An Implementation Strategy for EHR in Small Primary Care Physician Offices: Incorporating Human Factors Engineering Principles

Capstone Project for Masters in Biomedical Informatics Degree OHSU

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Certificate of Approval

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Has been approved

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Acknowledgements

I would like to extend my sincere gratitude for the advice and support of my advisor, Dean F. Sittig, PhD, who has contributed an incredible amount to the current knowledge base we have regarding clinical information systems and their implementations. I am deeply indebted to him for his patience, wisdom, and contribution to this project.

Abstract *There has been a huge adoption gap of health information technology in small primary care physician offices in the U.S. that is poorly understood. Usability barriers, cost, and time factors may all contribute. Poor office workflow efficiency has anecdotally been reported to complicate efforts, and the Center for Medicare and Medicaid Services developed the Doctors Office Quality-Information Technology toolkit to address this issue. The CMMS Office Systems Survey reviewed the use of this tool, but that data is not yet published.*

Recently, to help reengineer the electronic health record (EHR) and implement it in a more provider- supportive fashion, ergonomics has been applied to health information technology. This capstone will review implementation of HIT in small primary care physician offices, failures of HIT implementation in the literature, and propose an ergonomic paradigm based on human factors engineering to develop more usable, useful, and safer approaches to the implementation of EHR into primary care practices. It will also suggest a schema to monitor these implementations. The importance of focusing on implementation efforts to the goals of transformational bioinformatics will also be reviewed.

Introduction

Since the Institute of Medicine's (IOM) 2001 report Crossing the Quality Chasm, the goal-oriented definition of quality healthcare has been that it must be safe, effective, efficient, timely, patient-centered and equitable.[1] The IOM found that the complexity of the healthcare system not infrequently leads to suboptimal care and medical error. As with other industries, information technology (IT) is seen as a way to achieve fundamental transformation of healthcare, providing all the right information at the point of care, improving chronic care processes through access to research information, automating work processes, and improving patient outcomes and satisfaction. The core application of information technology within the primary care providers' office is the electronic health record (EHR). Yet diffusion of EHRs in the U.S. has been slow, and fraught with unforeseen consequences which, when reported, have caused some medical professionals to minimize their use even more.

The Importance of HIT Diffusion to Transformational Bioinformatics

The American Medical Informatics Association (AMIA) recently added transformational bioinformatics as one of its three major domains of informatics (with clinical informatics and public health informatics being the other two domains), the Institute of Medicine (IOM) initiated the Clinical Research Roundtable, and the National Institutes of Health (NIH) is in the process of reengineering its funding policy to focus on translational research.[2,3,4] Yet it is clear

that developing health information systems is and will continue to be a major stumbling block to taking basic biological research findings to the bedside to improve the healthcare of populations. In addition, it is clear that the field of medical informatics itself suffers from a lack of translational research.[4] A chief medical information officer (CMIO) is still a relatively new position in health care organizations, and HIT projects are often led by chief information officers (CIOs) with technological expertise but little or no background in informatics.[5] Hence, the sociotechnical performance of healthcare information systems, of which we do have some understanding,[7] is not being translated to hospital executives who buy systems, nor to implementers or end users.

Lehmann suggests in an editorial in Methods of Information in Medicine that a new peer-reviewed journal be created to focus on "applied informatics."[4] His vision is that this journal will become a must-read for healthcare executives and clinicians worldwide. I believe the effort needs to be much larger – more broad government support for the creation of the healthcare infrastructure required to translate basic science to the bedside through electronic medical records, education of healthcare leadership about the importance of a CMIO to guide purchases and implementation of HIT,[6] and further transparency of implementations for research purposes to better understand the human/computer dyad and sociotechnical issues in HIT implementation.[7] If not, bioinformatics will be "lost in translation."

Current Knowledge of HIT Systems and Their Implementations in the U.S. and Beyond

EHR implementation in primary care has been successful in a number of academic settings and some smaller primary care settings from which many lessons have been learned. A recent review[8] of implementation in seven countries stresses the importance of "sociotechnical factors or "fit" factors in directly influencing success. Workflow processes must be analyzed to know how the new system will fit in prior to implementation, and overhauled prior to "go live." Other concerns including patient privacy, patient safety, provider/patient relations, staff anxiety, quality of care, financial factors efficiency, and liability can be mitigated through sound project management, strong leadership, implementation of standardized terminologies, and good staff training.[8,9] Implementations can be "big bang" (quick) or incremental, with the latter recommended for larger organizations with complex cultures.[9] However, Badger, Bosch and Toteja describe a successful rapid implementation at George Washington University Medical Faculty Associates of the Allscripts Healthcare Solutions product (Chicago, Illinois) using a well-thought out and codified project management approach.[10] In addition to a full-time project manager (who was also the director of the department first implementing the EHR), a project steering committee consisting of the CEO, the COO, the CIO, and a leadership triad consisting of the senior leadership from administration, physician and information technology areas of the practice led the effort. Work groups also provided design suggestions and participated in the development and delivery of the implementation process led by a steering committee member. "Escalation paths" were identified to keep the project on time and budget. Workflows were

reengineered prior to EHR rollout, and training was modified by the needs of end-users with "just-in-time" training.[10] This was real-time training that hinged on staffing a room where meals were served and professional trainers and project team members were available for training daily between 7am&7pm. Immediately after training, physicians were brought up live on the EHR for reinforcement. Other lessons learned in addition from this implementation were not to misrepresent the EHR as panacea to end-users, to be sensitive to the "uncovering" of embarrassing issues, and resist entrenched loyalties and support structures from previous workflows.[10]

Other descriptions of successful implementations can be found in the literature as well.[9,11] However, far fewer case studies of small primary care physician practices who have achieved successful implementations are available.

