
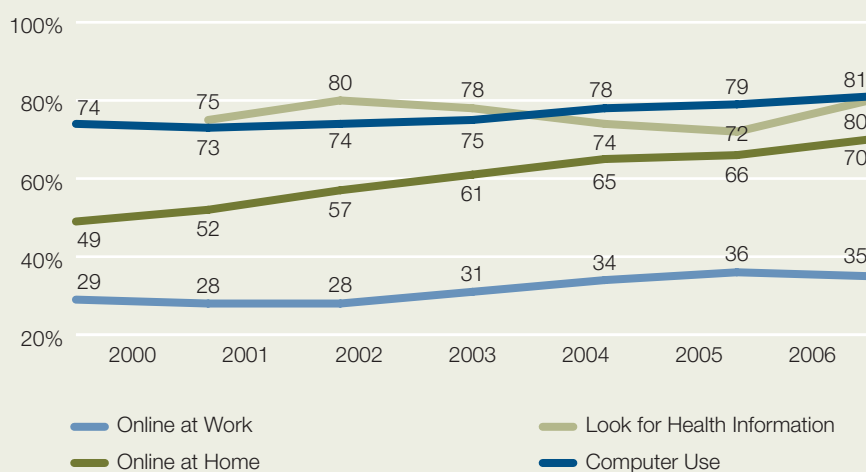
Source: Harris Poll

In recent years, an increasing share of the population has mobile access to e-mail and the Internet. A study conducted by the Pew Internet & American Life Project in December 2007 indicated that 58 percent of American adults have used a cell phone or personal digital assistant (PDA) to send text messages, e-mail, browse the Internet or use other media, and 41 percent have logged on to the Internet away from work or home with a wireless laptop connection or handheld device.[20] Although Internet use currently does not vary considerably by race or ethnicity, mobile connectivity varies dramatically by age, race and ethnicity. While 53 percent of white respondents sent or received text messages, 68 percent of African Americans and 73 percent of Hispanic respondents had done so. While 18 percent of white respondents accessed the Internet on a mobile device, 27 percent of African American and 22 percent of Hispanics had done so. Also, 96 percent of Americans ages 18–29 have used a cell phone or PDA for one of several mobile communication functions, compared with 85 percent for ages 30–49, 63 percent for ages 50–64 and 35 percent for ages 65 and over.[21]

In 2007 about 84 percent of the online population in the United States said that they had ever looked for health information online, and 53 percent of all U.S. adults said that they had looked online for health information in the past month. The data shown in Table 1 are for people who specifically access the Internet to look for information on health topics such as diagnoses or symptoms as distinguished from personal health information.[22]

Current Levels of Consumer Use of and Access to EHRs and PHRs: What Do We Know?

In this section, we start by reviewing the available estimates of public EHR and PHR use. Findings from our review are summarized in Table 1 by functionality categories. It should be noted that there is vast literature on the emergence of different technologies and tools for consumer decision-making, shared decision-making between patients and providers, communication tools and other functions. We focus here on national estimates that are survey-based rather than on the

multiplicity of studies that measure consumer use of tools in specific hospitals, health systems or research studies. The fact that consumer use of some of these tools is now measurable in the general population is a testament to the growth of efforts to expand public use and awareness of these tools.

As we reviewed surveys and polls, we considered sources other than surveys of consumers and the general public as part of our review of national estimates. We found wide variations in the recent reports. While America's Health Insurance Plans (AHIP) estimates that approximately 70 million Americans could have access to claims-based PHRs, and *The New York Times* published an estimate that 20 percent of the U.S. population have PHRs in an August 2007 article, Tang and colleagues estimate that only 1 percent to 2 percent of Americans actually have direct access to their own personal health information through applications such as Epic's MyChart which provides a view into the provider's electronic EHR (Tang, 04/11/2008), a figure similar to what we found in several surveys.[23, 24] Industry estimates are likely to vary by the lens through which they are viewed—payers, providers, product vendors and consumers are likely to offer differing perspectives of theoretical vs. actual access. Surveys of consumers are the principal source of data for this assessment, as we attempt to understand what the public perceives and experiences with these technologies in theory and in practice.

EHR and PHR Use: From 2005 to 2007, only a few surveys conducted online and by telephone have asked the general public if they have electronic or personal health records. We looked first at questions about the public's experience with EHRs in their physician's offices. A *Wall Street Journal/Harris Interactive* online survey conducted in October 2005 showed that 16 percent of Americans said a doctor had "ever used an electronic medical record to capture medical information" for a respondent or their family members.[25] A 2007 survey sponsored by Kaiser Permanente cast a broader net, asking the public if their primary care doctor uses a "computer record system." Fifty-seven percent of the general public said 'yes' to this measure. The significant gap between these reported estimates shows that minor changes in question wording can alter the public's reports of their experiences, observations or attitudes. It is likely that a high proportion of people have observed some sort of computer record system in their physician offices, given administrative, billing and electronic scheduling systems. Given the reported estimates from physicians about EHR use, it is clear that 57 percent is likely a considerable overestimate of the proportion of the public who has an EHR.[26]

The Liang survey is the only publicly reported survey we found that documented consumer use of health plan records online. Twelve percent of survey respondents indicated that they have used a health insurance company Web site to review personal medical records.[27]

Several surveys do inquire about the use of patient gateways to information in a provider's EHR by the public. In 2006 consumers were asked if they "use or have access to" an electronic record maintained by their doctor, and only 2 percent reported use and an additional 4 percent reported access.[28] A 2007 survey of 2,100 adults revealed that 64 percent of the public does not know what a PHR is and, among those who do indicate that they know, only 11 percent said they use one to track their medical history. A 2006 Health Industry Insights survey similarly found that less than 10 percent of the public keep personal health information in a computer or Internet application.[29] Four surveys probed the public's experience

with both paper and computer-based personal health records. Kaiser Family Foundation sponsored surveys in 2004 and 2006 reported that 32 percent and 34 percent of the public, respectively, had "ever created [a] set of medical records" to ensure personal and provider access to health information.[30] In 2004 Harris found 42 percent have a "personal or family health record" on paper or computer, though only a small proportion of this group kept such records in a computer format. A similar proportion of the public reported ever trying to obtain copies of their own medical records in 1999.[31]

These measures illustrate several complexities in understanding consumers' access to and use of medical records, including where records are stored, who has access to them and whether such records are computer or paper-based. Given the variations in these estimates, interpreting them requires careful attention to the structure of questionnaires, the precise language of questions, the year of data collection, the mode of survey and the population of interest.

Where available, we examined estimates of EHR and PHR use by race, ethnicity, age and income. Harris data from 2005 showed differences by age, race, education and income in responses to a question asking: "Has a doctor ever used an electronic medical record to capture information?" Respondents ages 50 and over (18 percent) were more likely than those under 30 years old (13 percent), and whites (17 percent) were more likely than blacks (8 percent) or Hispanics (11 percent) to indicate use of this technology by a doctor.[32] Answers to a 2007 survey item, "My doctor maintains an electronic record of my medical history in his or her office," show considerable variability; but no trend by age, significant differences by income (29 percent with incomes of $75, 000 and over, 9 percent of those with income less than $15,000), and a very different picture by race than the 2005 question (22 percent white, 30 percent black, 28 percent Hispanic).[33] These variations may be due to respondent knowledge or understanding of concepts, changes in question wording, sample composition and size, survey mode or other factors.

Our inquiry focused on more detailed functionality measures, where specific activities might be more readily identified by individuals regardless of their awareness of record systems. For these measures, no significant differences were seen by age, gender, race, ethnicity, education or income in data supplied to *The Wall Street Journal and Harris Interactive*.[34–36]

Diagnostic Test Orders and Results Management

In 2005, 8 percent of the public reported that their physician had used digital imaging equipment to transfer images.[37] In 2006 more detailed questions indicated that 2 percent of the public actually used an option to get diagnostic test results via e-mail and 3 percent said they had access to this option but did not use it.[38] Both surveys were conducted online, and margins of error are not available for these estimates. Within health systems where patient gateways are available, use of these functions may be higher. The PatientSite Experience in Boston indicated that after high usage in the initial months, monthly use of results viewing functions ranged from 10 percent to 15 percent of enrolled patients.[39]

Patient Support and Decision Support

Five percent or less of the general public report having used or having had access to home monitoring devices for the measurement of physical symptoms to monitor disease.[40, 41] Four percent indicate use of and 3 percent access to e-mail reminders for preventive care and other services from their physician offices.[42]

Electronic Communication and Connectivity

Four percent of the general public report having communicated by electronic mail directly with physicians.[43]

Administrative Processes

Three percent of the public use, and 4 percent have available but don't use, processes in their physician offices for Internet appointment scheduling.[44] A much larger proportion reportedly use interfaces provided by insurance plans for billing and other administrative tasks, including 29 percent who say they have used a health insurance Web site to learn about coverage and claims.[45]

Table 1: **Summary of National Estimates From Consumer Surveys**

Function	Estimates		Sources
EHR and PHR Estimates (includes Health Information and Data Elements):	MDEHR* "Use or have access to an electronic medical record to capture information" (2005)	16%	25
	"My doctor maintains an electronic record of my medical history in his or her office" (2007)	23%	33
	PCP has "computer record system" only (2007)	57%	63
	PTGATEWAY* Individual accesses M.D.'s EHR online (2006)	4%	28
	PHR: Ever used (paper or electronic) (2006)	17%	29
	PHR: Individual keeps own health records in any format, paper or computer (2004–2006)	32%–42%	28, 30, 64
	PHR: Individual keeps record on computer (2005–2007)	2%–9% 28%	25, 28, 29, 33
	PLANEHR* Access health records on health plan Web site (2007)	12%	63
Results Management:	M.D. can send digital images (2005)	8%	25
	Individual has received diagnostic test results electronically (2006)	2%	28
	Individual has electronic transmission test results available but hasn't used them (2006)	3%	28
Patient and Decision Support:	Home monitoring device (2005–2006)	2%–5%	25, 28
	E-mail reminders for preventive services either used by M.D. office or available to individual (2006)	4%	28
Electronic Communication and Connectivity:	Exchange e-mail (2006)	4%	28
	See home monitoring (2005–2006)	4%–8%	25, 28
Administrative Processes:	Appointment scheduling online (2006)	3%	28
	Access health plan claim information online (2007)	29%	63

* if an individual has an electronic health record maintained by any health provider (MDEHR); or health plan (PLANEHR); if the individual can view information in that record (PTGATEWAY)

Drivers of and Barriers to Adoption of EHRs and PHRs by the Public

Better Communication, Better Quality of Care

While estimates of the access to and use of EHRs and PHRs remain at a low, multiple surveys document the public's piqued interest in the promise of EHRs and PHRs. Many of the same surveys referenced here, while providing only limited measures of consumer use, provided extensive data on interest and hypothetical use. Most recently, *The Wall Street Journal and Harris* surveys showed that three out of four Americans would be interested in using EHR functions,

including electronic tools to communicate with physicians (74 percent), schedule appointments (75 percent) or receive e-mail reminders from their doctor's office (77 percent). Two thirds would like the ability to receive diagnostic test results by e-mail (67 percent).[46, 47] A more recent Deloitte survey echoes the public's enthusiasm for expanded access to electronic records and scheduling and enhanced communication with physicians.[48]

The possible benefits of EHRs have also been probed. In *The Wall Street Journal/ Harris* survey, more than half of Americans agreed that EHRs can help decrease medical errors and medical care costs, as well as improve the quality of care by cutting redundant and unnecessary procedures. However, 30 percent or less agreed strongly with these statements, and this is among a population of online users. Online national surveys for the Markle Foundation have also found high interest in and perceived value of PHRs and their functions (62 percent to 75 percent), including e-mail, access to immunization records, access to test results and tracking of medications, with 54 percent saying that using a PHR would improve their overall quality of health care.[49–52]

Increasing Public Access to Online Health Information and Tools

The public's use of computers and the Internet to participate in health care research is growing. Trends compiled by Harris Interactive since 2001 show an increase from 29 percent of the general public to 52 percent in 2007 who say they frequently or sometimes go online to search for health information.[53] Several major corporations are aiding those online searches, including WebMD, AOL, Google and Microsoft, and are actively offering or developing online tools and applications for health consumers, including personal health record applications.[54] Whether the public's apparent thirst for health information will translate into a desire to manage one's own personal medical information and records is a question that remains open. Theoretical interest may not translate into actual use when real products and services become available.

Privacy Concerns

The most significant obstacle to public acceptance raised by these surveys remains concerns about privacy and security of personal health information. Such concerns can easily emerge when the vast majority of the public has yet to experience PHRs or EHRs. Westin and colleagues have conducted multiple surveys about these important privacy issues,[55] which have also been addressed by surveys sponsored by Markle Foundation, and the California Healthcare Foundation's 2005 National Consumer Health Privacy Survey.[56–59]

In several online surveys, Westin and Harris Interactive report considerable public concerns about privacy. In 2006, 62 percent of the public said "the use of electronic medical records makes it more difficult to ensure patients' privacy," although similar proportions recognized the potential for EHRs in cost and error reductions and increased patient safety. Specific concerns are the leakage of sensitive health information, reduction in federal privacy rules, increased sharing of information without a patient's knowledge, inadequate data security and the possibility that medical errors could increase rather than decrease. The 2006 survey indicates that a plurality of the public (42 percent) felt that at present privacy risks of EHRs outweigh the potential benefits. It is important to note however, that in most

surveys that allow the public to express uncertainty about these issues, 20 percent to 30 percent say they don't know enough to be certain of their opinions.[60, 61] Another survey conducted for the Markle Foundation in December 2006 probed more specific circumstances of concern to the public. Asked about a "network to provide people with access to personal health information online," 80 percent said they were "very concerned" about identity theft, 77 percent about marketing firm access, 56 percent about employer access and 53 percent about insurance company access to this information. The majority are willing to share information and relax privacy to detect disease outbreaks (72 percent) or respond to bioterrorist attacks (58 percent), and they would like the federal government to play a role in establishing rules to protect the privacy and confidentiality of health information.[62]

Although the public is concerned about privacy, these concerns may not be based on an extensive understanding of the ramifications raised by the storage of personal health information among the wide array of public and private entities that are developing electronic record solutions for consumers. Experts express considerable concern about the protection of health information in a competitive marketplace where government regulations are still being developed. These issues are discussed in greater depth in Chapter 6 of this report. As public awareness of and experience with these issues increases, concerns are likely to change in unpredictable ways.

Conclusions

Federal data indicate that EHR adoption by health professionals is gradually increasing, as discussed in Chapter 2 of this report. Our review of consumer surveys about EHRs and PHRs reveals that the public is aware of these changes but, as yet, has little experience with personal use or gateways into those EHR systems or with use of their own computerized PHRs. Public surveys are still conducted in a context where the vast majority of Americans have not encountered these technologies and their responses are, therefore, only hypothetical. A few major studies indicate that in systems where people are offered patient gateway access, there is considerable use and satisfaction. But in the general population, it is difficult to measure that level of experience with much certainty.

The public's lack of experience with these tools does not apparently dampen their enthusiasm for the promise of better information and better communication with health providers. The public still sees great promise in the possibilities of improved health care quality, safety and communication as EHR and PHR use expands. Several studies have demonstrated that the public has a seemingly insatiable appetite for health information, especially information that is personally relevant to their own or their family members' health. The more that personal health information can be viewed in the context of population information, publicly reported data, shared decision tools and the like, the more personally relevant quality data may become.

Those concerned with the potential for disparities in access to or use of these technologies by vulnerable populations will find a dearth of data to assess those issues. More recently collected data do not show major differences by race or ethnicity, but data on education, income and age do show variability. Certainly, more data are needed to fully understand the role of respondent knowledge, access to and use of health care, health status and other factors that could influence use of health services and exposure to technology. Further, changes in question

wording are inevitable as the technology evolves and new standards are proposed. A standard approach to measurement would allow us to improve trend and point estimates for the U.S. population and for key demographic groups of interest in this population. The proportion of U.S. adults who currently report access to or use of EHRs or PHRs is small enough to make subgroup analyses difficult. The federal survey with the nearest term possibility of informing these data is NAMCS, but findings at the patient level remain unavailable at this writing.

At present, there are insufficient national surveys with an adequate sample size, adequate response rates and high quality content to allow valid, generalizable estimates of EHR or PHR adoption in the United States. Nearly all available surveys suffer from limitations, including a lack of validation of individual report to provider record, high proportions of respondents who are unaware of or inexperienced with the concepts and technologies, and infrequent publication in peer-reviewed literature. We relied almost exclusively on press releases and follow-up contacts with survey firms or sponsors to obtain questionnaires, methods and more detailed information. Nevertheless, several organizations have provided key metrics that are referenced consistently by academic researchers, government agencies and the press.

While some surveys have made efforts to define the concepts of "electronic health record" or "personal health record" for respondents, a lack of consistent terms and definitions leads to considerable variation in reported responses. This makes comparisons of results across surveys and over time extremely difficult. Measures will be improved if questions can consistently make distinctions among the following:

- Personal medical or health records kept on paper or computer by individuals
- Electronic medical or health records kept by providers and payers
- Functions of EHRs and PHRs viewed by individuals and patients
- Functions accessible and available for electronic access by patients
- Functions actually used/viewed/updated by individual patients
- Time frame of reported use
- Impact of privacy concerns on use
- Impact of use on quality and cost of care

The information base that is currently available to judge the impact of EHRs and PHRs through the course of accelerating adoption is inadequate. If these technologies are to transform health care, we must develop mechanisms to measure and understand that transformation through the eyes of those people the health care system serves. Engaging the patient and the public in judging and purchasing quality health care requires that we take the necessary steps to link the public and the personal in health data.

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Chapter 5: Regional Health Information Organizations and Health Information Exchange

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Executive Summary

Health information technology in general, and health information exchange (HIE) in particular, holds the potential to offer substantial cost savings while improving quality of care. In this chapter, we report on the latest effort to advance electronic health information exchange in the United States: regional health information organizations or RHIOs. We examine the data that suggest HIE will have a substantial impact on health care system costs, saving approximately $80 billion annually, while reducing medical errors and improving quality. Nonetheless, a recent study of all 145 RHIOs in the United States found that only 32 are actively exchanging clinical information electronically across independent entities and, of these, only 20 have achieved at least a modest scale.[1] Further, RHIOs experience a high failure rate, with more than 25 percent of these efforts failing in a short time frame. We explore three obstacles that have slowed progress in this area: funding and participation, legal and regulatory, and technical.

The first obstacle, funding and participation, is likely the most challenging to overcome. Many RHIOs are heavily dependent on grants from governmental and philanthropic organizations. This is due to the fact that most potential participants do not yet see enough financial value in HIE facilitated by the RHIOs to pay for it. The major health care delivery organizations may not view participation in a RHIO as an optimal business strategy. Organizations that have a dominant position in a market, for example, do not want to make it easier for their patients to get care outside their system by making readily available the clinical data patients need to do this. A recent study of RHIO stakeholders confirmed that this is a factor behind the low participation rates in many RHIO efforts.[2] If one or more of the major delivery organizations in a given community decides not to participate and share their data, the value of HIE in that area declines significantly—along with the incentive for other organizations to participate. Thus, if external funding were to cease, it is unclear whether the participating organizations would step in to fund RHIOs.

The second obstacle is around legal and regulatory issues. Concerns about violations of the Health Insurance Portability and Accountability Act (HIPAA) and unauthorized access to patient data have slowed many efforts. There is little legal precedent for HIE and, as a result, it is unclear whether these concerns are well-founded. Ongoing efforts by federal and state agencies seek to clarify the relevant privacy rules, thus allowing provider organizations to exchange patient data electronically. With many federal and state regulations to address, significant work remains.

Finally, RHIOs face several technical challenges. Most U.S. health care providers do not have electronic health records (EHRs) and the ones that do are not able to

readily communicate with each other, due to lack of standards and interoperability. Further, the IT systems used by other entities with clinical data (i.e., public health departments, payers, pharmacies, independent laboratories and radiology centers) must also be configured to share data. The technical architecture necessary to allow different systems to effectively participate in HIE is still developing. In the interim, many RHIOs have opted to use a less challenging approach to view data that's based on a secure portal as opposed to end-to-end integration.

Despite these barriers, a number of RHIOs are exchanging clinical data and many more are in the planning phases.[1] To summarize the current state of activity, we identify the major sources of financial support for these incipient organizations. Although few good data sources are available, our review suggests that many RHIOs are receiving support from federal and state entities and few are self-sustaining. We then discuss the operational RHIOs that have received the greatest amount of attention and are often touted as models. We find that several of these RHIOs have made substantial progress towards community-wide HIE. Whether these organizations will truly become models for other RHIOs to emulate, or whether each RHIO will need to find its own path to address the specific needs of its community, is not known. We will need to carefully monitor the activity of these organizations as we track the path towards a nationwide health information network.

Introduction

Spurred by evidence of the inefficiencies and errors created by suboptimal clinical data exchange in our health care system, an electronically interconnected delivery system is on the forefront of the national health policy agenda. With the growing adoption of health information technology (HIT), health information stored in clinical systems like EHRs can be leveraged to reduce inefficiencies and errors by sharing it electronically across other settings in which care is delivered. At the national, state and local level, many new efforts have sprung up to promote electronic data exchange across independent entities. The vision and potential benefits of health information exchange are clear: if a patient arrives in the emergency room of a hospital that is not affiliated with her primary care provider, availability of her clinical information to the emergency room physician will likely improve her care and reduce waste. However, there are substantial barriers to realizing this vision, and current efforts attempt to address the technical, legal, regulatory and business challenges that lie ahead.

RHIOs are currently the primary entities working to promote electronic HIE at the local, state and regional level. RHIOs have been defined by the federal government as organizations that support state or other regional projects to harmonize the privacy and business rules for electronic health information exchange.[61] While some groups define RHIOs more narrowly, others have adopted a far broader definition, leaving little consensus on the characteristics common across RHIOs. With no single definition, the terms RHIO and HIE are often used interchangeably and indistinguishably to describe efforts focused on the electronic exchange of health-related data. Definitional ambiguity has produced vastly different estimates of the number of RHIOs in the United States. In general, health information exchange, which is the sharing of clinical data across independent organizations (i.e., providers, pharmacies and payers), is a goal of most RHIOs. A RHIO, which generally aims to facilitate HIE, is just one way to achieve HIE.

Despite little agreement on the characteristics that constitute a RHIO, similarities can be found among these organizations and they are often defined by the RHIO's geographic scope. A 2006 HIE survey found that 39 percent of these efforts take place on the local level, 34 percent at the state level and 12 percent at the regional (or multistate) level.[37] A state-level RHIO may focus on changing state laws to allow for electronic data exchange, while a local RHIO typically focuses on building the technical infrastructure needed to share data in a community. The focus of the RHIO then determines the relevant stakeholders. A state-level RHIO may convene all the RHIOs operating in the state, while a local RHIO would target hospitals, provider practices, payers, laboratories, pharmacies and public health departments. Thus, RHIOs can look quite different, as their scope of activities, participants, funding and organizational structure varies widely.

At the federal level, RHIOs have received attention and support following President Bush's call for the National Health Information Infrastructure (NHII), also referred to as the National Health Information Network (NHIN). The NHII seeks to provide "anytime, anywhere health care information and decision support … via a comprehensive knowledge-based network of interoperable systems."[66] The NHII could deliver value in multiple health care arenas: costs could be lowered, quality could improve as error rates are lowered, research results could be translated into practice more rapidly, and early detection of bioterrorism could increase.[66] The hope is that RHIOs, given that they are locally based and thus in a position to respond to the unique requirements of their market, will have more success establishing the NHII as compared to a government-sponsored, top-down approach. By linking RHIOs together in the future, the NHII could then be achieved. Some federal oversight is needed to develop policies and technical approaches to interoperability, which is currently the responsibility of the Health Information Technology Standards Panel (HITSP) created by the Office of the National Coordinator for HIT (ONC). ONC also supports regional efforts through four contracts, totaling $18.6 million, to create operational prototypes for the NHII. The Agency for Health Care Research and Quality (AHRQ) awarded grants to six states as part of the five-year State and Regional Demonstrations in Health Information Technology.[3] It is hoped that these demonstration projects will join successful local efforts as models for achieving the NHII. With the dual goal of fostering local HIE and the NHII, the current strategy combines top-down and bottom-up approaches.

At this early stage, RHIOs are still experimental, and little data is available on the best approaches to accomplishing HIE in local markets or an NHII across the country. Nonetheless, data have started to emerge on the progress to date. To understand the enthusiasm and momentum surrounding RHIOs, this report begins with a summary of their hypothesized benefits. Next, we discuss the obstacles that must be overcome for their development. We then review the current state of RHIOs at both the local and state level. Finally, we conclude with some thoughts on the future of RHIOs as the entities that will enable us to achieve nationwide HIE.

Benefits of Health Information Exchange

The motivation for RHIOs is based on the hypothesized benefits of the health information exchange they facilitate. The benefits of HIE are projected to be significant, with short-run cost savings resulting from administrative efficiencies (i.e., fewer chart pulls), reduction in redundant tests and avoidance of unnecessary hospitalizations. In an analysis of the value that could be created by national health information exchange and interoperability (HIEI), Walker and colleagues concluded that fully standardized HIEI would result in a net savings of $77.8 billion annually.[63] They describe four levels of HIEI. Level 1 is the base case, in which no IT is used to share information. Level 2 involves the use of machine-transportable data or the sharing of non-standardized data via fax. Level 3 includes the use of machine organizable data or non-standardized data that is transferred using structured messages, through the use of interfaces to translate between sending and receiving organizations. Level 4 is the most sophisticated level of HIEI and involves machine interpretable data. In Level 4, true end-to-end integration is achieved as data is transmitted using structured messages that contain standardized and coded data. Customized interfaces are not required to translate data between systems,[63] motivating the HITSP efforts at the national level to establish data exchange standards. A key finding of the Walker paper is that different stakeholders (i.e., payers, providers, labs, radiology centers, pharmacies and public health departments) may realize varying levels of return on investment (ROI) in HIEI. Specifically, providers would bear a disproportionate share of the cost of HIEI, as they implement the necessary clinical systems, and would realize a lower ROI compared with other types of stakeholders such as payers. The need for RHIOs, a neutral third party that brings together the varying stakeholders, is justified by this misalignment of incentives.

In addition to the cost savings described in the Walker paper, there are projected clinical benefits from HIE. Hillestad and colleagues discuss multiple ways in which interoperable EHRs with HIE capabilities can improve clinical care while saving money.[34] HIE can improve patient safety by eliminating errors introduced by human-mediated exchange of clinical data, thereby reducing medication errors and adverse drug events. Further, data shared through EHR systems can be utilized during routine care visits to identify patients who need preventative services and to track the progress of care for patients' with chronic diseases who may be receiving care in other institutions. While some benefits will come from using EHRs with robust decision support, greater clinical benefit can be realized with accurate and complete patient data.

There are other benefits of HIE as well. Recently, several important efforts have begun to address health system reform at the regional level. Some efforts have focused on improving safety or efficiency while others, such as *Aligning Forces for Quality: The Regional Market Project* (sponsored by the Robert Wood Johnson Foundation) has focused on broader changes in the delivery of health care in its communities. Greater health information exchange will greatly enhance the successes of these regional initiatives to make care better for citizens living in those areas. Although few empirical studies document the clinical benefits of HIE, there is little doubt that the greater availability of accurate, relevant clinical data will allow clinicians to provide higher quality care for their patients.

The added value of RHIOs stems from their ability to facilitate HIE. Whether RHIOs are the best method of achieving HIE is an open question. The United Kingdom and other countries approach clinical data exchange as a public good that should be fully funded by the government. In contrast, the U.S. treats RHIOs as small businesses and requires them to have viable business models.[23] The eHealth Initiative's HIE Value and Sustainability Model concludes that the scope of RHIOs should be determined based on the activities that will result in the greatest financial gain while minimizing risk.[23]

Obstacles to Health Information Exchange

RHIOs face a number of obstacles that must be overcome in order for them to facilitate HIE. These obstacles fall into three broad categories: (1) funding and participation; (2) legal and regulatory; and (3) technical.

Funding and Participation

National estimates of the cost of HIE include the cost of connectivity as well as the IT systems that must be adopted. Given the low level of EHR adoption among physicians and hospitals, substantial resources would be required to ensure that ambulatory clinics and acute care facilities have HIT systems. Walker and colleagues estimate the full cost of HIEI to be $320 billion for level 3 and $276 billion for level 4 over a 10-year implementation period. To achieve either level, the clinician office system costs would be $163 billion and the hospital system costs would be $27.1 billion, with the remainder covering interface costs. Ongoing, annual costs are estimated to be $20.2 billion for level 3 HIE and $16.5 billion for level 4 HIE, split almost evenly between system and interface costs.[63] Level 3 is projected to cost more than level 4 because it requires customized interfaces to accommodate non-standardized electronic vocabularies.[63] Using different assumptions, Kaushal and colleagues estimate that the NHII would require a $156 billion investment over five years ($102.7 billion for systems and $52.97 billion for interoperability), after which annual operating costs would run $48 billion per year ($26.9 billion for systems and $20.82 billion for interoperability).[67]

Individual RHIOs must convince stakeholders to provide resources to cover expenses and to participate in HIE. While most are incorporated as not-for-profit organizations, RHIOs still must acquire funding to cover capital and operating costs. As part of the Kaushal paper, the authors estimate the capital costs for central, super and national "hosts" that facilitate HIE at various levels, based on the experience of a prominent RHIO, the Santa Barbara County Care Data Exchange.[67] A central host, the closest entity to a RHIO, is projected to incur capital costs including $125,000 in fixed costs, $50,000 for security and interoperability software, and $126,000 for a server, T1 line and systems administration. In reality, the level of funding required depends on the scope of a RHIO's activities, but the Kaushal paper's estimate of capital costs suggests that, once operating costs are added, it is substantial. Further, capital costs are incurred during the development stage, when a technical infrastructure is implemented. Potential participants are often asked to contribute during this stage, before the benefits of an HIE infrastructure have been realized. This requires a convincing value model which, under the current health care reimbursement structure, does not necessarily exist for all stakeholder groups. As David J. Brailer, M.D.,

Ph.D., former Director of the Office of the National Coordination for Health Information Technology, wrote in a recent *Health Affairs* article reflecting on his experience with the Santa Barbara County Care Data Exchange, "the quality benefits of HIE, such as lives saved, errors reduced, emergency visits averted, and referrals eliminated, were explored in the Santa Barbara project. In other words, hospitals and physicians were asked to adopt HIE on its merits and, by doing so, risk reducing the very activities that drive their revenue."[6] In addition, the value realized by HIE varies by community. In communities where patients do not move between institutions to receive care, little value will be derived from data exchange. In communities with large, non-competitive delivery systems, patient data is often available to external providers via a portal. This was true in Santa Barbara, and it decreased the incentive for stakeholders to pay for the RHIO. An additional challenge stems from the need for communal action; the first participant in HIE realizes no value, but the value rises exponentially as additional participants contribute data. When combined with the need for up-front capital to fund development, there is a strong incentive for potential participants to "free-ride" until the exchange is up and running.

As a result of these obstacles, a substantial portion of current RHIOs funding comes from state and federal grants, with some additional support from philanthropic organizations and private groups.[24] A survey of all 145 U.S. RHIOs conducted by Adler-Milstein and colleagues found that, of the 20 operational RHIOs that have achieved at least modest scale, 45 percent relied on grant funding as they prepared for electronic data exchange and 40 percent continued to rely on grant funding after becoming operational.[1] While 20 percent relied on grant funding during all phases of development, 45 percent never required grant funding, revealing that success without grant support is possible. Another survey conducted by the Healthcare IT Transition group found greater reliance on grant funding, with 80 percent of RHIOs in the development stage relying on grants for funding. This survey also found that 68 percent of RHIOs plan to become self-sustaining and 44 percent stated that they are "operationally self-sufficient"[29] However, among this group, 88 percent expected to apply for some grant funding to cover future capital expenses. To date, AHRQ alone has given $166 million in grants and contracts to states for HIE implementation.[19] While grants give RHIOS the ability to create an infrastructure without establishing a business model upfront, this early funding may allow them to bypass the challenge of creating buy-in from stakeholders. Thus, the effort may be driven by the availability of funds, instead of a perceived community need for HIE, cultural readiness to engage in data exchange or the providers' desire to share data. The Santa Barbara County Care Data Exchange, once heralded as a model for RHIOs, ceased its data-sharing activities after receiving millions of grant dollars and is a visible example of the risk of this approach.

