

Grant Final Report

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Statewide Implementation of Electronic Health Records

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Abstract

Purpose: To evaluate the effects of a statewide intervention on the adoption and use of electronic health records (EHRs) and related health information technology (HIT).

Scope: The Massachusetts e-Health Collaborative extensively implemented EHRs throughout three diverse communities. This study comprehensively evaluated the intervention and measured trends in HIT adoption across Massachusetts.

Methods: Multiple statewide surveys of office staff and physicians addressed barriers to adoption and use of EHRs. A quasi-experimental pre-post study evaluated the effect of EHR implementation on medication errors. A randomized controlled trial assessed the effects of academic detailing on the uptake of new EHR systems. Merging survey results with claims data enabled the evaluation of the relationship between EHRs and quality of care. An additional analysis examined the relationship between EHRs and malpractice claims.

Results: The most important barrier to EHR adoption was financial, which was most apparent in small practices. While a majority of physicians had adopted EHRs by 2005, only a small fraction regularly used key functions, including clinical decision support. EHR adoption was associated with lower rates of malpractice settlements. The relationship between EHRs and quality of care is complex and depends not only on EHR adoption but also usage of key EHR features.

Key Words: electronic health records, evaluation, health information exchange

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Final Report

Purpose

This research project was funded to evaluate electronic health record (EHR) adoption and implementation in Massachusetts through the following four project aims.

Aim 1. To evaluate the effectiveness of an intervention designed to increase the rate and extent of adoption of electronic health records in physicians' offices throughout Massachusetts.

Aim 2. The goal of Aim 2 was twofold; first, to determine the effect of EHR use on medication error rates and second, to determine the effects of EHR use on quality of care in primary care office practices.

Aim 3. To develop, pre-test and administer a survey to Massachusetts licensed physicians before and after implementation of a multi-stakeholder collaborative intervention.

- Aim 3a: To measure the degree and correlates of physician receptivity to (readiness to adopt) EHRs.
- Aim 3b: To assess the effects of the statewide program on physician receptivity to and use of EHRs
- Aim 3c: To measure potential facilitators of EHR adoption by physicians.

Aim 4. To measure the effectiveness of academic detailing in fostering successful implementation and usage of EHRs among physicians adopting such systems.

Scope

While electronic records are being used increasingly in developed nations, their impact on safety and quality has been variable. Many features of EHRs, including electronic prescribing, interoperability and decision support, reduce opportunities for medical errors during the provision of care and have the potential to also improve quality. While implementation of an EHR system has the potential to enhance the quality and effectiveness of a physician's practice, many physicians have encountered a variety of barriers that dissuade them from electing to use this tool in their practices. These barriers include financial, technological and other challenges.

The Massachusetts eHealth Collaborative (MAeHC) is a multi-stakeholder group which was formed with the aims of enhancing EHR adoption in Massachusetts, setting up clinical data exchange, and encouraging hospitals to adopt computerized physician order entry (CPOE). Established with a coalition of 34 stakeholders who champion health information technology,

and initial financial support from the Blue Cross Blue Shield of Massachusetts, the largest medical insurer in the state, MAeHC is working to improve the quality and safety of ambulatory care in the state through widespread EHR adoption and use.

In 2005, the MAeHC completed a proposal process for selection of three Massachusetts communities as pilots for full statewide EHR implementation. The state of Massachusetts has over 6 million residents that are cared for by approximately 20,000 physicians in about 6,000 practices. The three selected communities represent over 150 ambulatory practices with more than 400 clinicians. Currently, the MAeHC has implemented full EHRs in all of these practices, and has created an operational clinical data exchange platform in two of the three communities.

The eventual intent of the MAeHC is to implement EHRs and set up clinical data exchange statewide, but to do this will require significant investment and necessitate an array of policy changes. To inform this effort, we conducted this grant to perform an evaluation of the impact of the Collaborative in the pilot communities.