Barriers to HIT Diffusion

There has been a huge adoption gap of health information technology (HIT) in the U.S., with only 18% of practices with ten physicians or fewer fully implementing EHR, and four-fifths of physicians in the U.S. practicing in these small groups.[12] There have been many barriers postulated for this phenomenon, which is most likely multifactorial and multicultural. First, there is no good "business case" for implementation.[13] EHR leads to higher billings, declines in provider productivity, and inconsistent error reduction.[13] Also probably contributing to the problem is the issue that the majority of practicing physicians have never received any formal

education in quality improvement.[14] A survey that sampled primary care physicians in 2003 found that the meaning of quality improvement varies, but most definitions involve better care for their patients – more consistent patient care, maintaining an evidence-based standard, in an appropriate way.[14] Cost and lack of time seem to be major barriers to this effort. Surprisingly, physicians frequently listed themselves as a barrier in small practices.[14] Since implementation and use of an EHR remains a voluntary effort in U.S. small independent primary care practices, and requires a significant commitment of time, money and efforts to overcome system usability barriers, the majority of primary care physicians in independent small practices remain paper- based. A survey of practices in Massachusetts in 2005 found that among primary care practices, hospital-based practices (34%) were three times more likely than non-hospital-based practices (12%) to have EHR, and practice size was inversely correlated with intention to institute EHR in the next 12 mos.[15] The most frequently reported barrier to implementation was lack of funding (42%) followed by no physician support for change (28%), lack of technical knowledge and support (23%), interference with workflow (22%), and inability to find a system to support the needs of the practice (20%).[15]

Davidson and Heinke[13] suggest that there are five steps between the availability of health information systems and the production of benefits, and that this nonlinear process may be thwarted at any step. They believe there are many reasons that may explain the lack of HIT diffusion. They emphasize that 1) because much of the commercial development to date has focused on practice management application, little is know about what clinical applications have been used successfully, and what features are missing or need redevelopment;

2) at this point, being paper-based does not put a small practice at a competitive disadvantage, and this will remain so until diffusion is accelerated; 3) research is lacking in so many areas that studies about overall improvement or lack thereof in quality of care, costs, and efficiency that can be attributed to HIT are premature.[13] A recent study is considered a landmark, as it is one of the first to find impressive relationships between the presence of several HIT technologies and complications, mortality rates, and costs in the inpatient setting.[16]

Current Barriers to EHR Implementation in Small Independent Primary Care Offices

Having spent 23 years as a primary care provider in many venues, as well as discussing this issue with colleagues, it is clear to me that the difficulty with EHR implementation into small independent primary care offices, where the Center for Disease Control (CDC) reports 24% of all primary physician office visits happen (CDC 2000), is multifactorial. However, I believe there are several major issues which, if attended to well, could lead to an improvement of the abysmal statistic that 75% of HIT implementations fail.[4]

First, workflow issues must be attended to prior to implementation, especially with the caveat that not only will HIT change current processes, it may lead to unexpected consequences in staff communication and other issues that may allow the introduction of new sources of error.[17] Unlike larger practices or clinics, small offices tend to function without formally codified standard operating procedures. Workflow may be somewhat disorganized and inefficient, hence the common complaint by patients that their physician's office rarely functions "on time." Poorly streamlined workflow patterns prior to the introduction of HIT may further complicate these

problems.

Second, current commercial EHRs on the market were clearly designed by IT personnel without a thorough understanding of primary care workflow or the domain of medicine. EHRs that cannot tolerate a great deal of customization have poor usability for the primary care physician and impede workflow instead of streamlining it,[19] resulting in incredible office stress that trickles down to all employees, may be very disruptive, and may even be visible to patients. Third, current implementation efforts are sorely lacking in a professional project management approach and often ignore the needs of end-users. Sometimes, the decision regarding EHR purchase and implementation may be made by an administrative staff responsible for funding, using poorly defined criteria, and implemented by the approach of the vendor, whose main caveat seems to be "find physician champions and superusers," if the practice is hospital-owned. In other situations, because of the large number of systems being offered for sale, it is difficult for the small independent primary care provider to identify a system that may meet his/her needs. Even a colleague of mine in one of the only cities with a successful regional health information consortium resorted to a listserv to get information about the specifics of the system he was considering, as advice from the experts in his city to his dilemma was not forthcoming. This also became a major issue for the Massachusetts eHealth Collaborative experience.[18] The simplistic approach to sale and implementation certainly results from the need for vendors to sell product, but does little to aid the implementation process except to give credibility to the importance of EHR to potentially improving the quality of medical care and avoiding error, especially in the busy primary care setting. Unfortunately, without removing the business and

sales competition of vendors, these unscrupulous practices may continue. The importance of the CMIO and other experts who are available for consultation to the small independent primary care provider cannot be underestimated in these issues. The Canadian COMPETE study (Computerization of Medical Practices for the Enforcement of Therapeutic Efficacy) , aiming to study the entire process of computerizing community-based primary care physicians in Southwestern Ontario, did include research on EMR selection.[20] Their 2003 study included a literature review and found no discussions of EMR selection within a standard health technology assessment approach. Therefore, they assembled a software selection team of technical, clinical and research personnel to carry out phases of an evaluation of multistep evaluation of the fifteen (out of an initial 40 who advertised as such) systems for use in the primary care setting. Over 18 months, family physicians completed reviews of live or demonstrations discs, which resulted in four systems that reached final evaluations. Of note, systems with higher quality database structure tended to score lower on user interface issues than text-based systems. Visits to EMR clinical user sites found them all complaining about their vendor's development speed, training, costs, and lack of integration with local labs, pharmacies and hospitals. In the final analysis, the scoring matrix for the physicians revolved around the domains of usability, database quality, and user-support issues. Evaluators ranked access to a chart summary, problem list, history of present illness, medication list, drug allergy list, and templates or macros for chart entry as priority. The investigators concluded that no perfect system exists. However, subsequent follow-up provided validation of the importance of the selection process, as 80% of practices implemented maintained high quality use of their EMR after two years. Their findings would validate the report by a 100 physician group from the U.S. who reported their efforts in a well-managed

selection process also led to their successful implementation efforts.[21]

In the following sections, I will attempt to address each barrier to successful implementation of EHR in small primary care offices in more detail, based on what we know currently know that is available in the literature.

