Physician use of electronic medical records: Issues and successes with direct data entry and physician productivity

Paul D. Clayton, Scott P. Narus, Watson A. Bowes III, Tammy S. Madsen, Adam B. Wilcox, Garth Orsmond, Beatriz Rocha, Sidney N. Thornton, Spencer Jones, Craig A. Jacobsen, Marc R. Udall, Michael L. Rhodes, Brent E. Wallace, Wayne Cannon, Jerry Gardner, Stan M. Huff, Linda Leckman
Intermountain Health Care and the Dept of Medical informatics at the University of Utah
Salt Lake City, Utah.

At Intermountain Health Care, we evaluated whether physicians in an ambulatory setting will voluntarily choose to enter data directly into an electronic health record (EHR). In this paper we describe the benefits of an EHR, as they exist in the current IHC application and the ways in which we have sought to minimize obstacles to physician data entry. Currently, of 472 IHC employed physicians, 321 (68%) routinely enter some data directly into the EHR without coercion. Twenty-five percent (80/321) of the physicians use voice recognition for some data entry. Twelve of our 95 ambulatory clinics have voluntarily adopted measures to eliminate paper charts. Of the 212 physicians who entered data in 2004, sixty-nine physicians (22%) increased their level of data entry, while 12 (6%) decreased. We conclude that physicians will voluntarily adopt an EHR system, and will continue and even increase use after implementation barriers are addressed.

Introduction

Based on 35 years of experience gained by using the HELP system [1-3] in the acute care setting and the work of others [4-6], Intermountain Health Care (IHC) is convinced that it is possible to favorably influence the quality of care provided to patients is by using an electronic health record (EHR) at the point of care.[7] IHC is a not for profit integrated health care delivery network which operates 20 hospitals (2200 beds with 120,000 admissions per year), employs 470 primary care physicians (internists and family practitioners) working in 95 ambulatory clinics (3,000,000 patient visits per year), and insures approximately 500,000 individuals.

Physicians have long been accustomed to using the computer to look for information that has been entered by others; however, it is only in the last decade that physicians on a national scale have begun to enter data directly.[8] The American College of Medical Informatics (ACMI) assembled an expert panel in 2004 to look at successful ambulatory and inpatient EHR implementations in order to identify common key success factors as well as factors that were barriers to EHR adoption [9]. The barriers to EHR adoption were found to be, in descending order of importance, capital cost of EHR, cost in time (to the users), security or confidentiality issues, cost to maintain EHR, interference with doctor-patient relationship, difficulty with learning new technology, lack of technical support, lack of control over technology choices, and lack of perceived benefits from computerization. These barriers seem to be well entrenched with many physicians despite recent peer reviewed articles showing value[10] or positive return on investment (ROI)[11] and other anecdotal reports of the value of EHRs in ambulatory settings [12, 13]. Assessments of ambulatory EHR implementations showed productivity declining for weeks to months, before returning to pre-implementation levels [14-16].

In this paper we report on our experience in encouraging physicians in the ambulatory setting to enter data. We discuss the benefits that accrue to themselves (productivity) and to their patients and we detail our approach to reducing the obstacles. We measured physician productivity before and after implementation of the EHR.

Methods

Beginning in 1992 in partnership with 3M Corporation, we constructed a longitudinal clinical data repository and a point of care ambulatory application (Clinical Workstation)[17]. Beginning in 1997, we made the ambulatory EHR application available on a voluntary basis to a limited number of primary care physicians that were employed by IHC. In 2000, IHC began to actively encourage physicians employed in our clinics to use the system. We began experimenting with voice recognition software in 1998. In addition to information (problems, notes, prescriptions, allergies, and other structured data) that are directly entered by providers at the point of care, data from multiple sources are fed to the clinical data repository (hospital discharge summaries, laboratory results, radiology reports and images, EKG, Microbiology, blood gases, ED visit notes, etc.).

Benefits

The system enables access to comprehensive, legible, and organized patient data and reference literature at the point of service. While networked computers are located in each exam room and physician's office, a provider can also access data over the Internet, via an extra layer of authentication (SecureID tokens or a VPN (virtual private network) connection).