If grant funding ceases to be available as a primary source of support for RHIOs, several alternate business models have been suggested. One potential model is to "franchise" successful RHIOs, allowing them to sell their experience, information and technology.[26] Though franchising will limit the initial start-up funds that are required, it still requires RHIOs to have a viable financial model where ongoing funds are secured and enough revenue (and cash flow) generated to cover the initial investment. In the Membership Fee Model, stakeholders pay a monthly or annual fee to support an array of shared services; the fee may vary among participants depending on factors such as their size and the types of data they

exchange.[27] The Adler-Milstein survey found that 50 percent of RHIOs receive a one-time financial contribution from participating organizations during the planning phase and 35 percent receive a one-time contribution after they are operational.[1] Alternatively, RHIOs can use an HIE Transaction Fee Model in which they charge a per-use fee for a specific HIE service or product.[27] For example, they may charge a transaction fee per clinical result delivered.[27] RHIOs may also follow a Program and Service Fee Model in which they charge a monthly or annual fee for participation in specific activities such as ePrescribing.[27] Forty percent of operational RHIOs collected a recurring fee from participants while in the planning phases and 65 percent collected a recurring fee once the effort became operational.[1] Experience with these various business models is insufficient to suggest which, if any, are viable.

While hospitals and physician practices are the most common participants in RHIOs,[1] most providers are not good candidates to provide long-term funding for RHIOs as they do not have the capital or the means to raise the billions of dollars needed to support their operations.[7] Furthermore, if RHIOs, and eventually an NHIN, are successful in creating a more efficient health care system, payers are projected to reap the largest return on investment as they stand to benefit the most from connectivity among providers. Therefore, third parties are often targeted as the stakeholder that should fund RHIOs.[7] However, non-profit insurers are subject to state and federal regulations that prevent them from easily tapping into current cash reserves, which would be required to fund RHIOs.[7] Commercial insurance companies have not been enthusiastic about providing sizeable financial support for RHIOs and currently participate in only 45 percent of the operational efforts.[1] Finding other stakeholders to fund RHIOs (e.g., pharmacies, public health departments) is a challenge as they are projected to realize much less benefit from HIE.[63]

Legal and Regulatory

Given the limited legal and regulatory experience with HIE, there are complex issues that RHIOs, as the facilitators of HIE, must resolve. The most important issue in this area is the privacy and confidentiality concerns that arise when sharing protected health information. RHIOs must consider: (1) who is authorized to view what data and how to enforce this; (2) how to secure communications through encryption; and (3) how to keep security up to date with changes in technology.[4] Because HIPAA regulations are already understood and followed by health care organizations, these standards can be used as a baseline for regulating the exchange of protected health information.[4] Unfortunately, following HIPAA regulations does not solve all the pertinent issues. As Brailer wrote in the *Health Affairs* article about the Santa Barbara Project, pursuing HIE is "intrinsically risky because of broad disagreement about which privacy policies applied and what actions those policies required providers to take. It became clear that the substantial ambiguity in existing security and privacy policies made this problem impenetrable. Any number of lawyers would draw different conclusions from the federal and state privacy rules that were spread across many chapters of code and among many agencies." The Health Information Security and Privacy Collaboration (HISPC), a collaboration between the federal government and 43 states, was established in 2006 to develop a consensus on privacy rules and is currently working to resolve these issues. Even if this consortium is able to reach consensus on privacy rules, whether their consensus statements will hold sway in the courts or assuage concerns among lawyers of participating organizations about sharing patient-level data remains unclear.

Technical

Another barrier to RHIOs stems from technical challenges. While several prototype data exchange architectures have been developed, these assume that clinical data reside in electronic systems and will be available to be shared as interfaces are developed. Given that the state of EHR adoption and use in the country is still quite low, many existing RHIOs have sidestepped this barrier by using secure messaging and a portal, which only requires a computer terminal with Internet access on the receiving end. If the goal is true end-to-end integration, both providers and receivers of data must have electronic systems and adhere to clear standards for data exchange. HITSP has begun to make progress towards the establishment of data exchange standards, and data exchange architectures are being developed. However, the technical issues have been fully solved. Given the myriad of vendors supplying the electronic systems where data reside, ensuring this information can be exchanged remains a substantial hurdle and will be a major cost of developing HIE systems.

The adoption of clinical systems is also an important barrier to overcome, as EHR use only extends to a small percentage of the health care market. A recent review of the literature found that the best evidence suggests that only 24 percent of physicians use *any* kind of an EHR, while only 9 percent of all ambulatory care physicians have EHR systems with robust functionalities such as electronic prescribing and clinical decision support.[42] Improving these rates will be a necessary, though not sufficient, step to widespread HIE.

Beyond EHR systems' direct cost, small providers are not well equipped to evaluate the many commercial products on the market and may be hesitant to purchase a system that is not guaranteed to comply with future standards. To help address these issues, the Certification for Commission for Healthcare Information Technology (CCHIT) was created by the American Health Information Management Association, the Healthcare Information and Management Systems Society and the National Alliance for Health Information Technology.[55] CCHIT, a voluntary, non-profit organization, was established to develop a certification process for HIT products that includes standardizing HIT, such as EHRs, to ensure they are interoperable, protect patient privacy and reduce the risk of HIT investments.[55] While several EHRs meet these certification criteria, the success of this process and its impact on adoption has not yet been assessed.

Other

Even if participation in RHIOs is robust, and the technical, legal and financial barriers have been overcome, other issues play a critical role in determining the value that can be garnered from RHIOs. Understanding institutional practices, human factors and workflow issues will be paramount, as simply enabling the greater availability of data will not guarantee its use. Organizations (and individuals) will need to learn how to incorporate this new information into their daily workflow, when to use it and when to ignore it. Given that most RHIOs are in their infancy, these issues have not yet been adequately examined. However, the need for user-friendly data coming from the RHIO, which are readily available for the clinician when he/she needs them and can be used in a way that fits the work patterns of busy clinicians, will be critical to ensuring that RHIOs deliver on the value they promise.

Local Level Overview

Scope and Activity: It is estimated that there are between 100 and 200 RHIOs nationwide. However, most are in the early planning or development stages. As of 2006, data from a Forrester Research report found that only seven RHIOs (six without Santa Barbara) were exchanging data and less than 13 other RHIOs were in the development stages.[7] These 13 RHIOs had selected vendors and were currently developing their systems for HIE, but they were not yet operational.[7] Even among operational RHIOs, the scope of clinical data exchange varies. All seven were exchanging radiology notes; six were exchanging lab results and inpatient, outpatient and ED records; four were exchanging prescription data from physicians; three were exchanging prescription data from retailers and data regarding prescription claims from payers; two were exchanging physician office visit records; and one was exchanging medical claims from payers.[7] Across the seven RHIOs exchanging data, the technical architecture also varied, with three models in use: virtual EHR, a managed clinical messaging system, and a publish and subscribe system.[7] In a virtual EHR model, physicians query the repository of EHR data available for a given patient and the system yields a results list of all patient encounters.[7] A clinical messaging system allows providers to exchange patient records from individual encounters as needed, instead of exchanging the patient's entire medical record.[7] Clinical messaging is less costly than a virtual EHR model, as it does not require end-to-end integration.[7] In the publish and subscribe model, servers search through HL7 (Health Level Seven) events and locate the data relevant to specific subscribers, such as the Centers for Disease Control and Prevention (CDC), making this model particularly useful for public health reporting. To date, no RHIOs have the publish and subscribe model as their principal architecture, but some RHIOs are including it as an additional capability.[7]

As of early 2007, an Adler-Milstein and colleagues survey identified 145 organizations that were believed to be pursuing electronic data exchange.[1] Of this group, seven reported that they had never pursued clinical data exchange and therefore were not RHIOs. Of the remaining 138 organizations, 36 organizations (26 percent) were defunct, leaving 102 organizations possibly pursuing clinical data exchange. Among the 83 organizations that responded to the survey, only 32 RHIOs (38 percent) reported facilitating clinical data exchange across independent entities as of Jan. 1, 2007. Three (4 percent) were facilitating data exchange between non-independent entities, that is, physicians and hospitals that were part of the same integrated delivery network. Forty-five RHIOs (54 percent) were still in the planning stages, and three (4 percent) were temporarily stalled, because of a lack of funding, but had not permanently stopped pursuing HIE in their communities. Of the 32 RHIOs facilitating clinical data exchange, 12 were designated as "small" efforts, with less than 5,000 patients for whom data exchange was possible.

Among the 20 remaining, modest-size or larger RHIOs, test results and medication histories were the most common types of data exchanged.[1] Seventeen RHIOs (85 percent) exchanged test results (for example, laboratory and radiology), followed by 14 RHIOs that exchanged inpatient data and medication histories. Outpatient care data were exchanged in 12 RHIOs; a smaller fraction was involved in exchanging other types of data, such as public health reports. As a result, hospitals

and ambulatory care practices provided data for exchange most frequently and also viewed data most frequently. Laboratories and imaging centers were also common providers of clinical data for exchange, but they viewed the data less often. Public health departments and payers were involved in both providing data and viewing data in nearly half of the RHIOs. Pharmacies and pharmacy benefit management organizations (PBMs) were infrequently involved.

The functionalities facilitated by RHIOs were consistent with the types of data exchanged. For example, viewing or delivering results was the most common functionality, with 90 percent of RHIOs offering this service. Clinical documentation (notes) and consultation/referrals were offered by half of the RHIOs. Five of them approached data exchange by offering EHR licenses in which the RHIO acts as a "middleman" between EHR vendors and participating care delivery organizations.

Funding: The survey by Adler-Milstein and colleagues asked respondents to report their funding sources as they planned for data exchange and after they become operational. During the planning phase, donated staff time or in-kind resources were the most common source of support, with 13 of the 20 RHIOs reporting it as a moderate or substantial funding source.[1] One-time financial contributions and grants or contracts were less common but still important sources of support for about half of the RHIOs. Many entities, such as state governments and regional foundations, support local HIE efforts; the eHealth Initiative (eHI) is the best known funding source for local efforts. eHI provides startup grants for multi-stakeholder collaboratives focused on using HIE and IT to improve health care. In 2004 eHI awarded grants totaling $2 million to the following nine projects: Colorado Health Information Exchange, Indiana Health Information Exchange, MA-SHARE MedsInfo e-Prescribing Initiative, MD/DC Collaborative for Healthcare Information Technology, Santa Barbara County Care Data Exchange, Taconic Health Information Network and Community, Tri-Cities TN-VA Care Data Exchange, Whatcom County e-Prescribing Project and Wisconsin Health Information Exchange.[20]

Once the data exchange is up and running, awardees are tasked with finding strategies to address the challenges of HIE and HIT.[20] For example, one of the Colorado Health Information Exchange's primary goals is to demonstrate a sustainable business model.[21] However, the Adler-Milstein survey found that only two of the nine RHIOs that received grant funding during the planning phase successfully transitioned off of grant funding once they became operational.[1] In general once they became operational, 13 RHIOs reported receiving recurring subscription or transaction-based fees as moderate or substantial sources of support. Other important forms of support in this early phase included donated staff time or in-kind resources (nine RHIOs), grants (eight RHIOs) and one-time financial contributions (seven RHIOs).[1]

Activities at the State and Regional Level

AHRQ has awarded grants to six states under its State and Regional Demonstrations in Health Information Technology project.[3] In October 2004 Colorado, Indiana, Rhode Island, Tennessee and Utah were awarded contracts. An additional contract was awarded to Delaware in October 2005.[3] AHRQ's goals for the State and Regional Demonstrations include: identifying and supporting state

and regional data sharing and interoperability activities; allowing clinicians access to patient information at the point of care; developing HIE that connects local provider systems; developing, implementing and evaluating a patient indexing system that allows health care providers to share information; demonstrating measurable improvements in the quality, safety, efficiency and effectiveness of care based on HIE; and identifying successful sustainability models and programmatic linkages to other regional and national HIE initiatives.[3]

Other state and regional activity has been furthered by state governments, many of which have allocated funding to establish state-level RHIOs with the hope that these entities will support and coordinate local HIE efforts. An AHRQ review of all the state-based efforts found that no two projects were identical.[24] For example, Arizona's Health Care Cost Containment System HIE is primarily state funded and utilizes a Web-based interface to exchange data. In contrast, the Quality Healthcare Alliance in Hawaii has received funding from several sources, including member donations, subscription fees and federal funding, and exchanges data through an Internet-accessible clinical data repository with an interoperable EHR.[24] The state-based efforts share the goals of quality improvement and cost reduction; however, there are differences in their funding sources, choice of technical architecture and the strategies used to reach these goals.[24] Thus, even if state efforts are individually successful at linking together local efforts, there is little evidence that they are heading in a trajectory that would make integrating them into a larger network seamless.

National Level Overview

ONC has actively promoted the development of national HIE by awarding $18.6 million to create operational NHII prototypes.[7] This contract was awarded to a consortium of technology developers and health care providers, lead by Accenture, Computer Sciences Corporation (CSC), International Business Machines (IBM) and Northrop Grumman. Each consortium will develop a prototype network for the secure exchange of data between pharmacies, laboratories, physicians and hospitals. The consortia will collaborate to ensure that data can also move seamlessly between the four networks.[32] In January 2007 each group presented their prototypes and business models at the Third Nationwide Health Information Network Forum. As a next step, these prototypes will be used as models for trial implementations of networks to exchange data at the state and regional level.[52]

Status of Select RHIO Efforts

The Indiana Health Information Exchange (IHIE) is the oldest RHIO in the country.[7] It began pilot testing in 1994 and was fully operational in 2004.[7] Early funding for IHIE was provided by the Health & Hospital Corporation of Marion County. Currently, IHIE's annual operating budget of $12 million is supported primarily by federal grants.[54] IHIE currently offers two major services–DOCS4DOCS and Quality Health First of Indiana.[38] IHIE partners with the Regenstrief Institute, an Indiana health care research foundation, to offer the DOCS4DOCS clinical messaging service. This service aggregates clinical data from several sources and gives providers 24–7 access to prevent duplicate testing.[39, 41] As of July 2007 DOCS4DOCS also delivers clinical information directly to providers' EHR systems.[15] DOCS4DOCS is currently used by 25 hospitals and 5,000 physicians.[39] Under the Quality Health First program, IHIE

utilizes data from DOCS4DOCS and the Indiana Network for Patient Care (INPC) database to provide physicians with reports that can be used to monitor their patients' care.[40]

HealthBridge facilitates HIE among 17 greater Cincinnati-area hospitals that are part of five large health systems: Mercy Health Partners, TriHealth, Health Alliance, St. Elizabeth Medical Center and Cincinnati Children's Hospital Medical Center. This RHIO, which formed in 1997, includes a Web-based clinical messaging system that delivers data including lab results, radiology results and Admission /Discharge /Transfer (ADT) information to providers.[31] Most recently, Mercy Hospital is offering the DXView tool to allow providers to review medical images over the Internet through HealthBridge.[45] HealthBridge is one of the few RHIOs currently exchanging data that is located in an Aligning Forces community. As mentioned earlier, regional initiatives to improve quality, such as Aligning Forces, have the potential to transform health care in the communities where they are focused. High-quality health information exchange may be a potential catalyst and can surely play an important role in helping regional initiatives for quality improvement be far more successful. Whether HealthBridge will be able to play that role is currently unclear. Of note, HealthBridge has only received one grant, a $29,000 local contribution for its public health alert program; participants in the RHIO cover the remaining expenses through monthly dues and access fees.[5]

Northwest RHIO in Spokane, Wash., serves the Inland Northwest Health Services Regional Healthcare Network, which draws patients from Washington, Idaho, Montana, Oregon and Canada.[18] This RHIO is made up of 30 hospitals, more than 20 clinics and 700 physicians, all sharing clinical data. Providers receive hospital, laboratory and imaging data through Northwest RHIO's electronic messaging system.[18] All participants share a common EHR system, which allows shared data for their more than 2.6 million patients to be standardized.[18]

The Taconic Health Information Network and Community (THINC), led by the Taconic Independent Practice Association (IPA), provides secure data exchange among the health care community, including providers, patients, payers, employers, pharmacies and laboratories.[14] Currently, THINC's secure network provides clinical, insurance, administrative and demographic data for 600,00 patients in New York's Hudson Valley region.[16] Members of THINC are also sharing prescription data from physicians, retailers and payers, lab results, radiology notes, in-patient records, out-patient records and emergency department (ED) records.[7] THINC has partnered with MedAllies, a Health Information Service Provider company, to oversee HIE and assist in EHR implementation among local providers.[60] THINC received grant funding from the eHealth Initiative.[16]

In 2003 MA-SHARE was formed by the Massachusetts Health Data Consortium to pursue clinical data exchange.[28] MA-SHARE acts to facilitate data exchange between providers, patients, payers, hospitals and the government.[44] MA-SHARE focuses on e-prescribing as a conduit to further HIE. But it has several additional projects, which include promoting the integration of health care data for better detection of bioterrorism through its Bioterrorism Syndromic Surveillance program; facilitating the adoption of electronic health records; encouraging electronic communication between providers and patients; making prescription

data available in EDs under the MedsInfo-ED program; allowing real-time access to pathology data from multiple institutions; simplifying physician credentialing; and looking at ways to provide secure e-mail exchange between institutions.[43] MA-SHARE is supported by grants from Blue Cross Blue Shield of Massachusetts, Partners HealthCare, Tufts Health Plan, Fallon Community Health Plan, Neighborhood Health Plan and the Massachusetts Medical Society.[44]

Michiana Health Information Network (MHIN) offers an EHR network that is utilized by physicians and practices in northern Indiana and southwest Michigan.[48, 62] MHIN allows providers to view clinical data, lab results and radiology results. It also offers a clinical messaging system and e-Prescribing.[7, 49] The network currently shares data from 200,000 medical records over a secure network among 480 registered physicians and five regional hospitals.[7] The MHIN network only allows providers involved in a patient's care to see that patient's records.[17]

Whatcom Health Information Network (HInet) is a health care intranet that currently serves 180,000 patients and connects physician offices, payers, community health services and hospitals in Whatcom County, Wash.[64, 65] HInet was established by St. Joseph Hospital and the Northwest Washington Medical Bureau (NWMB) in 1996.[64, 65] Initially, St. Joseph Hospital and NWMB funded HInet and, in 2000, HInet began charging providers for services.[64] HInet allows providers to view hospital records and lab results through its online EHR system.[35] Recently, HInet added e-prescribing, along with medication interaction alerts and allergy alerts, to its available services.[65]

MedVirginia, a RHIO that serves the Richmond, Va. area, was established in 2000 and began operating in 2006.[46, 47] MedVirginia functions as a Web-based portal for clinical data exchange[47] that is used by more than 270 physicians.[46] MedVirginia requires providers to pay for putting clinical data online but allows them to view medical histories, check laboratory results and transmit referrals for free.[46] Participants also pay fees to utilize e-prescribing and electronic charting, and to integrate the MedVirginia network with their practice management systems.[46] As MedVirginia expands, its goal is to become a statewide RHIO that offers interoperable EHRs through its network.[46]

In Tennessee, the MidSouth eHealth Alliance (MSeHA) is developing HIE between providers in Shelby, Tipton and Fayette counties.[22] Through MSeHA, participating health care organizations share clinical information, including labs, medical records and medication histories.[50] Patient information is shared only with those providers involved in a patient's care, and patients can choose to "opt out" of participation in MseHA.[22] Vanderbilt University provides the technology to support the sharing of clinical information.[22] Funding for MSeHA comes from an AHRQ contract, the state of Tennessee and Vanderbilt University.[28]

CareSpark, established in May 2005, seeks to provide HIE to 17 counties in southwest Virginia and northeast Tennessee.[11, 13] The CareSpark RHIO consortium is currently developing the technical infrastructure to support HIE across these counties. CareSpark plans to sustain funding through monthly purchaser enrollment fees, monthly provider investments and third-party funding through grants, vendors and contributors.[12] CareSpark not only allows physicians to access patient test results, it also provides reminders when patients are due for tests or screenings according to its best practice guidelines.[33] A main focus of the RHIO is

to ensure that individuals in the region, especially children and the elderly, are up to date with their vaccinations.[51] In February 2007 CareSpark announced it would begin enrolling patients in April 2007 and be fully operational by July 2007.[33]

The California Regional Health Information Organization (CalRHIO) is a statewide RHIO working to create a secure system for HIE.[8] Currently, CalRHIO is in phase I of its implementation plan. In this phase, CalRHIO is working to establish Statewide Online On Demand Information Services that will offer a master patient index, a record locator service, e-prescribing and a medication history query.[9] This service will also offer an Integration Hub that will translate clinical data between different EHR systems and an EHR Gateway that will pull national lab data into physician's EHR systems.[9] Participants will choose which services they would like to use and will pay only for those services.[9] In phase II, the RHIO will work on regional expansion to link local data with the Statewide On Demand System.[9] Currently CalRHIO has joined with HP, Medicity and Perot Systems to build the statewide HIE system.[10] By 2014 CalRHIO plans to enable access to 90 percent of Californians' health information.[36] The total level of investment in CalRHIO is not available.

Gulf Region

One area of particular interest is the Gulf region, given the impact of Hurricane Katrina on states such as Louisiana, Mississippi and Texas. While these states face additional obstacles, the need for HIE is particularly obvious following such extensive disruption to the health care system. Nonetheless, these states are moving forward with HIE initiatives. In November 2005 Texas, Alabama, Mississippi and Louisiana formed the Gulf Coast Health Information Technology Task Force (GCHITTF) to plan and implement HIE in this region.[59]

In Texas, the state created the Texas Health Information Technology Advisory Committee. This group was established to oversee HIT in Texas and to make recommendations regarding the governance, financing and technology related to HIE.[56] The advisory committee has two main goals: to encourage widespread EHR adoption and to develop organization, technical and social capacities for HIE.[56]

In Mississippi, Gov. Haley Barbour established a Health Information Infrastructure Task Force in March 2007.[25] As Mississippi rebuilds post-Katrina, improving the health care system in the state is an important goal. Gov. Barbour indicated the need for secure and accessible health information for everyone in Mississippi, especially for vulnerable populations such as the elderly.[30] The task force will establish goals and guide the progress of HIE in Mississippi.[30]

Louisiana has established the Louisiana Health Information Exchange (LaHIE) as a prototype for a NHIN.[58] LaHIE's primary goal is to establish a HIT infrastructure that will result in the standardized exchange of patient information among providers.[58] It is also focusing on HIE in areas of the state devastated by Hurricane Katrina.[58]

Alabama has focused its efforts on sharing health information during disasters. Health care professionals in Alabama created the Disaster Online Health Network (DOHN) to facilitate HIE.[57] This network will collaborate with the Alabama Incident Management System to establish access to patient records that already exist in payer networks.[57] Alabama has also created the Alabama Incident

Management System (AIMS), a Web-based system that will provide "real-time bed, staff, supply and issue data from every hospital, nursing home, community health center, Emergency Medical System agency and medical needs shelters during times of disasters."[57]

Conclusions

Given the current challenges facing our health care system, HIE in general and RHIOs in particular represent a compelling solution to improve quality and reduce the cost of care. However, our evaluation of the data suggests that RHIOs are very much in the early stages of their development. It is encouraging to see the substantial progress of select RHIOs at the local, state and regional levels. While the planning and implementation differs in the various states, the primary goals are the same—to make health information available electronically in a secure manner such that it can be shared among providers, payers and other health-related organizations. As more RHIOs develop and become operational, we must consider the barriers to implementation and ongoing funding. The government and philanthropic organizations are currently providing the majority of funding for HIE.[24] However, the sustainability of this approach is unclear. While several studies have indicated that the cost savings will outweigh the costs of HIE, the evidence does not yet appear to be compelling stakeholders, such as payers and providers, to invest in RHIOs or other HIE methods.

There are several potential paths that could allow RHIOs to become successful. One path is for the current RHIOs, despite being heavily dependent on grants, demonstrate financial value to participating organizations in a way that these organizations become financial partners, funding the RHIOs to financial independence. Their demonstrated value could become the catalyst for the next generation of RHIOs, which would be less grant-dependent and reach financial sustainability earlier. Alternatively, the RHIOs could demonstrate value to society at-large leading public entities, such as state and federal governments, to continue to fund RHIOs. It is unclear whether state and federal entities will have the appetite to provide the funds needed—likely hundreds of millions, if not billions, of dollars—to support hundreds of RHIOs over a long period of time.

The success of RHIOs, or some equivalent mechanism for supporting HIE, is critical to achieving the NHIN that policy-makers are striving to make a reality. However, significant challenges, including sociological, technical and financial barriers must first be overcome. Over the past few years, widespread enthusiasm and momentum have pushed the development of HIE and RHIOs but, if they do not begin to show compelling evidence that they can deliver on the hypothesized benefits, it is likely that attention will shift to other solutions.

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Chapter 6: Emerging Privacy Issues in Health Information Technology

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Introduction

The evolution of health law is, in part, the story of the law's interaction with—and impact on—the introduction and diffusion of new technologies.[1] Because the collection, use and dissemination of health information goes to the heart of the health care profession, the adoption and use of technology can be expected to both shape and be shaped by the legal context in which health care takes place.

This chapter examines the evolution of health information technology (HIT) in a legal context, focusing on questions of privacy and security. Health information has always been central to the practice of medicine and the quality of health care. Health information technology itself does not create valuable information; rather, it facilitates the transparency and sharing of information that already exists, functions that are considered essential to reducing health care disparities, improving quality of care, reducing costs and increasing the transparency of health care services. Thus, efforts to increase the rate of HIT adoption for certain key functions, such as electronic health records (EHRs), as well as more recent efforts to encourage the use of personal health records (PHRs), have brought heightened awareness to various legal matters—in particular, issues related to privacy and security. The implications of these technologies on the diffusion of health information have received considerable attention, given their impact on the volume and flow of personal health information.

Background

The electronic accumulation and exchange of personal health information promises significant benefits to health care consumers, providers and payers alike. Many health policy experts believe that broader HIT adoption may lead to the availability of more complete and transparent information, ultimately helping to contain health care costs while simultaneously improving health care quality. The current policy emphasis on HIT adoption and use reflects this belief in HIT's potential.

Advancing electronic health information as a core aspect of health care practice was a basic goal of the Health Insurance Portability and Accountability Act of 1996 (HIPAA). In addition to helping develop national health information privacy standards, HIPAA also simplified federal health care programs claims administration, laying the groundwork for electronic data exchange.[2] The Medicare Prescription Drug Improvement and Modernization Act of 2003 (MMA) built on this trend by establishing federal electronic prescribing policy, as well as mandating "safe harbor" protection from federal anti-kickback and anti-physician self referral laws for non-monetary gifts that involve the donation

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1   Jacobson P. *Medical Liability and the Culture of Technology, Medical Malpractice and the U.S. Health Care System*, Sage WM and Kersh R, (eds). New York: Cambridge Press, 115–136, 2006.

2   P,L, 106–191 (106th Cong. 2d Sess.) §261

of health information technology.[3] Legislation to further encourage HIT adoption has been introduced in Congress.[4] President Bush has made adoption of interoperable electronic health records within 10 years a national priority, and the administration's recent Medicare reform proposal calls for the secretary of the U.S. Department of Health & Human Services (HHS) to develop and implement a system for encouraging nationwide adoption and use of interoperable EHRs and to make personal health records available for Medicare beneficiaries.[5] An executive order signed by President Bush in 2004 prioritized the development of technology standards and adoption incentives and instructed federal agencies to develop and execute a strategic plan to guide the nationwide adoption of interoperable HIT in both the public and the private sectors.[6] A subsequent executive order issued in 2006 outlined additional steps to foster HIT diffusion within certain federally sponsored and administered health programs.[7]

HHS, which has primary responsibility for HIT adoption policy, responded to the first executive order with a roadmap for adoption. Released in 2004, the roadmap set goals for achieving the national adoption of interoperable HIT on a systemic basis and identified implementation strategies in both the public and private sectors.[8] The following year, HHS began awarding contracts to address key aspects of this plan, including harmonizing HIT standards industry-wide, developing a certification process for HIT products, addressing variations in policies and state laws that affect privacy and security practices, and creating prototype architectures for widespread health information exchange through a nationwide health information network (NHIN).[9] These actions were accompanied by the 2006 release of federal rules modifying existing fraud and abuse regulatory standards, in order to incentivize the adoption of interoperable HIT.[10] (See Chapter 2 in this report). In addition, the 2006 executive order required federal agencies that purchase and deliver health care to use interoperable HIT.

HHS actions related to the development and diffusion of industry-wide standards have been informed by the American Health Information Community (AHIC), a federal advisory committee composed of public and private sector health care leaders, whose mandate has been the development of recommendations for accelerating interoperable electronic HIT diffusion.[11] Other ongoing federal

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3   P.L. 108–173 (108th Cong. 1st sess.) §101(a) adding §1860D-4(e) of the Social Security Act.

4   As of February 2008, literally hundreds of pieces of proposed legislation addressing one or more aspects of health information had been introduced in the 110th Congress. http://thomas.loc.gov/cgi-bin/thomas (search conducted by authors, February 28, 2008).

5   The Medicare Funding Warning Response Act of 2008, S.2662 (Introduced in Senate February 25, 2008); H.R. 5480 (Introduced in House February 25, 2008).

6   Executive Order 13335, *Incentives for the Use of Health Information Technology and Establishing the Position of the National Health Information Technology Coordinator* (Washington, D.C.: April 27, 2004). Available at: http://www.whitehouse.gov/news/releases/2004/04/20040427-4.html

7   Executive Order 13410, *Promoting Quality and Efficient Health Care in Federal Government Administered or Sponsored Health Care Programs (*Washington D.C. Aug. 22, 2006) http://www.whitehouse.gov/news/releases/2006/08/20060822-2.html

8   Department of Health and Human Services, *"The Decade of Health Information Technology: Delivering Consumer-centric and Information-Rich Health Care: A Framework for Strategic Action," (Washington, DC: July 21, 2004).* The roadmap was updated in 2006 to include goals for protecting consumer privacy.

9   Department of Health and Human Services, "*Health Information Technology Initiative: Major Accomplishments 2004-2006," (*Washington, DC: 2006). Available at: http://www.hhs.gov/healthit/news/Accomplishments2006.html

10 71 Fed. Reg. 45140; 45110-45134 (Aug. 8, 2006). See HHS News Release Aug. 1, 2006. http://www.hhs.gov/news/press/2006pres/20060801.html

11 Department of Health and Human Services, "*Health Information Technology Initiative: Major Accomplishments 2004–2006,"* op. cit. AHIC is currently being transitioned to a public-private partnership (AHIC 2.0) based in the private sector. DHHS plans for the successor to be designed and ready for initial operation in Spring 2008, with full transition completed by Fall 2008. *See* http://www.hhs.gov/healthit/community/background/.

agency activities include the certification of HIT products, the development of technical standards for interoperability, and the identification and correction of privacy and security issues in nationwide HIT implementation. Efforts also involve initiatives to advance information access in specified high priority areas, as well as the regional and national exchange of data through a "networks of networks" within the NHIN.[12]

Health Information Privacy

One of the most complex aspects of HIT adoption has been assuring privacy and security. The privacy and confidentiality of health information and its maintenance in a secure fashion always have been critical aspects of health care. Because HIT has the potential to make health information far more accessible, it has become particularly important to maintain a high focus on privacy and security considerations, even as health information has enabled critical reforms in the areas of health care quality, equality, patient safety and transparency. This heightened attention to privacy and security is the result of the serious effects that can flow from the unauthorized disclosure of personal health information, ranging from embarrassment to stigma and discrimination in employment, insurance and government programs.[13] Furthermore, patient fears about improper disclosure may lead to "privacy protective behaviors" such as avoiding essential clinical or public health tests or medical treatments, or refusing to participate in important research programs.[14] These fears stem from concerns that providers and, even more so, health insurers might misuse personal health information. Indeed, consumer surveys have found that concern about health information privacy is widespread, particularly when the information is in an electronic form. Notably, these concerns arise even among individuals who agree with the potential benefits of HIT.[15]

Recent Government Accountability Office (GAO) reports have identified the need for more rapid and comprehensive federal efforts to address health information privacy issues.[16] In June 2007 the GAO recommended improvements in virtually all administrative aspects of federal privacy laws, including clarifying federal legal

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12 *Ibid.*

13 Gostin L.O., et al. "Informational Privacy and the Public's Health: The Model State Public Health Privacy Act," American Journal of Public Health, September 2001, Vol. 91, No. 9, 1338, at 1338.

14 Verhulst S. "The Architecture for Privacy in a Networked Health Information Environment," The Connecting for Health Common Framework (Markle Foundation, 2006), at 3–4; Goldman, Janlori (1998). "Protecting Privacy to Improve Health Care," Health Affairs (Nov-Dec): 47; Appelbaum, P. "Privacy in Psychiatric Treatment: Threats and Responses," American Journal of Psychiatry 159:11 (November 2002), 1809–1818, at 1810; Gostin at 1338.

