Electronic Medical Records

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Health Economics and Policy

Spring 2013

ABSTRACT

Electronic medical records systems (EMR) are part of the triple aim of national health reform: better quality, better population health outcomes and lower costs. The evidence in the literature is mixed as to whether the benefits to investing in EMR outweigh the costs, yet federal incentives (e.g. 'meaningful use') have led most hospitals and providers to implement EMR. The implementation of Porter Medical Center's (PMC) EMR has been underway since early 2010. We surveyed nurses, physicians and pharmacists associated with PMC to assess the impact of the implementation. We find training sessions are viewed most favorably of various support services, while satisfaction with the Meditech system is lower than that for LSS or Medhost. Our recommendations include: instituting 'department champions' to coordinate customization of EMR within each department at Porter Medical Center, providing individual department specific training sessions, and clarifying the Project Plan for the future in order to foster a vision of change. We are optimistic about the prospects for Porter Medical Center and are grateful to the many generous contributors who gave time, insight and guidance for this report.

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ACKNOWLEDGEMENTS

EXECUTIVE SUMMARY

Our project was to understand the adoption of electronic medical records (EMRs) at Porter Medical Center (PMC) and the impact of the implementation on different aspects of the hospital such as costs, productivity, efficiency, patients, clinicians, and the administration. Ultimately, by gathering knowledge through empirical research, a survey designed to understand clinician perspective on EMRs at PMC, and discussions with doctors, nurses, and administrators, we formulated four recommendations for the future of EMRs at PMC.

Through recent empirical research, we found that some of the controversy surrounding EMRs includes effects on medical expenditures, patient safety, doctor-patient relations, slow implementation, software user-friendliness, clinician training, physician involvement, and changes in workflow and efficiencies.

Some of the main takeaways and key obstacles identified from our clinician survey were that clinicians have a difficult time keeping fast paced and high productivity levels since EMR implementation, there is more dissatisfaction with Meditech in comparison to L.S.S. and Medhost, and that there is a desire for clinicians to be involved in the decision making process of EMR and a desire for increased transparency with the project. However, overall we have found a positive trend with increased satisfaction with EMR since the beginning of implementation and we find that the majority of clinicians are hopeful for the future of EMR.

From these two sources, we formulated four recommendations for EMR at PMC moving forward:

- Institute Department Champions to coordinate EMR implementation efforts in their department.
- Hold lunch training sessions for individual departments at a time.
- Publish an updated Project Plan to share with the entire organization.
- Improve user outlook about the EMR project.

INTRODUCTION

As part of Professor Holmes' Health Economics and Policy class at Middlebury College, our project was to learn the history and understand the current standing of Electronic Medical Record (EMR) implementation at Porter Medical Center (PMC). Our goal was to research how EMR implementation at Porter Hospital was affecting physician satisfaction and productivity, possible changes in the daily workflows of the hospital, relationships with patients, quality of care and patient safety, and the costs and benefits of the overall process.

Throughout our project, we had weekly phone calls with our mentor, Dr. Bob Sideli, CIO of Columbia University Medical Center and Associate Professor in the Department of Biomedical Informatics at Columbia University, who provided us with advice on project management and insight into how to best understand EMR at PMC. In order to gain perspective from within the hospital, we also met with physicians and administrators at Porter Hospital including Dr. Sal Morana, COO at PMC, Dr. Ben Rosenberg, Orthopedic Surgeon at PMC, and Kate Lombard. In addition, we spoke with Dr. Charles Jung, Administrator and Chief of Orthopedics at Group Health, who provided us with insight into EMR at the national level and his experience with the successful implementation of EMR at Group Health.

Our group also attended various meetings in order to learn more about the administrative decision-making process regarding health information technology at Porter Hospital and in Vermont. We attended the PMC physician meeting regarding EMR, two Board meetings, and a Blueprint for Health meeting.

Our learning also involved reading the empirical research, as listed in the references section of the appendix.

This report is organized as follow:

- ✓ Section 1 provides background on EMR implementation at the Federal and State level, as well as an overview of recent empirical research on the impact of EMRs. In this section we also provide a brief overview of the history of EMR implementation at Porter Medical Center.
- ✓ Section 2 introduces our survey, which was distributed to the Porter medical staff in order to better understand clinician perspective on EMR. This section includes survey design, methodology, summary statistics, and key findings from both our quantitative and qualitative results.
- ✓ Section 3 describes and supports our four recommendations: (1) instituting department champions, (2) holding targeted and effective department-specific lunch training sessions, (3) updating the long-term project plan and make it readily available to the entire medical staff, and (4) improve end-user outlook and create a vision of change.
- ✓ Section 4 includes concluding remarks.
- ✓ Section 5 is the appendix, which contains our contact list and annotated bibliography.

Cumulatively, our group spent 170 hours our on project.

I.   BACKGROUND

National EMR Implementation

Under President Obama's Patient Protection and Affordable Care Act (ACA), signed into law March 23, 2010, $27 billion in subsidies were created over a ten-year period to incentivize the nationwide implementation of EMR. This policy arose in light of a study by the RAND Corporation supporting EMR as a means for reducing national healthcare expenditures and improving healthcare efficiency and quality. The study predicted annual savings of $81 billion with an adoption rate of 90% nationwide (Kellerman & Jones, 2013).

According to the ACA, hospitals and physicians are required to comply with 'meaningful use' EMR guidelines as established by the Health Information Technology for Economic and Clinical Health (HITECH) by the year 2015. Once compliant, hospitals are entitled to financial rewards; however, failure to satisfy 'meaningful use' requirements by 2015 will result in financial penalties. Financial penalties would begin with a 1% reduction in Medicare reimbursements in 2015, with further reductions in subsequent years (Encinosa, 2005).

By virtue of this American public policy reform, there has been a tremendous pressure on hospitals and professional healthcare providers to implement EMR. To date, only 1.9% of all U.S. hospitals have fully operation systems compliant with 'meaningful use' guidelines (stage seven on figure 1). However, more than 176,000 healthcare providers have received over $9 billion in subsidies for reaching the first of seven 'meaningful use' stages. In addition, 20% of more than 5000 U.S. hospitals are within the final three stages of 'meaningful use'.

Figure 1. HIMSS Analytics (2013) "Electronic Medical Record Adoption"

United States EMR Adoption Model^{SM}

Stage	Cumulative Capabilities	2012 Q4	2013 Q1
Stage 7	Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP	1.9%	1.9%
Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), full R-PACS	8.2%	9.1%
Stage 5	Closed loop medication administration	14.0%	16.3%
Stage 4	CPOE, Clinical Decision Support (clinical protocols)	14.2%	14.4%
Stage 3	Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology	38.3%	36.3%
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable	10.7%	10.1%
Stage 1	Ancillaries - Lab, Rad, Pharmacy - All Installed	4.3%	4.2%
Stage 0	All Three Ancillaries Not Installed	8.4%	7.8%

Data from HIMSS Analytics® Database ©2012   N = 5458   N = 5441

Vermont EMR Implementation

This national incentive to implement EMR is evident in Vermont, where the state's Department of Health Access and Vermont Information Technology Leaders (VITL) has supported several state initiatives to encourage the shift to EMR. The state's Department of Health Access has developed the Vermont Health Care Information Technology Plan, which aims to create a statewide network of electronic health records. The three major steps of the plan include: (1) assisting healthcare practitioners with adopting and implementing electronic health records; (2) increasing statewide practitioner communication through the Vermont Health Information Exchange; and (3) helping practitioners use the information technology to improve quality of care delivered to patients (VITL).

