

Research Paper ■

Correlates of Electronic Health Record Adoption in Office Practices: A Statewide Survey

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Abstract Objective: Despite emerging evidence that electronic health records (EHRs) can improve the efficiency and quality of medical care, most physicians in office practice in the United States do not currently use an EHR. We sought to measure the correlates of EHR adoption.

Design: Mailed survey to a stratified random sample of all medical practices in Massachusetts in 2005, with one physician per practice randomly selected for survey.

Measurements: EHR adoption rates.

Results: The response rate was 71% (1345/1884). Overall, while 45% of physicians were using an EHR, EHRs were present in only 23% of practices. In multivariate analysis, practice size was strongly correlated with EHR adoption; 52% of practices with 7 or more physicians had an EHR, as compared with 14% of solo practices (adjusted odds ratio, 3.66; 95% confidence interval, 2.28–5.87). Hospital-based practices (adjusted odds ratio, 2.44; 95% confidence interval, 1.53–3.91) and practices that teach medical students or residents (adjusted odds ratio, 2.30; 95% confidence interval, 1.60–3.31) were more likely to have an EHR. The most frequently cited barriers to adoption were start-up financial costs (84%), ongoing financial costs (82%), and loss of productivity (81%).

Conclusions: While almost half of physicians in Massachusetts are using an EHR, fewer than one in four practices in Massachusetts have adopted EHRs. Adoption rates are lower in smaller practices, those not affiliated with hospitals, and those that do not teach medical students or residents. Interventions to expand EHR use must address both financial and non-financial barriers, especially among smaller practices.

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Introduction

Electronic health records (EHRs) represent an essential tool for improving the safety and quality of health care, though physicians must actively use these systems to accrue the benefits.¹ The Institute of Medicine and others have suggested that the

wide-scale adoption of EHRs could be pivotal for improving patient safety and health care quality.^{2–4} EHRs may also reduce the costs of providing ambulatory care.^{1,5}

However, despite emerging evidence about the benefits of EHRs, there are considerable barriers to adoption.^{6–8} Most physicians in office practice in the United States do not currently use this technology,^{9–12} although many other countries are much farther along and some have nearly complete adoption.^{13,14} A nationally representative survey in 2003 showed that only 17.6% of physicians in office-based practices in the United States used EHRs,¹⁰ though industry-sponsored surveys have reported higher rates of adoption.¹⁵

Increasing public policy attention is being focused on the adoption of EHRs. Executive and legislative leaders in Washington D.C. have called repeatedly to expand the use of EHRs and other health information technology (HIT),^{16–19} and the newly created Office of the National Coordinator for Health Information Technology within the Department of Health and Human Services has responsibility for encouraging universal implementation of EHRs by 2014.²⁰

Relatively little is known about the correlates of the adoption of EHRs by medical practices.⁶ Qualitative research,^{5,21,22} limited survey data,¹¹ and anecdotal reports⁷ suggest that start-up costs and the lack of financial incentives are key barriers to EHR adoption among physicians in the community. In addition, Miller and Sim

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have underscored issues such as slow and uncertain financial payoffs as well as underlying barriers to adoption, including inadequate technical capabilities of existing systems and the need for concurrent workflow adaptation.²¹ Gans and colleagues' survey of medical practices found that lack of support among physicians and inadequate capital resources were among the most substantial barriers to adoption.¹¹

In the context of Rogers' framework of the diffusion of innovations,²³ organizational factors may be important correlates of EHR adoption by medical practices. Shortell's work suggests that the culture for innovation and change may be an important correlate of EHR adoption in ambulatory care.^{24,25} We speculated that organizational factors, ranging from the size and location of the practice to its financial stability and the degree to which its culture emphasizes quality and innovation, as well as physician characteristics and technology-related factors, would predict EHR adoption. Therefore, we undertook a statewide survey to examine the barriers to and facilitators of EHR adoption among office practices in Massachusetts in 2005.

Methods

Sample

Using a database from a private vendor (Folio Associates, Hyannis, Massachusetts), supplemented with information from the Massachusetts Board of Registration in Medicine (<http://www.massmedboard.org>), we identified physicians from all specialties practicing in Massachusetts in the spring of 2005. After excluding physicians who were residents in training, retired, or without direct patient care responsibilities, the total population of physicians was 20,227. These physicians practiced in 6174 unique practice sites in Massachusetts.