Workflow and EHR

Anecdotal reports of EHR implementation in small practices report a poorly streamlined office workflow prior to HIT implementation will complicate the effort. In April 2005, the National Institute for Health Care Management (NIHCM) Foundation convened a panel to address this issue. One focus group focused on office workflow, defined as the interaction patterns among an office staff as they fulfill tasks and produce outcomes using available resources, and how it is aided or hindered by IT.[13] Panelists who successfully implemented HIT emphasized that practices who redesigned their workflow discovered fewer interruptions, delivered comprehensive care better, and were better able to address their patients' concerns. These reengineering efforts appear to be office-specific and were not delineated, however.

In perhaps the only study of its kind, Pascal Carayon and her group studied the implementation of an EHR in a small primary care office near Madison, Wisconsin from the perspective of the office staff, using pre and post- implementation user surveys, interviews with key personnel, and a work analysis.[22]EHR implementation took four months. Selection criteria for the software

included capability, serviceability, user friendliness, popularity, recommendations, and was made by the steering committee, project team, expert end users, and in IT department. There was variability regarding perception of technical difficulties with implementation of the EHR, with half of the respondents reporting them to be significant. Critical issues included interfacing the EHR with billing, vendor problems, and a system upgrade that failed before going live. In addition, underestimation of the amount of work required for implementation was cited, as well as dysfunction within the project team, lack of authority of the project manager, resistance from administration, and resistance from end-users (who themselves cited work increases, technical interruptions, and time pressure). The work analysis found a significant increase in dependency on computers, and employees felt that they had less resource control. There was no difference in the amount of time physicians spent caring for patients, but perhaps more ancillary staff time was spent in patient care. Office staff definitely spent more time on computers and less in preparation activities (e.g., chart pulls) Their study conclusion was that a successful EHR implementation must focus on the following:

1. Analysis of needs of medical providers and key administrators
2. A strong physician leader champion of the project
3. A dedicated project manager
4. A project leadership team of key personnel from clinical, office, and IT
5. Gathering needs of other users early in the planning process
6. Obtaining buy-in by clinicians and office staff early in the process

Recognizing the importance of office workflow efficiency to successful HIT implementation in the small physician office, the Doctors Office Quality – Information Technology (DOQ-IT) program developed by the Medicare quality improvement organization has been made available through several state Medicare organizations to assist in this effort. Part of this effort, A Systems Approach to Operational Redesign workbook, uses structured methods and case studies to evaluate the five key areas of office redesign: patient flow, point of care documentation, in-office communication, chart abstraction, and document management.[23] Participation in DOQ-IT also allows for peer-peer interaction in implementation of IT and complementary support from the state- based Medicare organization for on-site visits, in addition to that provided by an IT vendor. DOQ-IT has been expanded to an online program called "DOQ-IT University", administered by MassPro. MassPro has also measured effectiveness of workflow redesign by using DOQ-IT in the Office Systems Survey. Though a very valuable resource, DOQ-IT is actually being used less frequently now than when it was first released, a phenomenon that is not well understood. Unfortunately, I was unsuccessful through months of efforts to obtain the data from the Office Systems Survey to include in this capstone.

Usability Barriers

Medicine is a cognitively complex domain, and the configuration of clinical systems and their user interfaces can either exacerbate or minimize this complexity.[24,25,26] When the complexity of

workflow processes and individuals with little tolerance for slowness or redundancy (physicians) is added to the mix, it becomes a recipe is for disaster. In 2004, most EMR vendors doubted that there was any "silver bullet" technology to dramatically simplify EMR usage.[41] Adding insult to injury, the federal Certification Commission for Healthcare Information Technology (CCHIT) certifies EHR in functionality, interoperability, and security, but usability is noticeably absent. However, poor usability leads to implementation difficulties and can create not only error but can even change physician cognitive processes that are dependent on data presentation. Miller-Jacobs and Smelcer entitled their 2007 presentation to the engineering community "Usability of Electronic Medical Record System: An Application in Its Infancy with a Crying Need." [26] They discuss that EHR selection by hospital administrators focuses on robust functionality which vendors exploit in their sales tactics, and then go on to say "the electronic medical record industry has yet to discover usability." Along the lines of the CCHIT scorecard for the categories graded for certification, an EHR usability score-carding method they called the "Human Factors International(HFI) EMR Usability ScoreCard , focusing on the home page, navigation, windowing elements, presentation, interaction, and task flow and task allocation was developed. The score-card assigns points to each, with the constraint that the total across all categories must equal 100 points. The three categories receiving the most points were navigation, interaction, and task flow and task allocation (their explanation being that these criteria are the most important to hospital administrators as they reflect learning time and physician efficiency). Under each category, they developed several criteria for measuring its scores. Several commercial products were scored

by a professional usability expert heuristically, and the results were quite disparate. Kushniruk and Patel presented a review of their use of cognitive and usability approaches to the assessment of health information systems.[27] Rather than basing their evaluation on questionnaires examining human-computer interaction (HCI) models that focus on user satisfaction or acceptance of technology,[28] which they feel limit discerning how health care workers actually use systems to perform complex tasks, they use cognitive task analysis. They suggest that up to 80% of user-interface problems can be detected with as few as 8-10 transcripts of subjects' interaction with the system under study.

Only recently has there been any published research on evaluating usability of commercial products in the medical and dental fields. Some, but not all, focus on heuristic approaches. eNotes, an electronic notes system, was evaluated by usability experts and found to need improvement in help and documentation, aesthetic and minimalist design, error prevention, helping users recognize and recover from error, and flexibility and efficiency of use.[29] Four dental commercial computer-based records were evaluated by formal usability methods with novice users, and had 286 usability problems documented primarily in the "consistency and standards", "match between system and the real world" and "error prevention." In addition, six problematic interfaces and interaction designs were present. They concluded such software involves a steep learning curve for novice users and potentially reduced system adoption.[30]

In a more recent and very enlightening case study of the implementation of an EHR into a pediatric hospital system, a predictive usability evaluation called Heuristic Walkthrough was

used to ensure the usability of their commercial product.[31] The hospital system conducted a comprehensive evaluation of several products where clinicians were a critical part of the evaluation and selection team, and a product was selected that allowed for customization. A user-centered design-based methodology using iterative design-prototype-feedback cycles was used. In addition, significant resources were put into redesigning work processes. The evaluation team was made up of usability experts and domain expert users who were then cross-trained in the others' skill sets didactically.