VITL is a Vermont non-profit organization that was created in July of 2005. Its mission is to help healthcare practitioners adopt and implement EMR, to create a statewide network of electronic health information, and ultimately, improve the quality and efficiency of the Vermont healthcare system. It is a public-private partnership, funded by the Vermont General Assembly's Vermont Information Technology Fund and contributions by insurance companies that insure Vermont citizens. Some of the services VITL provides to healthcare practitioners include aiding the implementation process of EMR and connecting practitioners to the Vermont Health Information Exchange network, which allows different healthcare providers to communicate test results, immunization records, and other information about patient history. In addition, VITL works with practitioners to link patient care data from their EMR to Vermont's Blueprint for Health program data registry. This database is a secure network that collects patient care data to analyze areas in which patient care delivery can be improved (VITL 2012 annual report).

According to VITL's 2012 Annual Report, there has been widespread adoption and implementation of EMR systems in the majority of Vermont primary care providers and hospitals. In 2012, VITL signed up 891 primary care providers to begin implementing EMR, which represents about 90% of all primary care providers in the state. Additionally, 770 primary care providers have achieved the 'Go-Live' stage of EMR, which represents a 35% increase since 2011 (Figure 2). For Vermont hospitals, 12 of the 14 hospitals are connected to the Vermont Health Information Exchange Network and eight of the hospitals, including Porter Medical Center, are using the core infrastructure database, a data storage system that allows different authorized healthcare organizations to collect and share medical data[1].

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[1] Southwestern Vermont Medical Center and Northeastern Vermont Regional Hospital were not actively working on the interface

Figure 1. VITL (2013) "2012 Annual Report"
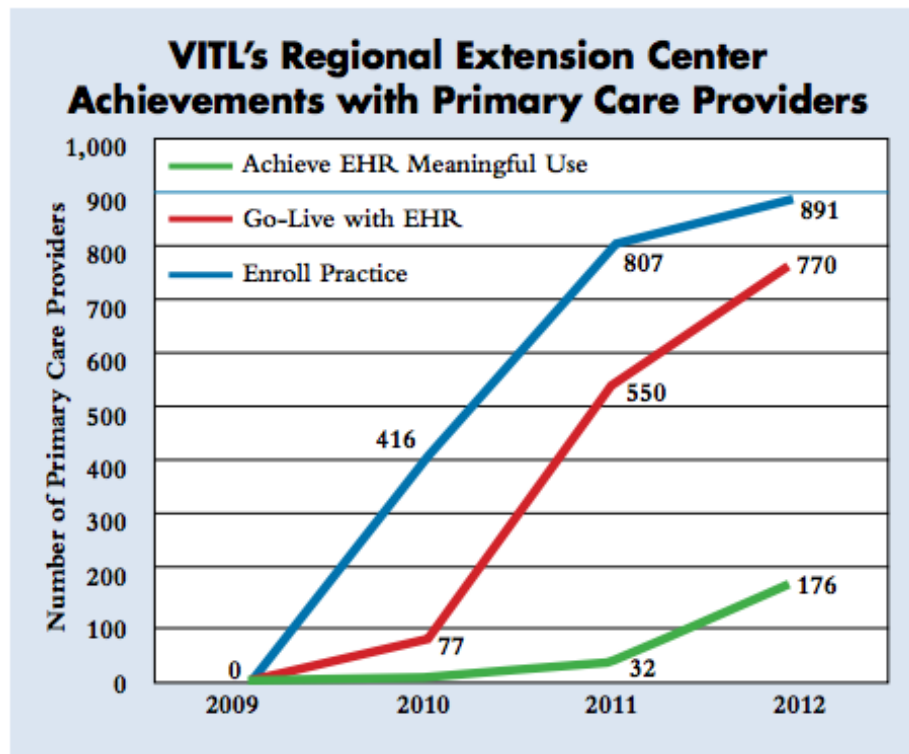
EMR Implementation Effects

　　　Despite both national and local movements towards EMR implementation, the jury is still out on whether EMR improves quality and/or reduces costs. Furthermore, several unintended consequences have emerged.

→ *Rise in Medical Expenditures*

- The original RAND Corporation study estimated that a 90% nationwide adoption rate of EMR could create $81 billion annual healthcare expenditure savings (Hillestad et al., 2005). However, such an adoption rate has not been achieved and U.S. aggregate health expenditures have increased from $2 trillion in 2005 expenditures to $2.8 trillion today. Figure 3 shows the Hillestad et al.'s (2005) original projected fall in spending versus actual spending through 2010. As of 2012, while EMR had not yet achieved the projected savings, there has been a notable slowed growth rate in actual national spending versus the health spending projection.

Figure 2. Kellermann and Jones (2013). "What it will take to achieve the as-yet-unfulfilled promises of health information technology."

Possible Improved Productivity Effects Of Health Information Technology On Future National Health Spending, 2002–16
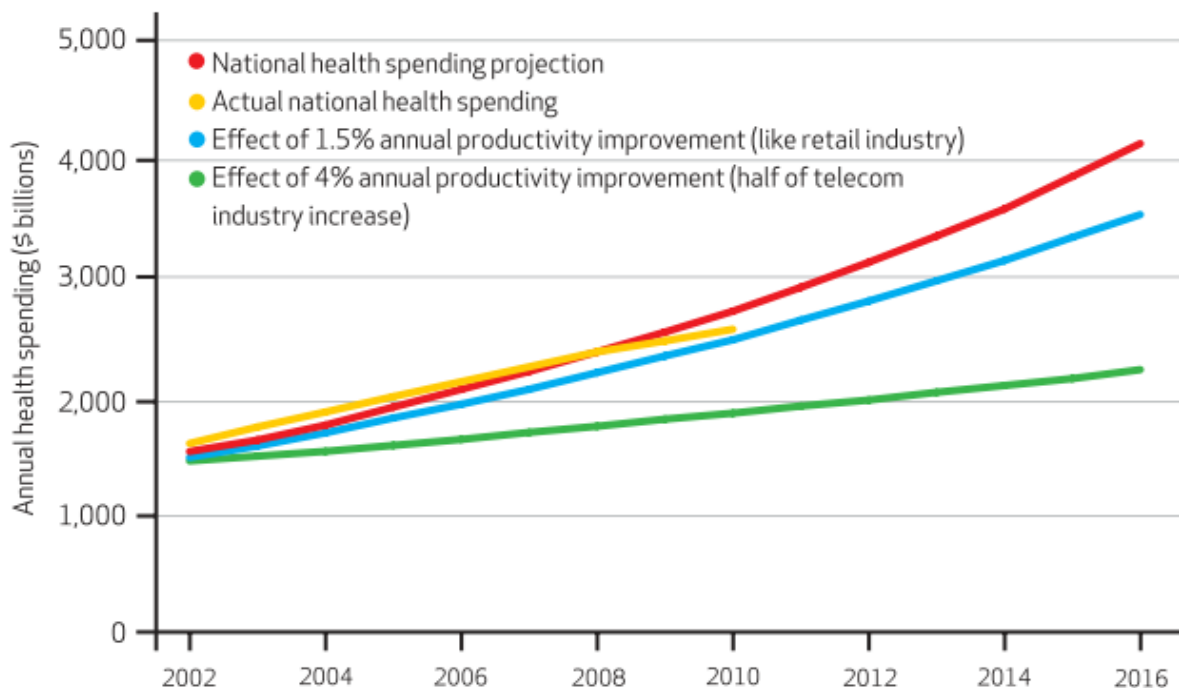
- Kellerman and Jones (2012) report that the failure of EMR to reduce medical expenditures is multi-factorial: slow nationwide wide adoption rates, inoperability and lack of communication between different EMR systems, and the incompatibility of EMR with the volume-oriented incentives created by a fee-for-service reimbursement system.

- A recent report by Ted Palen (2012) at Kaiser Permanente Institute for Health Research also reported that EMR implementation and patient access to online clinical records has actually increased the demand for medical services, further increasing medical expenditures. This is due to the fact that patients have quicker and easier methods for contacting their clinicians, as well as for diagnosing, treating, and monitoring their health. Additionally, by having access to personal medical records online, patients have more information readily available, which can in turn increase concerns regarding their health and increase frequency of clinician consults. By comparing patients with access to online records to patients without access to online records, the study found a significant increase in per-member rates of office visits, telephone calls, and an increase in clinical after hour visits. Figure 4 below demonstrates higher mean office visits per month of online patient users versus patient nonusers. Overall, the study estimated that in a health system with 100,000 patient members, a switch to online clinical record access for patients increases clinical visits by 50,000 and telephone calls by 30,000.

