

## Refereed papers

# Imminent adopters of electronic health records in ambulatory care

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## ABSTRACT

**Background** Although evidence suggests electronic health records (EHRs) can improve quality and efficiency, provider adoption rates in the US ambulatory setting are relatively low. Prior studies have identified factors correlated with EHR use, but less is known about characteristics of physicians on the verge of adoption.

**Objective** To compare characteristics of physicians who are imminent adopters of EHRs with EHR users and non-users.

**Design and participants** A survey was mailed (June – November 2005) to a stratified random sample of all medical practices in Massachusetts.

One physician from each practice ( $n=1884$ ) was randomly selected to participate. Overall, 1345 physicians (71.4%) responded to the survey, with 1082 eligible for analysis due to exclusion criteria. 'Imminent adopters' were those planning to adopt EHRs within 12 months.

**Measurements** We assessed physician and practice characteristics, availability of technology, barriers to adoption or expansion of health information technology (HIT), computer proficiency, and financial considerations.

**Results** Compared to non-users, imminent adopters were younger, more experienced with

technology, and more often in practices engaged in quality improvement. More imminent adopters owned or partly owned their practices (57.4%) than users (33.5%;  $p < 0.001$ ), but fewer imminent adopters owned their practices than non-users (65.7%;  $p < 0.001$ ). Additionally, more imminent adopters (26.0%) reported personal financial incentives for HIT use than users (14.8%;  $p < 0.001$ ) and non-users (10.8%;  $p < 0.001$ ).

**Conclusions** Imminent adopters of EHRs differed from users and non-users. Financial considerations appear to play a major role in adoption decisions. Knowledge of these differences may assist policy-makers and healthcare leaders as they work to increase EHR adoption rates.

**Keywords:** adoption barriers, electronic health records, healthcare information technology

## Introduction

An Institute of Medicine (IOM) report in 1999 estimated that 44 000 to 98 000 people die each year in the USA due to medical errors, drawing attention to the problems of quality and patient safety.<sup>1</sup> These errors are often the result of system failures, exacerbated by the lack of complete health information for providers.<sup>1,2</sup> Health information technology (HIT) is an important tool for addressing these issues.<sup>2,3</sup> HIT includes computerised provider order entry, personal health records, and electronic health records (EHRs), among other technologies. EHRs can significantly improve providers' ability to provide quality care by facilitating standardisation, providing decision support, and improving legibility.<sup>4</sup> HIT may also be a means of lowering healthcare costs, improving workflow efficiency, and promoting communication among clinicians and between patients and their physicians.<sup>5,6</sup>

Nonetheless, current EHR adoption rates in the USA are low and, although limited data are available, the rate of increase in adoption appears to be modest.<sup>7,8</sup> A 2005 national estimate indicated that 23.9% of physicians were using EHRs and 5% of hospitals were using computerised physician order entry.<sup>8</sup> In addition, physicians practicing solo or in small groups were less likely to implement EHRs than large group practices.<sup>8</sup> In Massachusetts in 2005, 52% of large group practices (seven or more physicians) had EHRs, compared with 14% of solo practices; even if practices have EHRs, this does not necessarily mean that their systems have robust capabilities or that the physicians use the systems effectively.<sup>9,10</sup>

Barriers to EHR adoption in the USA include misalignment of incentives, high upfront costs, provider resistance, productivity concerns, vendor transience, and a lack of standards for vendors.<sup>11–13</sup> Many of these barriers have been found internationally as well. One important potential barrier in the USA is provider resistance to adoption of EHRs; this requires detailed investigation, although it is important to note that provider resistance is intertwined with other factors.<sup>14</sup> Other barriers include privacy and security concerns, issues with interoperability, lack of standards relating

to EHRs [AU2], limited technological support, and ongoing costs.<sup>5,15,16</sup> In the USA, solo practitioners face particular financial barriers and have more challenges with technological support.<sup>10</sup> Moreover, providers may be overwhelmed by the number of EHR vendors – more than 90 have been certified by the Certification Commission for Healthcare Information Technology – and may find it difficult to choose a system,<sup>17</sup> although this may be an issue of market maturity that will change over time as it has in Croatia and the United Kingdom.<sup>18</sup> Finally healthcare quality is expected to be substantially improved by EHRs, yet the results to date within the USA and internationally have been mixed.<sup>19</sup>