15 California HealthCare Foundation, "California Health Privacy Survey," 2005. http://www.chcf.org/topics/view.cfm?itemID=115694; Westin A F. and the Program on Information Technology, Health Records and Privacy, *How the Public Views Health Privacy: Survey Findings From 1978–2005*, Hackensack, NJ: CSLR, February 23, 2005. http://www.privacyexchange.org/survey/surveys/surveys.html; Bishop L, et al., *National Consumer Health Privacy Survey 2005*, The California Healthcare Foundation, Executive Summary (2005); Kass N E et al., *Medical Privacy and the Disclosure of Personal Medical Information: the Beliefs and Experiences of Those with Genetic and Other Clinical Conditions*, 128A Am. J. Med. Genetics 261 (2004); Wall Street Journal Online/Harris Interactive Health-Care Poll, Few Patients Use or Have Access to Online Services for Communicating with their Doctors, but Most Would Like To, Sept. 22, 2006. http://www.harrisinteractive.com/news/newsletters/wsjhealthnews/WSJOnline_HI_Health-CarePoll2006vol5_iss16.pdf

16 GAO, *Health Information Technology: Early Efforts Initiated but Comprehensive Privacy Approach Needed for National Strategy*, GAO-07-238 (Washington, D.C.: Jan. 10, 2007).; GAO, *Health Information Technology: Early Efforts Initiated but Comprehensive Privacy Approach Needed for National Strategy*, GAO-07-400T(Washington, D.C.: Feb. 1, 2007); GAO, *Health Information Technology: Efforts Continue but Comprehensive Privacy Approach Needed for National Strategy*, GAO-07-988T (Washington, D.C.: June 19, 2007); GAO, *Health Information Technology: HHS Is Pursuing Efforts to Advance Nationwide Implementation but Has Not Yet Completed a National Strategy* (Washington, D.C.: February 14, 2008).

requirements, reviewing standards used for patients to consent to the disclosure of personal health information, clarifying disclosure standards to be used by covered health care entities, improving the interaction between federal and state privacy laws, improving enforcement of regulations establishing the right to view and amend information, and enforcing existing performance standards and protections.[17]

The GAO reports recall the historic tension that exists between law and health care: advances in technology (in this case, health information technology) have vastly outpaced efforts to establish a modern, workable legal framework within which such advances are implemented and held to accountable standards. Furthermore, while amending long-standing legal standards is difficult in any context, modernizing privacy law poses particular challenges because the law is highly variable (much privacy law emanates from state law), deeply rooted in the national culture and extraordinarily dense.

Addressing these legal challenges is one of the major hurdles that policy-makers face, both in creating a national, interoperable health care network and in achieving information transparency and utility. As legislative proposals that seek to further HIT adoption are considered, privacy and security concerns are paramount, particularly in situations where a compelling need for personally identifiable health information on the part of health care providers, payers or the government *cannot* be found.[18] It is within this environment that lawmakers and the courts must find a balance between society's need to improve the quality, safety and efficiency of health care and the protection of personal health information.

In one of the most celebrated cases decided by the U.S. Supreme Court, Justice Louis D. Brandeis wrote that privacy is "the right to be left alone."[19] Americans hold a strong belief in their right to privacy, a right that is protected by common law (law developed over time in individual cases), which serves as the foundation of the U.S. legal system.[20] Privacy is also a constitutional concept, found in the Fourth Amendment to the U.S. Constitution, as well as in state constitutions and state statutes.[21] Indeed, the preamble to the federal Privacy Rule, promulgated pursuant to HIPAA, notes that the existence of a generalized right to privacy as a matter of constitutional law suggests there are enduring values in American law related to privacy. For example, the need for security of "persons" is consistent with obtaining patient consent before performing invasive medical procedures. Moreover, the need for security in "papers and effects" underscores the importance of protecting information about the person contained in personal diaries, medical records or elsewhere.[22]

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17   GAO, *Efforts Continue*, op. cit.

18   Mariner W. "Medicine and Public Health: Crossing Legal Boundaries," *Journal of Health Care Law and Policy*, Vol. 10 at 121 (2007) for a discussion of whether as a matter of law, public health agencies should be able to obtain individually identifiable personal health information about patients in order to be able to identify persons in the community with chronic and non-contagious conditions.

19   *Olmstead v. U.S.*, 277 U.S. 438, 478 (1928); *see also* Warren, S, and Brandeis, L. "The Right to Privacy," *Harvard Law Review*, Vol. IV, No.5, (Dec 15, 1890).

20   Consider, for example, growing concerns about identity fraud and the ease with which strangers can access another's personal data, either from on-line sources or from the age-old method of sifting through discarded personal effects. *See e.g.*, a 2006 survey conducted for the Markle Foundation that demonstrated that 80% of respondents were concerned about identity theft, available at http://www.markle.org/downloadable_assets/research_doc_120706.pdf, accessed on 6/6/07; *see also* the cases and examples listed on the Privacy Rights Clearinghouse hotline, available at http://www.privacyrights.org/cases/victim.htm, accessed on 6/6/07.

21   Gostin L O. (2000). Public Health Law: Power, Duty, Restraint. University of California Press (Berkeley and LA, CA). pp. 132–134.

22   Standards for Privacy of Individually Identifiable Health Information, Final Rule, 65 Fed. Reg. 82,462, 82,464 (Dec. 28, 2000); *see also* Standards for Privacy of Individually Identifiable Health Information, Proposed Rule, 64 Fed. Reg. 59,918, 60,008 (Nov. 3, 1999).

In addition, there has been a long-standing debate as to whether certain types of health information merit stronger protections than others.[23] Among the categories of information singled out as particularly sensitive, information related to topics such as mental illness or sexually transmitted diseases have received considerable attention, given the high degree of harm that can result from unauthorized disclosures.

Privacy law in the context of health information, like all law, continues to evolve. Although the U.S. Constitution does not expressly provide a right to information privacy, personal privacy has long been a concern of the courts.[24] In *Whalen v. Roe* the U.S. Supreme Court recognized a limited Constitutional right to privacy with respect to information held in governmental databases.[25] Attempts to apply *Whalen* more generally to information privacy have been inconsistent, however, leaving the question of Constitutional protection of health information privacy largely unresolved.[26]

Over the past 30 years, however, the federal legislative framework for information privacy has grown considerably. The Privacy Act of 1974 regulates the disclosure of individual health information maintained in federal government records.[27] Federal regulations for health care programs, such as Medicaid,[28] and laws governing federal substance abuse treatment programs[29] contain provisions intended to safeguard health information privacy. In addition, the Gramm-Leach-Bliley Financial Services Modernization Act of 1999[30] established information privacy protections for financial institutions (defined to include health insurers).

HIPAA, enacted in 1996, is the principal law establishing the modern legal framework for health information privacy. The law's privacy provisions were implemented through a federal regulation issued in 2000[31] and revised in 2002.[32] Provisions related to the standardization of electronic health information data and health information security also have been implemented by regulation in the ensuing years.[33]

The HIPAA Privacy Rule represents the first and, to date, the only national standard for the protection of the privacy of individually identifiable health information in any format. It regulates the use and disclosure of protected health information (PHI) by "covered entities," defined as health plans, health care clearinghouses and health care providers who transmit health information.[34]

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23   *See e.g.*, Standards for Privacy of Individually Identifiable Health Information, Final Rule, 65 Fed. Reg. 82,462, 82,471 (Dec. 28, 2000) in which the preamble discusses the need for balance between and among various stakeholders.

24   See Mariner W. "Medicine and Public Health," op. cit.

25   *See* Rosenbaum S & Painter M. "Policy Brief 2: Assessing Legal Implications of Using Health Data to Improve Health Care Quality and Eliminate Health Care Disparities," at 6 (citing *Whalen v. Roe*, 429 U.S. 589 (1977)).

26   *Ibid.*

27   5 U.S.C. § 552a (2000).

28   42 U.S.C. §1396a(a)(7)(2004). *See* Rosenbaum S, MacTaggart P, and Borzi P.,"Medicaid and Health Information: Current and Emerging Legal Issues," Health Care Financing Review, Winter 2006–2007, Vol. 28, No. 2, 21, at 26; Rosenbaum S, Borzi P, Burke T, and Nath S, "Does HIPAA Preemption Pose a Legal Barrier to Health Information Transparency and Interoperability?" BNA's Health Care Policy, Vol. 15, No. 11, 3/19/2007, at 13.

29   42 USC § 290dd-2.

30   Pub. L. No. 106–102, 113 Stat. 1338 (1999)

31   65 Fed. Reg. 82462.

32   67 Fed. Reg. 53182.

33   The unofficial version of the HIPAA Administrative Simplification Regulation Text, 45 CFR Parts 160, 162, and 164, as amended through Feb. 16, 2006, is available at http://dhhs.gov/ocr/hipaa/finalreg.html. Accessed August 7, 2007. A summary of the Privacy Rule issued by the Office for Civil Rights of HHS can be accessed at http://hhs.gov/ocr/privacysummary.pdf. Accessed August 7, 2007.

34   45 CFR §160.103.

PHI is defined as "individually identifiable health information" that is held or transmitted by a covered entity (or its business associate) in any form or media, whether electronic, paper or oral.[35]

The HIPAA Privacy Rule establishes two categories of disclosures—required and permissive. Only two types of disclosures are considered required; most disclosures under HIPAA operate under a policy that defers to provider custom and practice.[36] Required disclosures include a covered entity's provision of a patient's own PHI to the patient or to the patient's representative, and requests by the HHS secretary for PHI for audit or other enforcement purposes.[37]

All other PHI disclosures are considered permissive, or "allowed" but not "automatic"—even disclosures that may be required by other federal or state laws.[38] Permissive disclosures fall into one of two categories: 1) those that can be made *without* patient authorization; and 2) those that require patient authorization. HIPAA requires covered entities to develop public privacy policies that state when and under what circumstances they disclose PHI.[39]

Under the provisions of the Privacy Rule, covered entities may not use or disclose PHI except as permitted or required. The rule also confers certain rights on individuals, including rights to access[40] and amend[41] their health information and to obtain a record of when and why their PHI has been shared with others for certain purposes.[42] In addition, the rule includes a number of administrative requirements for covered entities, including the designation of a privacy official for each covered entity,[43] the creation of rules related to the development and institution of privacy policies,[44] and the development of provisions addressing the distribution of notices of those policies to patients.[45]

At the same time, HIPAA does allow the permissive disclosure and sharing (through secure[46] and interoperable electronic systems) of personal health information for a number of defined purposes. For example, the Privacy Rule stipulates that PHI can be disclosed without written patient authorization for purposes related to treatment, payment and health care operations.[47] Indeed, health plans often require such disclosure in exchange for financial reimbursement. Aggregated and de-identified health information also can be used pursuant to the Privacy Rule to advance public understanding of the quality of health care and the process of quality improvement.[48] The federal government is

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35   45 CFR §160.103.

36   See Rosenbaum S, Borzi P, Burke T, and Nath S, op cit.

37   45 CFR §164.502(a)(2).

38   A list of permitted disclosures may be found at 45 CFR § 164.502(a)(1).

39   45 CFR §164.520.

40   45 CFR §164.524(a)(1).

41   45 CFR §164.526(a)(1).

42   45 CFR §164.528(a).

43   45 CFR §164.530(a)(1)(i).

44   45 CFR §164.530(i).

45   45 CFR §164.520.

46   The HIPAA Security Rule[1] requires covered entities to use reasonable and appropriate safeguards to 'ensure the confidentiality, integrity, and availability' of any electronically-transmitted health information and to 'protect against any reasonably anticipated threats' to the security of that information. 45 CFR §164.306(a)(1)-(2), et seq. This standard applies to faxes and other electronic transmissions of information as well as e-mails.

47   45 CFR §164.506(a).

48   45 CFR §164.512(b).

empowered to impose sanctions for violations of the Privacy Rule,[49] but the law creates no private right of action for individuals to enforce the law or to redress potential privacy violations.[50] Despite this, its provisions may effectively set a standard of conduct for protected health information.

Finally, there is a considerable, albeit highly variable, body of privacy law at the state level. Some states maintain comprehensive laws that apply to persons and entities that "collect, acquire, use or disclose information"[51] within the state. Other state laws are targeted to certain diseases, types of information or populations, such as persons with HIV or sexually transmitted diseases, persons who are being treated for alcohol or substance abuse, victims of sexual abuse, and public health or genetic information.[52] This interstate variation in health information protection laws is among the most contentious issues related to the widespread adoption and exchange of electronic health information.

HIPAA Pre-emption & State Law

The concept of "pre-emption"—that is, the provisions in HIPAA that address the relationship between federal standards governing the use and disclosure of PHI and state laws—is one of the most complex aspects of the Privacy Rule. HIPAA creates a federal legal pre-emption (that is, an override) of state laws "contrary to" HIPAA's privacy standards, while at the same time protecting state laws that establish "more stringent" privacy rights for individuals.[53] Unlike the broader pre-emption provisions found in the Employee Retirement Income Security Act (ERISA). HIPAA does not simply sweep away all state laws that "relate to" health information privacy,[54] rather it pre-empts only those state laws that conflict with its standards, while preserving stricter or more protective state laws.[55] Put another way, HIPAA establishes a *federal floor*, but not a *federal ceiling*, on personal health information privacy law.[56]

Confusion over HIPAA's federal-state pre-emption structure has led some electronic health information exchange stakeholders to question the potential for "more stringent" state privacy laws to prevent the sharing of health information otherwise permitted by HIPAA. The question of whether this potential is real is an important one. A recent review of HIPAA pre-emption case law by George Washington University (GW) researchers concluded that there is no evidence to support the perception that the HIPAA pre-emption structure acts as a legal barrier to the creation of interoperable health information systems. The study found no evidence in judicial interpretations of HIPAA that either HIPAA or state privacy laws act as barriers to the disclosure of health information essential to quality health care, nor was there evidence that either HIPAA or more stringent state laws bar the use of such information to create transparent aggregated and de-identified

49 42 U.S.C. §1320d-5 and 6.

50 *See, e.g.*, *Acara v. Banks*, 470 F.3d 569 (5th Cir. 2006).

51 See Rosenbaum S & Painter M, "Policy Brief 2: Assessing Legal Implications of Using Health Data to Improve Health Care Quality and Eliminate Health Care Disparities," at 8.

52 Ibid. http://www.gwumc.edu/sphhs/healthpolicy/chsrp/downloads/using_health_data_s_rwj.pdf

53 45 CFR §160.203.

54 "Rosenbaum S, Borzi P, Burke T, and Nath S, op, cit 3.

55 45 CFR §160.203(b).

56 Does HIPAA Preemption Pose a Legal Barrier? Op. cit at 3.

health information.[57] Even in the few cases where state law was found to be more stringent than HIPAA's privacy standard (thereby preventing a disclosure "permitted" by HIPAA), the courts uniformly supported providers' option to control data disclosure within the existing HIPAA framework without considering it a violation of state law.[58] According to the case law review:

> "[t]he underlying conflicts that appear to be driving disputes involving the relationship between state laws and the HIPAA privacy rule appear to focus on the disgorgement of information as part of the legal process rather [than] the use of information to improve quality, reduce disparities or create transparency."[59]

The study concluded that rather than treating HIPAA and state law as conflicting regulations, courts have overwhelmingly interpreted HIPAA in such a way as to enable covered entities to comply with both federal and state law.

Finally, the GW pre-emption analysis found that if a covered entity desires to disclose PHI, it generally can find a way to do so: by adopting a disclosure policy that permits disclosure, by observing a state reporting requirement or by exercising an exception to state privilege law. As the review made clear, HIPAA essentially permits covered entities to substitute their own institutional practices and policies for variable state disclosure laws through its "permitted disclosure" procedures. Accordingly, courts generally conclude that HIPAA's classification of most disclosures as permissible leaves the decision to disclose up to the entity.[60] This structure vests enormous power in covered entities to determine disclosure rules for personal health information, as well as health information transparency in general. To the extent that HIPAA vests disclosure discretion in providers, it would appear that most interoperability considerations may lie with the providers themselves. Indeed, in a number of HIPAA cases contained in the GW HIPAA pre-emption analysis, the courts explicitly discuss the role of provider custom and practice in establishing the full parameters of health information disclosure and voice concern over the extent to which health care providers and their counsel rely on HIPAA as a basis for non-disclosure when, in fact, disclosure in many instances is at the discretion of the provider.

Because of the potential for misunderstandings about the breadth, scope and content of the HIPAA Privacy Rule, and its potential impact on interoperable and transparent health care information systems, the HHS Office of the National Coordinator for Health Information Technology (ONC) and the Agency for Healthcare Research and Quality (AHRQ) jointly sponsored a project (titled *Privacy and Security Solutions for Interoperable Health Information Exchange*) to explore state variations in privacy law. In September 2005, AHRQ entered into a contract with RTI International, a Research Triangle Park, N.C.-based research institute, to implement and oversee a national, multidisciplinary effort, the Health Information Security and Privacy Collaboration (HISPC). HISPC worked in collaboration with the National Governors Association (NGA) to assess and develop plans for addressing variations in organization-level business practices, policies and laws related to privacy and security that affect electronic health information exchange.

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57 Id at 11.
58 Id. at 2.
59 Id. at 5.
60 Id. at 2.

The findings from the first stage of the project consist of a summary of reports submitted by 33 states and one territory documenting the variability in state laws, business practices and policies related to electronic health information exchange. The participating states noted that a substantial amount of this variability stems from general confusion and misunderstanding in businesses' interpretations of both state and federal law, including interpretations of HIPAA itself. As stated in the report:

> "The state teams report a general lack of understanding about the Privacy Rule's premise to generally allow for uses and disclosures of PHI for the core treatment, payment, and health care operations purposes. This lack of understanding is reflected in the business practices and policies of many stakeholder organizations…" [61]

It is notable that the HISPC study does *not* conclude that HIPAA pre-emption acts as a barrier to the creation of interoperable health information systems, nor does it recommend moving U.S. health information law toward a national standard. While six of the state teams commented on the desirability of clarifications or revisions to the Privacy Rule, participating states generally recognized that changes to federal law were unlikely and focused instead on proposing alternative solutions to improve health information exchange.[62]

Emerging Issues in Law and Health Information Privacy

Personal Health Records

The accelerating development and use of *personal* health records, or PHRs, highlights a second point of controversy surrounding HIPAA. As discussed above, HIPAA restricts the definition of a "covered entity" to health plans, health care clearinghouses or health care providers who transmit health information electronically in connection with certain transactions. This definition excludes some entities involved in electronic health information exchange, including some PHR vendors, which effectively means that the law does not apply to them. These vendors, such as "myPHR" (developed by the American Health Information Management Association or AHIMA)[63] and WebMD,[64] offer consumers a Web-based (or other software) gateway to creating a personal health record, which the site agrees to host. The Internet superpower, Google, also recently announced a pilot program with the Cleveland Clinic that will allow patients to store their personal health records online, import records from different health providers, and search for doctors and find health care information from Google Scholar, discussion groups and other sources.[65] Notably, some PHR vendors that do not qualify as covered entities pursuant to HIPAA, including the new Google venture,

61 Privacy and Security Solutions for Interoperable Health Information Exchange: Assessment of Variation and Analysis of Solutions, July 2007. Section 3.2. AHRQ Contract No. 290-05-0015, RTI International. Available at: http://healthit.ahrq.gov/portal/server.pt?open=514&objID=5554&mode=2&holderDisplayURL=http://prodportallb.ahrq.gov:7087/publishedcontent/publish/communities/k_o/knowledge_library/features_archive/features/outcomes_from_the_privacy_and_security_solutions_for_interoperable_health_information_exchange_project.html

62 *Ibid,* Section 5.2.3.

63 Cite to www.myPHR.com.

64 Cite to http://www.webmd.com/personal-health-record.

65 California HealthCare Foundation, iHealthBeat. Google CEO Details Online Personal Health Record Service (February 28, 2008). Available at: http://www.ihealthbeat.org/articles/2008/2/28/Google-CEO-Details-Online-Personal-Health-Record-Service.aspx.

have chosen voluntarily to abide by the law's privacy rules in an apparent effort to gain a market advantage over those who choose not to comply. Regardless, if such vendors were to violate HIPAA's Privacy Rule in spirit, there would be no legal recourse pursuant to the law.

In 2008 the World Privacy Forum issued a warning regarding the use of personal health records. In particular, the group noted the vulnerability of PHRs that fall outside the protection of HIPAA, advising consumers to use caution when signing up for such services and pointing out the risks involved, including the possible loss of health insurance.[66] Approaches are currently being developed to address this perceived legal gap in HIPAA standards. AHIC, for example, created a workgroup specifically to address confidentiality, privacy and security issues. The workgroup solicited public feedback in 2007 on the following "working hypothesis," which defines the entities that should be held to HIPAA's requirements or at least to HIPAA-like standards:

"All persons and entities excluding consumers that participate in an electronic health information exchange network at a local, state, regional or nationwide level, through which individually identifiable electronic health information is stored, compiled, transmitted or accessed, should be required to meet privacy and security criteria at least equivalent to relevant Health Insurance Portability and Accountability Act (HIPAA) Privacy and Security Rule requirements."[67]

The workgroup's stated goal was to evaluate whether the "overall, baseline standard" for participating in electronic health information exchange networks should be "changed to a standard that is different from or exceeds the current HIPAA privacy and security rules."[68]

Likewise, a legislative proposal in the 110th Congress, the *Wired for Health Care Quality Act* (S. 1693), also addresses the definition of "covered entity." The bipartisan bill, coauthored by Senators Edward Kennedy, Michael Enzi, Hillary Clinton and Orrin Hatch, is similar to S. 1418 (passed by the Senate in late 2005). The current version, however, includes an added provision amending the definition of "covered entity," for the purposes of the HIPAA regulations, to include an "operator of a health information electronic database"—an entity that:

1. is constituted, organized or chartered for the primary purpose of maintaining or transmitting protected health information in an electronic record set or sets;

2. receives valuable consideration for maintaining or transmitting protected health information in an electronic record set or sets; and

3. is not a health plan, health care clearinghouse or health care provider [already covered by the HIPAA privacy regulations].[69]

The National Committee on Vital and Health Statistics (NCVHS), a public advisory body to the HHS secretary, also has entered into this debate. NCVHS

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66   Gellman R. Personal Health Records: Why Many PHRs Threaten Privacy. The World Privacy Forum, February 20, 2008 at http://www.worldprivacyforum.org/pdf/WPF_PHR_02_20_2008fs.pdf.

67   Fed. Reg. Vol. 72, No. 89 at 26392 (May 9, 2007).

68   *Ibid.*

69   Wired for Health Care Quality Act, S. 1693, Sections 3013 (a)-(b) (Committee on Health, Education, Labor, and Pensions, Ordered to be reported with an amendment in the nature of a substitute favorably, 6/27/07;. Placed on Senate Legislative Calendar under General Orders, Calendar No. 318, 8/1/07).

recently sent a letter to the secretary expressing concern that many of the new entities "essential to the operation" of the NHIN fall outside HIPAA's definition of a "covered entity." Specifically, the advisory panel pointed to "health information exchanges, regional health information organizations, record locator services, community access services, system integrators [and] medical record banks" as outside the law's purview. The committee recommended that HHS and Congress move quickly to establish laws and regulations "that will ensure that all entities that create, compile, store, transmit or use personally identifiable health information are covered by a federal privacy law."[70]

Whether these proposals expand HIPAA's reach to include electronic health information exchange stakeholders that are not currently considered "covered entities" remains to be seen.

The Need to Strengthen HIPAA Standards

The content of HIPAA's privacy protections has been criticized as well. Legislation recently introduced in Congress by Senators Patrick J. Leahy and Edward M. Kennedy aims to correct "long-standing errors" in the handling of confidential health information, imposing criminal and civil sanctions for unauthorized disclosure of sensitive information.[71] Among other provisions, the bill requires employers, health plans, health and life insurers, health care providers and others seeking to disclose protected health information to obtain a signed, written authorization from an individual in connection with any treatment, payment or other purpose.[72] According to the bill, HIPAA's standards "shall remain in effect to the extent that they are consistent with this act. The secretary shall amend such federal regulations as required to make such regulations consistent with this act."[73] Were this legislation to be enacted–and none of the legislative proposals fostering HIT adoption have been enacted to date–the fundamental framework of HIPAA, ensuring a flow of information related to treatment, payment and health care operations with disclosure in the most judicious fashion, would in all likelihood be transformed and replaced by a specific consent standard.

The Problem of "De-Identifying" Data

Finally, the rapid proliferation of electronic databases and the "extraordinary pace of technological developments" calls into question our ability to continue to truly mask "protected" personal health information, even when aggregated and de-identified, perhaps exacerbating privacy-related fears especially related to research and public health endeavors. In contrast with public perception, very little information is necessary to re-identify a person's data. Researchers Sweeney and Malin found that 87 percent of the U.S. population is uniquely identifiable by the three attributes of zip code, date of birth and gender.[74] Participation in

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70 NCVHS, Letter Re: Update to privacy laws and regulations required to accommodate NHIN data sharing Practices (June 21, 2007). Available at: http://www.ncvhs.hhs.gov/.

71 Health Information Privacy and Security Act, S. 1814, Referred to Senate Committee on Health, Education, Labor, and Pensions (July 18, 2007).

72 *Ibid.* Sections 202, 203.

73 *Ibid.* Section 401(e).

74 Malin B, Sweeney L. "How (not) to protect genomic data privacy in a distributed network: using trail re-identification to evaluate and design anonymity protection systems." J Biomed Inform 2004;37: 179–92.

disease-specific DNA databases is thought by some to be particularly risky in terms of privacy protection—individuals can be uniquely identified by only 75 of the "single-nucleotide polymorphisms" (SNPs) of the 100,000 SNPs typically entered into databases used to genotype individuals.[75] The unexpected ease of re-identification, coupled with the publicity such news engenders (Sweeney was able to re-identify and obtain the health records of Gov. William Weld (Mass.) based on his birth date, gender and zip code), may exacerbate privacy protective behaviors, perhaps leading to reluctance to participate in research. Researchers are exploring ever more complex technical methods for de-identification, but questions remain as to whether our laws, policies and practices will or can keep up with the delicate balance between identifying and de-identifying personal health information.

Moving Forward

Grounded in concepts of both safety and quality, a fundamental purpose of HIPAA is to ensure that providers have access to patient medical records in order to guide treatment decisions.[76] The legal barriers that are often raised with respect to HIPAA and HIT interoperability may therefore be more perceived than real. In these situations, careful thought with respect to how the law can and should be applied to new situations may help eliminate these misperceptions.[77]

As discussed above, the authors of the HIPAA pre-emption study concluded after extensive research that the extremely limited evidence of actual conflict between the federal Privacy Rule and state laws may not justify undertaking a strenuous legislative effort to create a uniform national rule that pre-empts various, more protective state laws.[78] Furthermore, legislative proposals that pursue diffusion and adoption of new health information technology without simultaneously addressing the need for consensus and clarification of privacy standards and protections will inevitably encounter the types of challenges that are already prevalent in the interaction between HIT and privacy law. These challenges do not end with individual health information. In fact, health care providers, health professionals and health service benefit plans—indeed, all industry stakeholders—can be equally zealous guardians of health information privacy when the information sought relates to their own practices. Thus, the privacy tensions raised by HIT are hardly exclusive to individual human beings.

The reality, of course, is that legal challenges can never be fully resolved, because points of legal tension continuously arise as new technology interacts with society and the legal framework that it has created. But in this respect, HIT is in good company; the history of American law is the history of flashpoints, as society attempts to create new standards of conduct in the face of change.

75 McGuire A and Gibbs RA, "No Longer De-Identified." Science. 21 April 2006. Vol.312.

76 *See* Rosenbaum S, MacTaggart P, and Borzi P, "Medicaid and Health Information: Current and Emerging Legal Issues," Health Care Financing Review, Winter 2006–2007, Vol. 28, No. 2, 21, at 27.

77 Rosenbaum S & Borzi P at 4.

78 Rosenbaum S & BorziP at 12.

Chapter 7: International Adoption of Electronic Health Records

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Executive Summary

The challenge of improving the quality and safety of health care while containing costs is not unique to the U.S. health system. Health Information Technology (HIT) is seen internationally as a mechanism to enhance care and manage costs. Yet, despite strong interest in HIT applications such as electronic health records (EHRs), providers have been slow to adopt such systems. This chapter examines the global state of EHR adoption, using published, peer-reviewed literature; published, non-peer-reviewed literature; and the opinion of HIT experts located in the countries we reviewed. Using this multipronged approach, we collected data on EHR adoption and use from many nations; however, no data was available for the vast majority of countries.

Our research suggests that there is tremendous interest in HIT internationally. Major organizations, including the World Health Organization (WHO) and the European Union (EU), have begun surveying nations on their eHealth policies and programs, although based on a broad definition of eHealth. We also identified several noteworthy efforts to shed light on the penetration of electronic records across the world. The WHO's *Building Foundations for eHealth: Progress of Member States* documents global progress towards the adoption of several eHealth components, including EHRs.[1] However, the WHO report focuses primarily on policies and plans for future implementation of eHealth and provides minimal information about the current state of adoption or use of systems such as EHRs.

More specifically, 72 of the 112 countries (63%) participating in the WHO survey responded that they had established a national eHealth policy. As defined in the WHO report, a national eHealth policy is a "framework and approach for developing eHealth in a country, established by government with the intent of achieving health goals, referring specifically to the use of information and communication technologies in the health sector." Although this definition is broad, the WHO report suggests that there is substantial and growing interest in eHealth and health information technologies worldwide.

Our review of the data from existing reports and expert discussions on HIT reinforces this picture. Several developed nations are approaching universal implementation of EHR systems, including Denmark, the Netherlands, Norway, Australia and New Zealand. Others, such as the United Kingdom and Germany, have made substantial progress. Many of the remaining developed nations have begun the implementation process, including Canada and Japan. The data from the developing and transitional nations are not as encouraging; while a few countries, such as Thailand and Iran, are establishing eHealth programs, few developing nations have made a significant investment in or progress towards implementing HIT systems. This might reflect the fact that, for many developing and transitional nations, HIT is a promising solution for the future but is currently overshadowed by other, more pressing priorities.

We found that individual nations used different paths to achieve high levels of EHR adoption in the ambulatory setting. The major factors driving adoption included governmental provisions of financial and nonfinancial support, standard setting, physician and medical society leadership, electronic billing mandates, and peer influence. However, none of these factors were necessary for all nations, and no nation used each of these enabling factors. This suggests that individual nations need to tailor such incentives to their unique circumstances in order to achieve high levels of EHR adoption in the ambulatory setting.

Introduction

Nations around the world are struggling with the challenge of improving the quality and safety of patient care while reducing health care costs. HIT is increasingly seen as an effective and practical way to do this. However, despite the tremendous interest in applications such as EHRs, computerized physician order entry (CPOE), clinical decision support systems, and electronic health information exchange (HIE), there have been few systematic evaluations of the state of HIT adoption internationally. As part of our work for the Office of the National Coordinator for Health Information Technology (ONC) and the Robert Wood Johnson Foundation (RWJF), we reviewed and synthesized the available information about EHR use worldwide.

Methodology

The WHO report, *Building Foundations for eHealth: Progress of Member States*, was a core resource for our review. However, its lack of specificity and broad HIT definitions required us to collect data country by country to fully understand the current state of EHR adoption. We used a multifaceted approach, beginning with Medline and Google searches for terms including "health information technology," "electronic health records," "electronic medical records" and "computerized medicine."[2] We then searched the references of reports and papers that discussed EHR use outside of the United States to identify additional data sources. We also examined the Web sites of organizations that address international HIT issues, such as the Healthcare Information and Management Systems Society (HIMSS), International Medical Informatics Association (IMIA), European Federation for Medical Informatics (EFMI), Health Information Network Europe (HINE), and European Institute for Health Records (EuroRec).

We chose to further evaluate HIT adoption in 31 of the countries identified through this initial search, specifically those that had large populations (and therefore where HIT adoption would have an impact on a large number of people), were well known to have HIT initiatives, or were identified through our initial screen to have meaningful HIT activities. For each of these countries, we performed a search using the HIT terms used in the initial search along with that nation's name. We also contacted pertinent government and nongovernment agencies in those nations, including their ministries of health and national representatives to the International Medical Informatics Association. We then synthesized the available information on EHR and HIT adoption for each nation. Because reliable information was not found for three of the 31 countries included in this more comprehensive search–France, Estonia and Russia–these countries were not included in the individual country profiles.