Methods

The goal of Aim 1: Practice Adoption of Electronic Health Records was to evaluate the effectiveness of an intervention designed to increase the rate and extent of adoption of electronic health records in physicians' offices throughout Massachusetts. At the time the application was submitted for funding, the anticipated intervention was a statewide effort to expand the adoption to all practices in Massachusetts. Shortly after funding of the project, it became apparent that the intervention would actually be a demonstration program to implement universal EHR adoption in three diverse communities in Massachusetts, an effort that became known as the Massachusetts eHealth Collaborative (MAeHC). As such, Aim 1 took on two dimensions: a) a pre-post evaluation of the MAeHC as an intervention in three communities to implement universal adoption of EHRs and b) a cohort study to examine the changes in EHR adoption and EHR usage across all of Massachusetts in 2005 and 2007.

All told, to satisfy the objectives of Aim, we conducted 3 statewide surveys and capitalized on at least two surveys targeted specifically to the participants in the 3 MAeHC communities. Our project began with a baseline survey of office practices throughout Massachusetts in 2005 and a parallel survey of physicians in Massachusetts in 2005. For the office practice survey, we surveyed a stratified random sample of 1829 practices in Massachusetts. The purpose of the survey was to determine which practices had adopted EHRs and how were key EHR functions being used. Almost concurrently, we conducted a survey of physicians across Massachusetts using the same sampling frame of 1829 practices, randomly selecting one physician from each practice for inclusion.

While our initial plans for 2007 included separate surveys of office practices and of physicians, we elected to merge these two surveys into a single survey of physicians in 2007 for the following reasons. First, the sampling for the two surveys was essentially the same, and we asked many of the same questions in 2005 in both the baseline office practice survey and the baseline physician survey. Furthermore, the response rate to the baseline physician survey (71%) was considerably higher than the response rate to the office practice survey (46%). Because of the suboptimal response to the baseline office practice survey, the eligible sample for the follow-up survey was much smaller than necessary to allow pre-post comparisons with adequate power

to detect effects. We elected to focus our resources on the 2007 physician survey, ensuring that it would include any scientific questions originally intended for the office practice survey, and enabling us to maximize response rate.

In collaboration with the MAeHC, we surveyed all practices in the three communities of the MAeHC in 2005 prior to commencement of the demonstration program of universal EHR implementation. A post-intervention follow-up survey is currently underway.

The above-mentioned surveys assessed practices' self-reported adoption and usage of EHRs and key EHR functions. We also sought to determine physicians' actual EHR usage after implementation in the MAeHC demonstration program. In order to do this, we acquired usage data from the EHR vendor used by the majority of MAeHC practices. These data include counts of physicians' use of key electronic elements within the EHR such as clinical documentation, medical history, vitals, and medication prescribing, among others.

Finally, we acquired clinical data exchange (also called health information exchange – HIE) usage data from one of the contracted HIE vendors to evaluate what health data elements are being sent to the HIE and which elements are being used and by whom.

Aim 2: Electronic Health Records Effect on Medication Errors and Quality of Care had two components: 1) to determine the effect of EHR use on medication error rates and 2) to determine the effects of EHR use on quality of care in primary care office practices.

In order to determine the effect of EHRs on medication rates, we recruited 14 MAeHC practices, representing 30 physicians in one community, to participate in two phases of the prescribing study. The design of this study was a non-randomized, quasi-experimental pre-post comparison study. All 30 physicians used paper medical records and paper-based prescribing at baseline, and all 30 physicians were scheduled to implement EHRs and e-prescribing through a staggered rollout program. We capitalized on this staggered rollout, as follows. In the first phase, all 30 physicians used duplicate (“carbonless copy”) paper prescriptions. Our study pharmacist evaluated each prescription for potential errors and then conducted chart reviews, using a data abstraction method previously validated by other studies, to look for potential adverse drug events. Between phase I and II, we lost 3 physicians to attrition. In our second phase, 14 physicians had adopted EHRs and were using the electronic prescribing module in their EHR, and 13 physicians continued their use of paper records and wrote paper prescriptions (using the duplicate prescription pads). Of the 14 physicians who used electronic prescribing, 3 did not use it exclusively; an intention-to-treat analysis will include these physicians in the intervention group, but practically speaking they will effectively be excluded, because only the small proportion of their prescriptions that were electronic were captured for analysis. An additional 3 physicians used an EHR from which we could not get electronic study data exports, leaving 11 physicians in the control group and 10 in the e-prescribing group. After chart review, the pharmacist reviewer presents all suspected ADEs or potential ADEs to two physician reviewers who will independently classify them as ADEs, potential ADEs, medication errors, or exclusions. This rating and classification methodology has been validated and used by our group in several previous studies, and we have previously demonstrated high inter-rater reliability for this process. The two physician evaluators will resolve all disagreements through discussion and consensus.