During a 2 week evaluation period, team members spent 2-3 hours on a task-guided walkthrough and 2-3 hrs on a heuristic evaluation. They identified 193 issues, of which 134 were potentially true positives. Primary sources of identified usability issues included consistency (15%), will the user know there is a control to complete a task (13%), flexibility and efficiency (10%), confusion over the next step a user should take (7%), and other sources (55%). Potential solutions included configuration changes made by the implementation team(16%), design changes/enhancements by the vendor when possible or for future release, and addressing problems through enhanced communication and training at rollout.

In her JAMIA viewpoint paper, Lorenzi discusses the abysmal success rate of HIT implementation, calling for bold action to "cross the chasm."[32] She divided the problem into that of design (usability), management(project), organizational, and assessment (using best known implementation practices), and most importantly, better integration between those domains. Human factors engineering is a solution that does all these things, and may lead to further successes, particularly in the small primary care office.

A Solution: Human Factors Engineering and Health Information Technology

The science of human factors engineering (HFE) has recently been applied to healthcare technology, and specifically HIT. Human factors engineering, also called ergonomics, is the discipline whose goal is to optimize the relationship between humans and systems.[33] The main thrust of this work in the recent past has focused on preventing medical errors. A review of this literature suggests that POE has until recently forced physicians to alter workflow and routines to accommodate the system.[34] These workflow and usability barriers were hard to overcome because of the commitment required by busy clinicians who lacked enthusiasm for POE. Successful POE implementations up to now have involved the efforts of committed champions, dedicated resources, a study of the environment of use, technical support 24/7, and a multi-disciplinary team of problem solvers.[34,35] Clearly, such efforts would be beyond those available and affordable to the small group-based primary care clinician. However, a human factors engineering perspective has most recently been found to be a method to improve usability and usefulness of systems. Schulman's comment that "if a tool is changed, the work flow and/or fine structure it is intended to support must necessarily change, and user acceptance is defined as a result of judging a new work/tool dyad"[36] summarizes what human factors engineering theory encompasses.

HFE looks at HIT implementation literature from four categorical standpoints: technological factors, individual/person factors, organizational factors, and social/cultural factors[37] – in

Other words, a sociotechnical model. The technological factors look at the IT itself, i.e., usability issues. The Technological Acceptance Model (TAM) identifies two predictors, perceived usefulness and ease of use, as predictors of successful implementation.[37] Enjoyment, another usability factor, has also been shown to predict implementation success. In addition, compatibility, or the degree to which implemented IT is consistent with work practices, needs, and values of users also predicts implementation success.[38]

In order to improve the safety and quality of healthcare, system redesign (including EHR) must improve the process of care, in other words, design must support health care provider performance and eliminate hazards.[38] Figure 1(Appendix) is derived from adaptations of the work system model to health care by Carayon et al.[38] Inputs of a system can interact to influence the performance of health care providers in the transformational process to outputs. Good human factors design can produce system inputs that better accommodate health care provider performance to achieve better outputs for all. The human factors engineering paradigm is more proactive because it sheds light on performance and hazard pathways. In addition, it's positive thinking approach of supporting performance in an environment with fewer hazards instead of focusing on reducing error and injury is certain to be much more palatable to health care providers.[37] The basic tenets of human factors engineering involve using a systems approach, allocating function appropriately, "honoring thy user," and using careful implementation strategies.

Human factors engineering research suggests technology implementation need to be designed carefully.[39] Organizational factors predicting success of technology acceptance include 1) how well the new technology will integrate with existing technology, workflow, the environment, and other social systems; 2) management commitment; and 3) presence of a structured program for implementation, including training and participation of end users. Technological factors predicting success of technology acceptance include response time, flexibility, breakdowns, usability(ease of use) and usefulness. Recent research in mandatory technology implementation has been mixed as to whether usability or usefulness is a better predictor of outcome. Job factors (especially changes in work structure) and individual factors (age, gender) may also be predictors of success.[39]

Paradigm for a Human Factors Engineering Approach to EHR Implementation in Small Primary Care Offices

I believe a human factors engineering, sociotechnical approach to EHR implementation in small primary care offices can dramatically improve success, and perhaps lead to sorely needed usability changes in currently available commercial products. In a recent article in the NY Times article, Dr. Farzad Mostashari, the assistant commissioner in the city's health department leading the Primary Care Information Project in New York City project is quoted as saying "Our experience here is that it's just hard. It's not impossible."[41]

Recent literature regarding this topic focuses on the necessary steps to EHR implementation in the small primary care office: decision, selection, pre-implementation, implementation, and

post-implementation.[42.43]

Decision to Transition from Paper to Electronic – Assessing Readiness

Unlike large institutions and clinic settings, the culture of small independent primary care offices are usually less formal and policies less codified. Employees look to their physicians for leadership and their attitude generally sets the pace and tone of the office. However, the changes involved in changing from paper to EHR involves all employees, and assessing readiness for change and resetting office tone to embracing change by the physicians is extremely important.[41,42] Object Health has developed the Community Clinic EHR Readiness Assessment,[43] co-sponsored by the California Health Foundation and Community Clinics Initiative of Tides that may be helpful to the primary care practioner to assess readiness in the various categories, including leadership, implementation, selection and contracting, clinical and administrative staff, accountability and finance, workflow, training, IT infrastructure, and IT support. After the first evaluation step, it is important to foster buy-in and focus goals for the office.[41,42] In terms of financing, Stark laws for IT have changed,[44] and it may be advantageous to contact hospital systems where providers are affiliated to investigate available resources. Hospital systems can contribute a significant amount of equipment and service in kind to assist its affiliate staff in EHR implementation. In addition, several problems with functional interoperability (with commercial laboratories, insurers, and pharmacies) have hindered the Massachusetts eHealth Collaborative (MAeHC) and the NYC Primary Care Information Project(PCIP) ,[46] and relationships with hospital systems could be leveraged to assist in establishing these interfaces.