We drew a stratified random sample of 1921 practices, with 100% over-sampling of primary care hospital-based practices and larger practices, as well as practices in rural areas, to ensure their adequate representation. We then randomly selected one physician from each practice for a survey. An alternative physician from the practice was randomly selected if we determined that the initially selected physician was no longer at the practice, retired, or deceased; 137 physicians were selected in this manner. If no replacement doctor was available within the practice, the practice was removed from the sample and, if available, a replacement practice was chosen randomly from the stratum in which the practice was classified. Practices that had closed were similarly replaced when a pool of practices not previously sampled remained available for re-sampling in the respective stratum. In total, 57 practices were replaced. The final sample size was therefore 1884 physicians (Appendix, available as a JAMIA online supplement at www.jamia.org).

The sample size was calculated to provide 80% power to detect differences of 10% or greater in comparisons of EHR adoption rates by specialty (primary care vs. other), hospital-affiliation, practice size, or geography (urban vs. non-urban).

Survey Questionnaire

We developed an eight-page questionnaire based on a systematic review of the literature regarding barriers to and

correlates of adoption of EHRs and other HIT, specifically focusing on ambulatory physician practices rather than inpatient care. We tested the draft instrument on seven Massachusetts physicians (both primary care and specialists) from within and outside the Boston metropolitan area and included both users and non-users of EHRs.

The final questionnaire (available from the authors upon request) included items designed to assess organizational characteristics and factors related to the EHR itself. The survey measured practice "demographics" (e.g., number of physicians, primary care vs. specialty) and included questions regarding Internet connectivity and current use of HIT. The survey also assessed the financial stability of the office practice, availability of capital for investment in HIT, and the presence of financial incentives for quality and specifically for the use of HIT. Respondents reported on perceived barriers to EHR adoption and on characteristics of the office practice environment that may impede or enhance the diffusion of this technology into office practices. For comparability, some of these items were based on similar questions in prior published surveys.^{9,26-29}

Survey Administration

Atlantic Research and Consulting (Boston, Massachusetts) was contracted to administer the survey between June and November 2005. The initial survey was sent via express mail with a \$20 cash honorarium to 1906 of the 1921 sampled physicians. Because this survey also served as baseline evaluation of a pilot program of the Massachusetts e-Health Collaborative (MAeHC; www.MAeHC.org), a not-for-profit consortium established to hasten adoption of EHRs in Massachusetts, staff from the MAeHC hand-delivered surveys (with no cash incentive) to the offices of the remaining 15 physicians randomly sampled for this survey who were coincidentally included as participants in the MAeHC. Subsequently, second and third mailings were sent to non-respondents, without remuneration. Between these mailings, multiple telephone contacts were attempted; 17 respondents (1%) completed the survey by telephone. A total of 94 physicians in the sample were deemed ineligible for the following reasons: 30 relocated to a different practice site; 1 was deceased; 62 had retired or closed their practice; and 1 had an address that was a corporate office, not a clinical practice.

The study protocol was approved by the Partners Health-Care Human Research Committee.

Statistical Analysis

Because our study design employed a stratified random sample, certain type of practices (i.e., hospital-based practices; large practices; and rural practices) are over-represented among our survey respondents. Therefore, our data analyses used sampling weights in order to insure that our study results are representative of all Massachusetts practices. The sampling weights were used to adjust for stratification by specialty, category of practice size, hospital affiliation, and urban/non-urban location. The sampling weights also incorporated strata-specific rates of non-response to the survey. For example, in Massachusetts there are 76 urban, hospital-based, primary care, solo practices. We sent surveys to all 76 of these practices, which would ordinarily have resulted in sampling

weights of 1.0 for each of these 76 practices (since each practice was representing itself). However, since only 53 of these 76 practices returned the survey, a sampling weight of $76/53 = 1.43$ was used for each of the 53 analyzable respondents (so that the 53 respondents represented all 76 urban, hospital-based, primary care, solo practices). As a second example, in Massachusetts there are 263 urban, hospital-based, specialty, solo practices. We sent surveys to 74 of these practices and received responses from 50 of these 74. Hence, weights of $263/50 = 5.26$ were applied to each of the 50 analyzable respondents (so that the 50 respondents represented all 263 urban, hospital-based, specialty care, solo practices). By using these sampling weights, the results in this report are representative of EHR implementation in all 76 urban, hospital-based, primary care, solo practices, all 263 urban, hospital-based, specialty care, solo practices, etc., in the state of Massachusetts, rather than the artificially constructed collection of 53 urban, hospital-based, primary care, solo practices, and 50 urban, hospital-based, specialty care, solo practices, etc., in the sample.