Figure 3. Palen, T. et al. (2012). "Association of online patient access to clinicians and medical records with use of clinical services."

Figure. Matched Cohort Mean Office Visits per Month

Each data point represents mean office visits from the preceding 30 days. The tinted area indicates a 30-day period on either side of the index date. Data from this 60-day period were excluded from the rate calculations reported in Table 2 and the generalized estimating equations analysis reported in Table 3.
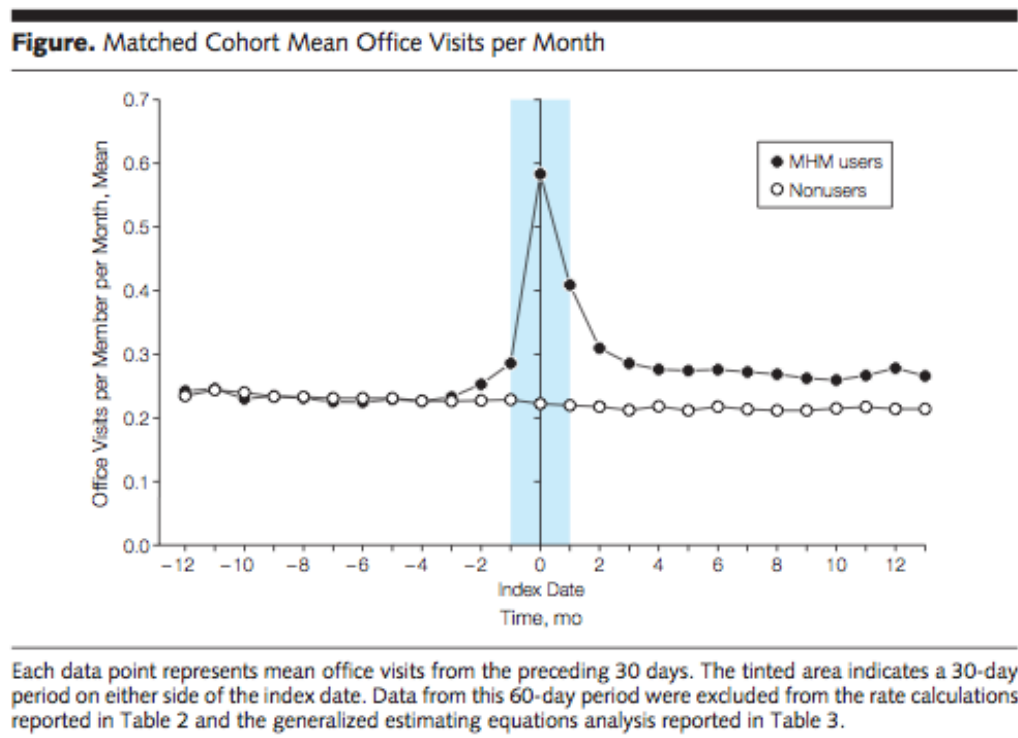
→ *Patient Safety and Doctor-Patient Relations*

- Patient safety and changes in doctor-patient relationships have been topic of concern with EMR implementation and empirical research and case studies have demonstrated mixed results.

- A study conducted by Walker et al. (2011) analyzed patient responses to EMR and found that while 90% of patients report they would like full access to medical records, only about 42% of patients actually sign up for online access, and fewer than half review online clinical records.

- Crane (2008) explains that EMRs can result in improved communication between clinicians and easier access to patient medical history. Discussions with physicians have also confirmed this since they are now able to access patient history from anywhere: from work, mobile on their phones, or from their homes. Additionally, EMRs provide clinicians with increased clarity of any patient allergies, current medications that could create adverse drug reactions, and information about past visits and test results that avoids expensive and unnecessary duplication of tests.

- Encinosa and Bae (2011) find that EMR implementation can have a positive impact on hospital-acquired conditions (HACs). An inpatient that acquires a healthcare-associated infection (HAIs) is six times more likely to die than an inpatient without an infection, and HACs can increase spending in hospitals by up to $28,000 (2002 dollars), or 52% per incident. While the study found that EMR systems do not significantly reduce the occurrence rate of HACs; once an HAC

has occurred, EMR systems reduce death rates by 34%, readmission rates by 39%, and spending by $4,850 (16%). The authors argue that EMR improves patient safety through better care coordination and increased ability to detect and respond to HACs, as well as increased monitoring and feedback provided by the system that can allow clinicians to learn more about HACs.

- The 2012 VITL annual report included a case study of Dr. Thomas H. Lewis, General Surgeon at Brattleboro Hospital in Vermont, which depicted a positive effect of EMR on patient education and doctor-patient relations. The physician reported that EMR is a 'powerful education tool' for patients, since the physician and his patients look at EMR together and discuss medical treatments and surgeries. Dr. Lewis often prints out EMR copies for his patients, so they follow along conversations about their lab results and x-rays.

- On the other hand, Campbell et al. analyzes the new types of errors that can emerge with the use of Computerized Provider Order Entry (CPOE). The author finds that errors from CPOE generally arise from poor data organization and screen layouts that make it difficult for clinicians to enter the correct orders in the correct way. For example, the author cites a clinician explaining that: "The biggest problem with orders [is that] people get frustrated finding the right spot to put something, or don't see what they need immediately, then end up entering orders in the miscellaneous section. This makes it easy to miss things and hard to capture data on the orders being entered" (Campbell, p. 552). Therefore, increased user-friendliness of EMRs is a driver of reduced systematic errors.

- A recent news article by Hancock (2013) highlights real examples of when these new types of medical errors have occurred at hospitals. Some of the cases the author cites includes: an order entry error that led to the death of a baby in Advocate Lutheran General Hospital in Illinois in 2010, a computer mistake in that produced incorrect prescriptions for thousands of patients at Lifespan Hospital in Rhode Island in 2011, and an error with the computer system at Trinity Health System which located doctor orders on the incorrect patient charts. Furthermore, Hancock argues that a major issue concerning EMRs is the fact that the government does not require healthcare providers to report deaths due to EMR mistakes. According to the article, computer mistakes that were voluntarily and anonymously reported to the Food & Drug Administration (FDA) included 44 injuries and six deaths.

- There is clearly a tremendous amount of controversy pertaining to EMR and patient safety. While some new types of medical errors can be created, EMR also has the potential to reduce the traditional types of medical practice errors. Therefore, gradual implementation processes and close attention must be observed when adopting EMRs.

  → *Implementation Lag*

- Kellermann and Jones (2012) explain that the U.S. EMR implementation is behind that of Western Europe and also far from the 90% adoption rate predicted by the original RAND study. According to their report, 40% of U.S. physicians and 27% of hospitals have adopted only a 'basic' EMR system. They accredit this lag in the "reluctance of many clinicians to invest the

considerable time and effort required to master difficult-to-use technology." Furthermore, there is a large disparity between small and large healthcare providers in EMR adoption due to the high financial burden for small providers, concern with increased technological dependence, and uncertainty regarding future policy changes regarding EMR.

- Additionally, a recent news article in Forbes (2013) reported that leading medical organizations such as the American Medical Association and the American Academy of Family Physicians have requested that the Obama administration review and extend the deadline for EMR implementation and 'meaningful use' compliance.

→ *Variable Software Usability*

- A major criticism of EMR implementation is the variation in software quality and poor usability of different EMR products. Kellermann and Jones (2012) report that one obstacle to EMR adoption is the lack of product transparency; hospitals are in a rush to adopt and meet meaningful use requirements but are blindsided by the poor user-friendliness of different EMR products. A large concern is that the financial incentives created by the government allow EMR vendors to have lower usability priority, instead "encouraging providers to purchase hard-to-use systems that will be costly to replace at a later date." Even more, the authors report that there is no means to compare data and records across differing EMR systems.

