Are physicians' perceptions of healthcare quality and practice satisfaction affected by errors associated with electronic health record use?

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ABSTRACT

Background Electronic health record (EHR) adoption is a national priority in the USA, and well-designed EHRs have the potential to improve quality and safety. However, physicians are reluctant to implement EHRs due to financial constraints, usability concerns, and apprehension about unintended consequences, including the introduction of medical errors related to EHR use. The goal of this study was to characterize and describe physicians' attitudes towards three consequences of EHR implementation: (1) the potential for EHRs to introduce new errors; (2) improvements in healthcare quality; and (3) changes in overall physician satisfaction.

Methods Using data from a 2007 statewide survey of Massachusetts physicians, we conducted multivariate regression analysis to examine relationships between practice characteristics, perceptions of EHR-related errors, perceptions of healthcare quality, and overall physician satisfaction.

Results 30% of physicians agreed that EHRs create new opportunities for error, but only 2% believed their EHR has created more errors than it prevented. With respect to perceptions of quality, there was no significant association between perceptions of EHR-associated errors and perceptions of EHR-associated changes in healthcare quality. Finally, physicians who believed that EHRs created new opportunities for error were less likely be satisfied with their practice situation (adjusted OR 0.49, p=0.001).

Conclusions Almost one third of physicians perceived that EHRs create new opportunities for error. This perception was associated with lower levels of physician satisfaction.

BACKGROUND AND SIGNIFICANCE

Purposeful and active use of robust electronic health records (EHRs) has the potential to improve patient safety and quality of care.[1–4] The promise of improved health outcomes coupled with cost savings was the primary motivation for President Obama's health information and technology initiative (HITECH).[5] HITECH's main goal is to achieve 'meaningful use' of EHRs.[5] Beginning in 2011, practices meeting 15 core objectives, most of which require use of basic EHR functionalities and computerized decision support, will receive incentive payments from the Centers for Medicare & Medicaid Services.[6] Ultimately, the meaningful use initiative strives to motivate physicians to actively incorporate EHRs into their routine clinical activities.

Over the last 5 years, an array of health information technology (HIT) public policy efforts has focused on EHR implementation. A 2008 survey of EHR use estimated a 13% national adoption rate.[7] While this proportion appears to be increasing, it does not appear to be doing so rapidly; a 2009 national estimate carried out using the same methodology found that only 17% of physicians and 10% of practices had adopted a basic EHR.[8] Moreover, multiple studies now suggest that EHR adoption alone is not sufficient to substantially improve quality.[9 10] Physicians must actively use clinical care tools, such as electronic prescribing and electronic visit notes, coupled with effective clinical decision support provided through the EHR, to improve patient care. Studies show that computerized physician order entry (CPOE) reduces the rate of medication errors[11 12] and can create substantial cost savings.[13] However, EHR usage remains low among physician practices: self-reported usage data reveal that physicians neither use EHRs regularly[9 14] nor use them to their full potential.[14 15] Use of EHR functionalities is highly variable, with most physicians reporting persistent use of some EHR functionalities yet infrequent use of others, including clinical decision support and registry tools.[14 15]

Why do implementation and usage levels remain low in spite of extensive research and public support for EHRs? Along with the financial implications of purchasing electronic systems, loss of productivity, and usability concerns,[16 17] apprehension about EHR-associated unintended consequences may be an additional barrier to adoption and use. Previous research has documented the negative unintended consequences associated with inpatient CPOE, such as workflow inefficiency and new errors, and has analyzed the effects of these negative unintended consequences on CPOE use.[18–21] New errors, including patient identification error, inappropriate module use, and data corruption, are associated with incorrect EHR use or system design.[22] Consequently, new errors can compromise patient care and ultimately impact physicians' perceptions about quality of care. Unintended consequences also threaten overall physician satisfaction with practicing medicine because they can impact physicians' work-lives.[23 24] Thus, the medical community may see EHRs as a double-edged sword—as effective care tools, yet also as complex, unpredictable, and a source of new opportunities for medical error.

OBJECTIVE

We surveyed physicians in Massachusetts who have adopted EHRs to characterize: (1) physicians' attitudes towards EHR-associated errors; (2) how errors impact their perception of EHRs; (3) how errors impact their perception of healthcare quality; and (4) how errors impact their overall satisfaction.

MATERIALS AND METHODS

The sampling, survey development, and survey administration methods have been previously described.[16] They are summarized briefly here.