There were only two exceptions in our analyses to the use of the sampling weights described above. First, no sampling weights were used in our comparison of respondents and non-respondents. Second, we estimated the percentage of physicians in Massachusetts who had EHRs by multiplying the sampling weights for practices, as described above, by the number of physicians in each survey respondent's practice. In this way, the physician EHR use percentage is representative of all physicians in Massachusetts.

We used SAS software (version 9.1) for all statistical analyses.³⁰ Comparisons between survey respondents and non-respondents were made using adjusted Pearson chi-square analysis. We used logistic regression to analyze predictors of adoption of EHRs. The dependent variable in these analyses was the response to the dichotomous survey item that asked, "Does your practice have components of any electronic health record (EHR), that is, an integrated clinical information system that tracks patient health data and may include such functions as visit notes, prescriptions, lab orders, etc.?" We created two separate models of the correlates of EHR adoption. In the first model, we included predictor variables that were exogenous practice characteristics that would not be a consequence of EHR adoption. These variables were specialty (primary care vs. non-primary care); number of physicians (1 vs. 2-3 vs. 4-6 vs. 7 or more); hospital-based (self-reported); geography (urban vs. non-urban); teaching (i.e., whether the practice has students or residents); whether the practice has incentives for quality of care; whether it has incentives for HIT adoption; the level of financial resources available for practice improvement or expansion; whether the practice has innovative staff (self-reported); and whether the physicians in the practice are innovative (Table 1). In the second set of regression models, we looked at EHR adoption as a function of the significant exogenous variables from above, as well as physicians' perceptions of the office practice's orientation toward quality of care and of their perception of barriers to beginning or expanding the use of computer technology in their practice. These perceptual variables were considered separately because of the dual possibility that either positive perceptions could lead to

Table 1 ■ Percent of Massachusetts' Office Practices Using Electronic Health Records (EHRs)

Characteristic*	Percent of Office Practices Using EHRs†	95% CI
Overall (100%)	23%	0.21-0.26
Specialty		
Primary Care (28%)	25%	0.21-0.29
Single Specialty (59%)	20%	0.17-0.24
Multi-Specialty (12%)	35%	0.28-0.42
Number of physicians		
1 (43%)	14%	0.10-0.18
2-3 (24%)	15%	0.11-0.20
4-6 (14%)	33%	0.28-0.40
7+ (17%)	52%	0.46-0.57
Hospital-based (11%)	52%	0.46-0.58
Non-hospital-based (89%)	20%	0.17-0.22
Urban (92%)	24%	0.21-0.27
Non-urban (8%)	21%	0.17-0.26
Teaching (35%)	40%	0.36-0.44
Non-teaching (65%)	14%	0.12-0.17
Incentives for Quality of Care		
Yes (24%)	29%	0.25-0.34
No (76%)	22%	0.19-0.25
Incentives for HIT		
Yes (23%)	33%	0.28-0.38
No (77%)	21%	0.18-0.24
Financial resources available for practice improvement or expansion		
Limited/None (96%)	23%	0.20-0.25
Moderate/Extensive (4%)	44%	0.30-0.59
This practice has innovative office staff.		
Agree (46%)	22%	0.19-0.26
Disagree (54%)	25%	0.21-0.28
This practice has innovative physician(s)		
Agree (63%)	25%	0.22-0.28
Disagree (37%)	21%	0.18-0.25

EHR = electronic health record; CI = confidence interval.

*Percentages may not add to 100 because of rounding.

†N=1181; results are weighted as described in the Methods.

EHR adoption, or that EHR adopters developed positive perceptions based on positive experiences.

Finally, we compared the influence of various organizations on decision making around EHR adoption in practices with EHRs versus practices without EHRs using weighted chi-square tests.