- However, a recent Bloomberg news release in March of 2013 announced that five major EMR software companies (Cerner Corp., McKesson Corp., Athenahealth Inc., Allscripts Healthcare Solutions Inc., and Greenway Medical Technologies) are forming a nonprofits with the purpose of creating a system that will allow data exchange between the different software providers. Unfortunately, Meditech, the company PMC contracted is not included. However, the article also mentioned that the Obama administration is also considering new standards for communicating between EMRs. Therefore, there has been a notable movement towards standardization of systems in order to facilitate data transferability.

- Dignity Health, formerly Catholic Healthcare West, based in California, is the eighth largest hospital organization in the United States. In the fall of 2012, the organization attempted to implement Meditech 6.0. The organization, consisting of three hospitals, originally budgeted $419 million to the project, which eventually grew to over $1 billion. In light of difficulties with the project, the organization terminated the program, and switched to Cerner. This case study exemplifies the poor quality standards of some EMRs, which can result in major overrun costs and even failure to implement.

→ *Clinician Training & Physician Involvement*

- Kellermann and Jones (2012) report that some of the most successful EMR implementations have occurred with active involvement of clinicians. For example, the Department of Veterans Affair's Veterans Health Information Systems and Technology Architecture has one of the nation's most successful EMR systems due to the involvement of clinicians during the development process. Additionally, Intermountain Healthcare implemented EMR with a very slow, yet incremental approach, with special attention to clinician testing and partnerships

between clinicians and the IT staff. Through this strategic approach, Intermountain achieved significant gains in the quality of healthcare delivered, and at a much lower cost than comparables in the United States.

- Campbell et al. (2006) reported negative effects associated with the institutional power structure of a healthcare provider group and frustration among clinicians when they are not involved in the decision-making process for EMR. According to the report, physicians feel a loss of professional autonomy when refrained from ordering the types of medications and services they prefer and feel limited by the rigid structure of EMR in comparison to the free-text in paper documentation. In turn, tension between physicians and the administration can "create significant problems for IT departments, and lead to problems with the application consistency, clinical coordination, and evaluation of impact on patient care" (p. 553).

→ *Changes in Work Flow and/or Efficiency*

- Campbell et al. (2006) report that Computerized Provider Order Entry (CPOE) creates new work for clinicians, slows the pace at which clinicians work and enter patient information, and increases the time spent at work. First, the training and time spent learning to maneuver the system takes away from time spent with patients. In addition, clinicians must spend more hours learning to integrate the new combination of electronic and clinical work. In particular, when there are multiple systems being used in a hospital, clinicians spend more time logging into different systems and transferring information from one system to another. The difficulty inherent in the navigation of poorly designed EMR systems also contributes to the slowdown in workflow. However, the authors conclude that the efficiency recovers over time.

- In the 2012 VITL Annual Report, Dr. Richard Clattenburg, a pediatrician and solo practitioner, adopted EMR with the help of a VITL Implementation Specialist, Betsey Walton. After nine months of implementation, Dr. Clattenburg reports improvements in efficiency and time spent with patients. He finds the online records eliminate time spent searching for patient records and creates more time to spend with patients. Additionally, after every visit, he is able to print out a note for patients with a summary of the visit and the treatments provided to increase clarity and quality of care provided.

II. EMR IMPLEMENTATION AT PORTER MEDICAL CENTER

The implementation process at Porter Medical Center began with selection of an EMR system. Working with an IT consultant, Porter sent requests-for-information to 13 different IT vendors in July 2008, receiving responses from 6 of the firms. Three of the six were invited to make initial demonstrations in early 2009. A broad-based group of staff, including physicians and clinical personnel, made up the IT Steering Committee. The Committee evaluated the systems and agreed to invite CPSI and Meditech to make second demonstrations. After the second demonstrations in spring of 2009, the Committee made a number of reference calls and visits to hospitals that had CPSI or Meditech systems in-place.

The Committee voted to implement the Meditech system with a 74% majority decision. During the visits and reference calls, all clients seemed satisfied by the amount of support provided by Meditech, but their Emergency Room solution was found to be unacceptable. The 6.0 version was "a relatively new product for Meditech, and there were very few examples of fully satisfied ER users" (CON 2010). Medhost was selected as an alternative solution to be implemented in the ER.

Two contracts were signed with Meditech; one for the basic Business Applications and the second for Clinical Applications, including EMR. This approach was utilized "in order to establish a favorable implementation schedule" (CON 2010). Included in the agreement was a stipulation that if the Hospital finds the support and assistance provided by Meditech to be insufficient, Meditech "will provide additional support at no additional cost (other than travel and out-of-pocket expenses)" (CON 2010).

An application for a Certificate of Need to purchase and implement a hospital information system was submitted to the state on February 12, 2010. The proposed capital expenditure was $4,359,177 (Figure 5). Implementation was scheduled to take place September 2010 to August 2012 (Figure 6). Each module was to be implemented individually, with 1-8 weeks of training scheduled before each module was to go-live. The complete EMR was to include the following systems with interfaces: 1) Meditech/LSS for financial, materials management, admitting and registration, order/entry results reporting, payroll, laboratory and pharmacy; 2) Philips for Picture Archiving and Communication System, (an existing system); 3) Pyxis for drug dispensing, (an existing system); and 4) Medhost for Emergency Department patient management and coding.

The CON was approved by the Commissioner on June 10, 2010. This decision was made after the Public Oversight Committee (POC) voted unanimously to recommend the application for approval. Among concerns was the study by the Division of Health Care Administration on the Porter Hospital CON. The committee concluded that "Porter needs to provide some options as to their plans in the event their assumptions cannot be met" (CON 2010). Furthermore, the POC was "most concerned with

Figure 5. Propsed Capital Expenditure from CON 2010

	Anticipated Capital Cost
Meditech - Phase 1	$713,700
Perot Systems - Hardware (capital)	451,522
Readiness Assessment Consulting (1/2 allocation)	12,500
Implementation Consulting (1/3 allocation)	225,694
Capitalized Interest	**45,311**
Contingency	60,000
Capital Cost of Phase 1	1,508,727
Meditech - Phase 2	1,225,720
LSS (for MD practices)	255,000
PPM Support Hardware (various vendors)	97,800
Medhost for ER (hardware and software)	699,250
Readiness Assessment Consulting (1/2 allocation)	12,500
Implementation Consulting (2/3 allocation)	452,066
Capitalized Interest	**23,114**
Contingency	85,000
Capital Cost of Phase 2	2,850,450
Total Capital Cost of 2 Phases	$4,359,177

[Porter's] ability to keep their expenses lower and the fact they don't expect any new full-time employees to be needed to manage the system on an ongoing basis" (CON 2010). These concerns were not properly addressed and are very accurate foreshadowing of problems to come.

Figure 6. Proposed timeline of implementation from CON 2010 correspondence.

