MEDINFO 2007
HISA Ltd Australia
© 2007 The authors. All rights reserved.

Evaluation of a Statewide Implementation of Electronic Health Records

Chelsea A. Jenter[a], Steven R. Simon[b], Lynn A. Volk[c], Eric Poon[a], Rainu Kaushal[d], Micky Tripathi[e], David W. Bates[a,c]

[a]*Division of General Medicine, Department of Medicine, Brigham & Women's Hospital, Boston, MA, USA*
[b]*Department of Ambulatory Care and Prevention, Harvard Medical School and Harvard Pilgrim Health Care, Boston, MA, USA*
[c]*Clinical & Quality Analysis, Information Systems, Partners HealthCare System, Wellesley, MA,USA*
[d]*Department of Public Health, Weill Medical College of Cornell University, NY, USA*
[e]*Massachusetts eHealth Collaborative,Waltham, MA, USA*

Abstract

The Massachusetts eHealth Collaborative is an effort to get all providers in the state to begin using electronic health records (EHRs), to implement clinical data exchange, and to get hospitals to begin using computerized provider order entry (CPOE). The Collaborative has implemented pilots in three communities in the state, and in this report we describe the evaluation of this effort, which is intended to inform strategies to spread EHRs, clinical data exchange, and CPOE across the entire state, with the aims of substantially improving the safety, quality, and efficiency of healthcare for the residents of Massachusetts. The evaluation will address how EHRs are used, the impact on the medication error rate, correlates of and barriers to adoption, whether an intervention aimed improving proficiency is beneficial, the impact of the EHR on quality, and an economic evaluation.

Keywords:

electronic health record, adoption, quality, safety, efficiency

Introduction

While electronic records are being used increasingly widely in developed nations, their impact on safety and quality has been variable [1-8]. 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 utilize this tool in their practices. These barriers include financial, technological and other challenges [5, 8-17].

The Massachusetts eHealth Collaborative (MAeHC) is a multistakeholder group which was formed with the aims of enhancing EHR adoption in Massachusetts, setting up clinical data exchange, and encouraging hospitals to adopt 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 6000 practices. The three selected communities represent over 150 ambulatory practices with over 400 clinicians. Currently, the MAeHC has implemented full EHRs in nearly half of these practices.

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 are performing an evaluation of the impact of the Collaborative in the pilot communities.

Methods

The evaluation focuses on four aims related to the implementation of EHRs. The first aim is to assess the ways that EHRs are used by physicians, ranging from those who use them proficiently to those who are just starting to use EHRs. The second is to assess how EHR use affects medication errors and overall quality of healthcare. The third is to identify physician characteristics that are correlated with the rate of EHR adoption, such as age, gender, innovational characteristics, in addition to practice characteristics such as a practice's financial health. Another aim is to facilitate EHR use through an intervention based on academic detailing [18], in addition to usual implementation strategies, and to assess whether academic detailing will accelerate EHR adoption and physician EHR proficiency. An economic evaluation is planned to calcu-

late the return on investment for EHR implementation. Finally, a preliminary evaluation of health information exchange (HIE) is planned for the final stages of the implementation effort. Evaluation across these aims will include assessment of the areas discussed below.

Effectiveness of intervention on rate and extent of adoption of EHRs

To assess the current rate of EHR adoption in Massachusetts, in 2005 we sent a one-page baseline office practice survey to the office practice managers of a random sample of 1829 ambulatory physician practices, representing approximately 30 percent of all practices in Massachusetts. A follow up survey is planned for mid 2007, after the full implementation of the EHRs in MAeHC's pilot communities. In addition, through the MAeHC, we have arranged to assess post-implementation EHR usage rates for specified features, as well as assess the planned health information exchange effort in the MAeHC communities.

Effects of EHR use on medication error rates

This aspect of the evaluation will compare errors found in handwritten prescriptions with those prescribed through the electronic health record system. Thirty physicians participated in the baseline measurement by using duplicate prescription pads for two weeks of data collection. A research pharmacist reviewed the prescriptions for medication errors, and performed subsequent chart review to clarify potential near misses and adverse drug events. A physician panel subsequently reviewed all near misses and adverse drug events.