Results

Respondent Characteristics

A total of 1345 completed surveys were returned, yielding a response rate of 71%. Respondents and non-respondents were similar with respect to specialty, practice size, hospital-based practice, and non-urban practice location. Of the 1345 respondents, 157 indicated that they do not see any outpatients, and 7 did not complete the principal question on EHR prevalence, resulting in 1181 respondents eligible for subsequent analysis.

Table 2 ■ Multivariate Relationship Between Practice Characteristics and EHR Adoption.*

Practice Characteristics	Adjusted Odds Ratio	95% CI
Specialty		
Single-specialty or multi-specialty	1.00	—
Primary care	1.25	0.85-1.83
Number of physicians		
1 physician	1.00	—
2-3 physicians	0.81	0.50 – 1.30
4-6 physicians	1.66	1.01 – 2.75
7 or more physicians	3.66	2.28 – 5.87
Hospital-based	2.44	1.53 – 3.91
Urban	0.73	0.39 – 1.36
Teaching	2.30	1.60 – 3.31
Incentives for quality of care	0.94	0.60 – 1.46
Incentives for health information technology	1.50	0.98 – 2.29
Moderate to extensive financial resources available for practice expansion and improvement	1.35	0.93 – 1.97
Practice has innovative office staff	0.76	0.52 – 1.10
Practice has innovative physician(s)	1.49	1.00 – 2.21

EHR = electronic health record; CI = confidence interval.

*Logistic regression analysis, modeling the outcome (presence of EHR) as a function of all listed characteristics. The model included all respondents (N=926) with non-missing values for all variables included in the model.

EHR Adoption

On a physician level, a total of 45% of physicians in Massachusetts had EHRs. However, only 23% of practices indicated that they had an electronic health record. Among them, more than half (53%) reported having EHRs in their practice for more than 3 years. Less than 15% of small practices (3 or fewer physicians) had EHRs (Table 1). In contrast, one third of practices with 4–6 physicians had EHRs, and more than half (52%) of practices with 7 or more physicians reported having EHRs. A majority (52%) of hospital-based practices had EHRs, while only one in five (20%) non-hospital based practices had adopted this technology. Among practices that reported teaching medical students or residents, 40% had EHRs, as compared with 14% of practices that were not involved in teaching.

Correlates of EHR Adoption

In logistic regression analyses, practice size was the strongest independent correlate of EHR adoption (Table 2). As compared with solo practices, practices with 4–6 physicians (adjusted odds ratio, 1.66; 95% confidence interval, 1.01–2.75) and those with 7 or more physicians (adjusted odds ratio, 3.66; 95% confidence interval, 2.28–5.87) were more likely to have EHRs. Whether a practice was hospital-based (adjusted odds ratio, 2.44; 95% confidence interval, 1.53–3.91) or involved in teaching (adjusted odds ratio, 2.30; 95% confidence interval, 1.60–3.31) was also correlated with having EHR. Practices indicating the availability of incentives for adoption of HIT were more likely to have EHRs than practices without such incentives (33% vs. 21%); in logistic regression analysis, there was a trend suggesting that incentive presence correlated with EHR adoption (adjusted odds ratio, 1.50; 95% confidence interval, 0.98–2.29). Similarly, there was a trend to suggest that practices self-

described as having innovative physicians were more likely to have EHRs (adjusted odds ratio, 1.49; 95% confidence interval, 1.00–2.21)

Table 3 shows the relationship between EHR adoption and indicators of office culture, office computing capabilities, and perceived barriers to HIT adoption or expansion, controlling for practice size, teaching status, whether or not the practice was hospital-based, whether the practice was self-described as having innovative physicians. Practices with EHRs were more likely to report that they were actively working to improve quality of care (adjusted odds ratio, 2.65; 95% confidence interval, 1.59–4.41). Offices with EHRs were also more likely to have e-mail, computerized scheduling systems, and e-prescribing.