EHR Selection

As previously discussed, the importance of EHR selection to successful implementation cannot be underestimated. Current resources for exposure to products on the market are available through vendor efforts with medical societies such as the American College of Physicians and American Academy of Family Physicians, or through the Health Information and Management Systems Society (HIMSS). However, there is really no organized approach to assisting the small primary care provider to select a product to suit/his her needs or ensure interoperability with regional health information organizations, present or future. For this reason, emulating community projects such as the Massachusetts eHealth Collaborative (MAeHC) or the NYC Primary Care Information Project(PCIP) is proposed by a consortium of federal and state organizations.[44] MAeHC chose four high quality commercial vendors to maximize interoperability, and uses Concordant as an integration vendor.[46] PCIP uses a single vendor, chosen for its modern architecture, flexibility, security and capabilities.[46]

In Canada, the most progressive of its provinces, Alberta, has already implemented the community project model, called the Physician Office System Program (POSP). In April, 2009, a single Alberta Health Services Board will replace the nine regional health authorities so as to streamline EHR funding in one place. The POSP is streamlining EHR selection for physicians by limiting vendors to only a few who must pass their "vendor conformance and usability requirements."[47] They have also put together a procurement guide to assist physicians in selecting their EHR.[48] Because interoperability between vendors is lacking, they have had to

secure an interface software vendor called BridgeForward Software for this purpose.

The selection process must include both the physician(s) and the clerical and medical office staff of the office to ensure that usability factors are assessed from all viewpoints. Perhaps "scorecards" such as the HFI scorecard could be developed for clerical and medical office staff as well as for physicians, and used in their evaluation. In addition, the importance of customization and availability by the vendor must be stressed. If clinical decision support software is to be purchased separately, the same selection criteria should be used if full functionality of the system is ever to happen.

In their evaluation of the EHR implementation into Mt. Ascutney Medical Center, a rural health center associated with Dartmouth, Dr. C. Frederick Lord relates that "just because functionality exist, doesn't mean you have to use it."[49] This is particularly important with clinical decision support and reminders. It may be more feasible to use clinical reminders in a more stepwise approach, rather than all at once.

Pre-Implementation

As previously discussed, it is of utmost importance to design a formal project management plan, including planning a budget and timeline and choosing a project manager for the EHR implementation. Rather than become a failure statistic, it may be wise to hire a consultant and/or leverage all available resources for this area in the project. Few physicians have the necessary skill set and/or experience, and vendor rhetoric does not supplant a solid project management

plan. However, physician(s) and their office manager could sketch out a rough plan to determine necessary allocation of personnel and time for the project, such as the following example:

Phase 1 (3 weeks): Using a version of the DOQ-IT workbook/toolkit A Systems Approach to Operational Redesign, members of the multi-disciplinary "team" the office has designated to lead the rollout will mode the current office workflow. An attempt will be made to model reengineered workflow to maximize efficiency, keeping in mind the role EHR will have in the model. This will require several meetings and a significant commitment of time by the "team".

Phase 2 (3 weeks): Rapid-reengineering trials of the newly modeled workflow will be trialed and redeveloped as necessary by the "team."

Phase 3 (2 weeks): Ethnographic analysis of office workflow will be performed by the "team"

Phase 4: EHR training of all staff.

Phase 5 (2d): EHR pilot trial followed by debriefing with all staff.

Phase 6: Customization by vendor team for identified problems in pilot, workflow reengineering for problems identified in the pilot.

Phase 7: EHR rollout.

Phase 8: Ongoing debriefings with staff.

Workflow should be assessed and redesigned during this time. As previously discussed, DOQ-IT University obtainable through MassPro is an excellent resource for this venture.

Few small primary care offices have codified standard operating procedures for the handling of

phone requests for drug refills, advice calls, lab or Xray results, or the procedures for moving patients through an office visit (i.e. a cycle). This can result in inefficiencies that can be magnified by the introduction of an EHR. This pre-implementation period is an opportunity to improve on these inefficiencies and improve cycle times as well as reinforce the culture of change discussed by Lorenzi in her review.[42]

Since multiple studies have suggested that office personnel will become more reliant on the computer, it is of utmost importance to ensure that workstations and terminals are easily available to all, and can accommodate all users during heavy workflow. In addition, backup procedures for "down-times" need to be formulated.

If at all possible, an heuristic evaluation of the system selected should be performed so that any possible pre-implementation customization of the software can be done, and if at all possible, a usability evaluation by a representative member of each staff category would also be ideal. Training of all employees would begin at this time. A small office should be able to schedule training around regular office hours, but if not, the time out of office to train must be allotted. The ideal situation would involve training that is customized to deal with the usability issues with the system that are already known, so that staff do not begin formulating their own "work-arounds" to deal with problems, leaving these "solutions" taped all over to various terminals and such. Training should also involve a "going-live" session with test patients, in a redesigned workflow mode.

Even the small primary care practioner should have an evaluative process for the EHR

implementation.[50] The AHRQ Resource Center has developed a formative Evaluation Toolkit which may be used as a template for such an evaluation.[51] Perhaps if regional community resource centers do become available, this data and lessons learned can be shared. This would be the time to put together an evaluative process.

Implementation

It is important to celebrate any successes in this effort. In addition, letting patients know of the implementation effort by posting fliers in the waiting room may help to allay their anxiety or discomfort over any added wait time during appointments.[41] Debriefing soon after initial implementation is important to discover any additional modifications in customization or workflow reengineering that need to happen. Implementation is an iterative, ongoing process, and it is important for the entire staff to participate and share their input and experiences with the system and reengineered workflow regularly. Rapid reengineering trials may be designed and deployed until all the staff is satisfied with the system and workflow.