1. We provide convenient reference literature (Micromedex, MDConsult, Up-to-date, etc.) in context via an Infobutton [18, 19] so that one can read about dosage considerations or get a patient hand-out in the Spanish language etc.

2. We enhanced the ability to communicate. We provide asynchronous messaging between care providers and between care providers and patients. The message log application also transmits test results to those who elect to subscribe so that they can annotate a laboratory result as they view it for the first time and send notes to staff or patients regarding disposition. All messages become part of the patient's longitudinal record. This communication capability enhances the ability to co-manage care of neonates, or others who are referred to specialists. Continuity of care is assured even though the patient does not see the same provider for every visit.

3. We provide capabilities for population management and analysis. A physician may ask for all patients for whom a particular drug was prescribed, or list of individuals with specific diseases. In addition to the analysis that can be evoked by an individual physician, the corporation also analyzes data to document quality improvement, cost saving, and operational metrics.

4. We have provided a patient-specific summary that, based upon a patient's chronic diseases, summarizes the data pertinent for the management of those diseases and gives specific recommendations for standards based care. This sheet is often given directly to patients after discussing it with them and it encourages them to assume more responsibility for their care.

5. To influence patient care and encourage adherence to recognized quality standards, we generate alerts, reminders, and suggestions when supported by patient data. Some of these rules are evaluated as the patient summary is generated; others are evoked when the physician enters prescriptions, measures of patient status (e.g. vital signs, growth descriptors, etc.), or when laboratory test results (INR, neonatal Bilirubin, etc.) are transmitted to the longitudinal record.

6. Cost savings from EHR use accrue more often to payers and providers. Tierney et al.[15] and Bates[20] found that availability of the comprehensive record reduced costs of repeated tests. We demonstrated reduced costs for transcription and document management (faxing, filing, retrieving, etc.). This was due to increased use of user-defined text macros ("HotText") to construct narrative notes. A user can construct text macros to reflect common clinical situations, e.g. "six week well-baby checkup" or "follow up visit for patient with diabetes." The user then activates the macro and makes a small number of changes to reflect the actual patient status.[21, 22]

Our EHR allows us to provide more efficient and better service to providers and patients. We reduced patient and physician delays in locating pertinent clinical information from the patient record. According to Smith et al. [23], in a non-automated environment, data that can impact patient care are missing in 14% of patient visits. We improved physician workflow by automatically generating instruments such as growth charts or Bilirubin Bhutani [24] charts so the context of data can be ascertained during data entry. Generating prescriptions for refill is simple, patient requests are documented and remain on task lists until resolved.

Impediments

We have worked to reduce common impediments to EHR use.

Set-up and Training. The time to set up and learn to use a system is often a challenge. Users share common lists, data entry templates and text macros to decrease start-up time for users. Nurses, medical assistants and front-office staff receive 4-8 hour classroom training. Physicians are introduced to the EHR and later receive 1 to 2 hour 1-on-1 training sessions at times and locations convenient for them. Refresher training is given as needed, through workshops, classroom discussion, and individual training.

Productivity/efficiency concerns. IHC performed two evaluations of physician productivity before and after implementation of an EHR in ambulatory practices. The primary evaluation was a pilot project to implement and evaluate an implementation of the EHR at three family practice clinics between June 1997 and June 1998. We evaluated staff and provider productivity, system availability, quality of patient care, patient record organization, communication, and provider and patient satisfaction; using surveys, work-study techniques, and automated tracking of computer use and productivity indicators. A separate evaluation was later conducted at a fourth site to validate the results of the first study.

Connections to external data sources. Costs required to construct interfaces to existing sources of data (hospital, clinical laboratory, etc) were

minimized because our integrated approach and scale. We currently have 36 types of interfaces for clinical data (multiple instances of many types) including one that allows transcribed documents to be uploaded from individuals.

Privacy concerns. Our approach to privacy has been to limit the scope of access by individuals to those patients for whom they have a legitimate need. These limitations are based upon five factors. 1) Established relationship between provider and patient. These relationships are created automatically when a patient is registered for treatment. 2) Relationships between providers, e.g. medical assistants who work with a physician or colleagues who cover for a provider. If the primary provider has the established relationship, the related providers will also be enabled. 3) Location of the user. 4) Current location of the patient. 5) Role of the user. Thus a nurse in the emergency room can see any patient's data, but a nurse on a hospital floor can only see patients that are currently in that hospital. We also keep audit trails of data access, stringently enforce breaches of confidentiality policy, yet allow physicians to "break the glass" when they actively certify that they have a professional relationship with a patient.