As compared with EHR adopters, practices without EHRs were significantly more likely to identify six of the 10 barriers to HIT adoption or expansion suggested in the survey (Table 3). More than half of all respondents identified each of the 10 suggested barriers as actual barriers. More than 80% of respondents identified start-up financial costs (84%), ongoing financial costs (82%), and loss of productivity (81%) as barriers; in adjusted analyses, practices that had not adopted EHRs were significantly more likely to identify these financial barriers. The only factor cited as a major barrier by more than half of physicians was start-up financial costs (overall, 57%; 65% of non-adopters vs. 32% of adopters).

The Role of External Organizations in EHR Decision Making

Table 4 shows the role played by various organizations in practices' decisions to adopt EHRs. More than half of all respondents (59%) identified their own practice group as an organization influencing the decision whether to adopt a new EHR system. Practices that had not yet adopted EHRs were more likely to report that external organizations influenced the EHR adoption decision. Fewer than one in five respondents overall (19%) reported that the state medical society or specialty organizations played a role in this decision.

Discussion

While almost half of physicians in Massachusetts are now using an EHR, a figure much higher than the national average, only about 1 in 4 office practices has adopted, due in part to the fact that small practices are much less likely to adopt. Other correlates of adoption were whether a practice is based within a hospital and whether a practice teaches medical students or residents. In addition, practices that employ computer technology other than EHRs, including electronic mail, computerized scheduling systems, and electronic prescribing, were more likely to have EHRs. While these factors may not be causal in the adoption of EHRs, their presence suggests that larger, financially stronger, and more technologically advanced practices have greater potential for undertaking the financially expensive and technologically challenging conversion from paper to electronic health records. That the most commonly cited barriers to HIT adoption were financial costs and loss of productivity further supports the notion that financial barriers must be addressed to increase adoption rates.

Table 3 ■ Indicators of Office Culture and Perceived Barriers to Adoption or Expansion of Health Information Technology as Correlates of EHR Adoption in Ambulatory Care

	Overall* (%)	EHR Adopters* (%)	EHR Non- Adopters* (%)	Crude Odds Ratio†	95% CI	Adjusted Odds Ratio‡	95% CI
Office Culture							
We are actively doing things to improve quality of care.	82%	89%	80%	2.09	1.37 – 3.16	2.65	1.59 – 4.41
After we make changes to improve quality, we evaluate their effectiveness.	59%	64%	58%	1.28	0.97 – 1.70	1.23	0.89 – 1.70
We have quality problems in our practice.	25%	28%	24%	1.19	0.87 – 1.62	0.79	0.55 – 1.12
Our procedures and systems are good at preventing errors from occurring.	47%	51%	46%	1.22	0.93 – 1.60	1.67	1.22 – 2.29
Office Computing Capabilities							
Office has email	66%	86%	60%	4.08	2.82 – 5.90	2.62	1.77 – 3.89
Office has computerized scheduling system	62%	87%	54%	5.73	3.93 – 8.36	3.72	2.44 – 5.68
Office has e-prescribing	21%	50%	12%	7.65	5.60 – 10.45	5.96	4.21 – 8.43
Office has broad-band	67%	79%	64%	2.14	1.55 – 2.94	1.41	0.98 – 2.02
Barriers to HIT Adoption or Expansion							
Lack of time to acquire knowledge about systems	77%	69%	80%	0.55	0.40 – 0.74	0.66	0.46 – 0.93
Physician skepticism	57%	49%	60%	0.64	0.49 – 0.84	0.53	0.39 – 0.73
Lack of computer skills	59%	57%	59%	0.90	0.69 – 1.19	1.04	0.76 – 1.41
Lack of technical support	66%	59%	68%	0.68	0.51 – 0.89	0.78	0.57 – 1.07
Lack of uniform standards	78%	68%	81%	0.49	0.36 – 0.66	0.57	0.40 – 0.80
Technical limitations of systems	79%	78%	79%	0.99	0.71 – 1.37	1.02	0.70 – 1.49
Start-up financial costs	84%	64%	90%	0.19	0.14 – 0.27	0.26	0.18 – 0.38
Ongoing financial costs	82%	63%	88%	0.24	0.17 – 0.32	0.35	0.24 – 0.50
Loss of productivity	81%	65%	86%	0.31	0.22 – 0.42	0.41	0.29 – 0.59
Privacy or security concerns	55%	47%	58%	0.65	0.49 – 0.85	0.83	0.61 – 1.13

EHR = electronic health record; CI = confidence interval.