Rogers' diffusion of innovation framework suggests that perceptions of the innovation, individual adopter characteristics, and contextual/managerial features within the organisation influence adoption.<sup>20</sup> With a better understanding of these factors, EHR adoption might potentially be accelerated. However, relatively little is known about characteristics of US providers who plan to adopt EHRs in the near future. We therefore surveyed 1884 physicians in Massachusetts to identify characteristics of EHR users, imminent adopters, and non-users. We use imminent adopters as our frame of reference, as these have recently made the decision to adopt an EHR.

## Methods

We provide here an overview of the sampling methods, survey content, and survey administration. Further details are available in a prior manuscript.<sup>10</sup>

## Sample

We used information from a private vendor database and the Massachusetts Board of Registration in Medicine to identify all physicians practising in Massachusetts in the spring of 2005. After excluding residents-in-training, retired physicians, and those without direct patient care responsibilities, the total physician population was 20 227, practicing in 6174 unique sites. We

drew a stratified random sample of 1921 practices and randomly selected one physician per practice. After omitting practices that had closed the final sample size was 1884 physicians.<sup>10</sup>

## Survey

We developed an eight-page survey based on literature regarding barriers to and correlates of EHR adoption in the ambulatory care setting. The final questionnaire (available upon request) included items designed to assess organisational and EHR characteristics. The survey measured practice demographics (e.g. number of physicians, specialty, and patient volume) and included questions regarding availability of technology and personal/professional use of technology. Respondents were also asked to report barriers to HIT adoption, and we measured practice environment characteristics that may impede or augment EHR diffusion. Physicians qualified as EHR users if they responded affirmatively to the survey question, 'Does your main practice have components of an 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?'<sup>10</sup>

We classified respondents according to EHR adoption status. Physician practices were categorised as users if they currently used an EHR, imminent adopters if they planned to adopt an EHR within the next 12 months, or non-users if they either expected to adopt after one year or had no plans to adopt. Survey responses were stratified by physician adoption category (i.e. users, non-users, and imminent adopters).

## Survey administration

Atlantic Research and Consulting (Boston, Massachusetts) administered the survey between 1 June and 30 November 2005. We sent the survey via express mail with a 20-dollar cash honorarium. Later, second and third mailings were sent to non-respondents, without compensation, via first-class and express mail, respectively. Multiple telephone contact attempts were made between mailings. If contacted by telephone, physicians were reminded to complete the written questionnaire and were given the opportunity to complete the survey by telephone; 1.3% of respondents completed the survey by telephone. Ninety-four physicians from the sample were deemed ineligible for the following reasons: 62 had retired or closed their practice, 30 had relocated to a different practice site, one was deceased, and one had a corporate office address. The Partners HealthCare Human Research Committee approved the study protocol.<sup>10</sup>

## Statistical analysis

Our survey consisted primarily of multiple choice questions and Likert scales. We used descriptive statistics, including means, percentages, and *p*-values, to evaluate survey responses. We used SAS statistical software (version 9.1) for all statistical analyses (SAS Institute Inc., Cary, NC).<sup>10</sup> Unlike prior analyses, the present study did not require the weighting of responses to account for the sample frame.<sup>10</sup> As such, estimates in this study may differ from previously published results.<sup>10</sup>

## Results

A total of 1345 completed surveys were returned, a 71.4% response rate. Of this group, a total of 263 physicians were excluded because they reported that they did not see patients in the ambulatory setting (*n*=164) or did not answer our question regarding timing of EHR adoption plans (*n*=99), leaving 1082 physicians eligible for this analysis. Respondents and non-respondents were similar with respect to specialty, practice size, hospital-based practice, and practice location.<sup>10</sup> We found that there were 385 current EHR users (35.6%), 115 imminent adopters (10.6%), and 582 non-users (53.8%; Table 1).