System performance and availability. We have redundant versions of hardware and network components. Most of our reliability problems occur when we upgrade software. We are moving to a synchronous back-up copy of the system at a remote site. This will support concurrent and synchronous test and production environments without data loss. To assess response time, we have remote workstations that are scripted to run simulated user transactions every minute. *Vendor Issues*. Our core architecture mitigates concern about vendor dependence and longevity.

Results

In January of 2000, 817 individuals used our longitudinal EHR. In January 2005, 7110 providers used the system to access the records of 252,795 individual patients. Of 472 physicians who are employed in our clinics the percentage of those who entered data gradually increased. See Table 1.

Physicians who enter data directly. In 2005, 321 of 429 (75%) of Physician Division providers who accessed the system also entered data. As shown in Table 2, in the first half of 2004, a total of 69 (37 + 29 + 3 + 0) physicians entered some but less than 50 records during a month. In the latter half, 29 of those physicians entered an average of 50-500 entries per month, 3 entered 500-1000 per month. Thirty-seven remained in the original classification (<50 entries). In all 46% of the 69 physicians who were in originally in the minimal data entry class entered more in the second half of the year. For those 103 (5 +75 + 23 + 0) who averaged between 50 and 500 entries per month, 22% (23/103) increased their average number of data entries in the second half of the year and one decreased the number of entries. For those who were making between 500 and 1000 entries per month, the increase was 8/31 (26%). Three of the highest-level users dramatically decreased the number of entries. In total, 63 users entered more data and 12 users entered less.

Table 1. Usage of the longitudinal record in the ambulatory setting.

Year	Total users	MD's enterin g data	Percentage of MD's entering data
2000	817	63	13%
2001	1132	89	19%
2002	1849	139	30%
2003	3249	185	39%
2004	4967	236	50%
2005	7110	321	68%

Table 2: Changes in levels of physician data entry use (entries/month) from Period 1 to Period 2. Bold cells indicate increasing use, italicized cells indicate decreasing use.

		Period 2: Jul – Dec 2004				
Entries per month	Period 1: Jan-Jun 2004	<50 entries	50-500 entries	500-1000 entries	>1000 entries	% increase
<50	69	37	**29**	**3**	**0**	**46%** (32/69)
50-500	103	*5*	75	**23**	**0**	**22%** (32/103)
500-1000	31	*0*	*4*	19	**8**	**26%** (8/31)
>1000	9	*0*	*0*	*3*	6	

Productivity. In the first evaluation, provider productivity as defined by relative value units (RVUs) per month, [25] decreased immediately after implementation of the EHR for two months. The approximate net decrease was 10% below average pre-implementation productivity levels. However, average productivity increased over the duration of the evaluation period, and average productivity at 6 months post-implementation was not significantly different than pre-implementation levels.

Transcription costs decreased as clinicians increased use of the clinical documentation module; in one clinic, the transcription costs were eliminated. Eighty-six percent (12/14) of all survey participants reported that information retrieval time was better with the EHR pilot system than their previous system. Eighty-three percent (5/6) of the providers believed that they provided better care for their patients by using the EHR. Eighty- three percent (5/6) of the providers and 93 percent (13/14) of all respondents did not want to return to their previous system. Staff productivity improved significantly. Reported benefits of EHR implementation included improved intra-office communication, decreased transcriptions costs, perceived improved quality of patient care, and improved record accessibility. The second study was completed at a clinic site that was felt to be more representative of the average clinician, and similar results were obtained; post-implementation average RVU's for the physicians increased 12% for the 12 month evaluation when compared to the pre-implementation levels. The documentation Hot Text generation tool [21, 22] contributed to savings of $670 per provider per month on transcription [26].

Eighty physicians use voice recognition for at least some of their date entry selected data entry (Dragon NaturallySpeaking Medical version 8). Most find it faster to use the Hot Text macros.