*N=1181; results are weighted as described in the Methods. The column percents indicate the weighted percent of respondents overall and among EHR adopters and non-adopters who endorsed each statement or characteristic. For the barrier items, the table indicates the percent of EHR adopters, non-adopters, and respondents overall who identify each item as a minor barrier or major barrier to beginning or expanding the use of computer technology in their main practice.

†The crude odds ratio represents the odds of EHR among those who agree with each statement as opposed to those who do not agree.

‡The adjusted odds ratio was derived from a logistic regression model modeling each statement or characteristic as a correlate of EHR adoption, controlling for the four exogenous variables determined to be statistically significant predictors of EHR adoption from Table 2, i.e., number of physicians, hospital-based, teaching, and the self-description as a practice with innovative physicians.

The EHR adoption rates in this study (23% of practices and 45% of physicians overall) were considerably higher than the national average of 17.6% of physicians reported in the 2003 National Ambulatory Medical Care Survey (NAMCS).¹⁰ A 2005 statewide survey in Florida found that about 24% of physicians in that state used EHRs, though that study was limited by a low response rate (28%).³¹ Nevertheless, both the Florida and the Massachusetts surveys came to similar conclusions regarding the factors associated with EHR adoption, especially practice size, and the barriers to adoption.

A key issue in all surveys regarding electronic health record adoption is what constitutes an EHR. For example, the NAMCS study did not define EHR, other than indicating that it excluded billing records.¹⁰ In such studies, it is possible that physicians indicating the presence of EHR may have systems with limited functionality. Like the study by Menachemi et al.,³¹ our study used an explicit definition of EHR, and as a result the rates in the present study are likely to be robust estimates of the adoption of functional EHRs.

The recently released results of the 2005 NAMCS survey do incorporate measures of EHR functionality in addition to the previously administered yes/no question about the use of electronic medical records.³²

While the Massachusetts EHR adoption level is more than double the national average, most of these physicians are concentrated in large group practices, with the four largest groups (Partners, CareGroup, Boston Medical Center, and Harvard Vanguard) combined including approximately 4000 physician users, accounting for approximately 44% of the State's EHR users. The large majority of physicians practicing in smaller practices still do not use EHRs. This finding is especially striking given that Massachusetts, a state with extensive commerce in technology and communications, has multiple academic health centers and large practice organizations that have been using EHRs for more than a decade. The lack of widespread adoption in this market illustrates the barriers facing physicians in small- and medium-sized practices across the country.

Table 4 ■ Organizations Influencing Practices in the Decision Whether to Adopt a New Electronic Health Record System

Organization	Practices with EHRs	Practices without EHRs	P Value
	Percent*	Percent*	
Your practice group	69	56	<0.001
Physician Hospital Organization(s) (PHOs) or Independent Practice Association(s) (IPAs)	40	43	0.46
Integrated Delivery System(s)	29	33	0.27
Managed care plans you work with	30	41	<0.001
Massachusetts Medical Society	18	34	<0.001
Your specialty's professional society	21	30	0.004
MassPRO or DOQ-IT†	8	22	<0.001
Massachusetts e-Health Collaborative‡	9	23	<0.001
The Leapfrog Group¶	6	16	<0.001

EHR = electronic health record.

*N = 1181. Percent reporting that each organization played a role in deciding whether to adopt a new electronic health record system for the practice. All percents are weighted; see text for details.

†MassPRO is the Massachusetts Healthcare Quality Improvement Organization (<http://www.masspro.org/>). MassPRO participates in the Doctor's Office Quality Information Technology (DOQ-IT) program, a two-year Special Study demonstration that is designed to improve quality of care, patient safety, and efficiency for services provided to Medicare beneficiaries by promoting the adoption of EHRs in primary care physician offices.

‡The Massachusetts e-Health Collaborative (www.MAeHC.org) was formed in 2004 as an initiative of the physician community to bring together the state's major health care stakeholders for the purpose of establishing an EHR system that would enhance the quality, efficiency and safety of care in Massachusetts.

¶The Leapfrog Group (<http://www.leapfroggroup.org/>) is an initiative driven by organizations that buy health care who are working to initiate breakthrough improvements in the safety, quality and affordability of healthcare for Americans.