The second component of Aim 2 examined the effects of EHR use on the quality of care. We obtained data from the Massachusetts Health Quality Partners (MHQP, www.mhqp.org) which aggregates NCQA HEDIS® quality measures for the state of Massachusetts. We linked this to the responses from our statewide survey of physicians (Aim 3) to determine EHR users and non-

users. We planned three separate analyses on EHR use and quality: pre-intervention (prior to MAeHC efforts to expand EHR use), a 5-year longitudinal analysis of EHR use and quality, and post-intervention (after the MAeHC pilot program).

In Aim 3: Physicians Adoption and Use of Electronic Health Records, we sought to measure and evaluate the degree and correlates of physician receptivity to EHRs, the effects of a statewide program on physicians' receptivity and use of EHRs, and potential facilitators of EHR adoption. As mentioned above under Aim 1, we conducted two surveys, in 2005 and 2007, of a stratified random sample of physicians across the state of Massachusetts. In addition, we conducted a third survey in 2007 of physicians newly licensed to the state to get an accurate picture of Massachusetts in 2007. We also conducted a census of all of the MAeHC practices in both 2005, with a post-EHR survey scheduled for early 2008. Because the surveys included nearly identical questionnaires and data collection methodologies, we have been able to merge data from the 2005 MAeHC survey with the statewide survey data.

Additionally, we collected malpractice data from the Board of Registration in Medicine in Massachusetts and linked this information with the 2005 survey data on EHR usage.

Aim 4: Effect of Academic Detailing Intervention on EHR Use. To satisfy the objectives of this aim, we conducted a cluster-randomized controlled trial in three communities. We identified all practices providing primary care to adults and practices of medical subspecialties in the three MAeHC communities. To minimize confounding, we included only practices that had adopted their EHR from the predominant vendor of the MAeHC. Within each of the three communities, we randomly allocated practices to receive either usual care or the academic detailing intervention. All practices in both experimental arms received the MAeHC implementation approach that included on-site work-flow redesign, training in the use of the EHR and other electronic systems, and technical support, as well as printed and online information, to support their adoption of the EHR. In addition to this "usual care", practice groups randomized to the experimental intervention received two academic detailing sessions. This intervention program followed established principles of academic detailing, which involved in-depth interviews to identify the barriers to and facilitators of adoption of EHRs among the physicians in the sample.

The academic detailing program established credibility through respected organizational sponsors, referencing authoritative and unbiased sources of evidence, and presenting both sides of controversial issues. In each community, we identified a well-respected clinician to serve as the academic detailer. Training of the detailers was standardized and involved a day-long series of sessions on the content of the intervention and skills for communication and behavior change. This educational outreach program included presentation of essential information, both to provide background and to inoculate proactively against known issues of controversy that physicians may consider. We also incorporated the perceived barriers to adoption in structuring counter-arguments to physicians' concerns.

We scheduled two detailing sessions with physicians in each of the intervention practices, once in the first 3 months of the intervention period and again in the second 3 months. The individual detailing visits took approximately 15-30 minutes. Detailers were taught methods for repeating and positively reinforcing a small number of desired behaviors related to adoption and use of key EHR functions within each detailing encounter. Data for the analysis of this intervention have come principally from two sources: actual usage of EHRs within each practice and written field observations from the academic detailers themselves. Analyses are examining the use of key EHR functions, e.g., clinical documentation, medical history, vitals, prescribing, among others, among physicians in the intervention and usual care practices. While we

considered telephone interviews with all study participants following the intervention period to assess physicians' attitudes toward EHRs and their work-life satisfaction, these data will be available from the written surveys of all MAeHC physicians, and from other MAeHC sources, obviating the need for telephone interviews.

Results

Aim 1: Practice Adoption of Electronic Health Records

Results of the baseline survey of office practices throughout Massachusetts have been published:¹ 46% of practices responded to the office practice survey. Practice managers, to whom this survey was addressed, reported that 18% of respondent practices had electronic health records in 2005. Larger practices and hospital based practices were more likely to have EHRs. In addition, primary care practices (23%) and mixed-practices of primary care and specialties (25%) were more likely to have EHRs than specialty only practices (14%). Hospital based practices were nearly three times more likely. We also conducted a statewide physician survey in 2005, sent to a randomly-chosen physician within the practices mentioned above (see Aim 3). In this survey, we asked similar questions and achieved a 71% response rate and a weighted EHR adoption rate of 23% in Massachusetts practices.