After half of the participating practices have implemented EHRs in 2007, we will export electronic copies of prescriptions from each EHR. The other half of the physicians will serve as a control group by repeating the duplicate prescription protocol completed at baseline. The research pharmacist will review both the electronic and duplicate prescriptions for medication errors. Chart reviews and physician review panels will also be performed. Comparison analyses will be done to assess any differences in prescribing errors between paper prescriptions and e-prescribing through the EHR.

Effects of EHR use on quality of care

Quality of care has often been measured by claims-based data collection. Studies have indicated that EHRs can improve the quality of medical care, though their impact has been mixed [2,5,19]. To assess the effects of EHR implementation on quality of health care in community-based practices, the study team will obtain both pre-EHR implementation and post-EHR implementation claims-based quality data from the Massachusetts Health Quality Partners (MHQP). Comparisons between the two years are planned. These data will be linked to the physician characteristics collected in the physician survey to measure EHR usage and its relation to quality.

Studies have also suggested that EHR data exports present a unique opportunity to get faster and potentially better quality data [3]. To evaluate this potential, the study team plans to collect and assess quality data elements exported from the EHRs and compare EHR-derived quality measurements with claims-based quality measurement.

Physician use of EHRs

To assess physician characteristics and practice characteristics, we mailed an 8-page survey to 1884 randomly-selected physicians in Massachusetts, representing approximately 10 percent of physicians in the state. The questions in the survey addressed office characteristics, physician attitudes toward health information technology (HIT), barriers to EHR adoption, facilitators of EHR adoption, among others. For those who had EHRs in their practice, questions focused on EHR functionalities and degree of individual usage. A similar post EHR-implementation survey is planned for mid 2007.

Effectiveness of academic detailing on implementation

While many physicians welcome the addition of EHRs to their practices, some have greater difficulty adjusting to the EHR. In order to accelerate physician fluency with EHRs, the evaluation includes an academic detailing intervention. Academic detailing is a method of changing physician behavior that has been effective in improving prescribing behavior.[20] Using the same methodology, the intervention group (~ 15 physicians) will receive two academic intervention sessions to help them acclimate and adjust to their new EHR system. The control group will receive the usual technology support offered through the MAeHC and the EHR vendor. After the intervention, both groups will be assessed for EHR usage and satisfaction.

Economic evaluation

The planned evaluation also includes an overall economic component, which will assess the costs, savings, and return on investment related to MAeHC's implementation, interoperability, and data exchange. With respect to data exchange, we will count the number of pieces of data of various types (laboratory results, prescriptions, radiology results) moving within the communities. The eventual plan is to link the data exchanges with a statewide data exchange.

Results

The implementation effort and associated evaluation are both currently underway. Results available to date are described below.

Results from office practice survey

In our baseline survey, sent in April 2005, forty-six percent (847/1829) of office practices responded.[10] The survey was addressed to the office practice manager at each site. Weighted responses indicated that 18 percent of these practices had EHRs at the time of the survey.

Adoption rates varied slightly by type of practice, with 23 percent of primary-care-only practices, 25 percent of mixed practices (both primary care and specialty care), and 14 percent of specialty practices reporting having EHRs. The rate in specialty practices was significantly lower than the primary-care-only and the mixed practices ($P<0.01$). Practice size was also significantly correlated with EHR adoption, as smaller practices reported less EHR adoption ($P<0.001$).

EHR users were asked about functionalities that were available in their system. The most common functionalities available were visit notes, lab test results, and medication lists. However, when asked about which functionalities the majority of physicians used, laboratory and radiology result retrieval capabilities topped the list, with 87 percent of practices reporting that the majority of clinicians actively used both functionalities.