From the physician perspective, many barriers constrain the adoption or expansion of computer technology in office practice. Most physicians indicated that financial factors, including start-up financial costs, ongoing financial costs, and loss of productivity, were barriers to technology adoption; among physicians whose practices had not yet adopted EHRs, more than 80% cited these factors as barriers. Prior studies have also suggested the importance of overcoming financial barriers to EHR adoption.^{5,10,11} In addition, our study revealed that a majority of physicians pointed to technical factors, including lack of computer skills, lack of technical support, lack of uniform standards, and technical limitations of systems, as important barriers. Furthermore, a majority of physicians (55%) noted concerns about privacy or security as a barrier to technology adoption in their practice. These findings suggest that overcoming the financial barriers represent a necessary but insufficient intervention for expanding EHR adoption.

In the context of Rogers' framework of the diffusion of innovations, our results support the notion that organizational factors play a critical role in determining how rapidly EHRs will be adopted. Of these organizational factors, the number of physicians in the practice and whether a practice is affiliated with the hospital seem to drive EHR adoption. While this study focused on the practice as the unit of analysis and did not focus on individual physician characteristics, we did observe that practices teaching medical students and residents were more likely to have adopted EHRs, independent of practice size, specialty, and hospital affiliation. It is possible that a practice's teaching status is a surrogate marker for physicians with a propensity toward technology or quality improvement efforts, for example; other dimensions of this study suggest that these factors may also be associated with EHR adoption. Alternatively,

the possibility exists that medical students and residents, who generally spend at least some of their training in hospital settings, are functioning as catalysts for the office practices that house them to adopt EHRs and other HIT that may be more prevalent in the inpatient setting.

A variety of organizations, ranging from hospitals and managed care organizations to medical societies and national coalitions such as Leapfrog, have launched efforts to enhance the adoption of EHRs in office practice. In his 2004, 2005, and 2006 State of the Union addresses, President George W. Bush has called for efforts to expand the use of health information technology.¹⁶⁻¹⁸ There has been bipartisan support for the National Coordinator for Health Information Technology's goal of universal EHR adoption by 2014,²⁰ including legislation promoting the use of EHRs coauthored by Senators Bill Frist, Hillary Clinton, Edward Kennedy, and Mike Enzi (Senate Bill 1418).³³ This legislation achieved unanimous approval in the U.S. Senate and is currently in a House subcommittee.³³

While the national agenda encourages adoption of EHRs, physicians in Massachusetts cited their own practice more often than any external organization as an influence on their decisions in this area. One-third to one-half of physicians noted that local or regional organizations influence the EHR adoption decision, and fewer than 3 in 10 physicians indicated that state or national entities, such as the state medical society, the state quality improvement organization, or the Leapfrog Group influenced this decision. National and statewide organizations may need to localize their efforts to be effective.

These data also underscore the fact that, from the policy perspective, while many factors are at play, probably the single most important concern is addressing the issue of the financial incentives for small practices.⁶ The more funda-

mental problem is that while providers incur the costs of purchasing an electronic record, nearly all the benefits accrue to payers and purchasers.³⁴ While it would almost certainly help if payers paid providers more if they used an electronic record, small practices may also need support of other types such as low- or zero-interest loans if they are to make the conversion.

The principal limitation of this study is that it was conducted in a single state, Massachusetts. However, it captured the responses from a broad range of physicians across the urban and non-urban locales of the Commonwealth and included small and large practices from primary care and all medical and surgical office-based specialties.

Conclusion

We found that in Massachusetts, while nearly half of physicians are now using an EHR, most small office practices still do not have EHRs, as in other parts of the country. While large, financially stable multi-specialty groups have adopted EHRs, most physicians practicing solo or in small groups have not, and they may not do so without additional assistance. Although the financial barriers to adoption predominate, other considerations, such as concerns about workflow and privacy, remain issues for most physicians. These findings suggest that programs and interventions intended to increase the adoption of EHRs should include a focus at the practice level since that is where decision-making about adoption occurs, and should help physicians modify their workflow to get the most out of the record, as well as explicitly acknowledging and addressing privacy concerns. External efforts to enhance adoption must address both the initial and ongoing financial costs of EHR implementation and the cultural and technological barriers to adoption.

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