Porter Hospital	Milestones Complete	% Compl	2010 SEP	OCT	NOV	DEC	2011 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2012 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Implementation Timeline																														
General Ledger / Fixed Assets	Live	100%	T	T	T	T	L																							
Budgeting / Exec Support Sys	Live	100%	T	T	T	T	L																							
Human Resources / Payroll	Live	100%	T	T	T	T	L																							
Data Repository	Live	100%	T	T	T	T	L																							
Reg/Med Rec/Abstract/Qual Mgt	Dictionary & Applications Training	50%	IS	D	T	T	D	T	T	T	T	T	L																	
Billing / Accounts Receivable	Dictionary & Applications Training	50%	I	D	T	T	D	T	T	T	T	T	L																	
Scheduling / Auth Ref Mgt	Dictionary & Applications Training	50%	IS	D	T	T	D	T	T	T	T	T	L																	
LAB / MICRO / BLOOD BANK	Dictionary & Applications Training	50%	D	I	D	T	D	T	T	T	T	T	L																	
Medical and Practice Mgt - Phase 1	Initial Training	20%			I	D	D	T	T	T	T	T	L																	
Imaging & Therapeutic Svcs (Rad)	Dictionary & Applications Training	20%				IS	IS	D	T	T	T	T	L																	
Materials Mgt / Accts Payable	Dictionary Training	20%				I	IS	D	T	T	T	T	L																	
Pharmacy	Dictionary Training	20%					I	D	T	T	T	T	L																	
Imaging & Therapeutic Svcs (Rad)	Dictionary & Applications Training	20%					D	T	T	T	T	T	L																	
Dictionary Training	Assessment Visit	10%					IS	D	T	T	T	T	L																	
Order Management / EMR	Assessment Visit	10%					IS	D	T	T	T	T	L																	
OR Management	Dictionary Training	10%					IS	D	T	T	T	T	IS	D	T	T	T	T	L											
Scanning and Archiving	Assessment Visit	5%				IS	IS			IS		D	IS	D	L															
Phys Care Manager - Phase 1	Kick-Off Call	1%								I	IS	D	T	T	T	T	T	T	L											
Patient Care / Bedside Med Verf	Phase 3	0%																												
Cost Accounting	Phase 3	0%																												
MEDHOST	Phase 4	3%						I	IS	H	T	T	D	T	L															
Medical and Practice Mgt - Phase 2	Phase 4 & 5 (staggered)	0%																			I	D	T	T	T	T	L			
Phys Care Mgr - Phase 2 (CPOE, Phys Doc)	Phase 5	0%																			IS	D	T	T	T	T	L			

I = Implementation
T = training
L = Live

The implementation did not go as planned. On December 31, 2012 Porter Hospital was issued an amendment to their Certificate of Need for a 63% budget overrun. Commissioner Kimbell summarized the situation by saying, "Porter's project has lacked appropriate governance and informed decision-making and has been characterized by poor project, financial and contract management." (CON 2012). Furthermore, the magnitude of the overrun was not revealed to the state until it had risen to 30% of the amount allowed in the 2010 CON. The new amendment states, "Porter may not spend, commit to spend, or encumber any amount on this project in excess of $7,113,290.43 regardless of when the project is completed. $7,113,290.43 is a cap through complete implementation" (CON 2012). The amendment was approved reluctantly, as "it is impossible to order Porter to remove its HIS/EMR system and it is impossible to recover the money it has spent and fining the hospital would be counter-productive".

Since then Porter has made a number of changes to the implementation process. Dr. Sal Morana has taken over as COO and instituted new initiatives to improve EMR at PMC. Among them is now an EMR weekly updates newsletter as a way to share current news on the project. A technical support hotline service has also been set up as a way for clinicians to get help when needed. Furthermore, individual training sessions are available in a room dedicated to training for those who want assistance with specific problems. Most recently, two new Meditech/LSS experts have been hired to aid in implementation.

III. SURVEY AND ANALYSIS

Survey Design and Summary Statistics

We implemented a survey to further understand which factors of the current implementation were most effective, the relative merits of the three EMR systems, and the areas to address moving forward so as to ensure patient safety, provider satisfaction, and workflow efficiency. The survey was distributed by email to all nurses, pharmacists, and physicians of Porter Medical Center, totaling approximately 150 providers. After keeping the survey active for two weeks, we achieved a 29 percent (44 individuals) response rate. Many of the survey questions were measured on a 4-point Likert scale, or taken as a qualitative response.

The survey was comprised of seven sections. The first section collected information on demographics, personal background characteristics, and usage of the EMR components. First, we surveyed characteristics, such as: age, gender, and tenure in healthcare. Respondents ranged from having 2 to 43 years of experience in healthcare, with a median of 15 years. We also distinguished the role each respondent played in the delivery of care at Porter Hospital. Approximately two-thirds were nurses, one-quarter of respondents were physicians and a remaining 14 percent were involved with pharmacy or interns (Figure 7a). Most of the nurses represented in our survey worked predominantly in inpatient settings, while the opposite was true for physicians. On the whole, respondents reported to be medium to high-level technology users.

There are three primary components to the EMRs at Porter Medical center. First, the Meditech software is used in both inpatient and outpatient settings, and 61 percent of providers represented in the survey use Meditech. The second most often used system is the outpatient

software, L.S.S., which is used by 26 percent of providers. MEDHOST is used by 13 percent of providers represented in the survey (Figure 7b).
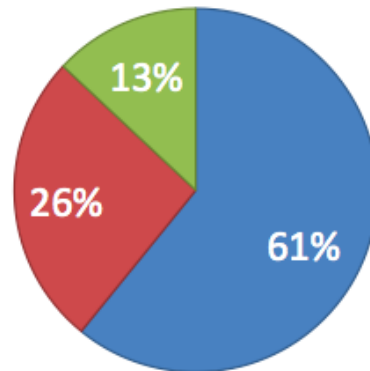
Figure 7a. Breakdown of respondents to EMR survey.
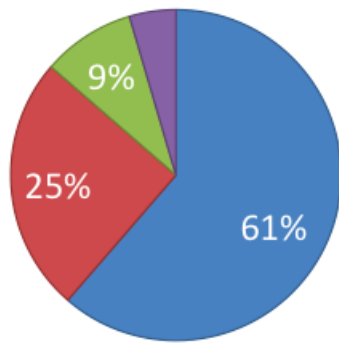
Figure 7b. Breakdown of EMRs.

The second section sought to identify changes in efficiency relative to a baseline prior to EMR implementation, as well as a more recent timeframe from the EMR implementation to current. We focus on the second time period, the 'new difference', as it informs us of the most recent trajectory of implementation (Table 1).

Table 1. Timeline.

Time on axis.

Although significant variation exists conditional on the type of provider, the overall average number of patients seen per day before EMR was approximately 12 patients/day, which dropped by about 2 patients/day for physicians and 1 patient/day for nurses at the time of initial implementation (Figure 8). Average daily patient visits have exceeded original levels for nurses

and are approaching original levels for physicians. These differences are point estimates, however we are encouraged that a larger sample would show statistical significance. Therefore, we understand these results as indicative not definitive.

**Figure 8.** Average number of patients seen per day.
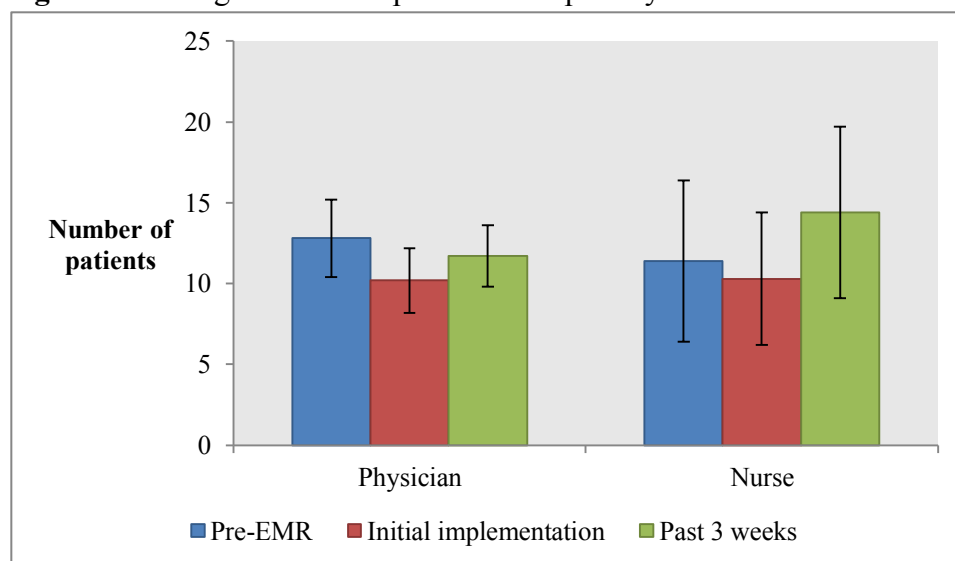
The same exercise was conducted for number of hours worked per day. We saw that, at baseline, physicians worked an average of about 10.5 hours per day whereas nurses worked approximately 9 hours per day. Both types of providers estimated an increase of about one hour each day at the time of EMR implementation (relative to baseline). Providers are working approximately the same number of hours currently, as during the time of EMR implementation (Figure 9).