Post-implementation

It is important to continually reassess workflow and HIT to assure it complies with current "best practices" of HIT implementations and reduce unintended consequences.[52]

The following in a list of areas that should ideally be assessed, and it would be important to learn from a vendor whether these can be assessed with the use of their system:

1. Clinical computing and network infrastructure
    a. Electrical power sources
    b. Security
    c. Computers/workstation availability
    d. Infection control – covers for keyboards and monitors, cleaning procedures
    e. Existence and testing of offsite backup of the main clinical database
    f. Downtime emergency "kit" available(copies of paper documents to be used), reactivation procedures
2. System and application level software
    a. Is the system working?
    b. Does it interface with hospitals, labs and radiology?
    c. How are vendor updates taking place, and when?
    d. Is there a daily record of interface efficiency?
3. Human-computer interface (Usability)
    a. Is there a record of system response time from the users' perspective?

b. Is the percentage of all order entered as miscellaneous or all freetext monitored?

4. Clinical users
    a. Is every clinician required to attend a "system downtime" class?
    b. Is there a training plan for all new users in place?
    c. Is there a 24X7X365 telephone HELP desk support available to all users?

d. What is the percentage of orders entered by the authorizing provider?

e. What is the percentage of orders entered by the authorizing provider?

5. Communication among clinicians, patients and caregivers

    a. Is there a planned downtime procedure?

    b. Is there a mechanism or procedure to notify clinical staff when a new order has been entered?

6. Organizational Policies, Procedures and Culture

    a. Is there a policy to inactivate computer sessions on terminals in publicly accessible places (like exam rooms) automatically following periods of inactivity (i.e., 10 min)

    b. Is there someone charged with reviewing records of activity, like audit logs and security tracking reports?

7. Supra-organizational or societal issues

    a. Is someone responsible for tracking federal rules and regulations as they relate to HIT?

    b. Are all users HIPAA compliant-certified?

    c. Are all laptops with potentially patient-identified data equipped with encrypted hard drives?

    d. Does the EMR provide an E/M coder embedded within the system, and has it been coded?

e. Are all mobile devices set to require a password before they can access the e-mail system?

Is there any evidence that the approach I have presented in this capstone can address the issues most important to the primary provider in EHR implementation? A recent study published in Canada's *Future Practice,*[52] a qualitative study of practices in Canada with EHR implemented for at least two years, suggests the lessons learned in individual practioners' offices are those I have addressed in this capstone. One physician said that the capabilities of the EHR did not meet his vision of what was possible, as it "did not support the clinic workflow." Another said that the lesson they learned was that "there is great value in developing a plan for implementation, a map laid out telling how we might most efficiently do things." Another suggested hiring expert IT support to manage computers and servers, and get good ongoing training from the vendor or other physician users."

Conclusion

EHR implementation across the U.S., which has become a priority for the recently elected President and his administration, has been heretofore unsuccessful, especially in small primary care offices, for a number of reasons that relate to finances, usability and poor fit with office workflow. With financial solutions forthcoming, a human factors engineering sociotechnical approach, which can compensate for usability and workflow issues, may offer a very viable solution to promulgate successful implementation of commercial EHR into small primary care

practices across the U.S., which comprise 80% of physician practices. In addition, it is hoped that community projects will develop to assist in this effort, and possibly collect data and lessons learned that may be helpful to assist primary care physicians and encourage vendors of current products to improve usability and interoperability of their systems. It is my hope that the reviews and suggestions provided in this capstone project are helpful to primary care providers, currently contemplating going from paper to EHR, in their endeavors.

Bibliography

Leviss,J, Kremsdorf,R, Mohaideen, MF, The CMIO – A New Leader for Health Systems, J Am Med Inform Assoc. 2006 Sep–Oct; 13(5): 573–578.

1. Institute of Medicine. 2001. Crossing the Quality Chasm: A New Health System for the 21st Century. Washington, D.C.: National Academy Press.

2. Butte AJ, Translational Bioinformatics: Coming of Age, J Am Med Inform Assoc 2008; 15(6): 709-14.

3. Sussman, S, Valente, TW, Rohrbach,LA, Skara,S, Pentz,MA, Translation in the Health Professions, Evaluation and the Health Professions, 2006, 29(1): 7-32.

4. Leuhmann,CU, Altuwaijri, MM, Li,YC, Ball,MJ,Haux,R, Translational Research in Medical Informatics or from Theory to Practice (A Call for an Applied Informatics Journal), Methods Inf Med 2008, 47: 1-3.

5.Leviss,J, Kremsdorf,R, Mohaideen, MF, The CMIO – A New Leader for Health Systems, J Am Med Inform Assoc. 2006 Sep–Oct; 13(5): 573–578.

6. Runy,LA, The Changing Role of the CMIO, Hosp Health Netw 2008, 82(2): 37-42.

7. Aarts,J, Doorewaard,H, Berg,M, Understanding Implementation: The Case of a Computerized Physician Order Entry System in a Large Dutch University Medical Center, J Am Med Inform Assoc 2004, 11(3): 207-16.

8. Ludwick,DA, Doucette,J, Adopting Electronic Medical Records in Primary Care: Lessons Learned from Health Information Systems Implementation Experience in Seven Countries, Int J Med Inform 2009, 78: 22-31.

9. Zaroukian,MH, Benefiting form Ambulatory EHR Implementation: Solidarity, Six Sigma, and Willingness to Strive, J Healthcare Inf Management ,20(1): 53-60.

10. Badger,SL. Bosch,RG, Toteja,P, Rapid Implementation of an Electronic Health Record in an Academic Setting, J Healthcare Inf Management , 19(2): 34-40.

11. Cooper,JD, Organization, Management, Implementation and Value of EHR Implementation in a Solo Pediatric Practice, J Healthcare Inf Management 2003, 18(3): 51-5.