Sampling

In spring 2005, we identified physicians practicing in Massachusetts from a commercial database (Folio Physician Database, FolioMed, Hyannis, Massachusetts, USA). We selected a stratified random sample of 1921 practice sites, and then randomly selected one physician at each of these practice sites for our survey sample. After excluding practices that had closed, 1884 physicians were included in the final sample. A total of 1345 physicians responded to the 2005 survey.

In 2007, we conducted a follow-up survey, which constitutes the data analyzed for this study. After excluding physicians who had moved (169), retired (25), or died (4), 1146 of our original physicians who responded in 2005 remained and were contacted for the follow-up survey. Physicians who answered the survey in both 2005 and 2007 are referred to as the 'responder' subsample. Physicians who did not respond to the 2005 survey were not recontacted in 2007.

To account for the fact that new physicians entered practice between 2005 and 2007, we conducted an additional survey in 2007. A total of 1769 new physicians were identified who had begun practicing since 2005. We contacted a random sample of 628.[15] After excluding physicians who had already moved out of the state (89) or retired (2), the 'new responder' subsample included 527 newly practicing physicians.

Survey and survey administration

We developed an eight-page mail survey that asked questions about availability, use, and physician perception of EHRs. Physicians answering affirmatively to the question, 'Does your main practice have components of any 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?' were considered to have an EHR, and were then asked questions about their perceptions of EHR implementation and use. Questions about perceptions of errors associated with EHR use were used to measure physician perceptions of healthcare quality. Physicians indicated on a 5-point Likert-type scale if they agreed that the EHR had created new opportunities for error and if the EHR had created more errors than it had prevented. For analysis, results of this 5-point Likert-type scale were dichotomized (respondents indicating that they strongly agree or agree were categorized as 'Agree' and respondents indicating that they neither agree nor disagree, disagree, or strongly disagree were categorized as 'Do Not Agree').

All physicians were surveyed about their perceptions of the effects of computers on clinical practice elements, regardless of whether their practice had an EHR. Using a 5-point Likert-type scale, physicians were asked if they thought that computers had a positive effect on quality of healthcare and medication errors. Physicians were also asked about their practice size, practice type (solo or group, primary care or specialty), years in practice, and participation in teaching activities.

Our survey was administered by the University of Chicago Survey Lab between March and July 2007. The study protocol was approved by the Human Research Committee of Partners HealthCare.

Statistical analysis

Analyses were conducted using SAS 9.1.3 and R 2.11.1. All hypothesis tests were performed at the 95% confidence level using Pearson's χ^2 test for independence on contingency tables. We used weighting to control for the complex sampling design. In the responder subsample, we used weights to control for our original stratification strategy, response rates in 2005 and 2007, and our one-physician-per-practice design (physicians from larger practices received higher weights than physicians from smaller practices since they had a lower likelihood of being sampled). For both the responder and new responder subsamples, we also used weights to control for differences in response rates between the two subsamples. The ultimate unit of analysis after all weights were applied was a physician practicing in Massachusetts in 2007.

RESULTS

Physician and practice characteristics

A total of 561 eligible physicians—all EHR users—were included in this analysis. Table 1 shows the characteristics of physicians with EHRs, including their sex, teaching responsibilities, practice type, practice size, years since graduation from medical school, and whether the physician's practice taught medical students or residents. More than half of physicians were male and 65% of respondents had teaching responsibilities. Most physicians worked in group practices. Of respondents, 33% were primary care physicians and 64% were specialists. Respondents

Table 1 Characteristics of Massachusetts physicians with electronic health records

Characteristic	% Of responders* (N = 561)
Sex	
Male	61.9
Female	37.1
Years since graduation†	
0–9	16.8
10–14	23.2
15–19	19.8
20–29	24.6
30+	14.1
Practice type	
Solo, primary care	6.1
Solo, specialty care	5.5
Primary care group/partnership	26.9
Single specialty group/partnership	32.6
Multi-specialty group/partnership	25.7
Practice size	
Solo (1–2 physicians)	15.2
Medium (3–5 physicians)	20.5
Large (6+ physicians)	60.8
Teaching‡	
Yes	64.9
No	33.5

*Unweighted results. Unweighted results are reported in Table 1. Tables 2–4 report results with weights applied (see Methods section).
†From medical school.
‡Survey asked physicians whether there were medical students or residents in their practice.