Figure 9. Average hours worked per day.
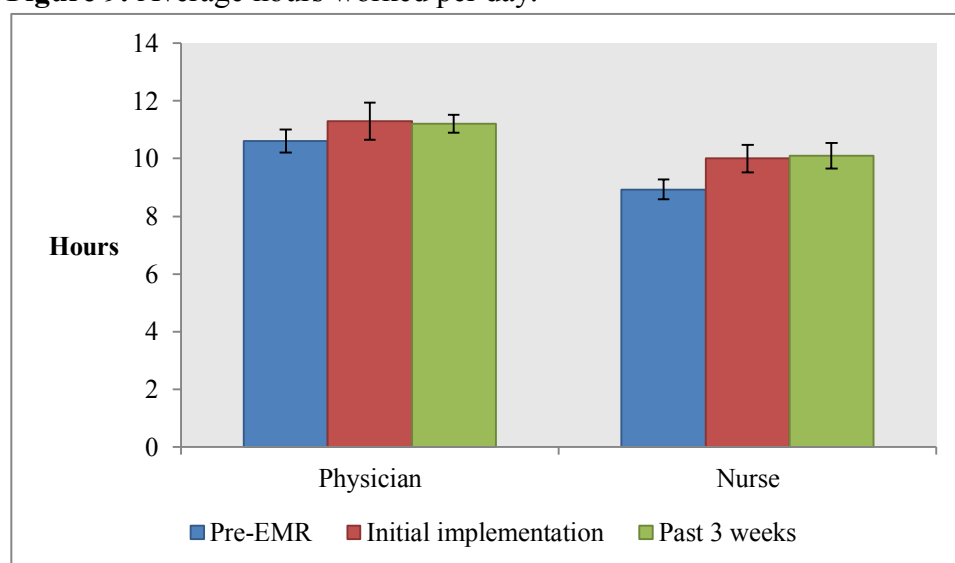
Lastly, we looked at the amount of time spent with each patient for physicians and nurses. We saw that physicians spent about 20 minutes per patient, whereas the mean number of minutes a nurse spent with each patient was 2 hours and 16 minutes[2]. Figure 10a indicates that physicians actually spent approximately 10 more minutes with each patient, whereas nurses spent about 30 minutes less with each patient at the time of EMR implementation (compared to baseline). Self-reported patient time has returned to baseline levels for physicians but not for nurses.

Figure 10a. Average time spent with each patient.
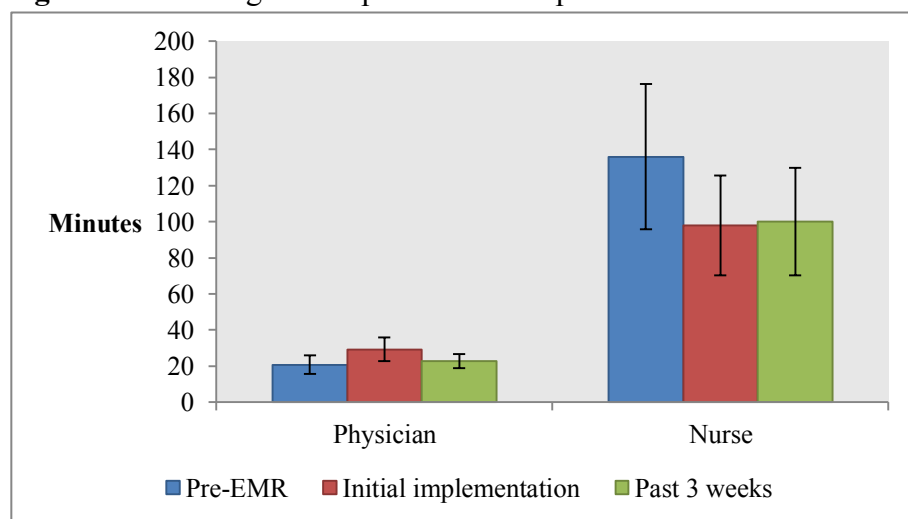
Even after removing nurses who spend more than 1 hour with each patient, the results still hold (Figure 10b).

Figure 10b. Average time spent with each patient, selecting out nurses who spent more than an hour with each patient.

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[2] It was noted in an interview with a stakeholder at Porter Medical Center that nurses from the labor and delivery department typically spend more than one hour with each patient during the process of labor, which is the reason for the greater average time nurses spent with each patient. To account for the weighting effect of providers who stated spending more than an hour with each patient, we conducted the same comparison after bounding the time spent with each patient to less than one hour.
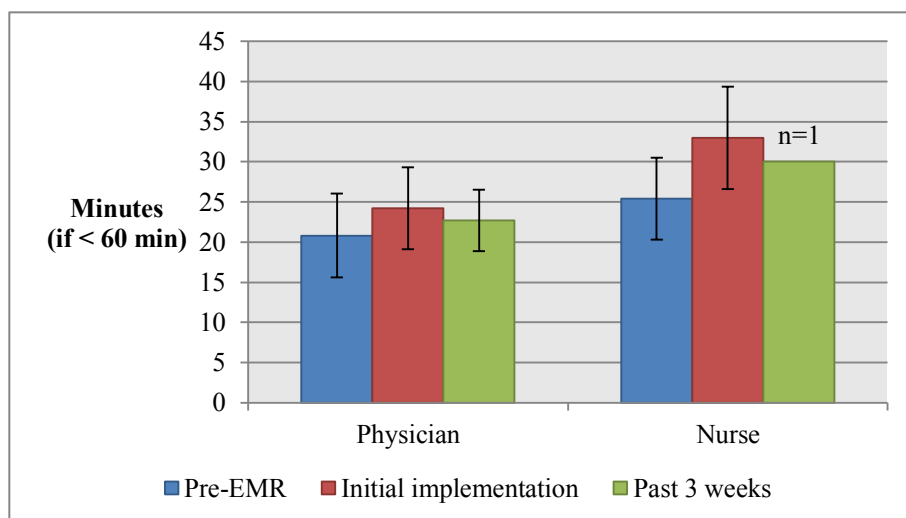
The third section asked about satisfaction with the system. The number of providers who were "Very Unsatisfied" decreased by 14 percentage points, and the fraction of providers "Satisfied" with EMRs increased by 7 percentage points. Approximately one third of the sample had an increase in satisfaction with the EMR system since the initial rollout. However, approximately 63 percent still remain unsatisfied or very unsatisfied (Figures 11).