The often vague, inconsistent definitions and terminology used within and across nations to describe HIT functionalities makes transnational comparisons of implementation difficult. In an attempt to achieve consistency, our chapter focuses primarily on the following measures: national percentage of doctors and/or hospitals that use EHRs, national percentage of doctors and/or hospitals that use e-prescribing, and amount the government spends annually on HIT funding. EHRs were defined as electronic record systems that replace paper medical records and have four functionalities: clinical documentation, provider order entry, results viewing and clinical decision support. This definition was developed by the expert consensus panel convened by the authors of this document on behalf of the U.S. Office of the National Coordinator for Health Information Technology. When we report data based on less precise EHR definitions, we describe the differences in those definitions.

Many nations have HIT initiatives outside of EHR adoption, such as clinical data exchange, use of electronic cards that hold clinical information that patients carry, creation of universal HIT standards and the rollout of electronic infrastructure. Many of these activities are vital components of a successful eHealth system. However, given the limited amount of publicly available data, we chose to report on the adoption and use of these other technologies only when they appear to be primarily for clinical purposes and thus may serve as a substitute for EHRs.

Overall Results

There have been several noteworthy efforts to measure the electronic record use worldwide. The WHO's report, *Building Foundations for eHealth: Progress of Member States*, which was based on a survey conducted between 2005 and 2006, attempts to document global progress towards adoption of several HIT components, including EHRs, CPOE and several administrative functionalities.[1] The WHO survey reported several important insights about the global state of HIT adoption. Nearly 50 percent of responding countries, for example, reported having a national eHealth task force or advisory board to provide advice on their strategies for eHealth adoption and use. The survey also found that 63 percent of responding nations reported that they have a national eHealth policy, defined as a "framework and approach for developing eHealth in a country, established by government with the intent of achieving health goals, referring specifically to the use of information and communication technologies in the health sector."

The WHO report's overall findings suggest that some countries are well on their way to establishing an electronic infrastructure and the technological capacity needed for eHealth implementation. However, for most nations, the impetus, funding, leadership and technical capability are still in their infancy. Not only has implementation lagged far behind policy to promote adoption, but there are severe disparities in the global diffusion of HIT. Nevertheless, interest in HIT is fairly universal and this interest permeates various governmental agencies, individual hospitals, health care financers and health care providers.

Given that our goal was to examine HIT adoption, we collected data from a variety of other sources about individual nations' progress toward adopting clinical IT systems. We present this data country by country, reporting when possible on: the existence and structure of national HIT plans; national EHR adoption

estimates by type of provider (general practitioner, specialist, hospital, etc.); and other relevant details about HIT adoption. In most cases, we were unable to adequately determine the primary facilitators or barriers to HIT adoption in individual nations.

Individual Country Profiles: Europe

Austria

National Plan: Government-based support of eHealth in Austria has occurred primarily through the E-Government Act of 2004, the Health Reform 2005 Act and the Health Telematics Act, which frames the secure exchange of individual health data.[3] The Health Reform 2005 Act made promoting information technologies in health care an institutional priority of the Ministry of Health. Among its goals, the most significant, medium-term project is the implementation of a national electronic health record (Elektronische Gesundheitsakte or ELGA). Governmental support for eHealth is guaranteed through laws mandating that in 2007 and 2008, 2 percent of all health care spending must be dedicated to eHealth.

Adoption by Providers: According to estimates, approximately 75 percent of GPs are using EHRs in their offices.[4] However, it remains unclear whether this truly constitutes the use of electronic systems for clinical care or if these systems are mostly being used for administrative functions. Experts also reported that electronic prescribing rates are extremely low both in doctor's offices and hospitals, and there are some pilot projects underway to increase use of CPOE and other clinical IT systems.

Belgium

National Plan: In Belgium, five federal ministries are responsible for eHealth: the Ministry of Health, the Ministry for Social Security, the Ministry of the Interior, the Secretariat of State for Administrative Simplification, and the Secretariat of State for Computerization of State. The federal government has developed several reimbursement schemes to support eHealth diffusion and implementation. It spends €16 million annually to promote the use of clinical and professional software for GPs, dentists, home care nurses and physiotherapists. Hospitals receive approximately €1.0 million annually to meet specific IT implementation requirements and to advance data exchange between local and regional GPs. Regional health networks receive funding ranging from €250,000 to €1.5 million per network annually (based on various factors including the size of the network, number of patients served, etc.), in addition to €250,000 from the federal level. The federal government also provided €1.8 million in initial funding for the BeHealth platform approved by the Council of Ministers in 2006.[5] This program promotes "digital access to all health information and applications through one portal site, on behalf of health care providers and patients."[6] The BeHealth model is the national technical platform for eHealth and, in the future, will serve as the basis for authentication services, patient index services and data reference services.[5]

Instead of creating a formal roadmap, the Belgian government's eHealth strategy is characterized by incremental initiatives. A Federal Commission founded by Royal Decree in 1999, Norms Related to Telematics in the Health Care Sector,

has published several recommendations for the Belgian government. These recommendations include that there be a certification process to ensure the quality and interoperability of ambulatory care software available on the Belgian market, as well as the adaptation or development of key reference databases for diagnostics, treatments, patient care and drugs. In addition to classifying and supporting the use of EHRs, the Belgian government has also invested in initiating health networks on a regional basis. These efforts promote the BeHealth program and supply funding for operational research on issues such as patient identification, electronic signature implementation, certification of hospital information systems and telemedicine.[3, 5] The government intends to introduce a national plan for interoperability of EHRs, known as the Summarized Electronic Health Record, although the timing of this program is unclear.[5]

Adoption by Providers: In 2007, 78 percent of Belgian GPs reported having access to label-certified family practice EHRs.[7] A lower percentage of IT penetration, between 30 to 50 percent, is reported for nurses and physiotherapists.[5] Some reports suggest that hospitals are using electronic systems to create inpatient hospital record summaries, by combining some nursing data and laboratory results.[7] However, we could find no surveys or other formal evaluations of the level of EHR use in Belgian hospitals.

Several factors appear to influence the relatively high adoption rates of EHRs by Belgian physicians. The European Communities report suggests that Belgian providers have a strong incentive to implement EHRs due to their dependence on funding sources that require electronic data sets with diagnostic and procedural information.[3] Funding, as described above, is clearly helpful. Long-standing eHealth policies and support for medical informatics among governmental and academic institutions also facilitate Belgium's advanced HIT status.[8]

Croatia

National Plan: The Croatian government has made financial investments in both the primary care sector (via a program known as the Primary Healthcare Information System, or PHCIS) and in hospital information systems. However, these investments have been very small: from 2003 to 2007, the total estimated spending by the government in these areas is reported to be €17.2, or less than 1 percent of the €2.3 billion spent on health in 2007 alone. This investment is projected to rise to €80 million between 2008 and 2012,[9] with most of the expenditures coming from public sources.[10] In its initial stage, PHCIS, which facilitates health care related data management and decision support processes, was used by only 2,300 family GPs. However, by 2008, the PHCIS program plans to extend its services to the entire primary care system, which includes 5,830 pediatricians, gynecologists, dentists, laboratories, pharmacies and home care nurses.

Adoption by Providers: Informal estimates suggest that, while Croatia is implementing a single primary care EHR nationally, we could not find published data or reports to verify the levels of adoption. Further, we do not know whether the EHRs that are currently being used are robust systems with functionalities we ascribe to EHRs. Data on the adoption of EHRs in hospitals or the use of e-prescribing by providers were not available.

One encouraging sign for Croatia is the national development of a single electronic record system, known as the Integrated Care Electronic Health

Record. This program has reduced confusion in the marketplace and the risk of purchasing a new system for many practitioners. Pilot tests with teams of GPs prior to the project's launch allowed policy-makers to work out many of the implementation difficulties.

Czech Republic

National Plan: The Ministry of Informatics, along with the Ministry of Health's Institute of Health Information and Statistics of the Czech Republic (IHIS CR), have been primarily responsible for creating the country's national health information system and shaping its eHealth policy.[11] In 2000 the government passed legislation addressing issues such as digital signatures, data protection, Internet confidentiality and telecommunications.[12] In 2006 eHealth services were included as one of the government's State Information and Communications Policy main priority areas.[13] The Czech Republic plans to keep its "patient identification, accessibility of health records, and interconnection and cooperation of health-care providers" initiatives linked closely to corresponding initiatives in the EU, in the interest of achieving maximum compatibility. Our review of the existing literature did not identify specific information on the country's HIT spending.

Adoption by Providers: According to a Web site Content Survey conducted by the Czech Statistical Office in 2007, approximately 70 percent of GPs have access to the Internet in their clinics.[14, 15] IZIP, the nationwide, Internet-based Czech EHR system, was developed in tandem by a private company, IZIP Ltd., and by the General Health Insurance Company of the Czech Republic.[16] It now has more than 1 million patient subscribers and has been touted as the most successful Czech eHealth initiative, receiving a United Nation's World Summit of the Information Society award in 2005.[17] IZIP functions as a medical database of insured patients, who consent to include their data in an Internet-based public information network, through which participating and authorized physicians across various care facilities can access information including laboratory and diagnostic tests, medical histories, prescriptions and other information found in an individual patient's medical file.[17] By partnering with the General Health Insurance Company, Czech Republic (GHIC CR)–a public insurance provider covering about 65 percent of the Czech population–IZIP has been able to widely implement their EHR system. However, direct estimates of the percentage of GPs or hospitals participating in IZIP are not publicly available.

Denmark

National Plan: While the government has taken an active role promoting the standardization and interoperability of eHealth across Denmark, funding for these initiatives has been relatively small in comparison to the country's substantial adoption rate. Specialists in private practice receive a small sum, equivalent to US$2,500, to install computers and electronic communications, or US$800 to invest in communications software if the specialist already has a computer.[18] EHR use among physicians is primarily voluntary; widespread adoption is largely a result of collegial pressure and the potential for communication, access and financial benefits. At the government level, the counties have funded a data consultant since 2000. These individuals serve a help desk function and provide training through regular visits to GPs. Additionally, the government funded practice coordinators for the different specialty fields.[19]

Building a regional health care data network, known as FynCom (later renamed MedCom), catalyzed HIT adoption in Denmark. This network was created in 1990 to link GPs in each county with that county's hospital system. Within two years, laboratory results and discharge letters were being sent electronically.[19] MedCom, a nonprofit organization, aims to help develop, test and disseminate electronic communication and data in the health care sector.[18] It coordinates the national communications services, sets all standards, certifies vendors and monitors compliance. MedCom's annual budget is currently US$4 million, although 40 percent of the budget is used to cover basic administrative expenses. The remaining 60 percent supports specific projects, such as promoting telemedicine and health information exchange between providers. It receives one third of its funding from the Ministry of Health, one third from the County Association and the remaining third from other sources.[18]

In 1999 the National Strategy for Information Technology in Hospitals was created to establish EHRs as the core of hospital IT systems.[20] Subsequently, the National Strategy for Information Technology in the Health Care System (2003–2007) was formed around the principle that "shared information is the foundation for seamless care and patient involvement."[21, 22] In the first few years, it primarily aimed to promote the development and implementation of EHRs. The Ministry of Interior and Health, National Board of Health, Association of County Councils and Copenhagen Hospital Corporation, MedCom and the Danish Standards Association have assumed responsibility for HIT. Historically, health technology participation was voluntary for physicians. However, Medcom developed a GP contract in 2004, followed by a specialist contract in 2006, mandating HIT use.[18]

The Danish National eHealth Portal, called Sundhed.dk, was launched in December 2003 as a partnership between all public health authorities based on MedCom's existing infrastructure. It permits citizens and health care professionals to access Danish health care services from the Internet. Specific features of the system include GP eServices, Ecommerce (pharmacies), a health appointment calendar, access to medical records, access to hospital diagnosis (since 1977), and health care authority communication.[23]

Denmark, along with Estonia, Lithuania, Norway and Sweden, was also part of Baltic eHealth. Its objective was to create a cross-border eHealth infrastructure throughout the Baltic Sea Region, with financial support from the European Commission, and to promote the use of HIT in rural areas to improve quality and assist with problems resulting from rural migration.[24]

Adoption by Providers: More than three-fourths of the Danish health care sector uses the national network, with at least 90 percent of all primary sector communication exchanged electronically. Every hospital, pharmacy, laboratory and general practice is part of the national network. Since January 2006 all private physiotherapists and private dentists have become part of the network. An estimated 98 percent of GPs use EHRs (including e-prescribing) in their practices; 74 percent of full-time specialists; 100 percent of pharmacies and hospitals; and 44 percent of local authorities. Furthermore, an estimated 50 percent of hospitals use an EHR system.[18, 19, 25, 26] Data shows that 85 percent of all prescriptions are sent electronically to pharmacies,[18, 19] though recent estimates suggest it might be higher. Virtually all pharmacies have IT systems that support e-prescription.[26] Information exchange is facilitated by the Internet-based Danish Healthcare Data

Network through VPN connections, a secure network connection that is layered on top of a public network, as part of a cooperative agreement with MedCom. HIT services delivered through the network currently include: referral and discharge summaries; prescriptions; teleradiology and teledermatology services; and laboratory result look-ups through the National Health Portal.[22]

A number of factors have contributed to Denmark's success with physician HIT adoption. Notably, the federal government has not directly funded Danish GPs to invest in EHRs and other electronic communication. When the health system in Funen County (where MedCom began) first deployed electronic communication, early users were the first to advocate for it, describing how the technology improved their work and promoting it to their colleagues. These promotions were formalized in 'GP days,' one-week GP education seminars where HIT workshops were held to discuss eHealth topics. Danish physicians have predominately self-financed the implementation of all HIT initiatives, primarily motivated by their desire to improve efficiency and increase revenue.[18, 19, 27] They also were eager to improve communication with hospitals, which enables them to receive test results and notifications of patient admissions and discharges more quickly. Danish physicians also report being more time-efficient both due to e-prescribing and their quick access to medical data.[18] Danish studies suggest that EHRs save GPs about 50 minutes per day and reduce telephone calls by 66 percent. Other factors for IT adoption in Denmark include the accreditation of vendor systems by MedCom beginning in 2000; peer pressure among GPs; and nonfinancial support in the form of help desks and other training.[19]

Finland

National Plan: The Ministry of Social Affairs and Health developed the first official plan for the utilization of information and communication technologies in 1996. Two years later, the Finnish eHealth strategy was updated to emphasize the need for seamless service chains. Key objectives of this strategy included the "adoption of digital patient and client records in all levels of care, combined with nationwide interoperability between distributed legacy systems, and being supported by a high level of security and privacy protection."[28] Interoperability is a particularly important factor in Finland due to the decentralized structure of its health care system.[28] In 2000 the government decided to begin funding national health information and computer technology development to promote its diffusion throughout Finnish society. Between 2000 and 2003 the government provided €10 million in HIT funding. On April 11, 2002, the Council of State launched a nationwide introduction to electronic patient records, to be completed by the end of 2007, as part of National Health Project Programme (implementation years 2003–2007). Since 2003 the program has received €800,000 annually to develop the National EHR Archive. To promote regional implementation of this project, funding was provided at the regional level (€11 million in 2004, €10.5 in 2005 and €5 million in 2006). Hospital districts and municipalities co-funded the project, each contributing 50 percent of the total cost.[28]

The Finnish government has remained the main funding source for HIT research and development. From 2004 to 2007 the Ministry of Social Affairs and Health earmarked €30 million annually for 'Information Society' projects pertaining to eHealth.[22] While championing HIT as a whole, HIT initiatives in Finland have focused on implementing standardized EHRs and administrative services such as

e-referrals. The government also passed regulations on the handling of electronic patient information and patient access to information.[28]

Adoption by Providers: Currently 96 percent of primary health care centers, where most Finnish GPs practice, use EHRs.[29] EHR adoption by secondary care units, such as small hospitals or specialist centers, is estimated to be 30 percent. Twenty out of the country's 21 hospital districts use EHRs as the main method for medical documentation, suggesting significant use among other health care providers, including specialists. However, whether all the hospitals in those districts use EHRs—and to what extent—is not known. Also, 89 percent of private sector providers use EHRs to some degree. In 2005 eReferral and eDischarge letter systems were used in 45 percent of primary care centers and in 16 of the 21 hospital districts; teleradiology was adopted in 29 percent of primary health care centers and in 18 of the 21 hospital districts. Picture Archiving and Communication Systems (PACS) are in the production phase in 15 of the 21 hospital districts, while the remaining 6 districts are in the launch phase. Finally, 65 percent of primary care health centers and 19 hospital districts use telematic exchange of laboratory data.[28] Another study of HIT in Finland reported that hospital use of IT is improving, with numerous systems in place including radiology information systems, pathology information systems and laboratory information systems.

A report on its HIT strategy credits governmental programs, regional activities, such as the creation of regional networks, and general progress in available technology as factors that have contributed to Finnish adoption of HIT.[29] Technological progress has also enabled HIT implementation, including citizen identification tools, such as a citizen smart card, which have been implemented at the national level.[30]

Germany

National Plan: In Germany, the Federal Ministry of Health is the primary entity responsible for HIT. The federal ministry receives assistance from the Ministries of Health at the Länder (state) level. However, medical doctors, nurses, insurance companies, hospitals, pharmacies and other self-administered entities in the health care sector are responsible for executing eHealth policies. In November 2003, the Law for the Modernization of Statutory Health Insurance passed, leading to the introduction of an electronic health card and the establishment of the institutions necessary for successful IT implementation. These institutions include the Trust Centre for the Health Insured Number, which created a system to safely determine a unique number for each German citizen's patient identifier. Additionally, the law established the Society for Health Telematics "to plan, implement and manage the necessary eHealth infrastructure services."[31] Germany's HIT strategy aims to "establish more citizen-oriented services; support patient-centered care; improve quality and services; reduce costs; and provide better data for health system management."[31]

Germany's HIT strategy rests on two pillars: the first establishes an IT infrastructure while the second pillar implements a private electronic patient record and other applications based on this IT infrastructure.[32] Its development stage was estimated to cost between €100 and €150 million, running from 2004 to 2007, with overall expenses anticipated to reach €1.5 to €2 billion (not

including costs associated with process change management). The government also contracted with Gematik, the organization overseeing the implementation of the electronic health card program, to address inoperability issues related to the largely decentralized structure of the German health care system.[31] To further promulgate HIT, the federal government piloted a number of initiatives in support of a national roadmap. Legislation has also addressed data protection, telecommunications, digital signatures, telemedicine and eHealth provisions, and IT product liability issues.[31]

Adoption by Providers: In Germany, studies estimate that between 42 percent and 90 percent of GPs use EHR systems, including a study by Schoen and colleagues suggesting that approximately half of GPs have EHRs.[33] This large range is partially due to differences in the EHR definitions used by experts and in surveys. Nearly 59 percent of German GPs report using CPOE, a higher rate than those reporting that they have laboratory results viewing or an EHR. Based on conversations with experts, we estimate that less than 1 percent of hospitals use electronic clinical notes and less than 0.5 percent of hospitals use electronic prescribing. While most German laboratories have systems that support electronic lab results viewing, paper and fax communication is still the preferred way of communicating results within hospitals.

EHR adoption in Germany was triggered by the near universal integration of computerized billing programs, which were linked with clinical documentation and results viewing software. Over time, many practitioners began to use these additional features and, although the level of use of these systems varies widely (thus leading to different estimates from different surveys), the EHR system capability exists in nearly every physician's office.

Ireland

National Plan: In Ireland, the Department of Health and Children and the Health Service Executive (HSE) are primarily responsible for the country's HIT policy. There are plans for a National Information and Quality Authority (HIQA) and, once established, it will have responsibility for standards and quality initiatives.[22] The Health Service Executive (HSE) that serves the southern area of Ireland has developed its own HIT strategy. This initiative, known as the Health eSHB, has ten strategic goals, some of which include implementing an EHR and enabling clinical and administrative systems.

Adoption by Providers: More than 80 percent of GPs in Ireland use an EHR system.[34] However, these data are not based on strict definitions of an EHR and, therefore, it is unclear which functionalities are readily available. Fewer doctors use EHRs in the hospital setting, though no national surveys have measured the actual percentage. Individual hospitals have electronic patient administration systems for administrative details, laboratory and radiology information systems. Some hospitals have order communication and reporting systems, as well as PACS. Electronic messaging between hospitals and general practices is reported to be commonplace, and includes laboratory results, radiology results, emergency room visits and hospital discharge data. E-prescribing has not extensively taken root. Although some Dublin-area teaching hospitals have begun to introduce e-prescribing within hospitals, electronic connections to retail pharmacies are still in their infancy.

Little information was available on the major drivers of EHR adoption in Ireland, although experts suggest that government funding was not at the heart of the country's efforts.

Italy

National Plan: In March 2006 the eHealth Board (Tavolo di lavoro permanente per la Sanità Elettronica or TSE) published an Architectural Strategy for eHealth that presented guidelines for the design of a national HIT infrastructure. Although there is a single national health service, most responsibility for health care in Italy rests at the regional level. Therefore, there are wide, regional variations both in defining HIT and in the initiatives designed to promote its implementation. While it is difficult to extrapolate the financial contribution of the Italian government to these efforts, estimates for Tuscany suggest that the Healthcare Planning Act (2005–2007) earmarked €15 million of direct regional assistance for eHealth implementation within this region.

Adoption by Providers: Of the estimated 55,000 Italian GPs and pediatricians, approximately 50 percent are using EHRs in their offices, of which approximately 14 percent engage in electronic exchange of clinical information with other stakeholders, such as clinicians or payers.[35] There are 1,222 public and private hospitals accredited by Italy's National Health Service, of which only an estimated 3 percent have implemented EHRs.[35] Networks for interoperability of GPs with hospitals and systems for e-prescribing and e-referral have been deployed in at least three regional contexts. The available data on EHR adoption comes from surveys lacking clear definitions.

The Netherlands

National Plan: The Netherlands has achieved a relatively high penetration of eHealth, despite scarce funding for HIT initiatives. In the Netherlands, much like in Denmark, health care providers finance eHealth initiatives from their practice budgets. The annual public budget, more than €35 million, funds components of the basic HIT infrastructure and "electronic general practitioner records." "Electronic medications records" allow health care providers to access patients' medication histories, while "electronic general practitioner records" serve as medical history summaries.[36] These components are seen as major steps on the way to achieving a full-fledged, national EHR. A series of government policies, including recent legislation mandating the use of EHRs, promote broad HIT use. However, providers have primary responsibility for purchasing and using HIT systems.[36]

Adoption by Providers: Despite the challenge of funding their own HIT systems, experts estimate that virtually 100 percent of GPs in the Netherlands use a GP Information System for the annual national influenza immunization campaign and for cervical screening. More than 90 percent utilize at least partial EHRs (e.g., entering clinical notes and prescriptions, laboratory results, correspondence, etc.) Similarly, in a 2006 Commonwealth Fund survey, Schoen and colleagues estimate that 98 percent of GPs used EHRs in their practices.[33] Conversely, in hospitals, electronic systems are mainly administrative, although there are a few individual hospitals (sometimes only certain departments) that have taken initial steps towards integrating clinical data. The long-term-care sector also uses electronic

systems primarily for administrative purposes, though this has recently progressed towards the introduction of EHR systems. E-prescribing integration is high in the Netherlands, where experts estimate that virtually all GPs prescribe electronically with the assistance of drug databases and decision support software available in the GP Information System. According to the Commonwealth study, 85 percent of Dutch GPs routinely prescribe electronically.[33] In hospitals, however, nearly all prescriptions are written on paper. The electronic exchange of clinical data has become a major focus in the Netherlands, primarily between laboratories and GPs, pharmacies and GPs, and hospitals and GPs (to convey admission, relocation and discharge information). Major government initiatives in this area are currently underway, with the expectation that these systems will be up and running by the end of 2007. However, electronic exchange between GPs and medical consultants in secondary care is extremely rare.

Compared to all other countries surveyed by the Commonwealth Fund, Dutch primary care physicians were the most likely to be able to share records electronically with clinicians outside of their practice (45%) and to practice solo (72%).[33] These factors may play into the high rates of HIT adoption in the Netherlands. Schoen and colleagues conclude that Dutch GPs acting "collectively in the 1990s through their national professional association to receive partial public financial support to reimburse start-up costs" played a role in the country's high rates of HIT adoption.[33]

Norway

National Plan: In Norway, national and municipal levels share responsibility for health care. The municipalities oversee primary care, while five regional, state-owned health authorities operate the hospitals within their respective regions. This structural organization potentially complicates EHR adoption, as IT investments are the responsibility of each municipality.[37] Norway is now reaching the end of its third national plan for eHealth: Te@mwork 2007. The first plan began in 1999, titled "More Health for Each bIT," while the second plan, "Si@!," ran from 2001 to 2003. Previous plans focused on electronic communication, telemedicine and developing a national IT infrastructure, but without an emphasis on EHR adoption.[37] Te@mwork 2007 aimed to address those areas through better strategy focus, documentation and project evaluation in order to further strengthen overall HIT in Norway.

Te@mwork 2007 consists of two goals. The first is to improve data flow in the healthcare sector, including: between patients and providers, and between providers and the municipalities, which hold important information about citizens.[37] The second focus of Te@mwork 2007 is to expand and promote EHR adoption.[37] Te@mwork 2007 also calls for a national policy to coordinate the development of IT within the municipalities. A proposed program for the municipalities would increase collaboration between health care and social services through a common set of goals and standards for each municipality.[37, 38]

Adoption by Providers: In Norway, the main EHR adoption players have been hospitals, GPs, laboratories, radiology institutes and the National Insurance Service. A specific number or percentage demonstrating the extent to which EHRs have been adopted in Norway, however, is not available. There are data indicating that electronic referrals within and across hospitals has skyrocketed, however, suggesting reasonably good HIT systems among Norway's hospitals (see Figure 1).[37]

Figure 1: **Percentage of Hospital Referrals That Are Sent Electronically in Each of the Five Regions of Norway**
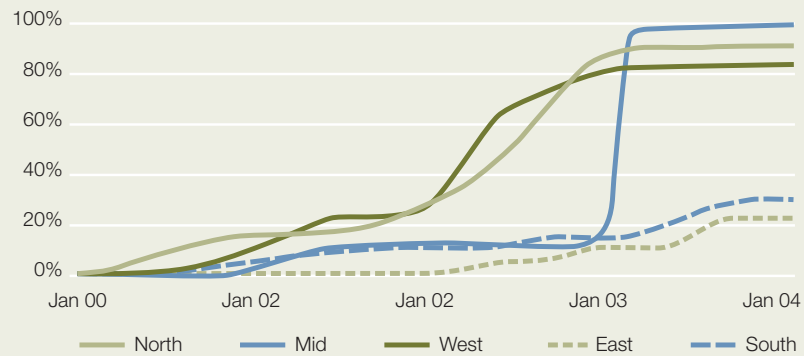
Current literature suggests that most primary care physicians use EHRs and that these systems functioned initially as stand-alone systems. However, they are increasingly capable of HIE and are being used to exchange data with other providers. By 2005 only two out of 80 hospitals did not have EHRs.[37]

A governmental agency released a national EHR standard in 2001. This standard mainly dealt with issues related to architecture, archiving and security, and it has been updated with changes in EHR capabilities.

PACS-trends in Norway

In 2005 it was estimated that nearly 100 percent of Norwegian hospitals have PACS. At that time, most hospitals either already had or were planning to digitize X-ray divisions and obtain the necessary equipment and systems for digital storing and communication of X-ray images.[39]

Spain

National Plan: According to a comprehensive plan of action for health information technology, Spain has ambitious national and state-level plans to develop eHealth initiatives.[40] By the end of 2007, the country will have invested €252 million in eHealth programs to implement electronic clinical records, electronic prescribing, electronic appointment booking and telemedicine initiatives. However, outside of a few exemplary facilities, comprehensive information technology is not being used consistently in the health sector. One obstacle currently impeding EHR adoption is the very outdated equipment used in most large Spanish hospitals.

Adoption by Providers: We found no recent, nationally representative data on the state of EHR adoption or use among doctors or in hospitals in Spain. A Harris Interactive study estimated 9 percent of general practitioners use EHRs, based on data collected in 2001.[25] An additional study, although it lacked a nationally representative sample, estimated, based on a survey completed by 47 hospitals, that nearly 28 percent of hospital pharmacies had an electronic prescribing system. Of those hospitals with electronic prescribing, 61.5 percent had the system linked to 75 percent or more of their beds.[41]

Sweden

National Plan: In 2002 the Ministry of Health published the Vård ITiden report, delineating strategies and possible measures to broaden the use of eHealth. This report was later coordinated with the 2004 Communication from the European Commission to create a new document, *An Action Plan for a European eHealth Area*.[42, 43] It is estimated that the Swedish government spends €61.67 per capita on health information technology. Created in 2000, Carelink was charged with linking regional HIT initiatives and advancing HIT adoption in Sweden.[44] HIT spending makes up 2.6 percent of the country's entire health budget. In recent years these funds have been used to extend EHR networks, data sharing capacity and electronic prescribing.[45] Sweden has also been involved in a number of cross-border eHealth initiatives, notably Baltic eHealth. Supported financially by the European Commission, this pilot program brought the Scandinavian countries (Denmark, Norway and Sweden) together with Estonia and Lithuania to cooperate on eHealth activities in the Baltic Sea Region.[46] With €1.2 million in funding from 2004 to 2007, Baltic eHealth also aimed to reinforce access to high-quality health care through telemedicine, in an effort to counteract current migration within rural Baltic regions to urban centers.[47]

Adoption by Providers: As of 2002 all hospitals and primary care centers in Sweden are connected via Sjunet, the telecommunication network administered by Carelink.[44] Experts estimate that 97 percent of primary care facilities and 81 percent of hospitals in Sweden have EHRs. However there is no data indicating how many physicians use such systems in their daily practice or to what extent these systems are fully operational.[48] There are a variety of systems in place across the country with little interoperability between them, limiting the extent of health information exchange that can occur. With respect to e-prescribing, the best data are from April 2006 and indicate that 55 percent of all national prescriptions are written in an electronic format—a substantial increase from 9 percent in November 2001.[44]

United Kingdom

England

National Plan: After going through various manifestations since its origin in 1998, National Health Service (NHS) Connecting for Health formed as a Department of Health agency in April 2005 with the primary role of delivering the National Programme for IT (NPfIT). NHS Connecting for Health functions as the single, national IT provider for the NHS and as overseer of the maintenance, development and effective delivery of IT products and services for the National Programme.[49] The National Programme for IT is in the process of implementing a multibillion pound (approx. £12.4 billion) infrastructure. The primary aim of NPfIT is to deliver better, safer care to patients via new computer systems and services that link GPs and community services to hospitals. Leaders hope that the end result of this integration will provide health care professionals with safe and secure access to patient information.[50] Some specific NPfIT programs include (statistics current as of 8/27/2007):

- Choose and Book, a program to streamline referral appointment bookings for GPs and patients. To date, nearly five million (4,920,553) bookings have been made. Choose and Book is being used for more than 40 percent of NHS referral activity from GP surgery to first outpatient appointment.

- Electronic Prescription Service (EPS) has produced nearly 34 million (33,943,825) prescription messages. EPS daily usage is around 15 percent of daily prescription messages.

- GP2GP Transfer facilitates movement of medical records between practitioners. GP2GP is accessible to 1,255 GP practice systems and has been used for 14,520 medical record transfers.

- Picture Archiving and Communications System (PACS), of which there are currently 108 across England with more than 300 million stored images.[51]

Despite this progress, there is substantial controversy over the NPfIT program's implementation and whether its current strategies are the most time and cost efficient. Recently, the director general of NHS IT, Richard Granger, resigned from his position amidst charges of maladministration. A study published in the British Medical Journal this year reports that the goals of NPfIT were universally supported, but various concerns remain regarding the best way to achieve these goals. According to the clinicians and senior trust managers interviewed for the article, implementation is hampered by local financial deficits, delays in implementing NPfIT-compliant patient administration systems, and poor communication between NPfIT and local managers.[52]

There exists an impetus towards the adoption of a nationwide EHR system in England, as well as the other three countries that comprise the U.K.: Northern Ireland, Scotland and Wales. The current state of adoption in each country, however, varies. All three countries have national plans for EHR adoption and are currently working to make those goals a reality.