Of the practices that reported not currently having an EHR, 13 percent reported having plans to adopt an EHR within the next year, 24 percent reported plans for implementing an EHR in the next 1-2 years, and 11 percent in the next 3-5 years. Fifty-two percent of practices currently without EHRs reported having no plans to adopt an EHR in the foreseeable future.

One challenge to conducting this part of the evaluation was the unavailability of a list of statewide practice manager names. We sent the mailings to the "attention of the office practice manager" at each physician's office. Having the actual names might improve response rates.

Results from the medication error rate evaluation

Data collection for this evaluation is nearly complete. We were able to gather over 4000 prescriptions from 30 ambulatory, primary care physicians; nearly 200 chart reviews were performed to assess whether near misses (prescription errors with the potential to cause harm) were actually adverse drug events (prescription errors that did cause harm).

Our plan for this part of our implementation evaluation encountered some challenges. In comparison with our previous studies in academic settings, a larger proportion of physicians opted out due to a variety of concerns. Applying for Institutional Review Board (IRB) approval from hospital-based community IRBs was also more complex than usual, in part because less research is traditionally conducted in these settings. Also, the participating physicians came from many small independent ambulatory practices, making communication with all the various stakeholders a challenge.

Results from the quality of care evaluation

We have received HEDIS data on approximately 80 percent of the primary care physicians from our statewide physician survey sample. Analyses comparing quality of care with reports of EHR usage are underway. The methods for this part of the evaluation involve using HEDIS measures via claims-based data from the Massachusett Health Quality Partnership, which involves a long time delay (1-2 years post data collection).

An additional aim of this part of our evaluation is to examine the feasibility of gathering quality data directly from the electronic health records. This methodology for assessing quality generated concerns around physician identifiers, as well as numerous technical challenges to extract these data from multiple EHR vendors.

Results from physician survey

We also performed a statewide survey in June of 2005; a total of 1345/1884 physicians responded (71%).[9] When weighted to represent the distribution of practice size, specialty, and whether the practice was hospital-based, 23 percent of practices reported having EHRs. Practice size was strongly correlated with EHR adoption. Only 14 percent of solo practices reported having an EHR, while fifty-two percent of practices with 7 or more physicians reported having an EHR. However, due to the large number of practices with more than 7 physicians in Massachusetts, 45 percent of the physicians in the state, ranging from 10 percent in solo practices to 72 percent of large practices, reported having EHRs in their practices (see Figure 1). Practices that engaged in teaching medical students or residents and hospital-based practices both reported higher rates of EHR adoptions.

Not surprisingly, physicians reported that financial considerations present the greatest barrier to implementation. Loss of productivity was also a concern for physicians, with 81 percent of responders selecting it as a barrier. Physicians not currently using EHRs more often reported financial barriers as "major barriers" as compared with physicians who had EHRs.

Additional analyses are underway that focus on the characteristics of practices that have EHRs, as well as analyses that compare the statewide survey data with data collected in each of the intervention communities.

We believe that the high response rate was achieved because we used express mail delivery with $20 cash incentives, and multiple mailings. In addition, all envelopes were addressed to the physician specifically, and any

returned mail was researched (and re-mailed, if possible) using multiple statewide databases.

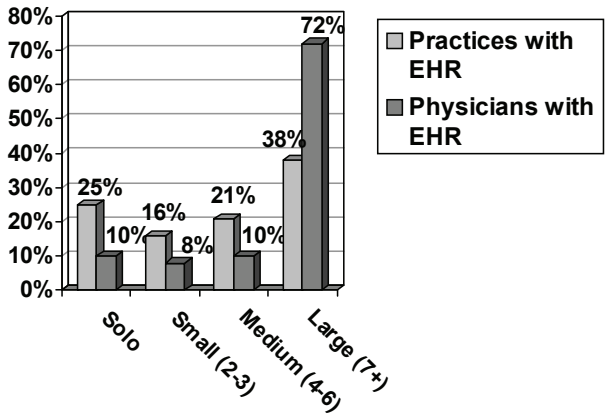

Figure 1 - Distribution of physicians and practices with EHRs by size of practice

Results from the academic detailing intervention

To date, we have been able to hire and train clinicians local to the communities participating in this intervention. This component of the evaluation is dependent upon EHR implementation, and the trained clinicians will begin the intervention in early 2007.