Figure 11. Provider satisfaction with EMRs.
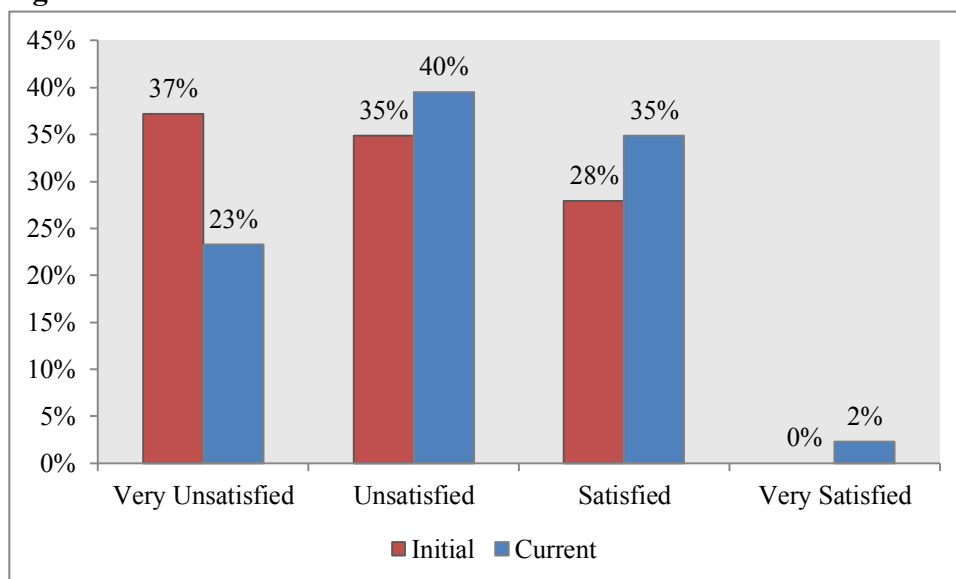
The fourth section of our survey asked about changes in safety, patient interaction, interaction with colleagues and ability to perform at the job for each EMR system: Meditech, LSS and MedHost. Our key intention was to separate the perceptions for the three distinct systems. We observe the fraction of people having some positive change in one of the four outcomes of interest, relative to the time of EMR rollout. The fraction of respondents changing their perception in a positive manner since EMR implementation was lowest for Meditech, at approximately 48 percent, while the fraction of respondents having a positive change was above

80 percent for LSS and MedHost. Efforts should be targeted at improving Meditech's perception among providers rather than the other two software systems (Table 2).

Table 2. EMR system comparison by fraction of total respondents seeing a positive change, for four key outcomes.

EMR System	Δ Patient safety	Δ Interaction with patient
Meditech	0.488 (0.079)	0.488 (0.079)
LSS	0.829 (0.060)	0.780 (0.065)
MedHost	0.878 (0.052)	0.854 (0.056)

EMR System	Δ Interaction with colleagues	Δ Ability to perform job
Meditech	0.415 (0.078)	0.439 (0.078)
LSS	0.805 (0.063)	0.805 (0.063)
MedHost	0.902 (0.047)	0.878 (0.052)

Standard errors in parentheses. N = 44 observations.

The fifth section compares the various areas of support offered during the implementation and gives ideas of which are most beneficial, as stated by providers. Ten percent of the survey respondents have negative perceptions of the CPOE hotline, while about 25 percent of respondents view it positively. However, approximately 30 percent of providers surveyed have not used the CPOE hotline. In contrast, only 2 percent find the newsletter to have a negative impact, and 26 percent view it favorably. About one-quarter of respondents do not rely on the newsletter for information. The teaching sessions seem to be the most helpful, with 34 percent viewing them favorably and only 5 percent viewing them unfavorably. We find the 41 percent who are "Neutral" and the 20 percent who "Have not used this resource" as a good number for individuals who have yet to benefit fully from this valuable resource (Figure 12). Moreover, targeted instruction and involvement in the decision making process are important. Respondents suggested training be "orderly and effective", as well as "specific to my area of work."

Figure 12. Perceptions of various support services offered since implementation.
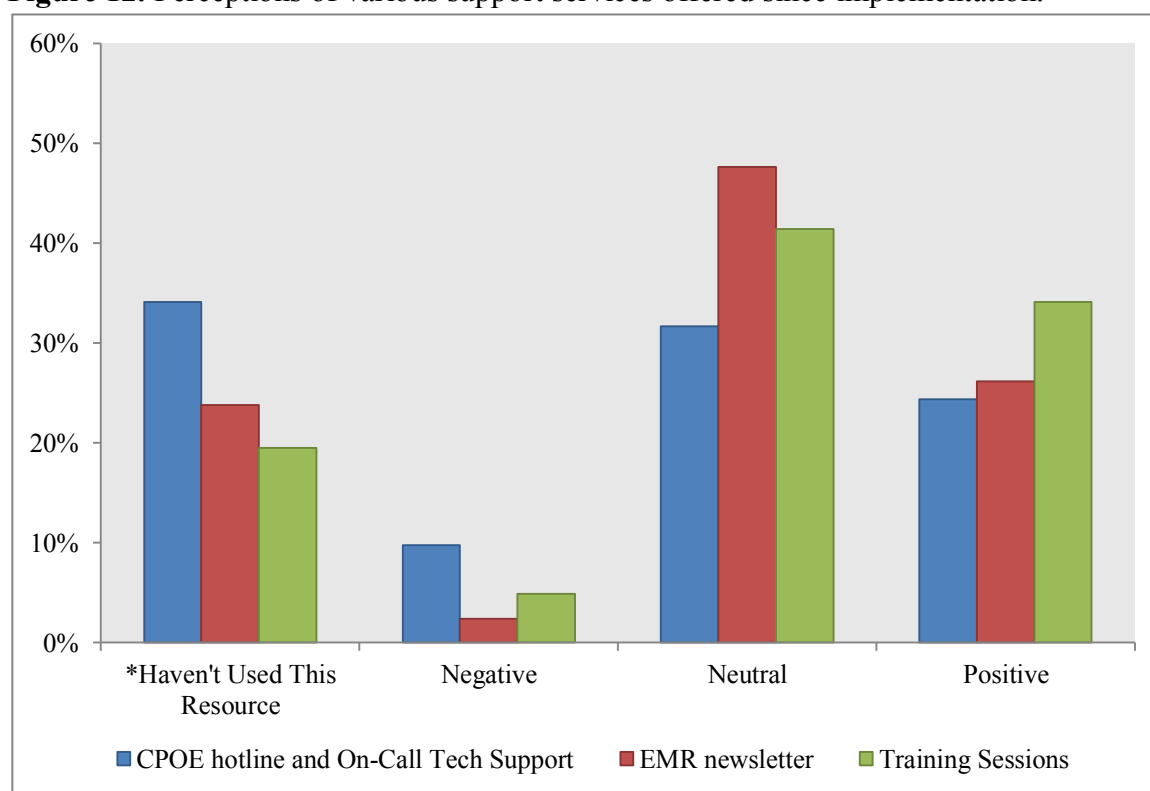
The sixth section asks about the degree to which a respondent is involved in using the EMR and participating in training sessions. The mean number of training hours attended was 4.2 hours in the past three months. Providers attending fewer than 2 hours of training in the past three months used paper order forms instead of CPOE due to safety concerns 3.7 times in the past two months, compared to those attending more than 2 hours of training who had an average of less than one instance of using a paper order form instead of CPOE (Figure 13, p<0.08).
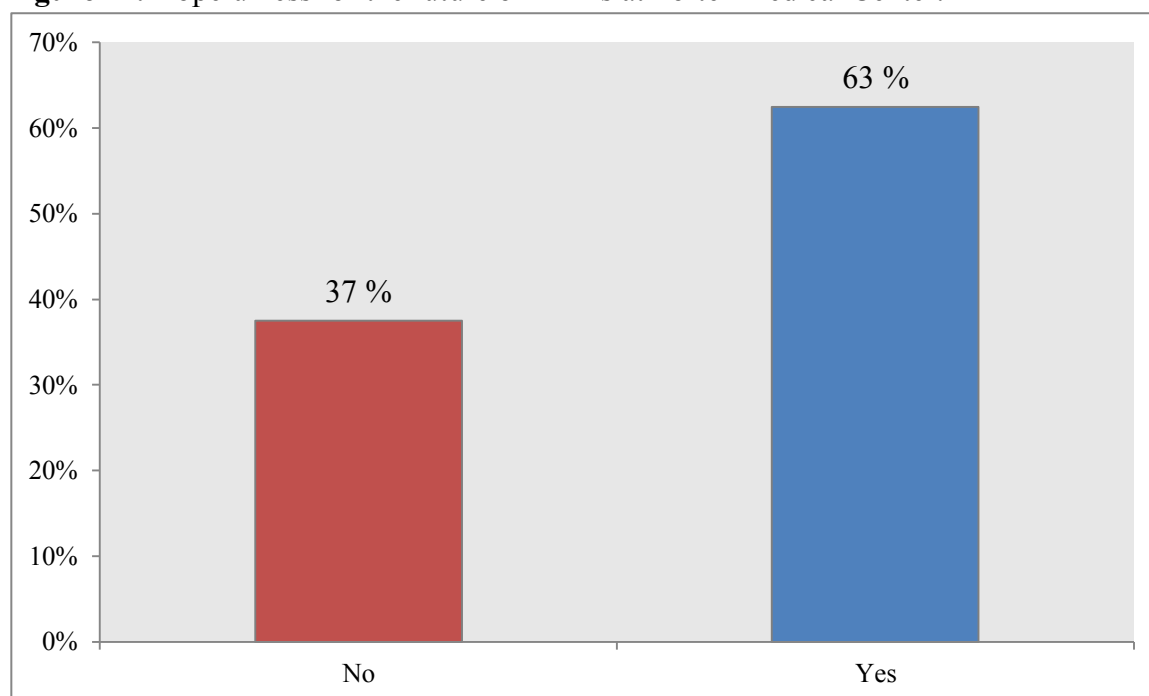
Figure 13. Number of paper orders used in place of CPOE by providers with varying involvement in training sessions.
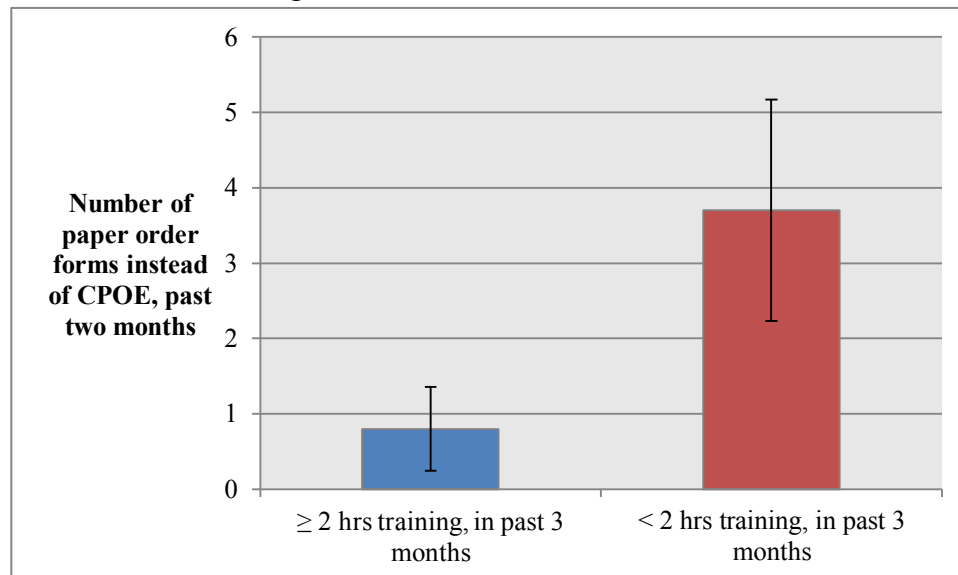
Despite the difficult start, over 60 percent of respondents from PMC are hopeful for the continued EMR system improvement (Figure 14).