Scotland appears to the closest to achieving full EHR adoption, having already introduced a PACS program in all hospitals and a national Emergency Care Summaries system, which contains information on current medication and allergies for more than 90 percent of the Scottish population.[53]

As of 2003 the Welsh National Assembly drafted a national strategy to support eHealth policy. One central feature of the Welsh EHR system will be an individual health record for each person in Wales. Wales also has several ongoing pilot programs, including an online patient portal to access health records and a project to assess the electronic transfer of clinical information.[54]

Northern Ireland has a national eHealth policy, which has been in effect since 2005. Currently all GP practices in Northern Ireland are connected to a secure GP network. In addition to a managed e-mail and Internet service, it allows pathology results to be received electronically. Northern Ireland is also transitioning towards e-prescribing with their Electronic Prescribing and Eligibility System, which will be implemented over the next two years.[55]

Adoption by Providers: Utilization of EHRs in general practice in England is estimated between 89 percent and 97 percent.[33, 56] Nearly all GPs use these systems for managing laboratory results and recording clinical notes, though prescribing medications and ordering laboratory tests electronically is less common. While there are no exact estimates, expert consensus opinion suggests that a very small number of hospitals have electronic documentation of clinical notes or CPOE. A survey conducted in 2004 identified 7.7 percent of hospitals as having electronic clinical results and 2.6 percent of hospitals as having e-prescribing.[57] The push

towards EHRs in hospitals to some extent has been hampered by the lack of end-user engagement by the NPfIT.

While a Commonwealth Fund survey estimated that 55 percent of GPs prescribe electronically,[33] our experts suggest that only about 5 percent of all prescriptions are being transmitted electronically to pharmacies. The Primary Care Summary Record program, which pulls a few key pieces of data from an EHR and transmits it to specialists' offices, as well as to hospitals, is currently being piloted. In the Fall of 2006 approximately 14 percent of primary care practices were able to create and transmit this summary record; the program should be fully implemented by 2008. Finally, the GP2GP program, which aims to ensure the transmission of the full EHR between GPs, is in its early stage of testing.

Much of England's HIT progress has come over the past decade and is largely due to the availability of inexpensive software and direct governmental funding of capital and recurrent EHR costs. Recently, the 2003 NHS contract with General Practitioners created a set of quality measurements and improvement requirements that necessitated better use of EHRs.[58] Our experts suggested that the long list of quality measures involved in England's pay-for-performance contract was central to improving the use of IT systems already in many doctors' offices but not always in use. The Commonwealth Fund survey credits England's national investment in IT capacity with its high levels of HIT adoption.[33] The Royal College of General Practitioners also asserts that the government played a significant role in eHealth adoption in England, writing, "the reason for the recently high rate of computerization is due mostly to the implementation of a government strategy from 1998."[59] Finally, the accreditation of vendor systems influenced the adoption of health IT systems.[19]

Individual Country Profiles: Asia

China

National Plan: According to a 2006 study investigating health informatics and two Pacific Health Summit case studies, China's HIT initiatives are concentrated largely in the public health sector rather than in the personal health care sector.[60, 61] Both HIT plans and adoption of standards are on the government's radar screen, with EHRs and the sharing of electronic health information between regional networks as the focus of its IT initiatives during the next few years.[60] Among public hospitals, funding for basic IT infrastructure comes from provincial and local governments, while funding for clinical IT systems, such as EHRs, comes from the hospitals themselves. Total HIT spending is estimated to be at 0.7 percent of the national health budget (about US$700 million), with 70 percent for hardware, 30 percent for software and 10 percent for services.[60]

Adoption by Providers: We could not find any nationally representative data on the state of EHR adoption or use among doctors or in hospitals in China. The National Bureau of Asian Research, in its HIT case study of China, concludes: "Development commenced in the mid-1990s with financial management systems; only in the last five years or so have clinical systems been implemented. China has made great progress in a relatively short time period, but weak application software and scarcities of implementation skills delay further progress."[60] A 2006 study

found that approximately 35 percent to 40 percent of hospitals have constructed a rudimentary hospital information system,[62] but it is unlikely that these represent true EHRs and the extent or sophistication of these systems is largely unknown.

Hong Kong

National Plan: The Hospital Authority, an independent organization established in 1990, manages all public hospitals in Hong Kong. The federal government's Secretary for Health and Welfare is responsible for forming health policies and monitoring the performance of the Authority. According to the Hospital Authority's Annual Plan for 2007 to 2008, HK$678M is budgeted for purchasing equipment and developing information technology and HIT is listed as one of its top priorities.[63]

Adoption by Providers: It is estimated that 20 percent of GPs in Hong Kong employ electronic records mainly for administrative purposes and only 10 percent incorporate clinical data into their EHR systems. Each one of the country's 43 public hospitals, which comprise 90 percent of the market, are fully computerized, with full hospital information systems and clinical systems including CPOE, electronic prescribing and PACS. Inpatient documentation and e-prescribing are not always done consistently, but all other components, including inpatient orders (with the exception of prescriptions), have been fully equipped for seven years. All discharge summaries, orders, schedules and outpatient activities are also electronic. Most private hospitals, which compose the remaining 10 percent of the market, are computerized mainly for administrative purposes. However, some have IT systems for clinical documentation and archiving. One study, which surveyed physicians about factors influencing their use of clinical IT, reported that HIT adoption has been slow in Hong Kong, with only about 30 percent of solo or small group practices using electronic tools for clinical purposes.[64]

Hong Kong has a fully interoperable medical data warehouse, with 7 million records containing clinical data and images mainly from the public sector. The medical data warehouse can be viewed by all public providers and some private providers.

India

National Plan: According to the WHO report, the Ministry of Finance in India has mandated that 3 percent of all government spending will go to information technology across all governmental departments–including the Ministry of Health. However, the amount of money that will end up in the Ministry of Health's HIT fund is not specified.[1] A number of telemedicine centers have been established in India, but the most recently published national health policy on the Ministry of Health's Web site (in 2002) mentions neither telemedicine nor HIT initiatives.[65]

Adoption by Providers: Generally speaking, EHR use in India can be characterized as showing "pockets" of activity, with the private sector largely driving and funding HIT.[66] For example, Indian hospitals embody a complete spectrum of EHR integration,[67] with individual facilities ranging from completely paper-based, to hybrid systems, to the occasional facility that is completely paperless. We were unable to find nationally representative data on the state of EHR adoption or use among doctors or in hospitals, but two recent studies concluded that HIT systems are not common in India.[68, 69] The author of an Indian HIT case study also opines that HIT adoption in India is far behind other

countries (although these "other countries" are not specified), but that HIT is on the government's and the private sector's radar screens.[66] For example, Swedish telecomm equipment companies were beginning to expand operations in 2005 as part of a new telemedicine alliance between India and Sweden.[70]

Iran

National Plan: In Iran, there are increasing levels of interest in implementing HIT, although efforts thus far are mostly in the planning phases. While the current health system is based on paper records,[71] Iran is working with the WHO to promote eHealth.[72] In September 2004 the WHO and the Iranian Ministry of Health and Medical Education held a conference in Tehran, with the goal of introducing participants to eHealth applications. The deliberations focused on explaining the concept of EHRs, outlining the infrastructure required for EHR implementation, and discussing the structure of EHRs as well as the related economic, legal and social aspects.

Adoption by Providers: In 2000 the Iranian Medical Informatics Association formed to promote the country's eHealth goals. But our research did not yield any nationally representative data on the state of EHR adoption or use among doctors or in hospitals in Iran, and we could not find any evidence that substantial numbers of providers have adopted electronic systems.

Israel

National Plan: We could find little data on the Israeli government's support of eHealth initiatives.

Adoption by Providers: Most primary care in Israel is delivered by four HMOs, and almost all Israeli doctors are either employees of these HMOs or work as contractors for them. Several experts suggested that the use of EHRs is widespread. However, we could find no data to independently substantiate this claim, making it difficult to have confidence in this conclusion. Despite the lack of publicly available survey data about EHR penetration in primary care clinics, several reports suggest that EHR use may be widespread as the four HMOs covering Israeli population have integrated EHRs to some degree.[73-75] A 2004 study of 26 Israeli hospitals (of which 23 responded), found that 91.3 percent used EHR systems.[73] Of these systems, the study found that 9.5 percent were connected to the central demographic repository, more than 85.7 percent to laboratories, 52 percent to surgical units, blood bank and radiology, and 50 percent to pathology. While some of these systems integrate laboratory results and imaging, much fewer (20 percent) had integrated some type of decision support. As such, it is difficult to discern the comprehensiveness of these EHR systems. Similarly, several experts suggested that all four of the organized systems that employ most Israeli physicians have established e-prescription systems. However, if a patient visits a physician privately and thus circumvents the HMO system, paper prescriptions continue to be used widely.

Japan

National Plan: Japan began using EHRs during the late 1990s. In 2001 the Ministry of Health, Labor and Welfare set a goal of having EHRs in 60 percent of all hospitals with greater than 400 beds[76] and, in 2002, they began providing direct government

subsidies to promote HIT. In 2000 the Health Information and Communication Standards Board was established to promote HIT adoption. The government provided 45 billion Yen (US$393.6 million) to 280 hospitals between 2001 and 2003. Between 2004 and 2007 the Japanese government pledged an additional 1.5 billion Yen (approximately US$12.6 million) to support the Interoperability of Health Information Systems Project.[77] Most recently, the Ministry of Health reported that, beginning in 2008, it plans to store all physical exam data electronically, with additional IT implementation planned through 2010.[78]

Adoption by Providers: In 2004, at the end of the 2001 to 2003 government subsidy period, only 12 percent of hospitals and 3 percent of clinics had adopted EHRs. After 2004 the pace of adoption slowed as hospitals became responsible for paying for EHRs.[79] Japanese EHR adoption has also experienced serious setbacks, such as in 2006, when half of the municipalities participating in a government-sponsored EHR adoption project abandoned their efforts after the government dropped its funding.[79] However, one recent study found that 65 percent of large hospitals (those with more than 400 beds) use CPOE systems.[77] Another study estimates that adoption rates in clinics hover around 6 percent to 7 percent; whereas in large hospitals (with at least 400 beds) they have reached 25 percent to 27 percent.[80]

South Korea

National Plan: Several South Korean governmental agencies—including the Ministry of Commerce, Industry and Energy; the Ministry of Information and Communication; and the Ministry of Health and Welfare—support eHealth through the National Health Information Project. South Korea has allocated US$1.1 billion to this project, which aims to implement EHR and a national health information network by 2010. Currently, the country is designing architectures and harmonizing standards. Funding for these initiatives comes from the National Health Insurance, which is compulsory, and social insurance, which pays hospitals more for radiology exams when they implement PACS, thus facilitating the adoption of PACS across South Korean hospitals.

Adoption by Providers: A 2005 combined mail and telephone survey of 283 hospitals (of which 43 percent responded) concluded that fully implemented CPOE was available in 80.3 percent of hospitals. In approximately 64 percent of all responding hospitals, more than 90 percent of physicians use the system. In contrast, a complete EHR system was available in only 9 percent of the hospitals that responded to the survey.[81] According to our experts, more recent estimates of hospital EHR utilization suggests that about 20.3 percent of tertiary hospitals (mostly large academic medical centers) employ EHRs, while 97.6 percent use CPOE. Among general hospitals with more than 100 beds, the rates are slightly lower, with only 14.7 percent employing EHRs and 84.2 percent using CPOE. Despite the high adoption CPOE rate, there are reportedly conflicts between physicians and pharmacists, which have resulted in very few hospitals sending their prescriptions electronically to external pharmacists. Electronic exchange exists in several (four to five) academic medical centers, which share patients' clinical information with clinics that refer their patients to academic medical centers.

Singapore

National Plan: The government implemented an EMR Exchange (EMRX) system to enable secure health information exchange between clinicians in the public sector.[82] This $500,000 system was implemented in 2004 to connect the electronic health records of the country's two major public health conglomerates: SingHealth and the National Healthcare Group.[83] Private practitioners provide 80 percent of primary health care services, while public hospitals provide 80 percent of hospital care. While the government funds national HIT initiatives such as EMRX, HIT implementation is primarily the responsibility of individual providers.[60]

Adoption by Providers: The public sector health care delivery system is divided into two major government-owned entities, National Healthcare Group (NHG) and Singapore Health Services (SingHealth), each of which are comprised of their own clusters of hospitals, specialty clinics and network of primary care clinics. By 2003 both NHG and SingHealth had achieved significant progress in HIT implementation.[61] In both sectors, any practicing clinician within the SingHealth or an NHG institution would have access to EHRs and clinical data that came from any other institution run by that public sector entity. According to an expert, SingHealth also has fully implemented e-prescribing among all of their clinicians.

There are also providers who practice outside these networks, although there are no data available on their EHR use.

Thailand

National Plan: The Thailand Ministry of Public Health has emphasized restructuring health information systems following the introduction of a universal health coverage scheme in 2001. As the primary driver for HIT in Thailand,[84] the Ministry of Public Health purports to have made HIT promotion a major priority, although we could not find reliable data on the level of investment by the government or any particular role it has played in setting standards. Recent surveys suggest that providers have a fairly high degree of interest in HIT.[85, 86]

Adoption by Providers: Currently, no nationally representative data on the state of EHR adoption or use among doctors or in hospitals in Thailand are available. However, anecdotal evidence and conversations with experts suggest that a small number of hospitals and individual physicians have adopted and are using EHR systems.

Individual Country Profiles: North and South America

Brazil

National Plan: The Brazilian government claims to have prioritized the adoption of HIT. While it has set an ambitious goal of having EHRs for 120 million Brazilians (about 70 percent of the population), we could not find data on the progress of this initiative.[87] The government's primary role has been as a facilitator of IT adoption, by setting standards for health information transmission and software systems, as well as establishing a legal apparatus to guarantee privacy and security of identifiable health information.[62] We could not find data on the government's financial investment in promoting HIT adoption.

Adoption by Providers: There are no nationally representative, high-quality data available on the state of EHR adoption or use among doctors or in hospitals in Brazil. However, EHR demonstrations are being introduced in a few major academic centers, although these efforts are targeted towards small populations. For example, about 3,200 pediatric oncology patients in 30 hospitals were connected by a system based on open-source software that provides electronic patient records and treatment protocols.[88, 89] It's unknown whether these small, boutique efforts will help propel HIT adoption more broadly.

Canada

National Plan: Launched in 2000, Infoway is a national effort to link laboratories, pharmacies and hospitals together to share clinical data. To date, Infoway has funded more than 227 projects in the Canadian provinces and territories. The cumulative expenditure of the fund has been Can$558 million, or 44 percent of its original $1.266 billion allocation. For 2007 to 2008, Infoway has earmarked Can$130 million in new project approvals.[90] Benchmarks set by Infoway, to be reached within the next 10 years, include ensuring that every Canadian has a comprehensive EHR, expanding EHR technology to doctors' offices, reducing patient wait times, creating patient portals to provide access to their individual EHR, and transitioning to computerized clinical systems.[91] The Infoway effort is not primarily paying for EHR adoption among physicians and hospitals but building infrastructure to link providers together electronically.

Adoption by Providers: In 2004 only 20 percent of primary care and family physicians reported having electronic laboratory results, and 16 percent used electronic patient records.[92] A Commonwealth Fund study suggests that by 2006, 23 percent of Canadian physicians were using an EHR and 11 percent were prescribing medications electronically.[33, 93] According to our experts, the EHR use was higher in those Canadian provinces where governments provided financial incentives for EHR adoption. EHR use in Canadian hospitals is also in its infancy. While many Canadian hospitals have implemented patient administration and results reporting systems, very few are using EHRs or e-prescribing. This is partially due to the fact that these systems rely on local operating or capital budgets rather than on national funding. The province of Alberta has undertaken one of the more ambitious projects in Canada. The provincial government tried to set up an Alberta-wide program to allow data sharing across hospitals, clinical laboratories and physicians' offices.[94] But the poor underlying levels of EHR use in primary care and the hospital sector has hindered the widespread adoption of this health information exchange program.

Mexico

National Plan: Mexico appears to have developed some HIT infrastructure to promote EHR adoption through the support of governmental agencies such as the Instituto Nacional de Seguro Social (IMSS) and the Ministerio de Salud (Secretaria de Salud).[95] In 2004 IMSS officials obtained a copy of the VistA software developed by the U.S. Department of Veterans Affairs through the Freedom of Information Act. The program was translated into Spanish and otherwise modified to fit the IMSS needs. In May 2005 it was installed in 12 Mexican hospitals as part of an ongoing, $100 million information-technology development program within IMSS.[96] Currently, IMSS operates 270 hospitals and more than 35,000 clinics,

providing health care services to 40 million people in Mexico representing nearly 40 percent of the population.

Adoption by Providers: While there is no national-level, publicly available data, reports from last year indicate that 56 Mexican hospitals are running a modified version of the VistA system and plans to install VistA in more hospitals by the end of 2008.[96] The 56 hospitals that currently operate IMSS-VistA range in size from 50 beds to 800 beds. Unlike IMSS clinics, each hospital operates its own independent IT system, so connectivity among hospitals remains fragmented. There are reports that the IMSS is testing a communications system to send HL7 messages between hospitals. The hospital systems are already connected to a central data repository, which was set up as the hub of a previously installed, homegrown EHR for IMSS clinics. An estimated 1,000 clinics covering approximately 75 percent of IMSS patients use an earlier EHR system, introduced in 2003, although the features of this older EHR system are largely unknown.[96] The extent to which EHRs have been implemented in primary care clinics, as well as in facilities not affiliated with IMSS, remains unclear.

Individual Country Profiles: Africa

South Africa

National Plan: The South African Department of Health has reported that, in order to bridge the gap between rural and urban health care delivery, the expansion of telemedicine is an urgent priority. As of July 2001, a number of telemedicine initiatives had begun in six different provinces. As of 2002, the country planned to integrate regional health information systems into one national health information system, including a national interface with labs and pharmacies.[97, 98] The implementation of these plans resulted in the National Health Care Management Information System (NHC/MIS), which currently uses EHRs in addition to administrative functions within select hospitals in all provinces. Given that much of South African health care is controlled at the provincial level, reports suggest that the federal government would like province-wide EHR systems and has stated that this is a high priority.[99] We could not find data on the levels of federal or provincial funding for the adoption of these systems or any other major initiatives on the part of the government to improve adoption.

Adoption by Providers: In spite of these plans, we could find no high-quality data on the state of EHR adoption or use among doctors or in hospitals in South Africa.

Australia

National Plan: Australia has made significant progress in the HIT arena and, in 2006, had plans to continue taking actions to enable eHealth for two more years.[1] Despite the challenge of funding and delivering of health services, the Australian federal government has worked in partnership with its states and territories to encourage interoperability, improve provider connectivity and security, and establish national HIT governance arrangements. With US$24 million in start-up funds, state health ministers in 2005 established the National E-Health Transition Authority (NEHTA) to connect information between Australia's HIT systems.[100] In February 2006, NEHTA, which is classified as a nonprofit corporate entity

jointly owned by the federal, state and territory governments, was granted US$112 million for new projects. Recently, however, NEHTA's abilities to meet key objectives, including interoperability, have been questioned.[101]

Adoption by Providers: Australia has experienced high rates of EHR adoption among GPs, with between 79 percent and 90 percent of GPs having access to EHRs in their offices. While most GPs' offices are computerized for administrative purposes, a recent survey found that 98 percent of GPs have the capability to prescribe electronically (typically printing out the prescription and handing it to the patient) and nearly 90 percent of these systems have some level of decision support.[102, 103] Sixty-four percent of GPs wrote clinical progress notes electronically most of the time, while another 14 percent did so at least part of the time.[102, 104, 105] A Commonwealth Fund survey found 79 percent of GPs reporting EHR use but a slightly lower rate of e-prescribing (81 percent), as compared to the McInnes study.[33] These slight variations are likely due to differences in wording and sampling. A key issue seems to be that there is nearly universal availability of these functions in systems that GPs use, but their actual use varies.

Hospitals in Australia have computerized patient administration and many use laboratory results reporting systems. However, computerized documentation is limited to electronic discharge summaries sent directly from hospitals to general practitioners, and there is little to no electronic prescribing.

New Zealand

National Plan: According to Didham and colleagues, New Zealand, a global leader in HIT adoption and usage among practitioners, does not have a specific policy regarding IT in general practice health care.[106]

Adoption by Providers: In New Zealand, nearly all GPs (99 percent) use a Practice Management System for clinical and administrative functions.[106] Of these, 90 percent write prescriptions electronically, 81 percent obtain electronic laboratory results, and 72 percent are storing full electronic clinical notes. These numbers are confirmed by a Commonwealth Fund study, which found that 92 percent of primary care providers use EHRs and 78 percent write prescriptions electronically.[33] Adoption of eHealth in hospitals lags far behind primary care, as most primary care settings have computerized patient administration and many use laboratory results reporting systems. However, less than 10 percent of hospitals have proper EHR systems, and there is little to no electronic prescribing.

Neither government funding nor explicit government policies are responsible for the high rates of HIT adoption seen in New Zealand.[27] Didham, et al., claim the main reasons practitioners adopt information technologies in their practices are "time efficiency, better access to services, linking to other health care services (such as electronic transfer of pathology results), and the public expectation of a modern health care facility."[106] New Zealand's government has influenced HIT adoption at some levels, however. Due to Ministry of Health as well as district-level and primary care groups' data capture obligations, GPs are pressured to use computerized systems. Furthermore, the widespread organization of GPs into groups facilitates HIT adoption.

Conclusion

Interest in health information technology as a tool to improve the quality and reduce the cost of patient care has grown to the point that both public and private sectors across the world have recognized its value. However, with 40 countries reporting an absence of a national policy regarding EHR and little activity in most of the nations that have national policies, the adoption and use of these systems is very much in its nascent stages.

Nationally directed initiatives, programs and policies constitute the first step towards the broader adoption of EHR systems across the world. Establishing an official policy and laying out goals for its implementation, however, are not sufficient. Realization of EHR adoption benchmarks set forth by governmental, agencies, policy-makers and private industry requires action. Some nations have progressed towards the universal implementation of EHR systems. Denmark, the Netherlands, Australia and New Zealand stand out as high achievers in this regard. Many other countries have made substantial progress, such as the United Kingdom, Ireland, Israel and Germany. And many other nations have begun the initial implementation process with good success.

Most of the successes have come from high-income countries, which have the financial resources (either public or private) to fund the adoption of these expensive technologies. The data from the middle- and low-income nations are not as encouraging. Few nations in developing and transitioning regions of the world have made much investment or progress towards implementing these systems. This represents an area where much improvement is needed, and where patients would gain from clinical systems that allow for more cost-effective, high-quality care.

Leadership by key government and clinical leaders has played an instrumental role in increasing the adoption of HIT in many instances. While public funding has been helpful in most nations, a large number of the nations with HIT adoption rates that are much higher than those in the United States have not had broad-based public funding of their systems. EHR adoption has been painfully slow in some countries such as Japan, despite substantial funding. The lack of leadership for their efforts likely played a role.

Most experts point out that there is no single reason or path that nations use for achieving high HIT adoption levels. Public policy plays an important role, but other factors, such as clinical leadership, funding and the right incentives in the broader health care system (such as paying for higher quality) all contribute to high rates of HIT adoption.

Denmark is a particularly compelling example of a nation with near universal HIT system but with little public funding. Most Danish GPs, for example, have funded EHR purchases themselves. Experts suggest that a combination of factors, including higher revenues, more effective communication with patients and other physicians, and peer pressure have all contributed to the high EHR adoption rates seen in this country. However, it should also be noted that Denmark has now mandated that all GPs use EHRs, and that government funds all GP services, thus giving it enormous informal influence over the behavior of providers.

More specifically, a study by Protti and colleagues elucidated six general factors that were crucial to HIT adoption by GPs in 10 countries currently considered leaders in HIT use.[107] These factors include: national IT health strategies, government funding, nonfinancial support, the presence of a unifying body to facilitate information exchange, historical policies and incentives that increased automated billing and peer leadership.

First, Protti found that while most of the 10 countries with advanced HIT adoption had a national IT health strategy, the comprehensiveness of these plans varied greatly. Scotland, for example, implemented a very thorough national HIT policy that specified particular national goals for electronic health records and which functionalities they should support, such as electronic prescribing and clinical notes. On the other hand, not all countries have relied on a comprehensive national IT policy to drive EHR adoption. For example, in Denmark, MedCom, a small grassroots organization that emerged before the country had adopted a formal national IT strategy, was largely responsible for driving Denmark's HIT adoption.

A second factor that drove HIT adoption in the 10 HIT-advanced countries was government funding. However, both the amount of government funding and its distribution vary greatly among these countries. In England, Scotland and Sweden, nearly all of the costs associated with HIT adoption were covered directly by the government. On the other hand, in Australia, the government only covered the initial expenses of HIT adoption, making modest, one-time grants to encourage GPs to buy and use computers in their offices and to write electronic prescriptions. Other countries used more indirect financial incentives for HIT adoption. In the Netherlands, physicians are reimbursed at a higher rate per patient if the physician uses an accredited EHR or promises to implement one within the next two years. Another means of indirect financial incentives has been the introduction of pay-for-performance incentives or quality targets that can only feasibly be reached or documented using EHRs. In England, for example, the Quality and Outcomes Framework, introduced in 2003, specifies that doctors will be paid a higher rate for providing high-quality care, which requires the use of electronic records for documenting delivered care.

Third, while government funding is a strong incentive for HIT adoption, governments can successfully motivate HIT adoption using nonfinancial means. Protti points out that in many of the 10 countries, the government also provided nonfinancial support directly to physicians or assisted with establishing HIT infrastructures. For example, in Denmark, county-funded "data consultants" regularly visited GPs offices to help with technical aspects of HIT adoption, while "practice coordinators" were hired to act as intermediaries between physician practices and hospitals to facilitate information exchange. In other countries, governments and medical associations also provide nonfinancial support for HIT infrastructure by certifying vendors of HIT systems, setting standards for HIT communication (such as standardized coding) or other types of change management support.

Fourth, Protti and colleagues point out that a unifying body—with the aim of facilitating national or regional information exchange—is an important factor in successful HIT adoption. Many of the world leaders in HIT adoption, including New Zealand, Scotland, England and Denmark, have national health networks

that serve this purpose. These unifying bodies may be public, private or non-profit entities. New Zealand's national health care network, HealthLink, is a private entity that controls 95 percent of all electronic national health information exchange. In Sweden, the state-owned pharmacy association, Apoteket, functions as a unifying body by coordinating the nation's 900 pharmacies and ensuring that they are capable of receiving e-prescriptions in a standardized manner. MedCom, the Danish grassroots organization that catalyzed HIT adoption has facilitated the country's clinical information exchange. In all cases, unifying bodies spurred HIT adoption by facilitating national or regional communication of electronic prescriptions, lab results and clinical messages.

Fifth, historical mandates or incentives driving physicians to automate their offices or billing processes were important driving forces for later HIT adoption. Protti suggests that automated billing was one of the strongest predisposing factors that allowed some countries to more efficiently adopt HIT. German doctors, for example, received direct financial incentives to automate their billing process from KV, the state-run clearinghouse for physician reimbursement, which offered doctors a 2 percent reduction in administrative fees if they submitted their claims electronically. In the Netherlands, the widespread use of computers in physician offices was in part attributable to historical governmental policies that made investments in computers for GPs offices tax deductible. Countries that achieved high rates of computer use in physicians' offices, especially those who used automated billing, were more predisposed to successfully adopting HIT later.

Finally, Protti found that leadership by peers and medical associations was one of the most important factors to prompt HIT adoption. In Denmark, early adopters of EHRs hosted information sessions at their offices and explained to other doctors how EHRs had changed their work. Furthermore, at annual seminars of the Danish general practitioners, at least one day was dedicated to discussing computerized records, including training on how to use various features. In Norway, EMR adoption took off in the early 1990s in part because prominent, well-known physicians spoke publicly about their use of EHRs. Finally, in the Netherlands, after the Dutch National Association of General Practitioners endorsed and lobbied for their use, EHRs were considered "good practice." As these examples illustrate, the support of physicians and physician groups–which functioned somewhat like peer pressure–is considered an incredibly powerful force in driving HIT adoption among GPs.

There are important limitations to our findings. First, although we attempted to look across the globe, there are surely pockets of innovation and activities around HIT that we were not able to identify. Although we spoke to experts from many nations, their assessments of the state of HIT adoption may not reflect broader views across the nation. Whenever possible, we tried to validate their assessments but this was not always possible. Third, we were able to find high-quality data from very few nations possibly because we focused primarily on the English language literature. It is entirely possible that there are reports and surveys in other languages that did not appear in our searches and were not known to the experts we contacted.

In conclusion, we examined the global state of HIT and found tremendous interest among nations from every continent. Although many nations have started establishing policies and guidelines around HIT use, very few countries currently

have meaningful levels of these technologies in their clinical settings. Those that do have gotten there through various paths, suggesting that there is no single formula for improving HIT adoption. Successful HIT adoption will require a combination of financial and social incentives that will need to be tailored to individual countries' unique cultural milieu and the structure of their health care system.

Table 1: **Rates of EHR Use Among Ambulatory and Hospital Providers Based on Best Data Available From Surveys and Reports**

	Percentage Ambulatory EHR	Percentage Hospital EHR
Europe		
Austria	75	N/A
Belgium	78	N/A
Croatia	60	N/A
Denmark	98	50?
England	89–97	7
Estonia	N/A	N/A
Finland	90–96	N/A
Germany	42–90	<5
Ireland	>80*	N/A
Italy	50	3
the Netherlands	95–98	<5
Spain	9	N/A
Sweden	97	81
Asia		
Russia	N/A	N/A
China	N/A	N/A
Hong Kong	10	90–95
India	N/A	N/A
Japan	6–7	10–27 (depends on size)
Korea	?	14.7–20.3
Singapore	N/A	N/A
Thailand	N/A	N/A
Iran	N/A	N/A
Israel	N/A	N/A
North and South America		
Argentina	N/A	N/A
Brazil	N/A	N/A
Mexico	N/A	N/A
Canada	23	<10
Africa		
South Africa	N/A	N/A
Australia		
Australia	79–90	<10
New Zealand	92–98	<10

* Estimates from Harris Interactive (2002).

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Chapter 8: Economic Analyses of Health Information Technology

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Overview

There have been relatively few rigorous economic analyses of health information technology (HIT) and health information exchange (HIE). In this chapter, we identify the theoretical and practical issues involved in executing economic analyses of HIT adoption, review the literature on economic evaluations of ambulatory EHRs, present potential analytical strategies for an economic analysis, identify promising types of data and data sources, and make preliminary recommendations about the most effective and useful analytical strategy. However, we do not go so far as to outline specific plans for analyses at this time.

The economic implications of HIT adoption vary considerably, depending on the specific technologies and functionalities considered, as well as the setting in which they are applied. We considered a variety of technologies and chose to illustrate approaches to economic analyses using electronic health records (EHR), including electronic prescribing (ERx), in the ambulatory care setting. We chose to focus on ambulatory EHRs as a technology that will perhaps have the most significant impact in terms of quality and safety yet has had relatively slow adoption. Economic constraints have been cited as an important barrier to HIT adoption in general, and EHRs in the ambulatory setting specifically. The approaches defined for economic analyses of ambulatory EHRs should be broadly applicable, with appropriate adaptation, to other settings as well. The HIT Adoption Initiative has previously defined a minimally functional EHR as one that includes health information and data, defined by the Institute of Medicine (IOM) as "critical patient information needed to make sound clinical decisions," order entry management, results management and decision support. Although we do touch upon other settings as well as the exchange of information across settings in this chapter, our primary focus is ambulatory EHRs.

Types of Economic Evaluation

Before reviewing the existing literature on economic evaluation of ambulatory EHRs and presenting options for further research, we provide a short introduction to economic evaluation methods. For a more in-depth discussion of economic evaluation in policy analysis or health care, see Stokey and Zeckhauser,[1] Weinstein,[2] Gold, et al.,[3] Drummond, et al.,[4] or the recent IOM report.[5] There are many types of economic evaluation for new technologies in medicine, each providing different types of information that may be more or less relevant to different policy- makers with different perspectives.

We describe four types of analyses: (1) cost-effectiveness analysis (CEA); (2) cost-utility analysis (CUA); (3) cost-benefit analysis (CBA); and (4) return on investment (ROI) analysis. Each is used explicitly or implicitly to compare at least two alternative strategies, by assessing the marginal changes in costs and outcomes

over a defined period of time. The intention is to identify the strategy that achieves the greatest benefit for a fixed amount of resources or that costs the least given a fixed level of benefit.