Analyses and manuscript preparations are ongoing for the post-EHR survey, the EHR usage data, and the clinical data exchange data. In a related study, we analyzed the processes by which each community selected the architecture and governance of their HIE; a manuscript describing this analysis is in press at *American Journal of Public Health*.²

In another analysis not planned in the original grant application, we compared practices' abilities to generate registries – i.e., lists of patients by diagnosis, laboratory result, or medication use. A manuscript reporting the findings of this study is currently undergoing peer review.

Aim 2: Electronic Health Records Effect on Medication Errors and Quality of Care

Upon completion of data collection for the medication errors study, 3471 prescriptions were eligible for baseline analysis, and 1449 were eligible for post-EHR control (paper prescribing) analysis, and 1706 prescriptions were eligible for post-EHR e-prescribing analysis. 294 chart reviews were conducted during phase I, and 218 chart reviews were conducted in phase II. Analysis and manuscript preparation of the pre-post comparison are both underway.

We have presented preliminary findings for the first of the quality analyses at the American Medical Informatics Association annual conference, the Society of General Internal Medicine annual meeting, and International Society for the Quality of Health Care conference. The manuscript examining the cross-sectional relationship between EHR adoption and quality of care is currently submitted for publication at a peer-reviewed journal. A manuscript reporting trends in EHR adoption and quality of care and a manuscript reporting the effects of EHR adoption on quality of care within the MAeHC are nearing completion.

Aim 3: Physicians Adoption and Use of Electronic Health Records

we conducted a survey in 2005 of a stratified random sample of 1884 physicians. 1345 physicians responded yielding a response rate of 71%. We found that 45% of physicians in Massachusetts had an EHR at their practice. Practices with 4-6 physicians (52%) were more likely to have an EHR than small practices with 3 or less physicians (15%). Other correlates of EHR availability included hospital based practices over non-hospital based practices (52% vs. 20%) and practices with students or residents over practices without (40% vs. 14%). Furthermore, we found that practices with incentives and practices containing innovative physicians, as self described, were more likely to have EHRs. Physicians working in practices that have an EHR were more likely to report working towards quality improvement. Physicians reported barriers to HIT adoption, including: start-up financial costs (84%), ongoing financial costs (82%), and loss of productivity (81%). These results were reported in an original report in the *Journal of the American Medical Informatics Association*.³

In a study published in the *Archives of Internal Medicine*,⁴ we reported that more than 80% of physicians with EHRs reported having the ability to view laboratory reports (85%) and document visits electronically (84%), but many fewer reported being able to order laboratory tests electronically (47%) or transmit prescriptions to a pharmacy electronically (45%). Fewer than half of the physicians who had systems with clinical decision support, transmittal of electronic prescriptions, and radiology order entry, actually used these functions most or all of the time. EHR users compared to physicians who had not adopted an EHR reported more positive views of the effects of computers on health care.

As mentioned in the Methods section, we conducted a study on the relationship between EHR adoption and malpractice settlements. For this analysis, we collected publicly available Board of Registration in Medicine data on paid malpractice claims. Using the survey mentioned above, 1140 respondents with data on the presence of EHR had available BRM records, and 379 (33.2%) of these respondents had EHRs. In this study, recently published in the *Archives of Internal Medicine*,⁵ a total of 6.1% of physicians with an EHR had a history of a paid malpractice claim, compared to 10.8% of physicians without EHRs (unadjusted OR, 0.54; 95% CI 0.33 – 0.86). In logistic regression analysis controlling for sex, year of medical school graduation, and practice size, the relationship between EHR adoption and paid malpractice settlements was of smaller magnitude and no longer statistically significant (adjusted OR, 0.69; 95% CI, 0.40 – 1.20). Among EHR adopters, 5.7% of physicians identified as “high users” of EHR had paid malpractice claims, compared to 12.1% of “low users” (P=0.14). While the results of this study are inconclusive, physicians with EHRs appear less likely to have paid malpractice claims. Confirmatory studies are needed before these results can have policy implications.