## Individual and practice characteristics

Individual physician demographics, such as gender, race, and years in practice were similar among users, non-users, and imminent adopters; however, age and ownership differed. Imminent adopters (mean age 49.1 years) were younger than non-users (52.3 years), but older than users (48.0 years; Table 1). More imminent adopters than users owned or partly owned their practices (57.4% vs 33.5%; *p*<0.001), but fewer imminent adopters owned their practices than non-users (57.4% vs 65.7%; *p*<0.001). Imminent adopters were more likely to have high-volume practices (80.9% vs 52.2% and 60.6%; *p*<0.001; Table 1). More imminent adopters were from practices with multiple physicians than from solo practices (Table 1). Of note, imminent adopters and users were less often in primary care than non-users (Table 1).

Survey respondents were asked questions regarding their office practice environment's quality and safety culture (Table 2). All three respondent groups indicated that their practices engaged in quality improvement activities, though non-users reported the least activity. However, current EHR users indicated more evaluation of these efforts than imminent adopters

and non-users (68.0% vs 65.8% and 58.6%;  $p=0.01$ ). Fewer non-users reported having quality problems at their practices than users and imminent adopters.

### Technology availability and utilisation

Imminent adopters were comfortable with computers (Table 2). In fact, more imminent adopters (90.3%) indicated that their office had access to an internet connection than either users (90.0%) or non-users (81.8%,  $p<0.001$ ). Imminent adopters were more likely to use the internet at least once daily than non-users, but less likely than EHR users (92.1% vs 83.9% and 93.7%;  $p<0.001$ ).

### Barriers to adoption or expansion of HIT

Physicians responded to a series of questions regarding barriers to adoption or expansion of HIT in their practices (Table 3). All three groups were similar with respect to their satisfaction with their current practice situation. The groups were not significantly different when asked whether their computer skills or their staff's computer skills would impede adoption or expansion of computer technology (Table 3).

Many imminent adopters viewed start-up costs (73.2%) and ongoing costs (76.4%) as impediments. Imminent adopters were less likely to report that these costs were barriers compared with non-users (73.2% and 76.4% vs 92.8% and 88.3%;  $p<0.001$ ); in contrast, more imminent adopters indicated that these costs were barriers compared with current users (73.2% and 76.4% vs 57.8% and 55.9%;  $p<0.001$ ; Table 3). In

**Table 1** Respondent characteristics

	Users <i>n</i> (%)	Imminent <i>n</i> (%)	Non-users <i>n</i> (%)	<i>p</i> -value
	385(35.6%)	115(10.6%)	582(53.8%)	
<b>Personal characteristics</b>				
Mean age (years)	48	49.1	52.3	<0.001
Gender (% male)	244 (63.4)	77 (67.0)	410 (70.5)	0.07
Race (% white)	313 (84.8)	92 (83.6)	481 (86.2)	0.72
Ownership (% owner or part owner)	129 (33.5)	55 (57.4)	373 (65.7)	<0.001
<b>Years in practice</b>				
<10	32 (8.3)	6 (5.2)	45 (7.7)	0.55
10+	353 (91.7)	109 (94.8)	537 (92.3)	
<b>Practice characteristics</b>				
Practice size (% high volume*)	201 (52.2)	93 (80.9)	353 (60.6)	<0.001
Practice type (% primary care)	56 (14.6)	18 (15.6)	229 (39.3)	<0.001
<b>Practice size</b>				
Solo	53 (14)	15 (13)	225 (39)	<0.001
2–3 physicians	47 (12)	32 (28)	147 (26)	
4–6 physicians	93 (25)	34 (30)	109 (19)	
7+ physicians	186 (49)	33 (29)	91 (16)	
<b>Number of practices at which care is provided</b>				
One	275 (71.8)	88 (76.5)	408 (70.3)	0.4
More than one	108 (28.2)	27 (23.5)	172 (29.7)	
<b>% Outpatient time at main practice</b>				
Up to 75%	88 (23.0)	27 (23.5)	147 (25.3)	0.71
> 75%	294 (77.0)	88 (76.5)	434 (74.7)	