12. Lee J, Cain C, Young S, et al, The Adoption Gap: Health Information Technology in Small Physician Practices, Health Affairs 2005 ;24(5): 1364-66.

13. Davidson S, Heinke J, Toward an Effective Strategy amd Use of Clinical Information Systems, J Am Med Inform Assoc 2007; 14(3): 361-67.

14. Holmboe E, Kim M, Cohen S, et al, Primary Care Physician Office-Based Practice and the Meaning of Quality Improvement, Am J Med 2005; 118(8): 917-22.

15. Simon,SR, McCarthy,ML, Kaushal, R, Jenter,CA,Volk,LA, Poon, EG, Electronic Health Records: Which Practices Have Them, and How are Clinicians Using Them, J Evaluation in Clinical Practice 2008, 14: 43-7.

16. Amarasingham,R, Plantiga,L, Diener-West,M, Gaskin,DJ, Powe,NR, Clinical Information Technologies and Inpatient Outcomes: A Multihospital Study, Archives of IntMed 2009, 169(2): 108-14.

17. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc 2006 Sep-Oct; 13(5): 547-556

18. 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 2009, 16(1): 132-9.

19. Scott,T, Rundall,TG, Vogt,TM, Hsu,J, Implementing an Electronic Medical Record System: Successes, Failures, Lessons, Oxford: Radcliffe; 2007.

20. Holbrook,A, Keshavjee, K, Troyan,S, Pray,M, Ford, PT, Applying Methodology to Electronic Medical Record Selection, Int J Med Inform 2003, 71: 43-50.

21. Miller,G, Gabard,C, EHR Case Study: How a Well-Managed Selection Process Led to Successful IT Implementation, J of AHIMA 2006, 77(9): 100-4.

22. Carayon,P, Smith,P, Hundt,AS, Kuruchittham,V, Li,Q. Implementation of an Electronic Health Records System in a Small Clinic: The Viewpoint of the Clinical Staff, Behavior and Inform Tech 2008: 1-16.

23. DOQ-IT, Medicare Quality Improvement Organization for the State of Michigan, www.mpro.org/doqit, Sept 12,2007.

24..Rose,AF, Schnipper,JL, Park,ER, Poon,ER, Li,Q, Middleton,B, Using Qualitative Studies to Improve the Usability of an EMR, J Biomed Inform 2005, 38: 51-60.

25. Horsky,J, Kaufman,DR, Pate,. VL, The Cognitive Complexity of a Provider Order Entry Interface, AMIA Symposium Proceedings 2003: 294-298.

26. Miller-Jacobs,H, Smelcer,J, Usability of Electronic Medical Record System: An Application in its Infancy with a Crying Need, Human Interface Part II, MJ Smith, G. Salvendy, eds., 2007.

27. Kushniruk,AW, Patel, VL, Cognitive and Usability Engineering Methods for the Evaluation of Clinical Informations Systems, J Biomed Inform 2004, 37: 56-76

28. Despont-Gros, Mueller,H, Lovis, C, Evaluating User Interactions with Clinical Information Systems: A Model Based on Human-Computer Interaction Models, J Biomed Inform 2005: 244-255.

29. Bright, TJ, Bakken, S, Johnson, SB, Heuristic Evaluation of eNote: an Electronic Notes System, AMIA Symposium Proceedings 2006: 864.

30. Thyvalikakath,TP, Monaco, V, Thabuganipalle,HB, Schleyer,T, A Usability Evaluation of Four Commercial Dental Computer-Based Patient Record Systems, J Am Dent Assoc 2008, 139: 1932-42.

31. Edwards, PJ, Moloney, KP, Jacko, JA, Sainfort, F, Evaluating Usability of a Commercial Electronic Health Record: A Case Study, Int J of Human-Computer Studies 2008, 66: 718-28.

32. Lorenzi,NM, Novak, LL, Weiss, JB, Gadd, CS, Unertl, KM, Crossing the Implementation Chasm: A Proposal for Bold Action, J Am Med Inform Assoc 2008, 15: 290-96.

33. Saathoff,A, Human Factors Considerations Relevant to CPOE Implementations, J Health Inf Manag 2006; 19(3): 71-8.

34. Chan W, Increasing the Success of POE Through Human Factors Engineering, J Health Inf Manag 2002; 16(1); 71-9

35. Ash J, Stavri PZ, Dykstra R, Fournier L, Implementing Physician Order Entry: The Importance of Special People, Int J Med Inf 2003; 69(2-3): 235-50.

36. Schulman J, Kuperman G, et al, Discovering How to Think about a Hospital Patient Information System by Struggling to Evaluate It, J Am Med Inform Assoc 2007; 14(5): 537-41.

37. Karsh,BT, Holden RJ, New Technology Implementation in Health Care, Handbook of Human Factors Engineering and Ergonomics in Health Care and Patient Safety, Pascale Carayon,ed., 2007.

38. Karsh B-T, Holden R, et al, A Human Factors Engineering Paradigm for Patient Safety: Designing to support the performance of the healthcare professional, Qual Saf Health Care 2006; 15(Suppl 1): 159-65.

39. Karsh B-T, Beyond Usability: Designing Effective Technology Implementation Systems to Promote Safety, Qual Saf Health Care 2004; 13: 388-94.

40. Lohr,Steve, Taking Innovation Beyond the 'Aha', NY Times, Sunday, March 1, 2009: BU 3.

41. Miller,RH, Sim,I, Physicians' Use of Electronic Medical Records: Barriers and Solutions, Health Affairs 2004, 23(2): 116-26.

42. Lorenzi, NM, Kouroubali A, Detmer,D, Bloomrosen M, How to Successfully Select and Implement EHR in Small Ambulatory Practice Settings, BMC Medical Informatics and Decision Making 2009, 9(15), provisional pdf accessed online March 1, 2009.