Costs. Our costs for the clinical information system (including hardware, software, networks, desktops, ancillary systems, interfaces, and support) average about 2% if IHC's gross revenues or about $2500 per user per year.

Reliability. For the last 12 months, our unscheduled downtime was 7.88 hours. (99.91% uptime). Our users would indicate that any down time is unacceptable.

Response time. During the last five years, the number of users has increased by a factor of 10; during that time our response time as measured by our scripted workstations has decreased by a factor of three. This has involved purchase of new hardware as our monitoring indicates loading of the system. Our current metric is 0.2 seconds average for a market basket of typical queries.

Discussion

In an environment where we did not mandate that physicians use an EHR, we have found that the total number of users has grown by an order of magnitude over a five-year period. During this time period the number of employed physicians who entered data directly into the EHR application increased from 50 to 330. While looking at results remains the most widely used application (7110 users per month), other applications have been heavily used. The communications capabilities are used to a greater extent than we anticipated. The Chasm report [27] has documented the number of errors that occur when there is poor communication. Synchronous voice communication has two negative aspects: 1. Two busy people must be simultaneously available when one of the two is thinking about an issue that needs to be communicated. 2. In a hierarchal social order, a respiratory therapist, dietician, or nurse may hesitate to call a physician (especially at odd hours). On the other hand the physician may want to know tidbits of information that these care providers have to offer. Asynchronous communication has traditionally required a letter or a fax and people do not typically go to that much work unless there are regulatory, policy, or significant medical reasons for documenting the communication. It is well known that physicians rarely read nurses notes in the inpatient setting. As a consequence, much information relating to the care of patients is not communicated. The widespread use of the message log capability by bright, busy people is a strong indication of the perceived value of enhanced communication.

Our data indicate that once a physician has learned how to use the application, there is little likelihood that the level of data entry will be reduced. Thus we conclude that the biggest barrier remaining after the reductions in obstacles that we have implemented is the initial period of reduced productivity. It takes time to learn the system and the patient load is not reduced. These conclusions agree with those of Levick, Lukens and Stillman [28] who found that financial compensation for the time required to become proficient with the system had the greatest impact on behavior. It should be noted that the choice to enter data occurs in an environment where there are no mandates or financial pressures to use the system. There are however peer pressures as colleagues treat patients for which they cannot find records. Even those who do not directly enter data into the computer insure that their dictated and

transcribed notes are uploaded into the clinical data repository.

One might ask why it takes so long to build and implement a system. Our philosophy at IHC based upon 35 years of experience is to try and avoid cataclysmic events as much as possible. By starting with a small number of users and improving the system functionality, response time and reliability, we have allowed people to voluntarily migrate and thus reduced the number of unhappy providers, reduced the chance of confrontational crises, and justified the expenses. Given that many large projects are not completed [29], we feel that this luxury of proceeding incrementally rather than with a big bang is prudent. We realize that others have succeeded with step function installations and been successful, but are unsure what the odds are when comparing the two approaches.

We conclude that when functionality is properly addressed, and once physicians voluntarily enter data into the EHR, they are likely to continue or increase use over time.