Table 2 Unintended consequences of electronic health records (EHRs)

Statements	Agree* (%)	Do not agree* (%)	Response rate† (%) (N=561)
Using the EHR has created new opportunities for errors	29.8	70.2	97.3
Our EHR has created more errors than it has prevented	2.1	97.9	96.6

*Weighted results.
†Unweighted response rates.

were fairly evenly distributed across the various 'years since graduation' levels. Of physicians surveyed, 61% worked in large practices (>6 physicians), while only 15% worked in solo practices (1—2 physicians).

Unintended consequences of EHRs

Table 2 shows the unadjusted weighted response frequencies of EHR users replying to questions about the unintended consequences of EHRs. Overall, 29.8% of physicians agreed with the statement 'Using the EHR has created new opportunities for errors' and only 2% agreed that 'Our EHR has created more errors than it prevented.' Unweighted response rates for the two questions were similar.

Attitudes towards EHRs and opportunities for medical error

Because a substantial proportion of physicians using EHRs agreed that the electronic systems created new opportunities for medical error, we further analyzed this subpopulation. Table 3 shows the characteristics of physicians agreeing that EHRs provide new opportunities for medical error compared to those who do not agree.

There were no clear demographic patterns in physician perceptions of EHRs leading to new types of error. There were trends towards increased concerns by female physicians (37% vs 28%; adjusted OR 1.35, p=0.20), specialty physicians in solo

Table 3 Characteristics of physicians who believe that electronic health records create new opportunities for error

	Agree (%)*	OR†	Adjusted p value
Sex			
Female	37.3	1.35	0.20
Male	27.9	1.00	—
Years since graduation			
0—9	29.6	0.89	0.82
10—14	14.1	0.41	0.01
15—19	42.3	1.37	0.38
20—29	48.9	2.11	0.03
30+	28.3	1.00	—
Practice type			
Solo, primary care	35.1	0.73	0.64
Solo, specialty care	51.1	1.13	0.83
Primary care group/partnership	40.1	1.06	0.83
Single specialty group/partnership	21.9	0.66	0.09
Multi-specialty group/partnership	36.8	1.00	—
Practice size			
Solo (1—2 physicians)	41.7	1.00	—
Medium (3—5 physicians)	18.8	0.64	0.31
Large (6+ physicians)	32.6	1.25	0.59
Teaching			
Yes	26.7	0.74	0.21
No	40.9	1.00	—

*Unadjusted.
†Adjusted for age, sex, practice size, practice, type, years since graduation, and teaching responsibilities.

practice versus other practice types (see table 3) and physicians without students in their practices (27% vs 41%, OR 0.74, p=0.21). However, the only statistically significant differences were in the age category, with physicians 10—14 years out of practice significantly less concerned (14%, OR 0.41 compared to physicians with more than 30 years of experience) and physicians 20—29 years out of practice significantly more concerned (49%, OR 2.11 compared to physicians with more than 30 years of experience).

Attitudes towards EHRs and their effects on healthcare quality

As described previously, national EHR implementation strives to enhance healthcare quality through multiple means, such as improving coordination of care, reducing errors, and providing access to patient data. Therefore, we hypothesized that physicians' attitudes towards EHR-associated errors might influence how they perceive the overall effect of EHRs on healthcare quality. Table 4 shows the relationship between these two variables. Only 3.2% of physicians who agreed that EHRs can create new opportunities for error also agreed that the overall effect of computers on quality was negative, with no association between the two variables in adjusted analyses (OR 1.74, 95% CI −1.31 to 0.20). However, the subset of physicians who felt that EHRs create more errors than they prevent was significantly less likely to agree that computers positively affect healthcare quality (OR 0.02, 95% CI 1.85 to 5.92).

Attitudes towards EHRs and physician satisfaction

Because previous research has demonstrated that EHRs can influence physicians' work environments, we examined the relationship between unintended consequences and physicians' current practice satisfaction (table 4). Physicians who agreed that EHRs create new opportunities for error were considerably less likely to feel satisfied with their practice than those who disagreed (16% vs 46%, OR 0.49, 95% CI 0.28 to 1.15). Physicians who believed that EHRs create more errors than they prevent were also more likely to be dissatisfied with their current practice (OR 0.10, 95% CI 1.07 to 3.72).