\* High volume is defined as more than 60 outpatient visits per physician per week

**Table 2** Office environment regarding quality and technology

	Users <i>n</i> (%)	Imminent <i>n</i> (%)	Non-users <i>n</i> (%)	<i>p</i> -value
<i>% Indicating agreement with the following statements</i>				
<b>Quality</b>				
We actively do things to improve quality of care	377 (88.3)	114 (88.6)	561 (81.1)	0.005
We evaluate the effectiveness of our quality improvement activities	257 (68.0)	75 (65.8)	328 (58.6)	0.01
We have quality problems in our practice	147 (39.2)	43 (38.1)	155 (27.5)	<0.001
Our procedures and systems are good at preventing errors	199 (53.1)	42 (37.2)	238 (42.4)	<0.001
<b>Technology</b>				
I use the internet daily or several times a day at my main practice	358 (93.7)	105 (92.1)	485 (83.9)	<0.001
I have access to an internet connection at my main practice	343 (90)	103 (90.3)	467 (81.8)	<0.001
I have access to email at my practice	346 (90.8)	91 (79.1)	376 (65.2)	<0.001
My practice uses a computerised scheduling system	347 (91.1)	103 (89.6)	369 (63.5)	<0.001

**Table 3** Barriers to HIT adoption or expansion at the practice

	Users <i>n</i> (%)	Imminent <i>n</i> (%)	Non-users <i>n</i> (%)	<i>p</i> -value
<b>Financial barriers</b>				
Start-up financial costs	210 (57.8)	82 (73.2)	515 (92.8)	<0.001
Ongoing financial costs	205 (55.9)	84 (76.4)	489 (88.3)	<0.001
<b>Workflow barriers</b>				
Training and productivity loss	223 (60.3)	95 (84.8)	475 (85.9)	<0.001
Loss of efficiency	51 (13.5)	20 (17.5)	127 (22.5)	<0.001
<b>Technical barriers</b>				
Lack of technical support	220 (58.1)	69 (61.1)	385 (69.8)	<0.001
Lack of uniform standards	250 (68.1)	81 (74.3)	453 (82.8)	<0.001
Technical limitation of systems	286 (76.9)	77 (69.4)	436 (80.4)	0.03
<b>Privacy or security concerns</b>				
	155 (41.0)	44 (40.0)	309 (55.3)	<0.001
<b>Personal barriers</b>				
Dissatisfaction with practice situation	285 (74.0)	83 (72.2)	414 (71.1)	0.62
Lack of computer skills of physician/staff	207 (54.9)	72 (63.7)	342 (61.2)	0.09
Lack of time to acquire knowledge about systems	257 (68.4)	81 (73.0)	446 (79.8)	<0.001
Physician scepticism	179 (47.6)	57 (51.3)	344 (61.8)	<0.001

general, a similar trend emerged for workflow (e.g. productivity loss) and technical barriers (e.g. technical support), with more imminent adopters indicating

these as barriers than users, but fewer than non-users. Technical limitation of the system was the only technical barrier which proved an exception to this trend.

The trend did not apply to privacy and security concerns. More users and non-users indicated these as concerns than imminent adopters (41.0% and 55.3% vs 40.0%;  $p<0.001$ ).