43. Community Clinic EHR Readiness Assessment Tool available at http://pbrn.ahrq.gov/portal/server.pt/gateway/PTARGS_0_8762_825567_0_0_18/Community%20Clinic%20EHR%20Readiness%20Assessment%20Tool.pdf, accessed March 1,2009.

44. Korn,JM, Electronic Health Records: How the New Stark Law and Anti-Kickback Rules May Help Speed Adoption, J of Onc Practice 2007, 3(2): 76-7.

45. Achieving Meaningful EHR Use: Leveraging Community Structures, 2009.

46. Mostashari,F, Tripathi,M, Kendall,M, A Tale of Two Large Community Electronic Health Record Extension Projects: What others can learn about overcoming barriers to adopting EHRs from Massachusetts and New York City, Health Affairs 2009, 28(2): 345-56.

47. Joint POSP Committee, Vendor Performance and Usability Requirements 2006 Volume 1, March, 2005, accessed at http://posp.ab.ca/files/VCUR2006FinalReportv.1.2A.pdf, March 18,2009.

48. Alberta Netcare POSP, Procurement Guide ver 1.1, May 6, 2006 available at http://posp.ab.ca/files/POSP_Procurement_Guide_May2006.pdf, accesses March 18, 2009.

49. Lord, CF, IT Project Evaluation: From Conception Through Implementation, AHRQ National Resource Center for Health IT, available at http://healthit.ahrq.gov, accessed March 18, 2009.

50. McGowan,JJ, Cusack, CM, Poon, EG, Formative Evaluation: A Critical Component in EHR Implementation, J of Am Med Inform Assoc 2008, 15(3): 297-301.

51. Cusack, CM, Poon, EG, Health Information Technology Evaluation Toolkit, available at http://healthit.ahrq.gov/portal/server.pt/gateway/PTARGS_0_807442_0_0_18/AHRQ_Evaluation%20Toolkit.pdf, accessed March 1, 2009.

52. DF Sittig, personal communication.

53. McCarrey,M, Hines,K, How Canadian Physicians are Using EHR in Clinical Care, Future Practice, January 6, 2009, 5-6.

Appendix

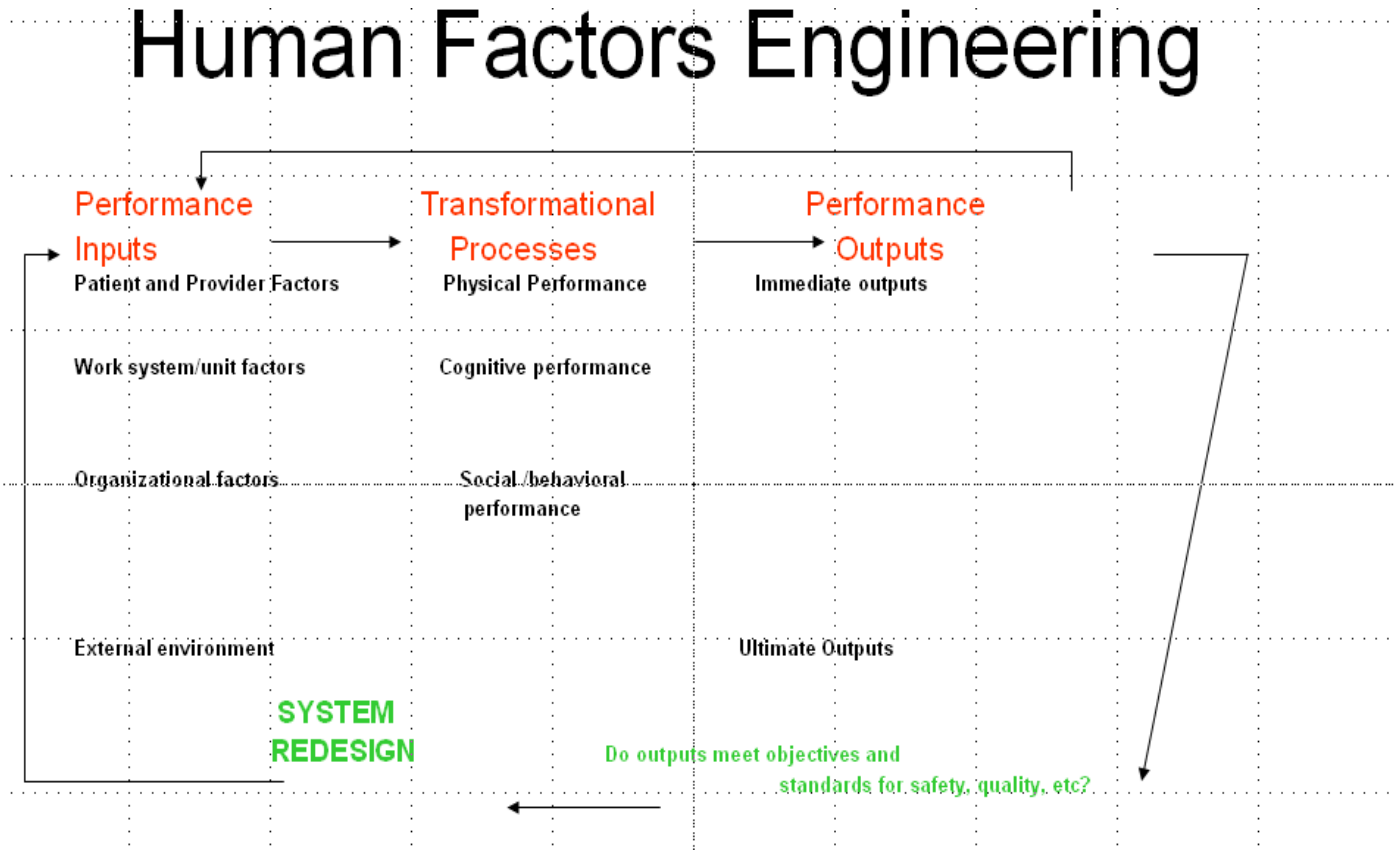

Figure 1 Karsh, BT, 2006