In an additional set of analyses, we compared physicians’ attitudes toward health information technology and other potential mediators of EHR adoption among physicians in the MAeHC practices as compared with physicians throughout Massachusetts. A manuscript reporting these comparisons has been accepted for publication.⁶

Aim 4: Effect of Academic Detailing Intervention on EHR Use

We completed a cluster-randomized controlled trial in three communities. We identified a total of 48 eligible practices and randomly allocated 19 to intervention (academic detailing) and

17 to usual care (as described in the Methods above). Trained academic detailers in the three communities met with 27 out of 30 eligible physicians in the 19 intervention practices. Meetings lasted a median of 36 minutes (range 15 to 65 minutes). Academic detailers conducted in-person or telephone follow-up visits with each of the 27 participating physicians. Analyses are currently underway to examine the pre- and post-intervention usage of key EHR elements in the intervention and usual care practices; primary analyses will employ a “difference of differences” approach. In addition, we are conducting a qualitative analysis of the extensive field notes taken by academic detailers following each encounter with study physicians; this analysis may yield novel information regarding the barriers to and facilitators of EHR adoption and usage in the months following implementation and office transformation.

Inclusion of AHRQ Priority Populations

A main focus of our project was the Massachusetts eHealth Collaborative pilot communities. The pilot communities serve several AHRQ inclusion populations, specifically low-income and minority populations in one urban community and rural populations in a separate community.

We compared the results from our statewide survey to our survey of only the practices involved in the MAeHC. A total of 355 MAeHC physicians (77%) and 1345 physicians from the statewide sample (71%) completed the survey. MAeHC practices resembled practices throughout Massachusetts in terms of practice size, physician age and sex, prevailing financial incentives for quality performance and HIT adoption, and available resources for practice expansion. MAeHC practices were more likely to be located in rural areas (9.5% vs. 4.4%). Physicians in both samples responded similarly on seven of eight self-assessments of the office practice environment for quality and safety. Internet connections were more prevalent among MAeHC practices than across the state (96% vs. 83%), but similar proportions of MAeHC physicians (83%) and statewide physicians (86%) used the Internet daily.

We also conducted an additional analysis on our statewide survey data, led by Dr. Ashish Jha, using a new methodology in which we were able to identify practices that served a high degree of minority patients. We compared these practices with those who did not serve a high degree of minority populations, and examined EHR availability and use.

Physicians who reported patient panels of more than 40% black or Hispanic had comparable levels of EHR adoption than other physicians (27.9% and 21.8% respectively, $p = 0.46$). Physicians from minority serving practices identified financial and other barriers to implementing EHR systems at similar rates, although these physicians were less likely to be concerned with privacy and security concerns of EHRs (47.1% versus 64.4%, $p=0.01$). Finally, physicians from high minority practices had similar perceptions about the positive impact of EHRs on quality (73.7% versus 76.6%, $p=0.43$) and costs (46.9% versus 51.5%, $p=0.17$) of care.

In a state with a diverse minority population, we found no evidence that minority-serving providers had lower EHR adoption rates, faced different barriers to adoption, or were less satisfied with EHRs. Given the importance of ensuring that minority-serving providers have equal access to EHR systems, we failed to find evidence of a new digital divide. These results were presented at the American Medical Informatics Association annual conference and have been published.⁷

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List of Publications and Products

Simon SR, McCarthy ML, Kaushal R, et al. Electronic health records: which practices have them, and how are clinicians using them? *J Eval Clin Pract.* 2008;14(1):43-47.

Simon SR, Kaushal R, Cleary PD, et al. Correlates of electronic health record adoption in office practices: a statewide survey. *J Am Med Inform Assoc.* 2007;14(1):110-117.

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Rudin RS, Simon SR, Volk LA, Tripathi M, Bates DW. Understanding the Stakeholders of Health Information Exchange: Experiences From Massachusetts. *Am J Public Health.* 2008 (In Press).

Additional Related Article of Interest

Goroll AH, Simon SR, Tripathi M, Ascenzo C, Bates DW. Community-Wide Implementation of Health Information Technology: the Massachusetts eHealth Collaborative Experience. *J Am Med Inform Assoc.* 2008;[Epub ahead of print].