References

1.Evans RS, Pestotnik SL. Applications of medical informatics in antibiotic therapy. Adv Exp Med Biol 1994;349:87-96.
2.Evans RS, Pestotnik SL, Classen DC, Clemmer TP, Weaver LK, Orme JF, Jr., et al. A computer-assisted management program for antibiotics and other antiinfective agents. N Engl J Med 1998;338(4):232-8.
3.Kuperman GJ, Maack BB, Bauer K, Gardner RM. Innovations and research review: the impact of the HELP computer system on the LDS Hospital paper medical record. Top Health Rec Manage 1991;12(2):76-85.
4.Scherrer JR, Baud RH, Hochstrasser D, Ratib O. An integrated hospital information system in Geneva. MD Comput 1990;7(2):81-9.
5.Slack WV, Bleich HL. The CCC system in two teaching hospitals: a progress report. Int J Med Inform 1999;54(3):183-96.
6.Overhage J, McDonald CJ, Suico JG. The regenstrief medical record system 2000:Expanding the breadth and depth of a community wide EMR. Proc AMIA Symp 2000:1173.
7.James BC. Implementing practice guidelines through clinical quality improvement. Front Health Serv Manage 1993;10(1):3-37; discussion 54-6.
8.Burt CW, Hing E. Use of computerized clinical support systems in medical settings: United States, 2001-03. Adv Data 2005(353):1-8.
9.Ash JS, Bates DW. Factors and forces affecting EHR system adoption: report of a 2004 ACMI discussion. J Am Med Inform Assoc 2005;12(1):8-12.
10.Embi PJ, Yackel TR, Logan JR, Bowen JL, Cooney TG, Gorman PN. Impacts of computerized physician documentation in a teaching hospital: perceptions of faculty and resident physicians. J Am Med Inform Assoc 2004;11(4):300-9.
11.Wang SJ, Middleton B, Prosser LA, Bardon CG, Spurr CD, Carchidi PJ, et al. A cost-benefit analysis of electronic medical records in primary care. Am J Med 2003;114(5):397-403.
12.Adler KG. Why it's time to purchase an electronic health record system. Fam Pract Manag 2004;11(10):43-6.
13.Barlow S, Johnson J, Steck J. The economic effect of implementing an EMR in an outpatient clinical setting. J Healthc Inf Manag 2004;18(1):46-51.
14.Chin HL, McClure P. Evaluating a comprehensive outpatient clinical information system: a case study and model for system evaluation. Proc Annu Symp Comput Appl Med Care 1995:717-21.
15.Tierney WM, Miller ME, Overhage JM, McDonald CJ. Physician inpatient order writing on microcomputer workstations. Effects on resource utilization. Jama 1993;269(3):379-83.
16.Chin HL, Krall M. Implementation of a comprehensive computer-based patient record system in Kaiser Permanente's Northwest Region. MD Comput 1997;14(1):41-5.
17.Clayton PD, Narus SP, Huff SM, Pryor TA, Haug PJ, Larkin T, et al. Building a comprehensive clinical information system from components. The approach at Intermountain Health Care. Methods Inf Med 2003;42(1):1-7.
18.Cimino JJ, Li J. Sharing infobuttons to resolve clinicians' information needs. AMIA Annu Symp Proc 2003:815.
19.Reichert JC, Glasgow M, Narus SP, Clayton PD. Using LOINC to link an EMR to the pertinent paragraph in a structured reference knowledge base. Proc AMIA Symp 2002:652-6.
20.Bates DW, Kuperman GJ, Rittenberg E, Teich JM, Fiskio J, Ma'luf N, et al. A randomized trial of a computer-based intervention to reduce utilization of redundant laboratory tests. Am J Med 1999;106(2):144-50.
21.Bowes W, Wilcox A, Narus S. The effect of text templates on physician data entry. Proc AMIA Annu Fall Symp 2002:979.
22.Wilcox AB, Narus SP, Bowes WA, 3rd. Using natural language processing to analyze physician modifications to data entry templates. Proc AMIA Symp 2002:899-903.
23.Smith PC, Araya-Guerra R, Bublitz C, Parnes B, Dickinson LM, Van Vorst R, et al. Missing clinical information during primary care visits. Jama 2005;293(5):565-71.
24.Bhutani VK, Johnson L, Sivieri EM. Predictive ability of a predischarge hour-specific serum bilirubin for subsequent significant hyperbilirubinemia in healthy term and near-term newborns. Pediatrics 1999;103(1):6-14.
25.American Academy of Family Physicians. Physician Productivity Discussion Paper. In.
26.Bowes WA, 3rd. Evaluation of the Impact of an Outpatient Computer System on Personnel at Three Family Practice Clinics. [Masters Thesis]. Salt Lake City, UT: University of Utah; 2000.
27.Institute of Medicine. Crossing the Quality Chasm: A new health system for the 21st century. Washington, DC: National Academy Press; 2001.
28.Levick D, Lukens HF, Stillman PL. You've led the horse to water, now how do you get him to drink: managing change and increasing utilization of computerized provider order entry. J Healthc Inf Manag 2005;19(1):70-5.
29.Sun Y, van Wingerde FJ, Kohane IS, Harary O, Mandl KD, Salem-Schatz SR, et al. The challenges of automating a real-time clinical practice guideline. Clin Perform Qual Health Care 1999;7(1):28-35.