Discussion

The aims of this effort are to better understand more about EHR adoption in ambulatory settings, what can be done to get physicians to high levels of proficiency after adoption, how EHRs affect medication safety and quality performance in communities, and what the impact of EHR adoption and interoperability are on quality. Although we are still early on this path, we believe the preliminary results are of interest.

The results from both of our statewide surveys indicate that the rate of EHR adoption in Massachusetts in 2005 was higher than in other states in the U.S.. Practice size, as well as teaching practices and hospital-based practices, were all correlates of EHR adoption. The high response rate achieved in the physician survey suggests that our protocol, and specifically the cash incentives, can be a valuable method of obtaining high response rates from busy physicians.

EHR adopters reported various degrees of functionality within their systems. Visit notes and lab tests were the most common functionalities available. However, though many practices report having specific EHR functionalities, physicians were not necessarily using them in their practice. In our office practice survey, office practice managers reported that their physicians were using certain functionalities less than 50% of the time, or even none of the time. In 25% of practices who had clinical decision support (alerts, warnings and reminders) within that practice's EHR system, respondents reported that less than 50% of the clinicians were using that functionality. This would indicate that though physicians have functionalities within their EHR system, they don't necessarily use all of them. Some functionalities that they are not using, like clinical decision support, are important for quality improvement efforts.

Therefore, decision support standards need to be developed that will aide the availability and use of key quality-enhancing features in EHR systems. Additionally, physicians need to be trained and appropriately motivated to take advantage of the EHR.

EHR non-adopters have slightly different attitudes and weigh the challenges differently from EHR adopters. In our physician survey, non-adopters scored financial considerations as a greater barrier than did those with EHRs in place. Also, non-adopters' plans for implementation vary greatly, with the majority reporting having no plans to adopt EHRs in the near future.

Challenges in conducting this type of multi-faceted evaluation include physician concerns about privacy and security, issues related to conducting research in small communities that are not accustomed to academic research, and logistical and technical difficulties associated with independent EHR vendor systems.

Building trust in the participating practices is a key component to overcoming these challenges. For each study component, investigators and staff explained protocols and plans at the local level. Clear communication and community leadership from the coordinating organization, the MAeHC, has proven to be essential to the success of the evaluation. Their support of this research, as well as their relationships with the physicians and the vendor systems, has facilitated study operations.

An early conclusion from the work to date has been that the community-oriented approach to interoperability appears to be especially important. Our impression is that the involved practices would not have moved nearly as rapidly to setting up community data exchange without the Collaborative. In addition, we are hopeful that we will be able to identify practices that are not using the EHR to its full extent, and move them to higher levels of use than would have occurred without the Collaborative.

Conclusions

Measuring the impact of a fully-funded EHR implementation program requires a multimodal evaluation approach. This evaluation will be comparing quality, adoption rates, and correlates of EHR adoption across the state. This

Massachusetts evaluation has the opportunity to compare pilot communities that have comprehensive support to implement EHRs with EHR adoption in the rest of the state. Information collected as part of this effort will inform implementation in the rest of the state, as well as both national and international audiences. While many countries have made investments in EHRs that far exceed those made by the U.S., it is easy to have implementations that do not deliver full value. Evaluations such as this one may help justify future investments and policy choices in particular around relatively new areas such as interoperability.

Acknowledgements

Thanks to Alexis Tumolo, Madeline McCarthy, and Deborah Williams for their support and diligent work on this project.

This work was supported in part by grant number 1 UC1 HS015397 from the Agency for Healthcare Research and Quality, and also by the Massachusetts eHealth Collaborative. Neither organization is responsible for the contents of this paper.

References

[1] Hillestad R, Bigelow J, Bower A, Girosi F, Meili R, Scoville R, and Taylor R. Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. *Health Aff* 2005; 24(5):1103-1117.