### Perceptions of computers in health care

Respondents were also asked about the effect of computers on several healthcare factors such as cost, quality, and communication. The same trend continued with users generally reporting the most positive perceptions of computers, followed by imminent adopters, and then non-users (Table 4). For example, 29.6% of users indicated that computers would have no effect or a negative effect on patient–physician communication compared with 38.6% of imminent adopters and 45.4% of non-users ( $p=0.001$ ). Likewise, 7.4% of users indicated that computers would have no effect or a negative effect on quality compared with 10.5% of imminent adopters and 21.3% of non-users ( $p<0.001$ ; Table 4).

### Financial considerations

Financial considerations were assessed at the practice and the individual level. The survey asked practitioners to what extent certain factors contributed to their personal and practice income. Imminent adopters reported more economic considerations for both their practice and personal earnings than users and non-users (Table 5). For example, more imminent adopters (26.0%) reported personal financial incentives for electronic information system usage than users (14.8%) and non-users (10.8%;  $p<0.001$ ). Following imminent adopters, users reported the next highest number of considerations, while non-users reported the least number of financial considerations. At the practice level, 37.8% of imminent adopters received financial incentives for their usage of electronic information systems compared to 28.2% of users and 14.7% of non-users ( $p<0.001$ ).

**Table 4** Perceptions of effects of computers

	Users <i>n</i> (%)	Imminent <i>n</i> (%)	Non-users <i>n</i> (%)	<i>p</i> -value
<b>Perceptions that EHRs have negative or no effect on:</b>				
Controlling costs of health care	119 (31.5)	43 (38.1)	155 (45.4)	<0.001
Quality of health care	28 (7.4)	12 (10.5)	121 (21.3)	<0.001
Interactions with the healthcare team	40 (10.6)	12 (10.4)	109 (19.3)	<0.001
Patient–physician communication	111 (29.6)	44 (38.6)	246 (45.4)	0.001
Clinicians' access to up-to-date knowledge	14 (3.7)	3 (2.6)	49 (8.6)	0.008
Medication errors	38 (10.2)	12 (10.5)	92 (16.2)	0.07

**Table 5** Financial considerations

	Users <i>n</i> (%) Yes	Imminent <i>n</i> (%) Yes	Non-users <i>n</i> (%) Yes	<i>p</i> -value
<b>Do the following factors contribute to your practice income?</b>				
Type of electronic information system	112 (32.8)	48 (48.5)	103 (20.7)	<0.001
Electronic information system usage	96 (28.2)	37 (37.8)	72 (14.7)	<0.001
Clinical quality (e.g. pay-for-performance)	118 (35.0)	53 (52.0)	133 (27.1)	<0.001
<b>Do the following factors contribute to your personal income?</b>				
Type of electronic information system	63 (18.4)	28 (28.9)	65 (13.4)	<0.001
Electronic information system usage	50 (14.8)	25 (26)	52 (10.8)	<0.001
Clinical quality (e.g. pay-for-performance)	80 (23.6)	40 (40.8)	96 (20.0)	<0.001

## Discussion

We assessed the characteristics of imminent adopters of EHRs and found that while they do not differ substantially from current EHR users and non-users with respect to most individual physician characteristics, younger age and greater experience with technology correlated with likelihood of being an imminent adopter. The practices of imminent adopters were more likely to be involved in quality improvement activities. Importantly, imminent adopters were less likely to own their practices than non-users, as well as more likely to have financial incentives to adopt HIT.

The ownership findings deserve comment. More imminent adopters owned or partly-owned their practices than users, but imminent adopters owned fewer of their practices than non-users. Since non-users are more often owners, it may be that they hesitate to adopt EHRs because they have a higher financial stake in the adoption decision. Small practices may also be more likely to be physician-owned than larger ones. Interestingly, in the UK structural characteristics of practices were not associated with IT adoption.<sup>21</sup>