The perspective taken by an economic evaluation is essential to understanding its meaning. An analysis that takes a provider's perspective will only consider the costs and benefits that fall directly to that provider. Health effects, for example, are unlikely to be directly relevant to a provider (though they may be indirectly relevant in terms of the provider's reputation and preference for offering high-quality care) and would be excluded from a provider-perspective analysis. Analyses taking a societal perspective consider all costs and benefits (including health); direct and indirect, regardless of whether they fall to the payer, the intended beneficiary, or other persons and entities. Comparisons of costs and benefits from a societal perspective, with the costs and benefits falling to specific entities, inform the development of policies to remedy over- or under-supply of a particular good, service or technology. As an example, it is possible that society will gain economically from EHR adoption because of reduced hospitalizations. However, most physician practices will never recoup the costs of an EHR from reduced hospitalizations. If additional data demonstrating benefits to physicians are not available, they will be reluctant to implement EHRs, even though overall costs to society might be lower if they did. In such a case, EHRs would be underutilized.

Cost-Effectiveness Analysis

CEAs are summarized in a cost-effectiveness ratio showing the marginal monetary cost of a policy per marginal nonmonetary unit of effect. For example, an analyst might assess the marginal cost per antimicrobial resistant infection (ARI) avoided of an antimicrobial stewardship plan aided by a clinical decision support system (CDSS), relative to another plan that is not computer-aided. Let us assume the CDSS costs $75,000 to implement over the first year, and the CDSS scenario has 10 fewer ARIs than the scenario without CDSS. If the program reduces drug use or increases the use of cost-saving generics such that costs are more than $75,000 lower in the CDSS scenario compared to the scenario without CDSS, the marginal cost of the CDSS and the cost-effectiveness ratio would be negative. The negative cost (i.e., positive savings) would make a clear case for implementing the CDSS. If the CDSS resulted in the use of better targeted, but more expensive antimicrobials, increasing costs by $15,000 relative to the scenario without CDSS, that would result in a positive cost-effectiveness ratio of $90,000/10 infections avoided = $9,000/infection avoided. Positive cost-effectiveness ratios force decision-makers to choose whether an effect is worth its cost. When making comparisons across studies, only strategies whose effects can be measured with the same metrics are comparable using CEA. So the CDSS described here could be compared to an academic detailing program that also measured cost per ARI avoided, provided the baseline scenarios were the same. CEA does not suggest an obvious policy choice when comparing two strategies with different outcomes, for example one that costs $9,000 per infection avoided and another strategy that costs $200,000 per life year saved.

Often, CEAs taking a societal perspective will frame their outcomes in terms of life years saved because that is a fundamental, if blunt, measure of health. However, it makes less sense to use life years saved for policies that have a minimal effect on longevity. Furthermore, comparisons based on life years saved make no allowances

for qualitative differences in life years (e.g., a year of life in severe pain is valued the same as a year of life with no pain at all). Though making comparisons solely across equivalent raw units of effect may limit the types of policies that can be compared, it avoids the need to make potentially controversial choices about how to convert different raw units of effect into comparable adjusted units.

Cost-Utility Analysis

CUA is a means of comparing technologies and/or policy strategies using adjustments that make different effectiveness measures comparable to one another, thus overcoming the limitation of CEA where only alternatives with identical raw units of effect may be compared. Here the common metric is life years weighted by utility, where utility is defined in the economic sense as a sort of well-being. In health care, utility is a measure of individual or social preferences for certain health states and it is used to weight years of life expectancy. Generally, death is assigned a utility of zero and perfect health is assigned a utility of one. Quality-adjusted life years, or QALYs, are one such effectiveness metric. Similar to the CEA, the CUA is summarized in a ratio, in this case cost per QALY gained.

Because QALYs are (in theory) equivalent regardless of the technology or policy being evaluated, they are a useful measure of effectiveness for making decisions from society's perspective where resources may be allocated in a wide variety of ways. Measuring QALYs, however, is extremely difficult in practice. To be useful for decision-making, QALYs must be measured such that two years living in a health state with a utility of 0.5 is equally desirable to one year living in a health state with a utility of 1.0 (perfect health). Measurement techniques that achieve this numerical characteristic while remaining robust across conditions and populations are elusive. There are many ways of measuring health utility, but it is not clear that they are all equivalent. Even assuming that the theoretical requirements of utility measurement could be met in practice, it is not clear that making resource allocation decisions based on cost per QALYs truly reflects the public's values. Underpinning CUA specifically and CEA generally is a utilitarian ethical framework, which makes equivalent a strategy that saves one year of life for ten people and another strategy that saves a ten years of life for one person. Thus, CUAs may be politically sensitive.

Cost-Benefit Analysis

CBA is similar to CEA and CUA, but with the notable difference that all outcomes are monetary. In some cases, nonmonetary outcomes such as injuries avoided are assigned a monetary value. Establishing an agreed-upon framework for monetarily valuing health effects may be no easier than measuring health utility. Typically, CBA results are presented as the ratio of marginal benefits to marginal costs; a ratio greater than one is favorable to the new technology or strategy. The advantage of CBA from the perspective of a government decision-maker is that the decision to fund a policy accelerating HIT adoption could be compared to other government policies, regardless of whether those policies have health effects. CBA is also useful to businesses such as payers and providers who are considering the value of a capital investment such as HIT.

Return on Investment

ROI analysis and CBA are essentially two sides of the same coin. The formula for determining ROI is (NPVb-NPVc)/NPVc where NPV is the net present value, *b* is benefits, and *c* is costs. CBA is NPVb/NPVc so ROI is simply CBA-1. However, because ROI analyses are typically conducted from the perspective of a business or organization, in practice ROI analyses focus exclusively on financial costs and benefits with no attempt to value costs or benefits that do not normally have a dollar value (e.g., such as pain and suffering or increased life span). The ROI is the percent change in the value of the investment, typically annualized over the time horizon of the analysis. If the benefits are greater than the costs, the ROI takes on a positive value. In the context of HIT adoption, ROI analyses are relevant to providers who are considering adding, updating or expanding an HIT system. When setting national HIT adoption policies, the Office of the National Coordinator for Health Information Technology (ONC) and Congress should recognize the ROI providers face over specific intervals of time to understand their barriers and incentives to HIT adoption.

Previous Work on the Economic Evaluation of Ambulatory EHRs

To prepare for our work designing an economic analysis of HIT adoption, we conducted a review of the literature with a focus on the use of EHRs in the ambulatory setting. Our purpose for conducting the review and presenting it here is to highlight some of the key methodological lessons and limitations of the existing studies. Our overall search strategy was designed to update the review conducted by Chaudhry and colleagues.[6] However, we further focused our search to include only U.S.-based studies that measured both the costs and the benefits of HIT adoption. We identified five studies that specifically examined the economic impact of EHRs and electronic prescribing in the ambulatory setting: Wang, et al.,[7] Barlow, et al.,[8] two by Miller, et al.,[9, 10] and Grieger, et al.[11] Key aspects of these studies are abstracted below:

1. Wang SJ, Middleton B, Prosser LA, et al. "A Cost-Benefit Analysis of Electronic Medical Records in Primary Care." *American Journal of Medicine,* 114: 397–403, 2003.

Research Design: simulation model

Cost measures: software, hardware, system design, training, implementation, transcription of old records, maintenance, support, decreases in productivity

Benefit measures: reductions in costs from paper chart pulls and transcriptions, reduced adverse drug events, more economically efficient prescribing, reduced laboratory/radiology ordering (capitated payment), increased revenue/reduced losses due to improved billing accuracy (fee for service)

Functionalities studied: electronic medical record; electronic registration and scheduling; electronic ordering of pharmaceuticals, lab tests and radiology; clinical decision support

Wang, et al. (2003) used a simulation model to estimate the costs and benefits of EHR adoption in a generic primary care setting. They assembled primary data from sources at Partners HealthCare, as well as data from published studies and expert opinion. The major strength of this study was the inclusion

of a comprehensive range of costs and benefits in the analysis. Though the authors conducted extensive sensitivity analyses, the study's key limitation was the underlying data. The primary data were based on the experience of a large academic medical system, which is unlikely to be broadly generalizable. There was also partial reliance on expert opinion for some of the costs and benefits. An additional strength of this study was the inclusion of payer mix as a factor influencing total benefits. However, the authors did not consider benefits accruing to stakeholders other than the provider or technology purchaser.

2. Barlow S, Johnson J, Steck J. "The Economic Effect of Implementing an EMR in an Outpatient Clinical Setting." *Journal of Healthcare Information Management*, 18: 46–51, 2004.

Research Design: pre-post study

Cost Measures: unspecified

Benefit Measures: averted transcription costs, averted chart transport and maintenance costs, averted chart development costs, improved billing accuracy, averted space costs

Functionalities studied: electronic record keeping and billing

Barlow, et al. (2004) used a pre-post study design to examine the economic effect of implementing an EHR in a multicenter, multispecialist ambulatory care organization in central Utah. Their study included the savings achieved by more efficient records management and billing. However, it is not clear what, if any, costs, were factored into the analysis. It is also unclear whether the EHR being studied included order entry or decision support functionalities, each of which are key components of a minimally functional EHR as we have defined it.

3. Miller RH, West C, Brown TM, et al. "The Value of Electronic Health Records in Solo or Small Group Practices." *Health Affairs*, 24: 1127–1137, 2005.

and

4. Miller RH, West C. "The Value of Electronic Health Records in Community Health Centers: Policy Implications." *Health Affairs*, 26: 206–214, 2007.

Research Design: series of retrospective pre-post studies

Cost Measures: hardware, software, training, installation, lost productivity, chart abstraction, hardware maintenance/support, office staff time, information system staff/support, communications costs

Benefit Measures: additional revenue from increased billing accuracy, reduced staff costs for chart pulls, reduced transcription costs, reduced paper costs, increased revenue due to larger numbers of patients seen, increased provider leisure time, pay for performance rewards, quality improvement

Functionalities Studied: electronic record keeping, scheduling and billing; care reminders; quality improvement accounting; electronic prescriptions and lab orders that were printed out for patients; electronic communication

Miller, et al. (2005, 2007) conducted a pair of in-depth case series (retrospective pre-post design) examining the EHR adoption experience in the context of solo or

small group practices and among community health centers. The authors included comprehensive lists of relevant costs and benefits in both studies and collected their data through extensive interviews and direct observation. While the data collection and analysis were among the most thorough in the published literature, important limitations remain. First, in the solo/small group practice study, physician practices were chosen for study from the customer lists of only two technology providers and only 20 percent (14) of the subjects identified agreed to participate in the study. These providers represent early and largely successful adopters. The CHC study was based on six centers out of more than 800 nationally. There was discussion of how EHR adoption would affect other payers, but there was no comprehensive analysis taking full account of the societal perspective.

5. Grieger DL, Cohen SH, Krusch DA. "A Pilot Study to Document the Return on Investment for Implementing an Ambulatory Electronic Health Record at an Academic Medical Center." *Journal of American College of Surgeons*, 205: 89–96, 2007.

Research Design: retrospective pre-post study

Cost Measures: hardware, software, technical support, and training

Benefit Measures: reduced costs from chart pulls, reduced costs from chart creation, reduced time to file test results, reduced staffing needs, reduced transcription costs, faster patient cycle time (more patient revenue), increased revenue from greater billing accuracy, reduced time from claim filing to claim payment

Functionalities Studied: electronic record keeping, document scanning and dictation, medication and allergy tracking, call processing, task management, immunization and vital sign tracking, electronic prescribing

Grieger, et al. (2007) used a pre-post study to evaluate the implementation of an EHR in six ambulatory care practices affiliated with an academic medical center in Rochester, N.Y. Although they did not explicitly estimate reductions in productivity as systems were brought online, they did indicate that the time it took patients to move through the office was unaffected by EHR introduction. The practices considered were hand-picked and are likely more highly motivated than an average practice. Electronic laboratory and radiology ordering were not studied. Payer mix was not considered (payment for the study practices was almost exclusively fee for service). This study had limited pre-implementation data.

Lessons from the Economic Evaluation Literature

While these studies are important first steps indicating that ambulatory EHRs will save most providers money (the CHCs studies almost all lost money), they each have limitations. There are important concerns about study design, data sources and underlying assumptions. There remains a need for additional work that more fully and accurately captures the costs and benefits of EHR adoption from a variety of perspectives.

Selection of Study Subjects

In order to understand the implications of existing research on the economic effects of EHR adoption, one has to take into account several factors. First, early

adopters of EHRs may differ in important ways from providers who have not yet adopted EHRs. They are likely more intellectually invested in EHR adoption, more technologically savvy and better able to financially handle the investment in EHRs. Second, providers who study their own experience or who agreed to be studied may also be different from other providers. Some of these early studies focus on evaluating homegrown systems at pioneering institutions. Many economic evaluations of EHRs have been performed by institutional stakeholders or advocates for EHR adoption, including vendors who have a vested interest in their success. This may have influenced the studies in subtle but important ways, particularly those that relied heavily on expert opinion, by increasing the likelihood of a positive publication bias. It is likely that successful adopters are more eager to share their experience than those whose systems failed on some level. Both early adoption and willingness to publish are likely associated with a positive return on investment in EHRs, and extrapolating published research findings to determine the effect of widespread EHR adoption will likely overestimate the economic benefit of EHR adoption.

Data from the provider survey being fielded by the HIT Adoption Initiative will provide information about the extent to which early adopters differ from later adopters and those who have not yet adopted EHRs. If at some point a meta-analysis of economic evaluations of EHR adoption were feasible, studies could be weighted according to the providers' propensity to adopt EHRs. Furthermore, future studies prospectively assessing the economic effects of EHR adoption should, in addition to following well-matched control groups, follow "poorly-matched" but potentially more generally representative controls. This could help us to understand how providers who are not planning on adopting EHRs in the short to medium term differ from those who are planning EHR adoption. Projections of the economic effects of EHR diffusion will have to take account of the changing characteristics of the marginal EHR adopter and how those changing characteristics alter the balance of costs and benefits.

Financial Mechanisms and Study Perspective

Three of the studies examined[12–14] considered costs and benefits falling to entities other than the provider (the technology purchaser). Payment mechanisms played a particularly important role in determining the total value to the purchaser. The financial risk of care paid for on a capitated basis falls to the provider. Wang and colleagues[15] found that, as the proportion of patients whose care is paid for on a capitated basis increases, the provider captures more benefits from reduced/more efficient prescribing and reduced utilization of radiological tests. As patient cost-sharing increases, reductions in utilization will also benefit patients (provided care is not compromised). Payers may benefit if reductions in utilization extend to fee-for-service patients as well. Providers with a large proportion of patients covered under fee-for-service arrangements will be able to use EHRs to more thoroughly document care, allowing them to code claims into categories with the highest possible reimbursement. This results in increased costs for payers and generally no additional benefits. Alternatively, Miller and colleagues[16] found that among CHCs, EHRs were used to increase quality of care. However, there was no mechanism in place, such as pay-for-performance, for CHCs to benefit from their improved quality. In this instance, the payers, including Medicaid, saved money through reduced utilization. These cases illustrate how financial factors and perspectives shape the distribution of costs and benefits stemming from

EHR investments. Analyses using a societal perspective will take full account of the costs and benefits falling to all entities and help to highlight instances where incentives are not aligned.

 Identifying the full impact of EHRs with HIE will likely prove to be an extremely challenging task. Some have suggested that the greatest benefit of EHR adoption will come from second and third order effects, such as the reduction of excess capacity and the elimination of some professional monopolies.[17] However, it will not be possible to precisely quantify such distal effects of EHR adoption for some time to come, if ever.

Practical Issues in Economic Evaluations of HIT

Some general principles are apparent in planning HIT evaluations. For example, it is preferable to use primary data and to consider multiple settings, stakeholder perspectives and functionalities. However, even after picking a type of HIT (e.g., EHRs) and a setting (e.g., ambulatory practice) in order to simplify this discussion, major analytic choices remain about how to approach economic evaluations. One critical choice is the unit of analysis. At least three units of analysis are possible: specific HIT functionalities, institutions or communities. If we adopt the functionality as the unit of analysis, economic evaluations of EHRs in the ambulatory setting would start by developing a list of all the functionalities available through EHRs. We would then measure the financial effect of each functionality and develop a summary score. The challenge of this approach is that accounting for interactions between different functionalities is nearly impossible, and capturing unanticipated costs and benefits may be difficult. Sensitivity analyses or other modeling techniques could be used to try to capture these effects. One way to account for some of the difficulties in valuing individual functionalities would be to group the functionalities either according to certain types of functionalities (e.g., medication ordering decision support) or elements that are most likely to be packaged together by an EHR vendor. One could then determine the effects of each of these groups. The advantage of this approach is that it most closely approximates what occurs in reality. However, while it minimizes the problem of missed interactions, it does not eliminate it.

Alternatively, an analysis could be performed at the level of an institution, whether it is an office practice, a hospital or a health information exchange. As an example, one could study the effects of an ambulatory EHR on the economic performance of physician groups. The effect of EHR adoption could be inferred by comparing groups with and without ambulatory EHRs. An analysis at the level of the institution would account for the interaction between different types of functionalities and other unanticipated consequences, whether positive or negative. For example, it is often argued that EHR adoption will hasten organizational improvement on a wide variety of dimensions because EHRs will make easily available the data necessary to continuously enhance the productivity and quality of health care processes. There are two related challenges to maximizing the generalizability of the findings from this approach: (1) identifying institutions that have adopted EHRs and yet are similar to institutions that have not adopted EHRs; and (2) controlling for confounding differences across institutions. These issues are critical, as studying a large number of institutions would lead to prohibitive costs, although sensitivity analyses and/or modeling

approaches might extend the value of a small sample. Even so, in order to obtain representative and generalizable information, a substantial number of institutions would need to be studied, including those in a variety of settings (e.g., rural, urban and suburban), a variety of sizes (e.g., the financial ramifications of EHR adoption are vastly different for a solo office provider versus a 50 provider practice), a variety of technologies (EHRs, electronic prescribing, and others) and a variety of vendors.

Finally, community-level/ecologic approaches to analysis may be warranted. Such an analysis would look at aggregate health and health care costs in a community as a function of community-wide ambulatory EHR adoption, and it would concentrate on costs and benefits from a societal perspective. It would be difficult to establish a causal relationship between adoption and economic effects in this type of analysis, but community-level studies will be necessary to provide face validity to more focused studies.

There are several other methodological issues in addition to the unit of analysis. For example, there are questions about settings (e.g., should home health care be included?); study sites (e.g., how many different practices should be studied?); type of functionality (e.g., how many different vendor systems should be studied?); optimal study design, data sources (e.g., what are potential data sources to measure financial effects for a given functionality? How do those data sources vary across practices?); evaluative methodologies (e.g., how expensive and challenging is the proposed data collection methodology?); and timing of measurement (e.g., over what time period do benefits accrue? How many periods of data collection are required?). There are no a priori answers to these questions; analytic plans will require the input of skilled economists and practitioners of economic analyses.

Data Collection for Economic Evaluation of EHRs

Noteworthy considerations for economic evaluations in the ambulatory setting include: the relative costliness and difficulty of performing primary data collection, particularly in studies that require patient surveys such as ones to determine adverse drug event rates; the difficulty of obtaining data from multiple sources such as clinical and billing records; and the difficulty of obtaining multiple types of data such as laboratory and radiology data. Below we outline the types of costs and effects we recommend including economic evaluations of ambulatory EHRs from the perspective of providers as well as potential data sources for this information (Table 1). The effects would need to be translated into dollars. For example, in the drug utilization changes category, implementation of an EHR may increase rates of generic substitution. In this case, the cost savings could be calculated by estimating the costs of trade medication use and subtracting the costs of generic medication use.

Table 1: **Data Inputs for Economic Evaluations of HIT**

Costs	Potential Data Sources
Hardware	Interviews with providers and vendors, commercial price lists
Software (e.g., annual license)	Interviews with providers and vendors, interview with physician organizations and associations
Implementation (e.g., initial training, conversion of existing paper records)	Interviews with providers, direct observation (for time)
Support and maintenance (e.g., ongoing training, software/ hardware upgrades)	Interviews with providers and vendors
Productivity loss (e.g., decreased visit rate, increased time for data entry)	Workflow studies, cycle time studies
Creating interfaces with other systems (e.g., billing, scheduling, nursing)	Interviews with providers and vendors
Effects	**Potential Data Sources**
Changes in the rates of chart pulls, transcriptions	Interviews with providers, office records
Changes in the use of space, particularly for record storage	Interviews with providers, office records
Changes in the rates of pharmacy call backs and the method refill work	Logs, observation
Changes in drug utilization (e.g., generic substitutions, formulary compliance)	Administrative data, claims data from pharmacy benefit managers (PBMs) and health plans
Changes in laboratory utilization (e.g., duplicate test ordering)	Administrative data, claims data from health plans
Changes in radiology utilization	Administrative data, claims data from health plans
Changes in rates of adverse events and medical errors	Primary clinical data, patient surveys
Changes in accuracy of coding, degree of charge capture and number of billing errors	Administrative data, interviews with providers, claims data
Changes in health status for patients with chronic diseases	Clinical data, administrative data, claims data from health plans
Changes in rates of preventative screening	Clinical data, administrative data, claims data from health plans
Changes in medical utilization [e.g., hospital admissions, emergency department (ED) visits, ambulatory visits]	Administrative data, claims data
Changes in patient and/or provider satisfaction	Surveys of patients and/or providers

A number of considerations should be taken into account in collecting economic data to evaluate EHRs. First, to be complete, evaluations should attempt to measure as many of the costs and benefits as possible. If choices must be made as a result of limitations in time and resources, evaluators should prioritize the effects likely to be largest and/or most salient to decision-makers. Regardless of the anticipated magnitude of costs and benefits from other sources, we also believe that studies must include issues that influence physicians' decisions to implement and use EHRs, for example, productivity losses to practices, as these

factors strongly influence the rate of physician EHR adoption. Within these high-priority areas, the feasibility and cost of data collection will vary. Evaluators may wish to start with high-priority costs and benefits that are relatively inexpensive to measure and include as many additional effects as resources permit. Such a process may involve an expert consensus process similar to that conducted by the HITEC initiative. (HITEC, the Health Information Technology Evaluation Collaborative for New York State, is a multi-institutional academic collaborative evaluating the effects of HIT and HIE policies across the state. Rainu Kaushal, M.D., M.P.H., an author of this chapter and a co-investigator in the HIT Adoption Initiative, directs HITEC.) HITEC engaged in a process to rate the magnitude and likelihood of financial benefit to be derived from varying EHR functionalities. Although subjective, these ratings take into account the available literature and form a starting point for prioritizing functionalities in an economic evaluation.

Additional Issues

Timing

Costs and benefits associated with EHR adoption will change and accumulate over time, so any economic evaluation ideally should take a longitudinal approach. Both up-front costs and ongoing costs need to be considered. Benefits are likely to accrue over a period of time, as providers will take some time to acclimate to new technology and only reap maximum benefits through iterative refinements. Measuring the health effects of HIT adoption will take substantially longer than the financial effects, particular for technologies that influence disease management. Ultimately, simulation modeling may be required to estimate the health effects of HIT adoption.

Practice Size and Economic Effects

There are two important and related issues of scale, which have received insufficient consideration in the literature on EHR adoption. First, many studies focus on the cost per provider as a standardized cost metric of EHR implementation. However, even holding most other considerations equal, the cost per provider is not likely to be consistent across practices of different sizes. Larger practices will be able to realize economies of scale that are not available to smaller practices. Thus, cost-per-provider estimates are really only comparable across provider groups of similar size.

Practice size also influences the ability to realize the costs and benefits of EHR adoption at a granular level. Typically, in economic analyses, the value of physician and staff time are estimated as a function of changes in time use and overall salary. For example, if an EHR allowed a physician to reduce the time s/he spent maintaining patient notes by two hours out of a 50-hour week, it would constitute a 4 percent savings in physician time. If the physician earned $200,000 per year, that would translate into a savings of $8,000 per year. In a large group practice serving a large population, it would be possible for physicians to increase the number of patients seen per day and/or for the practice to reduce the number of physicians in the practice to capitalize on the additional efficiency afforded by an EHR. However, in a solo practice located in a rural area, where the number of patients is not easily increased and the physician cannot save personnel costs by reducing staffing, there is no way to

realize the gains possible due to increased efficiency except in terms of the value physicians/other staff place on leisure time relative to work time/wages. Similar issues would ensue in the event that EHRs *reduced* efficiency. Beyond personnel matters, small practices may be more limited in their ability to absorb changes in cash flow than larger ones. In short, smaller practices have less flexibility to reallocate human, cash and capital resources to maximize their profits.[i]

Network Effects

When assessing the societal impact of EHR implementation and developing EHR adoption strategies, it is critically important to evaluate costs and benefits from multiple stakeholder perspectives. Most economic evaluations of EHRs to date have taken the perspective of the provider, with the RAND study as a notable exception.[18] That is likely because providers have generally been financially responsible for purchasing EHRs. However, benefits accrue to many stakeholders, including other providers, payers, large employers and patients. Stakeholder perspectives should include those who make adoption decisions, those who implement, use and interact with EHRs, and those who benefit from EHR use.

Even absent widespread HIE, the elements of a minimally functional EHR can only be evaluated in the context of the community/market-level technology environment in which EHR adopters are operating. For example, the success of electronic prescribing or laboratory test ordering technology–key elements of computer physician order entry (CPOE) and a minimally functional HER–will partially depend on whether providers have arrangements with pharmacists and laboratories that are properly equipped to accept electronic orders and, in the case of laboratories, to report results electronically. If the surrounding pharmacies and laboratories are unable to accept electronic orders, there will be no resultant economic benefit as electronic transmission cannot occur.

Second-order costs and benefits stemming from network effects may emerge as stakeholders with sufficient market share begin to drive the behavior of the entities with whom they interact. HIT adoption rates by pharmacies and laboratories could drive EHR adoption by providers if, for example, pharmacies and laboratories reach a decision to interact with providers chiefly through electronic means. Similarly, payers could demand that providers adopt certain technologies or functionalities. Or payers could institute new financing mechanisms (e.g., pay-for-performance, bundled payments, partial capitation) that force or encourage changes in the delivery and effectiveness/efficiency of care while at the same time altering which economic effects are counted as costs or benefits by which entity. While providers' market share could be a driving force in EHR adoption, physicians (and to a lesser extent, hospitals/health care systems) have tended to have much more localized market power, and payers and pharmacies/laboratories have become increasingly regional or national market forces.

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i   Though providers may not be able to redirect efficiencies into profits, Robert Miller's study of community health centers provides an interesting illustration of how resource allocations can take place if providers are so motivated. While the community health centers studied were unable to achieve positive returns on their investment, what efficiencies they were able to extract by implementing EHRs were redirected into efforts aimed at quality improvement. Thus, even absent a positive financial return on investment from the health centers' perspectives, there were positive benefits from a societal perspective.

Recommendations for Economic Evaluations of EHRs—Building a Reference Case

Aggregating the findings of several analyses to reach a consensus about the value of EHR adoption is complicated. As is clear from an examination of the existing literature on EHRs in the ambulatory setting, there is wide heterogeneity in study designs, the data used and data collection methods. Some studies are simulations, some are pre-post designs and others are case series. The functionalities under consideration vary from study to study, as do the specific costs and benefits the authors considered relevant.

Within a definable technology and setting such as ambulatory EHRs, we would suggest moving towards a reference-case analysis analogous to that described in the 1996 report from the U.S. Public Health Service's Panel on Cost-Effectiveness in Health and Medicine.[19] A reference case would delineate specific costs and benefits for inclusion in the analysis, specific standards for data collection and specific minimally useful study designs that include appropriate control subjects. The reference case would also establish a baseline set of stakeholders for whom costs and benefits should be measured. We recommend that ONC and other agencies interested in the value of EHRs establish reference cases by technology, setting and level of analysis to be used in all economic evaluations of EHR adoption.

As a starting point, we propose that economic evaluations of EHRs should be based on primary data rather than expert opinion; that they occur from multiple perspectives, including providers and payers; that they consider multiple settings; and that they consider multiple HIT functionalities, focusing initially on EHRs in the ambulatory setting. Some of these analyses ultimately may also incorporate HIE. It is clear that there is no ideal study design that, by itself, will provide sufficient evidence on the value of EHR adoption. Convincing evidence would have to be based on the aggregation of many different study designs and settings incorporating different types of data. Minimally, we would suggest some ROI analyses from the perspective of providers and CBAs from the perspectives of payers and society. We would recommend a portfolio of analyses, including those at functionality, institution and community-wide units of analysis. The exact number of studies necessary to ensure representativeness of the sample needs to be determined. For each study, it will be important to assess and characterize the type of EHR that is being used and how it is being used. We consider each type of study in turn below and present a preliminary set of recommendations for a reference case to use in evaluating the costs and benefits of an ambulatory EHR. In general, we do not address nonmonetary outcomes such as quality, safety and health outcomes in detail, as the quality subgroup of the HIT Adoption Initiative is performing this analysis.

Studies Using Functionality as the Unit of Analysis

We would suggest a process that includes:

1. Developing a list of EHR functionalities in the ambulatory setting

2. Creating meaningful groups of related functionalities

3. Determining a conceptual framework to describe economic effects of different types of EHR functionalities

4. Determining study sites

5. Rank ordering functionality groups by the likelihood of achieving an economic effect, the magnitude of the economic effect in a given setting, and the policy relevance of the effect

6. Determining economic metrics, sources of data, sample size and data collection methodologies for the highest ranking functionalities

7. Analyzing data

8. Aggregating data across studies

We describe each of these steps in more detail below.

1. List EHR functionalities

To assist with future analyses, we developed a comprehensive list of EHR functionalities. These are included in Appendix A. This list of functionalities was initially derived by HITEC from the Certification Commission for Healthcare Information Technology (CCHIT) standards. Additional functionalities with likely economic effects, such as decision support for electronic prescribing, were added.

2. Grouping of functionalities

There are several ways to group these functionalities. In Appendix B, we illustrate one such grouping method. The Quality Subgroup of the HIT Adoption Initiative describes one approach to grouping in Chapter 9. Briefly, they started with five different lists and combined elements from each list in order to create a single grouping of functionalities. Although not as applicable to quality measurements, we added one category of functionalities to the Quality Subgroup categorization, entitled administrative tasks including coding and billing, as these will be important to economic measurements. The functionalities that we list in Appendix B should not be viewed as definitive but rather as one example of a lexicon. The Office of the National Coordinator may wish to use another grouping.

3. Determine a conceptual framework to describe the economic effects of EHR functionalities

For a successful analysis of HIT's economic effects, it will be important for investigators to develop and apply a conceptual framework that describes and then groups the ways in which certain functionalities may save money or incur further costs. For example, electronic results management may result in economic savings through decreased ordering of redundant laboratory studies, and this may be grouped into a category of decreased utilization. Another example is that electronic results management leads to economic savings through faster response to critical laboratory results, and this may be grouped into a category of efficiency or of improved health effects. An effective conceptual framework will allow valid and reliable descriptions of the economic effects of EHRs.

4. Determine study sites

Study sites should be determined early in the course of a study as the rank ordering of functionalities will be dependent on the implemented EHR, the setting and the surrounding network. For example, a study designed for an ambulatory rural practice with a newly implemented EHR and no surrounding

ancillary HIT capabilities will differ from that designed for an ambulatory academic practice with an iteratively refined EHR surrounded by the electronic capabilities of area pharmacists and laboratories. We would suggest that each study site focus on evaluations of those aspects of an EHR where they are sufficiently powered to demonstrate a difference. For example, evaluating the quality effects of an early EHR implementation would likely be inconclusive as quality benefits take time to accrue. However, changes in the efficiency of some services may be measurable after only a short period of time and, three years after EHR implementation, it may be feasible to measure changes in quality.

5. Rank order the groups of functionalities by the likelihood of achieving an economic effect, the magnitude of the economic effect and policy relevance

Each group of functionalities would then be rank ordered by the likelihood of achieving an economic effect and the magnitude of the economic effect on a high, medium and low scale. These rankings could occur from the perspective of multiple stakeholders, such as providers or payers. Once ratings such as these are developed and validated, they would have to be tailored to an individual implementation, study site and use case scenario. For example, the functionalities chosen to study will vary by study site depending on the exact components of the EHR implementation (e.g., whether checks for formulary compliance are introduced into the system); the surrounding network HIT capabilities (e.g., whether the pharmacy is able to accept electronic transmission of prescriptions); and the practice location (e.g., urban versus rural), among other factors.

In addition, policy relevance needs to be considered. For example, a study conducted by the federal government might focus primarily on Medicare beneficiaries. Primary outcomes may include effects on Part D, whereas secondary outcomes might include effects on federal employee health benefits or Medicaid patients. Policy relevance will vary depending on the perspective of the funding agency.

6. Determine economic metrics, sources of data, sample size and data collection methodologies for the highest ranking groups of functionalities

Based on the rank ordering, certain groups of functionalities would be of most interest. A given study site would then need to apply these overall rankings to their specific implementation, the timeline of that implementation (e.g., benefits driven by efficiency effects accrue more rapidly than health effects), and the use case scenarios. After selecting which EHR functionalities are most likely to result in meaningful results for a given site, studies would then be designed around these areas.