[2] Institute of Medicine. Crossing the Quality Chasm: A New Health System for the 21st Century. National Academy Press, 2001.

[3] Institute of Medicine. Key capabilities of an electronic health record system. Accessed on June 24, 2006, http://www.nap.edu/catalog/10781.html?onpi_newsdoc073103.

[4] Bates DW, Ebell M, Gotlieb E, Zapp J, and Mullins HC. A proposal for electronic medical records in U.S. primary care. *J Am Med Inform Assoc* 2003; 10(1):1-10.

[5] Bates DW. Physicians and ambulatory electronic health records. *Health Aff* 2005; 24(5):1180-1189.

[6] Michael Bainbridge, chair, Primary Health Care Specialist Group, British Computer Society, personal communication with Dr. David Bates, 16 February 2004.

[7] Bomba D. A comparative study of computerised medical records usage among general practitioners in Australia and Sweden. *Medinfo* 1998; 9 Pt 1:55-59.

[8] Miller RH, and Sim I. Physicians' use of electronic medical records: barriers and solutions. *Health Aff* 2004; 23(2): 116-126.

[9] Simon SR, Kaushal R, Cleary PD, Jenter CA, Volk LA, Poon EG, Orav EJ, Lo HG, Williams DH, and Bates DW. Correlates of electronic health record adoption in office practices. *J Am Med Inform Assoc* (in press).

[10] Simon SR, McCarthy ML, Kaushal R, Jenter CA, Volk LA, Poon EG, Yee KC, Orav EJ, Williams DH, and Bates DW. Electronic health records: which practices have them, and how are clinicians using them? *J Eval Clin Pract* (in press).

[11] Gans D, Kralewski J, Hammons T, and Dowd B. Medical groups' adoption of electronic health records and information systems. *Health Aff* 2005; 24(5):1323-1333.

[12] Burt CW, and Sisk JE. Which physicians and practices are using electronic medical records? *Health Aff* 2005; 24(5):1334-1343.

[13] Baron RJ, Fabens EL, Schiffman M, and Wolf E. Electronic health records: just around the corner? Or over the cliff? *Ann of Int Med* 2005; 143(3):222-226.

[14] Audet AM, Doty MM, Peugh J, Shamasdin J, Zapert K, and Schoenbaum S. Information technologies: when will they make it into physicians' black bags? *Med Gen Med* 2004; 6(4):2.

[15] Miller RH, West C, Brown TM, Sim I, and Ganchoff C. The value of electronic health records in solo or small group practices. *Health Aff* 2005; 24(5):1127-1137.

[16] Poon E, Jha A, Christino M, Honour M, Fernandopulle R, Middleton B, Newhouse J, Leape L, Bates DW, Blumenthal D, and Kaushal R. Assessing the level of healthcare information technology adoption in the United States: a snapshot. *BMC Med Inform Decis Mak* 2006; 6(1):1.

[17] Loomis GA, Ries JS, Saywell RM, Jr., Thakker NR. If electronic medical records are so great, why aren't family physicians using them? *J Fam Pract* 2002; 51(7):636-641.

[18] Soumerai SB, and Avorn J. Principles of educational outreach ('academic detailing') in improve clinical decision making. *JAMA* 1990; 263(4): 549-556.

[19] Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, Morton SC, Shekelle PG. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Ann Intern Med* 2006; 144(10): 742-752.

[20] O'Brien, MA; Oxman, AD; Davis, DA; Haynes, RB; Freemantle, N; Harvey, EL. Educational outreach visits: effects on professional practice and health care outcomes. Cochrane Database of Systematic Reviews 2000: 2: CD000409.

Address for correspondence

Chelsea A. Jenter, MPH
Project Manager
Clinical & Quality Analysis, Information Systems
Division of General Medicine, Department of Medicine
Brigham & Women's Hospital
93 Worcester Street, 2nd floor
Box 81905
Wellesley, MA 02481