Imminent adopters were more likely than users to report start-up and ongoing costs as hindrances to adoption or expansion of HIT, but perhaps not surprisingly imminent adopters were less likely than users or non-users to report cost as a barrier. Without substantial government incentives similar to those in the UK, financial barriers will probably continue to be important in the USA. One study estimated that the average EHR start-up cost for ambulatory practices ranged from \$16 000 to \$36 000 per physician.<sup>12</sup> This barrier is augmented by the uncertainty of return on investment.<sup>12</sup> Without immediate economic benefit, physicians are understandably hesitant, though EHR-related benefits will probably accrue over time.<sup>12</sup> More imminent adopters than users and non-users reported that factors such as payment for HIT use contribute to their practice and personal income. These data suggest that financial incentives that promote adoption may be effective. In the UK, after providers were incentivised to utilise EHRs through computerised data reporting measures, attitude towards computer usage improved.<sup>22</sup> Although we did not formally investigate incentives, the level of incentives present for individual providers in Massachusetts during this interval was modest, suggesting that even modest incentives can influence adoption rates. It is uncertain with pay-for-performance what level of reimbursement is necessary to change provider behaviour, and whether pay-for-performance will improve quality.<sup>23</sup>

The observation that imminent adopters are more likely to be younger and more experienced with technology is consistent with the fact that medical students

and physicians in training are increasingly exposed to HIT in medical school and in teaching hospitals.<sup>24</sup> Nonetheless, provider age has not always been associated with levels of satisfaction with health information technology.<sup>25</sup>

Although practice environments were similar among the groups, imminent adopters were more likely to be engaged in quality improvement activities than EHR users and non-users. HIT reduces errors related to legibility and communication, which are targets of patient safety and quality improvement efforts.<sup>26,27</sup> Thus, imminent adopter practices may adopt EHRs with the expectation that the new systems will improve quality and prevent errors. Alternatively, providers who focus on quality may be more open to new innovations.<sup>20</sup>

Overall, imminent adopters had extensive access to email and internet connections. They also frequently used the internet. As such, imminent adopters were well equipped to utilise and expand HIT in their practices.

Imminent adopters were similar to users with respect to concerns regarding patient privacy and security. Computers contain large amounts of sensitive, personal health information. As a result, they are an opportune target for persons seeking personal information. Without consistent industry standards, this information may not be appropriately safeguarded, contributing to providers hesitating to adopt EHRs.<sup>27</sup>

Our results are consistent with previous studies addressing barriers that suggest that lack of technical support, lack of industry standards, interoperability concerns, high upfront costs, and physician scepticism all represent important barriers to adoption.<sup>11,12</sup> More imminent adopters than users reported these barriers as obstacles to EHR expansion or adoption, but fewer imminent adopters than non-users reported these barriers. Consequently, addressing these well-known barriers, ideally within a conceptual framework such as that for the diffusion of innovation, will be important in accelerating EHR adoption.<sup>28</sup>

The principal limitation of this study was that it was conducted in a single state, Massachusetts. However, it captured responses from urban and non-urban providers, and small and large practices, as well as primary care, medical, and surgical office-based specialties.

## Conclusion

Adoption and standardisation of EHRs could potentially improve the quality, patient safety, and efficiency of the US healthcare system.<sup>29</sup> Even though the USA spends more on health care than any other country, it does not make the most of information technology,

and it lags far behind most other industrialised nations in ambulatory EHR adoption.<sup>5</sup> Understanding the characteristics of imminent adopters is essential to increasing the diffusion rate of EHRs, which are complex technologies. Of the characteristics we identified, financial incentives are clearly the most readily modifiable and even small incentives correlated with being an imminent adopter. In the UK, the structure of financial incentives had a significant positive nationwide effect on both the adoption of EHRs and healthcare quality.<sup>30</sup> Policymakers and healthcare leaders should be cognisant of these characteristics as they design interventions to increase adoption of EHRs. While diffusion of EHRs could significantly improve safety and quality of care for patients, it may also improve the efficiency of our system, closing the gap between US health expenditures and other countries.

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**CONFLICTS OF INTEREST**

None.