DISCUSSION

While almost one-third of current EHR users agreed that EHRs could create new opportunity for error, our respondents almost universally agreed that EHRs do not create more errors than they prevent. As expected, physicians recognize that 'new opportunities for error' and 'overall error prevention and creation' are not mutually exclusive outcomes. The EHR may create some new errors, but on the whole, the EHR was perceived to prevent more errors than it creates. Some alternative hypotheses might also help explain this finding. For example, new errors might be recognized and intercepted before they reach patients or other providers. Physicians may also avoid using EHR features that are 'error hotspots' and prevent creation of new errors. Still, our finding suggests that physicians across all settings have a positive perception of EHRs and are hopeful that they can be powerful tools for improving patient safety and quality.

Even physicians who reported new opportunities for error did not associate EHRs with negative changes in healthcare quality. As expected, physicians who perceived that EHRs created more errors than they prevented were also less likely to believe that EHRs improved healthcare quality. However, physicians who reported new opportunities for error did not report lower healthcare quality. Although we might have expected them to be more skeptical about the overall benefit of EHRs, 89% of

Table 4 Unintended consequences of EHRs and perceptions of quality of healthcare

		Computers have a positive effect on the quality of healthcare				Physician satisfied with current practice			
		Agree (%)	Disagree (%)	Adjusted* OR	Adjusted* p value	Agree (%)	Disagree (%)	Adjusted* OR	Adjusted* p value
Using the EHR has created new opportunities for errors	Agree (%)	26.6	3.2	1.74	0.152	15.6	14.1	0.49	0.0013
	Disagree (%)	52.2	18.0			45.6	24.7		
Our EHR has created more errors than it has prevented	Agree (%)	1.6	0.5	0.02	0.0002	0.7	1.4	0.10	0.0004
	Disagree (%)	77.2	20.7			60.5	37.4		

*Adjusted for age, sex, practice size, practice, type, years since graduation, and teaching responsibilities.

physicians who agreed that EHRs create new opportunities for error also indicated that EHRs were associated with improved healthcare quality. Our findings suggest that while a sizeable proportion of physicians notice that EHRs can cause errors, these new errors have not yet compromised their positive views on EHRs' impact on safety and quality.

However, these new errors may still be significant because physicians reporting such errors also reported decreased practice satisfaction. As expected, physicians who felt that EHRs created more errors than they prevent were more likely to agree that EHRs negatively impact quality. Additionally, physicians who noticed new errors were more likely to be dissatisfied, even though most of them felt that EHRs overall prevent errors. While our study cannot determine this association's directionality, these new errors may create the need for re-work or additional checks, thereby undermining physician satisfaction. Further research to examine the impact of new errors on EHR acceptance and adoption may be warranted.

Our study has two key limitations. First, the survey was limited to a single state, and thus, the responder population may not reflect the national physician population. For example, our responder sample contained a lower percentage of solo practice physicians as compared to the national physician population. Therefore, the attitudes towards EHRs, unintended consequences, and quality of healthcare described here may not be generalizable to the national physician population. However, because Massachusetts has an early investment in EHRs, our findings may still herald national trends under HITECH. Additionally, the cross-sectional survey design prevented us from identifying the temporal relationships between variables and limited our ability to determine the directionality of associations.

This study has several implications for EHR design, policy, and future research. Given that users report new opportunities for error, greater focus should be placed on improving EHR design. By identifying those features of the EHR that physicians believe present new opportunities for error, and the tactics that physicians employ to work around opportunities for error, developers can both enhance current functionalities and create new tools to minimize new EHR-associated errors. Furthermore, given that most physicians did not believe that EHRs have created new opportunities for error, despite considerable evidence that they have, additional education and training may be necessary to help physicians to identify, report, and mitigate EHR-related errors.

Our findings also suggest several additional research areas. First, additional research might focus on perceptions of EHR-related unintended consequences among new adopters of EHRs, particularly those receiving HITECH incentives. In this study, physician-users (or their practices) voluntarily adopted EHRs. It is likely that HITECH incentives will bring in a new group of users more reluctant to adopt EHRs, and their perceptions of the unintended consequences may differ from those observed in this study.

CONCLUSION
Overall, physicians using EHRs did not believe that EHRs create more errors than they prevent, and agreed that EHRs improve quality in the aggregate. About one-third of physicians recognized that unintended errors can occur as a result of implementing an EHR, and these attitudes about errors are associated with decreased levels of physician satisfaction.

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