For example, a study site may wish to understand the economic effects of generic substitution through electronic prescribing and CDSS. Presuming that there is a dominant PBM in their community, and that this PBM is willing to provide access to data, they could use these data to conduct a pre-post study to assess the effects of generic substitution prompts on prescribing rates of generic medications. In conducting such a study, it would be important to perform risk adjustments for the pre- and post-study populations. It would also be necessary to have a record of EHR prompts to substitute a generic for a trade medication and the provider's response to these prompts to properly understand the EHR's role in changing prescribing behavior.

In addition, this same study site may choose to determine the effects of a number of medication decision support functionalities designed to reduce rates of medication errors and adverse drug events. In this case, they would likely need to design a pre-post study utilizing prescription review to determine medication errors, chart review to determine sequelae of these errors, and patient surveys to determine adverse drug events. A monetary value could then be placed on each averted adverse drug event based on previously published literature or additional de novo survey data collection. Again, it would be necessary to have a record of EHR prompts for medication prescribing support and the provider's response to these prompts.

Finally, this study site may choose to analyze their billing practices pre- and post-implementation of an EHR. Again, they would choose a cohort of patients, perform appropriate risk adjustment, and then collect and analyze billing data for differences that result from more appropriate billing after the implementation of the EHR.

Prior to finalizing the selection of any economic metrics, sample size and power calculations would need to be performed to determine whether or not studies of the proposed metrics are feasible and likely to result in significant results.

7. Analyze data

Analyzing the data for an economic evaluation involves accounting. All marginal costs and benefits (changes relative to the status quo) would be summed for specific parties to get the economic effect on individual entities and then across parties for a societal-level analysis. To begin with, each economic effect would be assessed to determine whether and to whom the cost or benefit applies. The costs and benefits would be enumerated, taking into account the timing of each. When the costs and benefits are summed, the values would be discounted at a rate reflecting the appropriate time cost of money applicable to the perspective of the analysis. For example, different discount rates might be applied to analyses taking the perspectives of providers, pharmacy benefits managers, patients or society as a whole. Social discount rates will be smaller, reflecting the opportunity cost of conservative investments of resources. Discount rates for certain providers may be higher, reflecting the greater average return on corporate investments. In all cases, sensitivity analyses should be employed to demonstrate the extent to which findings depend on the assumed discount rate.

8. Aggregate data across studies

Assuming the reference case analysis has been employed, synthesizing the findings of several analyses to reach a consensus about the value of HIT adoption would be relatively straightforward. Studies employing the reference case framework typically would all have comparable data collection methods and information on costs and benefits for a given technology, setting and level of analysis. The strongest case for establishing the value of a technology in a particular setting will come when results, aggregated at different levels of analysis, all reach the same conclusion. A well-conceived and executed research agenda for the economic evaluation of HIT, with strict data and method standards, will maximize the ability to aggregate across studies.

Studies Using the Institution as the Unit of Analysis

In the remainder of this chapter, we briefly consider planning for both institution and community level analyses. Although it is beyond the scope of this chapter to provide a detailed analysis plan for these types of studies, we thought it would be helpful to touch on some major considerations. We also note that such analyses are crucial for detecting the overall effect of HIT on organizational efficiency and quality, since it is hypothesized that EHRs, once widespread within organizations, may lead to waves of continuous improvement that would have been impossible in their absence.

The conduct of institution-level studies would benefit from the development of a reference case for this type of work, just as proposed for the functionality analysis. Many of the same steps outlined for a functionality-level analysis will be relevant for the institution-level analysis, with the exception of steps 1 and 2. Using such a reference case for guidance, the analysis would start with the selection of types of institutions and specific sample institutions for study. The selection process would be driven by the desired policy outcome of the study. For example, for inpatient CPOE, several hospitals implementing a specific, or several different, vendor-based EHR systems could be selected. For each institution, economic metrics would be analyzed in a pre-post study design with concurrent controls. Cost metrics would include, among others, information systems implementation and operational costs, information systems staffing, hardware, software, productivity loss and creating interfaces with other systems. Measures of effects would include overall revenue, clinical revenue, cost per case, billing capture, radiology and laboratory test utilization, risk adjusted mortality, other health effects, staffing and medical record space. Hospital administrative and billing data would be the primary sources of information.

Kaushal and Bates conducted an ROI analysis of an inpatient CPOE system at Brigham and Women's Hospital.[20] In this study, they used primary data, which was collected largely as part of grant-funded studies, assessing outcomes of specific CPOE decision support elements. Some of the outcomes were described in financial terms, while many were described in health safety terms (e.g., averted adverse drug events). In the case of the latter, they monetized the health effects using already published costs of ADEs. They then summed costs across the institution, both capital and maintenance costs, and summed savings across different clinical decision support elements. In their study, they provide a cumulative ROI analysis for the hospital. They are presently extending this work to a number of hospitals across Massachusetts. Similar studies of HIT functionalities could be conducted across institutions.

Studies Using the Community as the Unit of Analysis

Here again, work should start with the construction of a reference case. Communities may be defined based on an area covered by a health information exchange or a payer. Alternatively, they can be defined as a market based upon methods similar to those employed in studies of managed care penetration or small area variations in medical care. More isolatable areas may provide more convincing results. The costs of implementing HIT systems included in the analysis will be the same as those used in institution-level studies. Rather than measuring HIT implementation costs for each provider in the community, environmental scans of HIT prevalence can be used together with institution-level estimates to generate

estimates of community-wide HIT costs. Community-wide metrics of effect would then be measured as a function of HIT prevalence and costs. These metrics should include overall health care spending, service specific health care spending and utilization (inpatient, outpatient, home health, pharmaceutical and diagnostic), mortality rates and morbidity rates (e.g., myocardial infarctions, nosocomial infections and diabetes-related amputations). Private, Medicaid and Medicare claims data, pharmacy benefits manager data, hospital data and public health reporting data would all provide inputs to the analysis.

Conclusion

In conclusion, we have outlined many considerations for an economic analysis of HIT. In order to simplify this discussion, we chose to focus on ambulatory EHRs. We then provided an overview of several economic approaches to analyses and performed a review of the literature. Using this information, we then outlined practical considerations for an economic analysis, including a discussion of data sources. We ended with recommendations organized by the unit of analysis, primarily focusing on functionality analyses.

Appendix A: List EHR Functionalities

1. Capture deviations from standard care plans, guidelines and protocols

2. Capture patient preferences

3. Check for drug-drug interactions

4. Display patient-specific data for chronic disease management

5. Document and schedule follow-up appointments

6. Document point-of-care laboratory results

7. Enable full electronic management of medical records

8. Enable inter-provider communication

9. Enable links to external knowledge sources

10. Enable physicians to manage panels of patients

11. Enable report generation for public reporting

12. Enter electronic referrals

13. Generate and record patient specific instructions

14. Maintain an electronic record of all patient encounters

15. Manage allergy list (without active drug-allergy checks)

16. Manage flow sheets

17. Manage patient advance directives

18. Manage patient consents and authorizations

19. Manage patient demographics and administrative information

20. Manage patient's past medical history, family history and social history

21. Manage (prioritize and sort) laboratory results

22. Manage problem list

23. Manage progress notes

24. Manage structured medication list

25. Notification of results availability

26. Perform drug-allergy checks

27. Perform drug-condition checks

28. Perform drug-diet checks

29. Perform drug-lab checks

30. Prescribe medications

31. Prompt corollary lab ordering

32. Provide alerts for adherence to standard care plans, guidelines and protocols

33. Provide alerts for critical lab values

34. Provide alerts for expensive medications

35. Provide alerts for laboratory charges

36. Present alerts for preventive services and wellness (e.g., pap smears and mammograms)

37. Provide alerts for redundant lab orders

38. Provide alerts regarding generic substitution

39. Provide alerts regarding formulary compliance

40. Provide decision support for immunization orders (including flu shot and pneumovax reminders)

41. Provide default drug dosages

42. Provide dosage checking

43. Provide reminders for adherence to guidelines for chronic disease management

44. Provide renal dosing guidance

45. Provide rules-driven financial and administrative coding assistance

46. Provide surveillance for ADEs

47. Send an order for a test (if onsite)

48. Support quality improvement measurement

49. Support supply management including documentation of medication and immunization administration in the office

50. Support the creation of legal documentation

51. View laboratory results

52. Voice recognition capabilities for documentation

Appendix B: Group EHR Functionalities

1. Electronic notes and health information management
   a. Enable full electronic management of medical records
   b. Manage patient advance directives
   c. Manage patient's past medical history, family history and social history
   d. Manage problem list
   e. Manage structured medication list
   f. Manage allergy list (without active drug-allergy checks)
   g. Voice recognition capabilities for documentation
   h. Manage flow sheets
   i. Manage progress notes
   j. Generate and record patient-specific instructions
   k. Capture patient preferences

2. Results management
   a. View laboratory results
   b. Provide alerts for critical lab values
   c. Manage (prioritize and sort) laboratory results
   d. Notification of results availability
   e. Document point-of-care laboratory results

3. Provider order entry with decision support for nonmedication orders
   a. Prescribe medications
   b. Provide alerts for redundant lab orders
   c. Send an order for a test (if onsite)
   d. Provide alerts for laboratory charges
   e. Provide decision support for immunization orders (including flu shot and pneumovax reminders)
   f. Enter electronic referrals

4. Medication prescribing support
   a. Provide alerts regarding generic substitution
   b. Provide alerts for expensive medications
   c. Provide alerts regarding formulary compliance
   d. Provide default drug dosages
   e. Check for drug-drug interactions
   f. Provide renal dosing guidance
   g. Perform drug-allergy checks
   h. Perform drug-lab checks
   i. Provide dosage checking
   j. Prompt corollary lab ordering
   k. Perform drug-condition checks
   l. Perform drug-diet checks

5. Clinical reminders during patient encounter
   a. Present alerts for preventive services and wellness (e.g., pap smears and mammograms)

6. Clinical guidelines, protocols or reference tools
   a. Provide reminders for adherence to guidelines for chronic disease management

    b.   Provide alerts for adherence to standard care plans, guidelines and protocols

    c.   Display patient-specific data for chronic disease management

    d.   Capture deviations from standard care plans, guidelines and protocols

    e.   Enable links to external knowledge sources

7. Population health management tools
    a. Enable report generation for public reporting
    b. Enable physicians to manage panels of patients
    c. Provide surveillance for adverse events including adverse drug events
    d. Support quality improvement measurement
    e. Immunization tracking
    f. Support performance measurement

8. Electronic communication
    a. Enable inter-provider communication

9. Administrative, billing and coding
    a. Manage patient consents and authorizations
    b. Manage patient demographics and administrative information
    c. Maintain an electronic record of all patient encounters
    d. Provide rules-driven financial and administrative coding assistance
    e. Support supply management including documentation of medication and immunization administration in the office
    f. Document and schedule follow-up appointments
    g. Support the creation of legal documentation

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Chapter 9: A Framework for Measuring the Effects of Health Information Technology on Health Care Quality

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Introduction

Health Information Technology (HIT) is generally understood as having the potential to transform the quality and efficiency of health care in the United States. The basis for this enthusiasm includes well-reasoned conceptual propositions, analogies with other industries, a limited set of empiric data and enthusiasm for information technology generally. To date, however, attempts to measure the impact of HIT on quality of care have fallen short of providing robust evidence with regard to the "value" of electronic technologies. In light of the significant expenses associated with the purchase, implementation and maintenance of these systems, health care providers have been wary of making the substantial financial (and organizational) investment necessary to convert to a fully electronic system without adequate evidence indicating that there will be significant economic or health benefits from that investment. As a result, there has been increasing interest, both in the public and private sectors, in establishing a better evidence base for the health and financial effects we can expect from HIT.

Measuring the consequences of HIT on the quality of care provided to patients and consumers is a critical factor in understanding its health effects. This is a challenging task because both quality of care and health information technology are complex, multifaceted concepts. Therefore, the multiple, interacting components of quality and HIT must be determined and the key associations of those elements need to be measured in order to make progress with this difficult problem.

In an attempt to provide guidance on the HIT components that should be measured and the aspects of quality we should expect those functionalities to improve, we have examined conceptual relationships between HIT and quality of care, existing empirical evidence on the impact of HIT on quality, and alternative approaches to measuring those effects in practice. We have reviewed these materials with an expert panel,* and with that panel's concurrence, set forth recommendations for assessing the quality effects of HIT. Our goal is to provide guidance to future investigators interested in assessing the health consequences of implementing HIT systems, so that research on this topic will provide the best possible information for policy development.

To make our task manageable, we limited our research to an investigation of the relationship between electronic health records (EHRs) and quality of care. Although HIT includes more than EHRs, electronic records are a central element of HIT. Health information exchange (HIE) is widely considered to be a critical component of HIT, and much of HIT's quality and efficiency benefits are thought

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* A list of panel members can be found in Appendix A.

to result from the data exchanged between EHRs and other electronic systems that store health information.

Nonetheless, true HIE, occurring between providers or delivery systems, has proved elusive to date. Thus, because evidence of the quality-related benefits of HIE is more limited and the conceptual underpinnings of the relationship are more speculative, HIE is not considered within the framework presented here. Our investigation also excluded personal health records (PHR), bar-coding and telemedicine. In addition, we do not discuss the ways in which electronic health information can itself be used for measuring quality of care, which many observers consider to be among the most important routes by which the EHR may improve health care quality. This complex and important topic is beyond the scope of this work.

 Measuring quality of care is an important component of quality improvement, and the electronic capture of data used to measure quality of care has the potential to create significant efficiencies in this process. Nonetheless, the Office of the National Coordinator for Health Information Technology (ONC) has been working with other groups to develop standards for quality data measurement and reporting. Finally, while efficiency of care is sometimes viewed as a component of quality, at other times efficiency and cost are grouped conceptually. Because the potential for improved efficiency is such a critical aspect of HIT, we have devoted an entire chapter of this report to the subject and therefore do not address it here.

We should point out one additional decision we made in choosing the focus of this chapter: to concentrate on approaches to evaluating what we would call direct, rather than indirect, effects of HIT generally, and EHRs particularly, on quality of care. Direct effects consist of the ways in which EHRs may affect provider and patient decisions and behaviors at the point of care. The principal mechanisms of such effects involve making available relevant information and decision support that are important to the care process, but otherwise might not be available or properly used. Examples of such effects include reminding physicians to order indicated preventive tests, assisting them with interpreting laboratory results, alerting them to critical abnormal findings, directing them in real time to existing guidelines for care, making available consultants' notes and recommendations in manageable and consumable form. Through mechanisms such as these, EHRs may plausibly lead to increases in the proportion of patients whose care conforms to guidelines; fewer overlooked or delayed diagnoses; and safer, more effective health care services.

Valuable as these direct effects are, however, there are other potential indirect effects of EHRs on quality of care that may be even more powerful in elevating the quality of the health care system over the long term. The mechanism of improvement for indirect effects consists of generating richer, cheaper and more relevant clinical information that can be used to measure performance at the practice, organizational and regional level. These data, it is hypothesized, will act through at least two pathways to elevate quality of care. First, the data will increase transparency in the health care system, and by alerting providers and patients to existing variations in performance, stimulate the former to improve and the latter to choose better performing health care practitioners and organizations. Second, the clinical data will, in themselves, provide the substrate for organizational improvement. Better data on process failures are vital to identifying and improving those processes. But at the current time, collecting such data is tedious and

expensive, reliant mostly on chart review and ad hoc data gathering activities. EHRs can make it much cheaper and easier for organizations to execute quality improvement projects.

In concentrating on describing methods for evaluating direct effects of quality improvement, we do not mean to imply that these are more important or powerful than indirect effects. Rather, we felt it was appropriate to start with the hypothesized consequences that had received the most attention to date in the literature and that are most amenable to traditional evaluation approaches. We plan in future reports to address approaches to evaluating indirect effects in greater detail.

Background

Defining EHRs

From a conceptual standpoint, the term EHR encompasses many related information technology functions. These functions serve a variety of purposes and often are not precisely defined. The Institute of Medicine (IOM) defined an electronic health record system as: (1) longitudinal collection of electronic health information for and about persons, where health information is defined as information pertaining to the health of an individual or health care provided to an individual; (2) immediate electronic access to person- and population-level information by authorized, and only authorized, users; (3) provision of knowledge and decision support that enhance the quality, safety and efficiency of patient care; and (4) support of efficient processes for health care delivery.[1]

An electronic health record is defined by the Healthcare Information and Management Systems Society (HIMSS) as:

> "a longitudinal patient record of patient health information produced by encounters in one or more care settings. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology reports… The EHR has the ability to independently generate a complete record of a patient encounter, as well as supporting other care-related activities such as decision support, quality management and clinical reporting."[2]

Focusing only on the first portion of this definition, one might infer that an electronic health record is simply an electronic version of a traditional paper chart. However, in addition to the standard, visit-specific information contained in paper charts, EHRs contain additional features (functions) that are intended to provide added utility. As a result, an EHR is often conceptualized from an IT standpoint as a specific set or bundle of IT functions.

A list of the functions that constitute an EHR may vary according to the purposes for which the list is being created. For example, the Certification Commission for Healthcare Information Technology (CCHIT) created a list of EHR functionalities for certifying EHRs.[3] In 2006 our expert consensus panel created a more limited list for determining the rate of EHR adoption in the United States.[4] For discussing the relationship between EHRs and quality, the Institute of Medicine identified eight core EHR functionalities. The IOM

list included: health information and data;* results management;* order management;* decision support;* electronic communication and connectivity; patient support; administrative processes; and reporting.[5]

Later in this chapter, we provide the results of an exercise designed to provide a useful list of functionalities for measuring the effects of EHRs on quality of care.

Defining Quality

Like EHRs and HIE, quality is difficult to define in a way that quickly and easily lends itself to empirical measurement. Nonetheless, several well known attempts provide sufficient grounds for making headway on this issue. The IOM defines quality as, "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[6] This static definition, while helpful for framing one's conception of quality, is not sufficiently specific to determine how quality can and should be assessed. For the purposes of assessment, such a definition is secondary to the question of what constitutes high-quality medical care. With this in mind, in 1990 Avedis Donabedian developed a list of seven pillars of quality: efficacy, effectiveness, efficiency, optimality, acceptability, legitimacy and equity.[7] These were later adapted by the IOM in its 2001 report, *Crossing the Quality Chasm*, to the following six quality aims, which constitute attributes of a high-quality health care system:

1. **Safe:** avoiding injuries to patients from the care that is intended to help them.

2. **Effective:** providing services based on scientific knowledge.

3. **Patient-centered:** providing care that is responsive to individual patient preferences, needs and values and assuring that patient values guide all clinical decisions.

4. **Timely:** reducing waits and sometimes harmful delays for both those who receive care and those who give care.

5. **Efficient:** avoiding waste, including waste of equipment, supplies, ideas and energy.

6. **Equitable:** providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location or socioeconomic status.[8]

In principle, studies of the effects of HIE and EHRs on quality should employ measures that capture these six attributes. These attributes are, of course, broad and multifaceted themselves and leave much room for the elaboration of subdimensions and corresponding submeasures. The quality measurement domains developed by the Agency for Healthcare Research and Quality (AHRQ) offer an alternative, complementary framework for assessing quality.[9] While this presents a valuable perspective, we chose to examine quality of HIT from the vantage point of the IOM quality aims for the purposes of this report.

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* Denotes a functionality that was determined by HIT Adoption Initiative Expert Consensus Panel (2006) to be one of the essential functionalities of an electronic health record for purposes of measuring EHR adoption.

Conceptual and Practical Challenges to Measuring the Effects of EHRs on Quality of Care

EHRs are neither necessary nor sufficient for high-quality care

One of the greatest challenges in assessing the effects of EHRs on quality of care is that EHRs are neither necessary nor sufficient to achieve high-quality care as it is understood today. Numerous examples of high-quality care can be found in settings without EHRs. Conversely, studies of EHRs and their component functions have sometimes found no benefit or even negative consequences. Taken together, these findings suggest that EHRs may be neither necessary nor sufficient for high-quality care. Many other factors in health care settings, including incentives, training, leadership and the design of care processes, significantly influence quality of care and thus likely modify the impact of EHRs.

In addition, the emerging field of macro-ergonomics, the study of how humans use technology such as EHRs in their work, suggests that the design of HIT technologies and the way users incorporate EHRs into their daily work are critical factors in determining their ability to improve measures of quality. If EHRs are not optimally designed, they may easily have a minimal effect or even adverse effects. Finally, the process of adopting an EHR system can be highly disruptive to health care delivery, possibly to the point of causing harm,[10] and implementation may be prolonged or never completed. Thus, the extent to which EHRs improve care depends on: (1) non-IT related factors in the micro-environment of care delivery; (2) human-IT interface design factors; and (3) the successful adoption of EHRs.

Nevertheless, anecdotal evidence from providers, reviews of published studies,[11] and theoretical considerations all suggest that EHRs hold significant promise for improving quality of care. The availability of real time information and decision support for practicing clinicians; producing information for accountability and feedback; the opportunity to link incentives to the information made available through these applications—all these outcomes strongly suggest that electronic records have substantial potential to improve quality. Indeed, the promise of these technologies seems so self-evident that there is a tendency to dismiss studies that fail to show their benefits. Studies of EHRs' effects on quality, therefore, face a special burden as they must take into account many confounding factors, such as those discussed in the preceding paragraph, which may obscure the independent effect of electronic information systems. If investigators fail to account for these factors, positive studies may overstate EHRs' effects and negative studies may understate them.

Finally, it is possible that EHRs would necessitate the creation of an altogether new standard of high-quality care. In other words, the combination of efficiency gains and care delivery improvements possible with EHRs may have been missed in the research to date. This is either because we don't have adequate metrics for capturing these effects or we are not far enough along in the adoption of EHRs for such benefits to be realized. While EHRs may themselves enable such a transformation, it is also possible that the organizational changes required to support and use EHRs (including the way physicians spend their time) could contribute to these improvements in care.

Limitations to the existing evidence base

The best evidence regarding the effect of EHRs on care quality comes from two different types of studies. The first type is a prospective trial (sometimes using group randomized design) of a specific EHR function's effect on care processes or, more rarely, patient outcomes. These studies focus on EHR functions rather than an EHR as a whole because of the practical problems associated with studying the de-novo introduction of an entire EHR into multiple practices. Such a trial would be both prohibitively expensive and very complex to carry out. The second type of study overcomes the narrow focus on functionality by looking at associations between EHR use and well-established measures of quality. This approach, called cross-sectional association, also suffers from important limitations. In the following sections, we examine these two approaches to gathering knowledge about the value of EHRs in more detail and examine the limitations inherent to both.

Generalizing from specific improvements in quality that result from specific EHR functions is problematic

The most comprehensive literature review of HIT's effect on quality of care has identified several important patterns in the existing body of research.[11] This review found an abundance of studies that prospectively evaluated the impact of specific EHR functions on care delivered for a specific clinical condition and in a particular setting. These studies provide relatively robust estimates of that specific HIT function's effect on the specific clinical situation. Unfortunately, most of these studies are of limited policy value because there is no straightforward way to aggregate them and produce a summary estimate of their health benefit. Each of the issues enumerated below represents a distinct challenge to our ability to generalize from the existing research:

1. One of the greatest limitations is that most research on EHRs has been conducted at a relatively small number of locations, typically at urban academic medical centers that utilize "homegrown" EHR systems. Results of trials that take place at a single location are limited by the following considerations:

   a. *The EHR system and its functions may be unique.* There is considerable variation across systems in user interface, design, information flow and management. A distinct advantage of a "homegrown" system, as opposed to the vendor software employed in the majority of settings, is the ability to tailor and subsequently modify the system and its components to serve specific needs of a particular setting. The unique technical and/ or design features associated with such a system may have a significant impact on the quality effects accrued and may therefore render them ungeneralizeable to EHR systems as a whole.

   b. *Microsystems have unique characteristics.* The quality effects experienced following EHR implementation in a single setting will be mediated by the characteristics of that particular organization, its systems and workflow processes.

   c. *The involvement of researchers may have influenced the implementation.* Most HIT studies have been led by researchers who are involved with EHR

development and/or implementation. Their desire to demonstrate positive results may affect the EHR or its use in ways that would not be seen in non-research settings.

d. *The extent of adoption (use) is often not measured.* Implementation of an EHR does not guarantee proper and/or effective utilization. Quality effects are mediated by various factors related to workflow and human-computer interfaces, which are neither easily captured nor measured.

e. *Measured improvements are likely to be dependent on baseline performance*: that is, when performance is poor at baseline, greater improvement may be easier to accomplish, and vice versa.

2. Another shortcoming of the literature on EHRs and quality is that many of the studies examine the effect of single EHR functions on single clinical care processes, thus highlighting quality effects that may not be generalizable to other functionalities or processes. A typical study of the effects of EHRs on quality of care examines a change in the delivery of a service (e.g., immunization) associated with an EHR functionality, for example, a reminder or registry. While it may be tempting to aggregate results from such studies to provide an overall estimate of the quality improvements from a specific function (e.g., reminders), this leap may not be valid. Reminders are likely to have varying efficacy for different clinical processes—for example, cervical cancer screening or reminders to elevate the beds of patients on ventilators.

3. Lastly, the majority of studies examining the effect of EHRs on quality have focused on a relatively narrow set of functionalities and outcomes. To illustrate this point, we inventoried existing studies of the quality effects of EHRs and identified gaps in the functionalities and quality domains covered by those studies. To identify the research, we used the work of Chaudhry and colleagues[12] and AHRQ reports concerning the work of their grantees.[13] To identify gaps, we categorized all EHR studies according to two criteria: the EHR functionalities the investigators examined; and the quality measures that those same studies used to determine the effects of EHRs on quality. We classified EHR functionalities using a grouping algorithm developed in collaboration with our expert advisory panel (details of this are presented later in the chapter). We grouped quality measures by their relevance to the six IOM attributes of high-quality care. Finally, we populated Table 1 on the next page, which indicates the number of research studies examining the relationship between particular functionalities and particular quality attributes.

Table 1: **Distribution of Quality Measures and EHR Functionalities Found in Existing Research**

N (total) = 155 (by study)						
	Safety	Effectiveness	Patient-Centeredness	Efficiency	Timeliness	Equity
1. Electronic notes and health information management	4 (3)	19 (12)	6 (4)	17 (11)	1 (0)	
2. Results management	2 (1)	4 (3)		2 (1)	4 (3)	
3. Provider order entry	22 (14)	22 (14)		26 (17)	3 (2)	
4. Medication prescribing support	29 (19)	24 (15)		12 (8)	3 (2)	
5. Clinical reminders	4 (3)	56 (36)	4 (3)	4 (3)	3 (2)	
6. Clinical guidelines and protocols	3 (2)	64 (41)	3 (2)	12 (8)	2 (1)	
7. Population health management tools		1 (0)			1 (0)	
8. Electronic communication						

The Table indicates that existing research seems to have addressed only a limited number of functionalities and potential quality effects. Importantly, most studies measure process improvements as primary quality endpoints. Improvements in health are difficult to derive from changes in process measures, when those measures do not have a well-established connection with morbidity and mortality. For example, studies that examine the impact of EHRs on medication errors can be linked to population estimates of health benefit because there is data linking medication errors to patient morbidity and mortality. An inventory of the performance measures used to assess quality effects across the studies reviewed by our group can be found in Appendix B.

Cross-sectional studies associating EHRs with quality have been poorly controlled

In contrast to the work cited above, where investigators isolated specific EHR functions and investigated changes in care processes or outcomes, other investigators have attempted cross-sectional studies examining the relationship between the use of EHRs and a variety of quality endpoints. These studies have the value of capturing the accumulated and interacting effects on quality endpoints of all the functionalities that make up an EHR.[14–18] However, problems emerge in interpreting these studies as well.

The most important limitation of cross-sectional, association studies lies in the difficulties associated with controlling for key confounders. An important principal of epidemiology is ascertaining the degree to which the study results could be explained by factors other than predictor of interest. In the case of EHRs, several factors influence the likelihood that an EHR will impact care delivery. Nonetheless, association studies to date have typically relied on self-reported measures of EHRs that did not carefully determine the functional capabilities,

the duration that system had been in place, or the extent of use of that system. In epidemiologic terms, the exposure variable has been poorly specified. The main predictor, an EHR or HIE, needs to be carefully defined and its distribution in the study population needs to be well understood and described. Without a precise definition of an EHR and/or HIE capabilities, as well as inclusion of variance of the "exposure" within the population being studied, cross-sectional association studies will fail to account for the complexity and variability of use among providers. This failure will bias such research towards the null hypothesis (that EHRs and HIE are not effective for improving quality). For example, Linder and colleagues failed to find that EHRs had any effect on quality of care in a study using nationally representative data, but the data they used did not allow them to control for any of the factors that influence the effectiveness of EHRs.[14]

Association studies are also subject to the trap of identifying unlikely or implausible relationships, leading to studies that lack a plausible explanation for their findings. These studies may find relationships for which there is no clear, clinical explanation, or purport negative results when the endpoints would be unlikely to be influenced by the technology to begin with. For example, a HIMSS study found numerous associations between hospital IT and hospital quality measures, but many of the statistically significant findings did not have a clear mechanism to support the finding.[16] Put differently, it is important that studies are interpreted with a full understanding of the technologies under investigation and their potentialities, and the characteristics of the measures utilized. Ideally, association studies should be hypothesis-driven.

Summary of Challenges

The evidence base for understanding the effects of EHRs on quality of care consists largely of: (1) well-controlled, prospective studies of EHR functionalities on specific clinical situations at a single site; or (2) cross-sectional association studies attempting to link the presence of an EHR to multiple measures of quality. Both of these types of investigations present major challenges for use in health care policy. To use the former, we need to aggregate studies of different EHR functionalities and patient outcomes to allow summary statements about their effects on patient health. At the current time, such aggregation does not appear possible. To use the latter, we need to be assured that the independent variable (EHRs and their associated functionalities) are well described, that their distribution and use are well characterized, that confounders are measured, and that results are clinically plausible. No studies to date have achieved this level of sophistication.

The challenge of creating evidence for EHR policy development is considerable but that has always been true of efforts to develop evidence for consequential policy decisions. In the remainder of this document, we outline a variety of considerations that, based on previous research and conceptual issues, we believe should be taken into account in designing future studies of the effects of EHRs and HIE on quality of care.

Towards a Framework for Measuring the Effects of HIT on Quality of Care

To increase the probability that future studies of the quality effects of EHRs provide rigorous and relevant evidence to support policy-making, we outline here some key goals and methods that investigators should consider as they develop their studies.

In particular, we describe the evidence that is essential to policy-makers to enable researchers to design studies that develop the evidence in question. Then, we provide lists of functionalities and quality metrics in the hope that these lists will help investigators develop comparable definitions of EHRs and related functionalities, and to use comparable measures of quality effects. By employing these or other consistent definitions of intervention and effect, researchers will increase the chance that their results will be comparable and susceptible to aggregation over multiple studies. Finally, we lay out a rationale for linking functionalities to effects. This rationale will, we hope, help researchers develop hypotheses that can be explored in EHR studies, whether clinical trials or epidemiologic investigations. The knowledge of such hypotheses can assist researchers in setting priorities for studies, and it will decrease the likelihood that studies explore associations that will not, ultimately, be convincing to policy-makers and HIT experts.

Goals of evidence development

To develop effective EHR policies, policy-makers would require information with the following characteristics:

1. Evidence that systematically explores both positive effects as well as negative effects;

2. Evidence that systematically explores both anticipated and unanticipated effects;

3. Evidence that addresses critical, policy-relevant indicators of quality and population health; and

4. Evidence that can be aggregated across studies to provide indications of population effects—both for groups of stakeholders and for the United States as a whole.

It is worth asking whether a single, well-designed clinical trial—the idealized way of studying medical interventions—would satisfy the needs of policy-makers for this sort of evidence. Such a trial might have the following characteristics:

1. It would include providers with a range of baseline performance on quality measures and a mean performance that matched the U.S. mean.

2. It would test a state-of-the-art EHR system (or systems) that was certified by federal standard setters, designed for ease of use and had known functionalities.

3. It would measure the extent of system use by providers both before and after implementation (exposure), including the use of particular functionalities.

4. It would measure high-priority quality effects relevant to all six IOM domains of quality.

5. It would measure characteristics of providers, their work settings, their organizations and their markets that might confound observations of the effects of EHRs.

6. It would assess positive, negative, anticipated and unanticipated outcomes.

Conducting such a study would pose enormous logistical challenges: it would face many conceptual and practical hurdles and would likely fail to meet all expectations. Nevertheless, it would still produce enormously valuable information for the HIT field. However, budget realities make it unlikely that a study of this size and scope—likely costing tens of millions of dollars annually over a number of years—will be undertaken any time soon. We should point out though, that millions of dollars will be spent over the next decade on small, scattered studies of limited policy value and that a single study costing tens of millions of dollars would be a relatively small investment, considering the size of the Medicare budget and the importance of the issue. Therefore, it is essential to outline some guidance that may improve the value of the many smaller, less expensive investigations on which policy-making is likely to be based in the future.

Toward a common lexicon of EHR functionalities

Future investigations of the quality effects of EHRs would benefit from a common lexicon of functionalities. Here we describe the process we used to generate such a list. We do not believe that this is necessarily the final or definitive list, but it is a start on developing such a lexicon. The Office of the National Coordinator and/or AHRQ may wish to amend this list or to convene another group to refine or revise it. Nevertheless, we describe our process and its results to provide a starting point for further efforts.

To generate this list of HIT functionalities, we started with five existing lists:

1. IOM list;[5]

2. ONC HIT Adoption Initiative list, used to define an EHR;[4]

3. Shekelle and colleagues' list from the Agency for Healthcare Research and Quality evidence-based resource center;[11]

4. a list employed by the Bates group at Brigham and Women's Hospital for their survey of physicians;[19] and

5. the CCHIT list of functionalities used for certification (for our purposes, we only used those elements related to clinical care and not those used for administrative and/or billing functions).[3]

Each of these lists has strengths and weaknesses for measuring the effects of EHRs on quality of care. While the broad categories of the IOM list are useful for creating functionality groupings, they have limited practical utility for research. The list endorsed by the HIT Adoption Initiative in its 2006 report is similarly limited by the general nature of its categories and the fact that it attempts to define the *minimum* functions necessary to constitute an EHR.

Conversely, the CCHIT list represents the other extreme. While the CCHIT list details many valuable elements that are missing from the prior lists, its high level of granularity limits the list's value for evaluating the quality effects of EHRs from a provider's perspective. The lists used by both the Bates and Shekelle groups described EHR elements at the level of detail that our project team and expert panel felt was most appropriate for measuring effects on quality. The Bates list was generated from a "vendor perspective," based upon the bundles of functionalities that are currently available. While this list captures a number

of elements that are integral to an inventory of EHR functionalities, the list created by the Shekelle group is the most useful starting point for our purposes. Although the Shekelle list was not developed specifically to measure the effects of EHRs on quality of care, of the lists we reviewed, it came closest to describing the functionalities used from a provider's perspective because it was generated through an empirical review of existing research.

In order to create a table that grouped EHR functionalities into a single organizational scheme, we combined the EHR functionalities found in the lists referenced above. We started with the eight IOM functionalities: health information; results management; order management; decision support; electronic communication and connectivity; patient support; administrative processes and reporting; and reporting and population health. We then organized the elements contained in the more granular lists (CCHIT, Shekelle and Bates) by placing them into the eight broader IOM categories. We removed duplications and resolved conflicts between lists by grouping functionalities according to how they would be viewed by a practicing clinician (e.g., CPOE instead of "order management") (Table 2). The list was reviewed and approved by our expert panel. We also created a shorter list of EHR functionalities (Table 3) that were considered to be particularly important for high-quality clinical care.

Table 2: **Expanded List of Functions Categorized Under IOM 8 Core EHR Domains**

1. Clinical Documentation/ Health Information
    a. Electronic notes
        i. Templates
    b. Problem/diagnosis list
    c. Medication/ allergy list
    d. Medication administration history
    e. Advance directives
	5. Electronic Communication and Connectivity
	    a. Provider-provider communication
	    b. Patient-provider communication (secure electronic messaging)
	    c. Health information exchange capability (interconnectivity among providers)

2. Results Management
    a. Laboratory (chemistry, microbiology)
    b. Imaging
    c. Specialty consult reports
    d. All other (vital signs, etc.)
	6. Patient Support
	    a. Health information resources (for patients)
	    b. Patient instructions
	    c. Personal health records/portal
	    d. Remote patient monitoring

3. Order Management
    a. CPOE
        i. E-prescribing
        ii. Referral
        iii. All other (labs, tests, etc.)
	7. Administrative Processes and Reporting
	    a. Administrative information

4. Decision Support
    a. Health information resources (for providers)
    b. Standing orders, protocols, and clinical pathways
    c. Alerts, reminders, warnings
        i. Preventive services and wellness
        ii. Standard care guidelines and protocols
        iii. Prescribing: drug interactions, dose warnings, drug allergies
        iv. Lab test-related alerts
	8. Reporting and Population Health
	    a. Registries with reporting functions
	    b. Automated quality reporting

Table 3: **List of EHR Functionalities Considered Likely to Impact Quality of Care**

1. Electronic Notes and Health Information Management (including problem/medication lists, note templates, care templates for specific conditions, etc.)

2. Results Management (e.g., lab results, radiology reports/viewing, abnormal lab/imaging alerts, etc.)

3. Provider Order Entry (e.g., electronic ordering of medications, tests, etc.)

4. Medication Prescribing Support (e.g., drug interaction alerts, dose calculators, renal impairment suggestions, etc.)

5. Clinical Reminders During Patient Encounters (e.g., routine screening/preventive care alerts, alerts for medications for specific clinical conditions, etc.)

6. Clinical Guidelines/Protocols (e.g., information regarding care for specific conditions, clinical pathways, etc.) or Reference Tools (e.g., UptoDate, Micromedex, etc.)

7. Population Health Management Tools (e.g., registries, lists of patients eligible for a clinical service, etc.)

8. Electronic Communication (e.g., secure patient/provider or provider/provider e-mails, Internet chat, etc.)

Towards a set of high priority measures to assess the quality benefits of HIT

One barrier to developing the evidence base for EHRs' effect on quality is the fact that we don't know which clinical quality measures are most sensitive to the improvements in care that we can expect from EHRs. To that end, we conducted an exercise designed to generate some hypotheses for the best measures of EHR effectiveness. This exercise consisted of asking seven practicing, general internal medicine physicians, enrolled in the Harvard General Medicine Fellowship program, to review all the National Quality Forum (NQF)-endorsed ambulatory quality measures and Hospital Quality Alliance (HQA) inpatient quality measures. They then rated the extent to which performance on these measures might be improved by each of the eight EHR functionalities listed above. We chose these clinicians because of their detailed knowledge of clinical care and their familiarity with both measures of health care quality and health IT functionalities. (Further details of the methods used in the exercise can be found in Appendix C).

For 83 of the 125 individual NQF and HQA quality measures, at least four of seven respondents agreed that one key HIT functionality would most improve performance on that particular measure. There were 23 measures for which at least six respondents agreed that specific measure would most impact quality (see Appendix C, Table 3). The 20 measures that study physicians judged to have the most potential to improve following the implementation of an EHR functionality are listed below in Table 4. Among them, electronic notes, clinical reminders and provider order entry were identified as having the greatest potential to improve performance on individual quality measures.

Table 4: **Top 20 Established Quality Measures Likely to Show Improvement Through Implementation of an EHR Functionality***

Quality Measure	Clinical Condition / Domain	HIT Functionality
Patients having documentation of allergies and adverse reactions in the medical record	Hypertension	Electronic Notes
Patients having a medication list in the medical record	Hypertension	Electronic Notes
Patients age 65 and older who reported discussing exercise or physical activity with their health provider in the last 12 months	General Prevention	Clinical Reminders
Patients with chronic obstructive pulmonary disease (COPD) who had a spirometry evaluation documented	Asthma	Clinical Reminders
Patients who received a dilated eye exam or stereoscopic photos by an ophthalmologist or optometrist for evaluation of retinopathy within the last year	Diabetes	Clinical Reminders
Patients age 18 and older who received at least a 180 day supply of medication and who received annual monitoring for the therapeutic agent	Hypertension	Provider Order Entry
Patient's chart recording whether there is tobacco use/exposure	Tobacco Cessation	Electronic Notes
Women ages 18–64 who received appropriate Pap testing	Screening	Clinical Reminders
Hospitalized acute myocardial infarction (AMI) patients given smoking cessation advice/counseling	AMI	Guidelines/Protocols or Ref. Tools
Hospitalized heart failure (HF) patients given smoking cessation advice/counseling	CHF	Guidelines/Protocols or Ref. Tools
Hospitalized surgical patients whose preventative antibiotic(s) were stopped within 24 hours after surgery	Surg. Infection Prevention	Guidelines/Protocols or Ref. Tools
Patients age 65 years and older who received at least one drug to be avoided in the elderly in the measurement year	Hypertension	Prescribing Support
Patients age 65 years and older who received at least two different drugs to be avoided in the elderly in the measurement year	Hypertension	Prescribing Support
Hospitalized surgical patients who received preventative antibiotic(s) one hour before incision	Surg. Infection Prevention	Guidelines/Protocols or Ref. Tools
Patients with HF who also have left ventricular systolic dysfunction (LSVD) who were prescribed an angiotensin-converting enzyme (ACE) inhibitor/ angiotensin II receptor blockers (ARB)	CAD	Clinical Reminders
Patients on digoxin with appropriate testing for potassium, creatinine, and blood urea nitrogen	Hypertension	Clinical Reminders
Percentage of D-negative, unsensitized patients who gave birth during a 12-month period who received anti-D immune globulin at 26–30 weeks gestation	Prenatal Care	Clinical Reminders
Hospitalized AMI patients given beta blocker at discharge	AMI	Guidelines/Protocols or Ref. Tools
Hospitalized pneumonia patients assessed and/or given influenza vaccination	Pneumonia	Guidelines/Protocols or Ref. Tools
Percentage of patients who were queried about tobacco use one or more times during the two-year measurement period	Tobacco Cessation	Clinical Reminders

* Limited to measures for which a majority of responders (at least four out of seven) chose the same key HIT functionality.
† Score ranges from 1 (no effect) to 5 (very large improvement); 3.0 represents a moderate improvement

This exercise, although clearly limited in scope, has some potential benefits. First, it could help inform future research examining the quality effects of EHRs. By generating hypotheses regarding measures that may be sensitive to the quality benefits expected from EHRs, we have begun to fill a notable void. This information could be a useful starting point for researchers hoping to identify measures to use in their assessments of EHRs. If the findings from our preliminary work are validated, the information would be helpful to providers trying to improve their performance on these quality measures. Finally, the exercise has highlighted the need for measures that will better capture the value of EHRs.

Improving Cross-sectional Association Studies

While existing cross-sectional association studies have major limitations, this method has some important theoretic and practical advantages. First, association studies can be conducted on large groups of patients relatively inexpensively, permitting sufficient sample sizes to measure population-based effects on morbidity, mortality and high-cost utilization of health services. Large sample sizes are also required for many important quality measures, such as those endorsed by the NQF. Therefore, we think association studies will be an important source of evidence for policy going forward. Nonetheless, to be useful, the design of these studies needs to minimize the problems we presented above.

Based on our analysis of the problems encountered with existing association studies, we think optimal association studies should include:

1. Providers with a range of performance on quality measures (optimally with a mean performance that matched the U.S. mean);

2. Commonly used EHR systems, certified by federal standard setters, with known functionalities;

3. Measurement of the extent of use of the EHR system by providers (exposure), including use of particular functionalities;

4. Measurement of high-priority quality effects relevant to all six IOM domains of quality;

5. Measurement of provider characteristics, their work settings, organization and markets, which might confound observations of the effects of EHRs; and

6. Assessment of positive, negative, anticipated and unanticipated outcomes.

Can EHRs themselves contribute to our understanding of the effects of EHRs on quality?

While prospective trials and cross-sectional association studies have been, and are likely to remain, the key sources of data regarding the effects of EHRs on quality, EHRs may be able to provide some evidence on this subject. Information stored within EHRs often contains sufficient data to make inferences regarding the role of EHRs in providing specific services. For example, reminders and alerts often require the user to turn the alert off before proceeding. This action may permit the capture and storage of information pertaining to the role of EHRs in adhering to the recommendations within the alert. This type of information, used in the appropriate clinical context, could be systematically mined from EHRs and used as

the basis for dose-response analyses of EHRs' value. While this approach has some potential, EHRs are seldom configured to readily provide this type of information.

Can EHRs increase the capacity for improvement in health care?

Throughout this report, we have emphasized the importance and limitations of the evidence base required to understand the effects of EHRs on quality of care. We therefore, necessarily, focused on existing measures of quality of care. Nonetheless, as noted above, many observers believe that much of the benefit from EHRs will be derived from their contribution to the *capacity for quality improvement*. This capacity refers to the ability of leaders and managers to implement changes in response to evidence of sub-optimal quality. The following two examples illustrate this point. First, at a basic level, EHRs can improve the capacity for quality improvement by removing the geographic difficulties associated with accessing charts for audits. Second, at a more sophisticated level, an EHR with reminders and searchable databases may be used as an information substrate for quality improvement projects (e.g., reports to clinicians comparing them to their peers on clinical or utilization metrics). Used in these ways, the EHR dramatically extends the reach of management to oversee quality within a delivery system. This potential greater capacity for quality improvement may not be readily identified in current quality measures. In addition, associations between EHRs and higher quality, in which there is no clear link between the EHR functions and quality measures, could possibly be explained by such an effect. While this is speculative, it is at least consistent with some recent literature.[18]

Summary

Difficulties inherent to quantifying the benefits of EHRs present some significant challenges for policy-makers. Aggregation of existing and future prospective, controlled studies may be possible and this possibility should be investigated. Nonetheless, we have low expectations that these exercises will produce meaningful summary estimates of quality benefits for population health. Large–scale, cross-sectional association studies are more promising, though these will require much more detailed data collection (including exposure data, outcomes data and data on potential confounders) than prior studies to avoid their limitations. EHRs may contribute to our understanding of the effects of this technology on health, though significant additional investment in the design and operations of EHRs would be required for this potential to be realized. Finally, we should consider the possibility that EHRs will increase the capacity for quality improvement and thus, have indirect (and thus difficult to measure) effects on health care quality.

Recommendations for Measuring the Effects of EHRs on the Quality of Health Care

The foregoing discussion suggests a number of recommendations for improving our understanding of the relationship between EHRs and quality of care. First, we believe several large-scale, prospective association studies of EHR implementation should be performed. While such studies are unlikely to meet all the requirements we laid out for an ideal study, we nonetheless think that they could be conducted in a way that would provide more definitive assessments of EHRs' effects on quality of care. The implementation of EHRs by previously unexposed groups of

doctors, which is currently happening with great frequency in the United States, represents an excellent opportunity to conduct such studies.

In addition, we have several recommendations to ensure the policy relevance of future research on the relationship between EHRs and quality. They include:

1. measuring in multiple domains of quality (especially under-represented domains);

2. measuring at the highest level of aggregation of HIT functionality;

3. encouraging the use of similar definitions of EHR functionalities;

4. using measures that will be most sensitive to the effects we are likely to see;

5. using measures with a known relationship to population health;

6. investigating the requirements for and potential to aggregate studies of specific functionalities across clinical domains;

7. for association and cohort studies, controlling for critical confounders (as outlined above);

8. for vendors, encouraging the development of EHR capacity to measure its effects on care delivery; and

9. developing metrics to measure the ability of EHRs to affect the capacity for improvement.

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Appendix A: Expert Panel on Quality and HIT

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- Frequency of non-intercepted, serious medication errors
- Frequency of medication errors, excluding missed-dose errors
- Frequency of intercepted prescription errors
- Medication turn-around times for loading dose of caffeine
- Accuracy of gentamicin dosages during hospitalization at the time of suspected late-onset sepsis
- Percentage of cases where patients were prescribed caffeine before two or three hours
- Accuracy of gentamicin dose at admission
- Reduced duration of therapy below the 10-day course
- Proportion of patients with otitis media who were treated with an antibiotic
- Percentage of encounters where prescription plan was changed
- Number of appropriate antibiotic regimens suggested by consultant vs. physician
- Number of times each antibiotic regimen was suggested
- Ordering of antibiotic to which all isolated pathogens were susceptible
- Physician-ordering of susceptible antibiotics in relation to culture collection time
- Frequency of drug ordering for drugs to which patients had allergies
- Frequency of excessive drug dosages
- Frequency of adverse events due to antibiotic susceptibility mismatches
- Appropriateness of drugs prescribed
- Number of days of excessive drug dosages
- Frequency of adverse events caused by anti-infectant agents
- Cost of anti-infectant agents
- Number of days that patients received excessive doses of antibiotics
- Number of adverse drug events (ADEs) secondary to antibiotics
- Number of patients on warfarin switched to triclopidine therapy
- Number of patients on aspirin switched to salsalate or acetaminophen
- Rates for prescribing of aspirin for patients with heart disease
- Frequency of reductions of medications due to risk for overtreatment
- Frequency of reductions in medication due to possible bleeding
- Frequency of reductions of metabolic toxicity
- Number of regimens changed due to metabolic toxicity
- Frequency of perioperative antibiotic use for patients where appropriate
- Appropriateness of timing of perioperative antibiotic use
- Number of postoperative infections/complications
- Overall prescription drug costs

- Differences in frequency of prescriptions for drug classes
- Frequency of antibiotic underdoses
- Frequency of antibiotic overdoses
- Frequency of medication errors
- Severity of medication errors
- Preventability of ADEs
- Frequency of preventable ADEs
- Number of attempted prescriptions cancelled
- Proportion of warning messages overridden
- Target prothrombin time ratios
- Time to reach a therapeutic prothrombin ratio
- Time to reach a stable therapeutic dose
- Number of patients with bleeding complications
- Accuracy of the predicted maintenance dose (studied at 14 days later)
- Number of days on warfarin with sub-therapeutic dose
- Number of days on warfarin with therapeutic dose
- Number of days on warfarin supra-therapeutic
- Number of alert firings
- Number of savings of drug doses
- Number of changed orders
- Time until adjustment of or discontinuation of medications
- Number of averted errors
- Frequency of delays in delivery of medications and information
- Frequency of disagreements between pharmacy and nursing medication profiles
- Rates of influenza vaccination
- Rates of pneumococal vaccination
- Rates of tetanus vaccination
- Rates of mammography among women over 40
- Rates of mammography appointments made
- Rates of blood pressure (BP) measurement
- Rates of Pap smears among women who are due
- Patients who received occular pressure measurement
- Rates of patients receiving stool exam for occult blood
- Frequency of lead testing
- Number of patients having chest roentgenogram
- Number of patients having tuberculosis (TB) skin tests
- Frequency of physician overrides in response to allergy alerts
- Rates for compliance with allergy alerts

- Drag (# of alerts for a given medication per year/# of orders per year)
- Drag differential (at beginning and end of study)
- Number of clinical laboratory and radiological tests ordered per admission
- Total charges for tests ordered during study period
- Frequency of redundant laboratory tests ordered
- Frequency of redundant laboratory tests performed
- Orders for antiepileptic drug (AED) serum levels before medications have stabilized
- Number of patients for whom serum digoxin was withheld,
- Number of patients for whom serum digoxin determination was ordered
- Radiology response time
- Frequency of ordering of appropriate "corollary" tests, etc.
- Frequency of errors of omission
- Time from when critical lab result was available for review until the appropriate treatment was ordered
- Time until critical condition was resolved
- Frequency of physician response to page regarding result
- Frequency of reports of physicians planning to do something in response to result
- Number of orders placed directly from alerts
- Clinician response to abnormal renal function test
- Clinician response to abnormal serum potassium
- Clinician response to serum uric acid
- Clinician response to abnormal liver function
- Clinician response to abnormal hemoglobin or hematocrit
- Clinician response to abnormal leukocyte count
- Clinician response to abnormal serum sodium
- Foot examination monthly in patients with diabetic neuropathy, peripheral neuropathy or history of lower limb ulcers
- Number of patients receiving an annual, complete physical examination
- Number of patients having determination of chronic blood glucose control every six months
- Number of patients having annual urine protein determination
- Number of patients having annual cholesterol level check
- Patients having annual opthalamic examination
- Number of elderly patients having seasonal influenza vaccinations
- Number of elderly patients having pneumococcal vaccinations
- Mean score of last recorded pressure
- Reduction in diastolic pressure
- Control of hypertension symptoms

- Number of cases where patients changed to beta blockers
- Cases where patients changed to diuretics
- Number of cases where patients increased ACE inhibitors
- Number of cases where patients changed to both beta blockers and diuretics
- Number of cases with no medication substituted
- Number of patients with six-month follow-up
- Nursing time spent manipulating data
- Nursing time spent charting
- Data gathering time (nursing)
- Nursing time spent at computer terminals entering or reviewing data
- Time spent in patient rooms at central station and elsewhere (nursing)
- Time spent ordering medications (M.D.s)
- Time spent looking for charts (M.D.s)
- Time spent entering patient notes (M.D.s)
- Time spent reviewing patient notes (M.D.s)
- Documentation of record
- Discharge instructions
- Appropriateness of testing and treatment
- Cost of care episode
- Frequency of discussions about advanced directives
- Patient interviews after all scheduled physician/patient outpatient encounters
- Number of completed advanced directives forms
- Diagnostic accuracy: measured as presence of the correct diagnosis on the hypothesis list and also using a derived diagnostic quality score before and after consultation with clinical decision support systems (CDSSs)
- Completeness of pediatric well visits: distribution of instructions, immunizations and lead testing
- Number of patients seen per doctor per day
- Length of follow-up
- Number of completed patient-encounter forms
- Number of items flagged that deviated from guideline adherence
- Patient report of changes in length of duration of consultation
- Patient report of how personal encounter is
- Patient report of ease of encounter
- Patient report of perceived level of privacy
- Number of patients with lipid levels measured (12 mos)
- Instruction in weight reduction
- Instruction in exercise

- Discussions regarding sodium restriction (6 mos)
- Number of patients who had glycoalated hemoglobin determination (6 mos)
- Patients receiving nutritional counseling (12 mos)
- Routine dipstick urine analysis protein (12 mos)
- Eye examination by eye specialist (12 mos)
- Foot care instruction (12 mos)
- Smoking cessation counseling
- Frequency of monitoring of patients receiving warfarin treatment monitoring (45 days)
- Number of patients receiving beta-blocker therapy
- Frequency of practice consultations
- Number of acute exacerbations of asthma
- Number of hospital contacts for patients with asthma
- Number of patients for whom an asthma care plan was made
- Frequency of assessments of asthma symptoms medication use
- Frequency of assessments of asthma medication use
- Length of stay
- Mortality rates
- Patient satisfaction
- Number of ambulatory visits
- Number of hospitalizations
- Glycosylated hemoglobin (HbA1c) poor control $>9.0\%$
- HbA1c control $<7.0\%$
- Blood pressure control $<140/90$ mm Hg
- Blood pressure control $<130/80$ mm Hg
- Eye examination
- Smoking status and cessation advice or treatment
- Complete lipid profile [amended by consensus to low-density lipoprotein (LDL) measurement]
- LDL control <130 mg/dl
- LDL control <100 mg/dl
- Nephropathy assessment
- Foot examination
- Blood pressure control $< 140/90$ mm Hg
- Complete lipid profile (amended by consensus to LDL measurement)
- LDL < 100 mg/dl
- Use of aspirin or other antithrombotic
- Smoking status and cessation advice or treatment

Continued

- Asthma clinical measures (Maine Health Information Center (MHIC) 2007)
- At least one office visit in last 12 months
- Asthma severity classification
- Documented use of controller medications for persistent asthma
- Documented action and/or school/day care plan
- Documented influenza immunization
- Completion of asthma control test or symptom free days
- Documentation of tobacco use/exposure
- Colon cancer screening (no reference)

Appendix C: Detailed Methods and Results of Exercise to Determine Quality Measures Most Likely To Be Impacted by EHRs

As described in the chapter text, seven practicing, general internal medicine physicians enrolled in the Harvard General Medicine Fellowship program were asked to rate the extent to which performance on 125 established quality measures might be improved by the implementation of eight different EHR functionalities. During this exercise, fellows were asked to assume that the implementation of each functionality was optimal and that the HIT system functioned well. We used a list of HIT functionalities that are believed to impact quality. The clinical areas and individual quality measures were taken from the NQF-endorsed ambulatory measures and the HQA inpatient measures, which have also been endorsed by NQF.

Our exercise had three parts. First, we asked each responding fellow to choose up to three HIT functionalities that would most improve care for a clinical condition (e.g., diabetes). Second, each respondent was asked to establish a link between individual quality measures and a single, specific HIT functionality that would most improve performance on that measure. Finally, we asked the respondent to quantify the level of impact, on a 5-point Likert scale where 1 equals no effect, 3 equals a moderate effect, 5 equals a very large effect, that the HIT functionality would have on the quality measure. Fellows were asked to complete tasks two and three for each of the 104 NQF and 21 HQA measures. This process was vetted through our expert panel, and the results were presented to them for review and approval.

Tables A1 and A2 summarize the results of the first part of our survey and show that different HIT functionalities were considered important for improving clinical care in different domains. For example, guidelines and protocols were selected as important for improving asthma care by 71 percent of the respondents (Table A1, first set of rows). There were only a few conditions in which there was unanimity among the respondents as to which functionalities would most impact care (i.e., medication prescribing support for improving appropriateness of prescribing (Table A1, sixth set of rows). Clinical reminders and guidelines/protocols (including reference tools) were the two functionalities chosen most often to broadly impact quality in the 16 clinical domains examined, each being chosen approximately a quarter of the time (Table A2).

Table A1: **Top Three Health IT Functionalities That Improve Clinical Care for a Specific Clinical Condition or Domain**

Clinical Condition/Domain	HIT Functionality	% Responded
Asthma	Guidelines/protocols or Ref. tools	71
	Clinical reminders	57
	Population management tool	57
Bone and Joint Disease	Electronic notes	71
	Guidelines/protocols or Ref. tools	71
	Clinical reminders	57
Diabetes	Clinical reminders	86
	Electronic notes	57
	Results management	57
Heart Disease	Clinical reminders	86
	Guidelines/protocols or Ref. tools	71
	Electronic notes	57
Hypertension	Clinical reminders	86
	Electronic notes	57
	Guidelines/protocols or Ref. tools	57
Medication Management	Medication prescribing support	100
	Provider order entry	71
	Clinical Reminders, Guidelines/protocols or Ref. Tools, Results management	29
Mental Health and Substance Abuse	Electronic notes	71
	Guidelines/protocols or Ref. tools	57
	Clinical reminders	43
Obesity	Clinical reminders	86
	Guidelines/protocols or Ref. tools	71
	Electronic notes	57
Prenatal Care	Guidelines/protocols or Ref. tools	100
	Clinical reminders	86
	Electronic notes, prob/med lists	43
Tobacco-Use Cessation	Clinical reminders	86
	Guidelines/protocols or Ref. tools	86
	Electronic notes	43
General Prevention	Clinical Reminders	100
	Guidelines/protocols or Ref. tools	71
	Electronic notes	43
Screening	Clinical reminders	100
	Guidelines/protocols or Ref. tools	71
	Population health management tools	43
Immunization	Clinical reminders	100
	Guidelines/protocols or Ref. tools	86
	Electronic notes	57

Continued

Clinical Condition/Domain	HIT Functionality	% Responded
Acute Myocardial Infarction	Guidelines/protocols or Ref. tools	86
	Electronic notes	57
	Clinical reminders	57
Congestive Heart Failure	Guidelines/protocols or Ref. tools	86
	Clinical reminders	71
	Electronic notes; prescribing support	43
Pneumonia	Guidelines/protocols or Ref. tools	100
	Clinical reminders	57
	Electronic notes; results management	43

Table A2: **Health IT Functionalities Most Frequently Selected to Improve Care for a Clinical Condition or Domain**

HIT Functionality	Percent
Clinical Reminders	25.2
Clinical Guidelines / Protocols or Reference Tools	24.6
Electronic Notes and Health Information Management	16.7
Results Management	8.8
Population Health Management Tools	7.6
Medication Prescribing Support	7.3
Electronic Communication	5.5
Provider Order Entry	4.3

Table A3: **Measures With Very High Agreement on Key HIT Functionality to Improve Performance**

Quality Measure	Clinical Condition / Domain	Key HIT Functionality	Avg. Score[†]
Unanimous agreement regarding key HIT functionality			
Patients age 65 and older who received at least one drug that should be avoided	Hypertension	Prescribing Support	3.3
Patients age 65 and older who received at least two drugs that should be avoided	Hypertension	Prescribing Support	3.3
Hospitalized surgical patients who received preventative antibiotic(s) one hour before incision	Surg. Infection Prevention	Guidelines / Protocols or Ref. Tools	3.3
Eligible women who were identified as sexually active who had at least one Chlamydia test in a year	Screening	Clinical Reminders	3.1
Patients age 50 to 80 who had appropriate screening for colorectal cancer	Screening	Clinical Reminders	3.1
Female patients age 65 and older who reported receiving a bone density test to check for osteoporosis	Screening	Clinical Reminders	3.0
Patients hospitalized for pneumonia whose initial blood culture was performed prior to the administration of antibiotics	Pneumonia	Guidelines / Protocols or Ref. Tools	3.0
Children two years of age who received all doses of the appropriate immunizations: DtaP/DT, IPV, MMR, HIB, hepatitis B, chicken pox, and pneumococcous	Immunization	Clinical Reminders	2.9
AMI patients given PCI within 120 minutes of arrival to hospital	AMI	Guidelines / Protocols or Ref. Tools	2.7
AMI patients given thrombolytic medication within 30 minutes of arrival to hospital	AMI	Guidelines / Protocols or Ref. Tools	2.6
Very high agreement regarding key HIT functionality (six out of seven respondents)			
Percentage of patients having a medication list in the medical record	Hypertension	Electronic Notes	3.7
Women ages 18 to 64 who received appropriate Pap testing	Screening	Clinical Reminders	3.3
Hospitalized AMI patients given smoking cessation advice/counseling	AMI	Guidelines / Protocols or Ref. Tools	3.3
Hospitalized heart failure patients given smoking cessation advice/counseling	CHF	Guidelines / Protocols or Ref. Tools	3.3
Hospitalized surgical patients whose preventative antibiotic(s) were stopped within 24 hours after surgery	Surg. Infection Prevention	Guidelines / Protocols or Ref. Tools	3.3
Patients with heart failure who were provided with patient education on disease management and health behavior changes during one or more visits	CAD	Guidelines / Protocols or Ref. Tools	3.2
Hospitalized pneumonia patients given smoking cessation advice/counseling	Pneumonia	Guidelines / Protocols or Ref. Tools	3.0
Hospitalized pneumonia patients given the most appropriate initial antibiotic(s)	Pneumonia	Guidelines / Protocols or Ref. Tools	3.0

Continued

Quality Measure	Clinical Condition / Domain	Key HIT Functionality	Avg. Score[†]
Patients with coronary artery disease (CAD) and prior MI at any time who were prescribed a beta blocker	CAD	Clinical Reminders	2.8
Patients who reported having a problem with urine leakage in the last six months and had discussed their problems with their practitioner	General Prevention	Clinical Reminders	2.5
Hospitalized pneumonia patients given oxygenation assessment	Pneumonia	Guidelines / Protocols or Ref. Tools	2.5
Patients with an upper respiratory infection (URI) who were not dispensed antibiotics within three days of the episode date	Asthma	Guidelines / Protocols or Ref. Tools	2.3
Patients with CAD who were prescribed an antiplatelet therapy	CAD	Clinical Reminders	2.3

[†] Score ranges from 1 (no effect) to 5 (very large improvement); 3.0 represents a moderate improvement.

There are several important limitations to our exercise. First, because only seven general medicine fellows were surveyed, this was not a robust determination of which HIT functions impact quality. However, these physicians are clinically active, have recently completed training, and have a good understanding of both quality measurement and HIT. Second, the respondents provided answers regarding the impact of EHR functionalities from a clinician's perspective. There are other important perspectives, such as that of a practice manager or a hospital chief medical officer, who might find that other functionalities are more useful for improving quality (such as disease registries for population management of diabetics). Third, we only examined a small subset of quality measures, and these measures were all focused on general medical care in the ambulatory and inpatient setting. Additional measures for specialty care and other clinical settings (such as nursing homes) are important, though most are still under development and are not yet mature enough for use. Finally, our survey intentionally focused on establishing the link between optimally implemented HIT functions and improvement in clinical care, and assessing the magnitude of this relationship. However, some HIT functions may have a negative impact on quality through increased wait times or an increase in errors while providers learn how to use a new HIT functionality (such as provider order entry). Further study is necessary to evaluate how HIT functions may negatively impact quality both during and following implementation, though this was beyond the scope of our exercise.