Figure 14. Hopefulness for the future of EMRs at Porter Medical Center.

Qualitative Responses

Below please find some of the thoughtful and informative responses that helped shape our recommendations in the following section.

Question: "Are there any problem areas that you feel need to be addressed?"

CANNOT RELY ON MEDITECH/LSS SUPORT

- "I feel that our greatest challenge in implementing this system has been untimely or unsatisfactory response to issues from Meditech and LSS internal support."
- **"**Support from Meditech and LSS is not good."
- "We need better training from the company in regards to the capabilities of the software"
- "LSS and Meditech do not communicate well which has led to a lot of problems"

EVIDENCE FOR NEED OF DEPARTMENT CHAMPIONS

- "[Department] related issues need continued improvement to maximize efficiency and decrease frustration of nurses and providers."
- "The build team is overburdened."*
- "The Physician Super User team does not meet often enough and does not have sufficient power to implement the changes they deem necessary"*
- "Timely specific updates for specific units would be great"
- "It would also be helpful to survey the different units and categorize them by their units. This would really help us to focus on areas of concern based on specific units."

NEED MORE TARGETED TRAINING SESSIONS

- "Better coordination of training opportunities. Less sessions with more information."
- "The flow of my work, the management of my time is different than it has been in the past, perhaps some instruction or tips on workflow with EMR?"
- "We don't really know or understand the capabilities of this program (or set of programs). We, the users, are told different things by different people on different days about what it can or cannot do."

SHARE UPDATED PROJECT PLAN WITH ENTIRE ORGANIZATION

- "The hospital administration is still not transparent regarding the state of the program with the board and possibly the state."
- "The medical staff is kept in the dark regarding upcoming requirements that the hospital administration needs to fulfill in order to collect their Obama dollars until the last minute."
- "The user group for the [department] is small and too little input was and is sought from the administration on how things can be improved."

VISION OF CHANGE

- **"**Staff moral needs to be addressed and nurtured to help change the attitude."

Question: "What would entice you to attend training?"

- "Food", *this response appeared five times*
- **"**Make it useful. At the last provider meeting, I learned one new thing in the last 5 minutes. The rest was a waste of time."
- "If it would be specific to my area of work."
- "If the training would actually be orderly and effective."
- "Training when new updates are implemented with time slots that are available to those who work off shifts"
- "Trainers who know the system better"
- "Staff to cover me while I attend."
- "New knowledge"
- "Coming away with a better understanding"
- "Open bar, or pay bar if not pricey"

Question: "Please use this space for any other comments"

POSITIVE
- **"**We have many more efficiencies to be realized in this system and I'm confidant that we will realize those efficiencies with time."
- "It has been difficult but we are making progress"
- "Overall the attitude towards implementation is moving in the positive direction. However, many days are spent solving EHR problems vs. focusing on patient care."

NEGATIVE
- **"**I am not getting faster with this system. I have gone from being a very productive physician to not being that productive at all. No one can seem to tell me what I should be doing differently to regain my productivity."
- "Practicing medicine was more fun in the dark ages before computers."
- "Every physician on staff in the hospital is busting their ass to try to make this thing work and worrying about when some serious error is going to occur cause of it"
- "The system is very antiquated."
- "The program is so poorly designed that it raises no hope of ever functioning well."
- **"**And lastly the program itself just plain sucks. Steve Jobs would roll over in his grave if he saw this unmitigated POS."

*Edited responses to protect confidentiality

IV. RECOMMENDATIONS

Recommendation #1: Institute Department Champions to coordinate EMR implementation efforts in their department.

One recommendation we have moving forward is to reinvigorate the "department champion" program. During implementation, various individuals received extra training to aid in

the process by acting as "super users". The goal was to have them use their extra experience to help other users who were struggling to learn the new system. This idea was from Meditech, which claimed to have found it very beneficial in other implementation projects. However, the program has not been used to its full potential: "the Physician Super User team does not meet often enough and does not have sufficient power to implement the changes they deem necessary"*.

Developing "champions" in each department has been shown to be a crucial step in EMR implementation. One 724 bed non-profit hospital cited the department champions as being instrumental during their very successful implementation of an EMR system (Luchetski, 2010). The paper covers their entire process from the factors to consider when choosing champions to the best practices to utilize them efficiently.

→ *Department Champions gather the EMR problems in their department to convey to the proper resource*

We recommend Porter adopt a similar program. By developing department champions to be in charge of distinct units, a structure will be put in place to aid in both fixing bugs during implementation and for maintenance of the system in the future. As one respondent said, "[Department] related issues need continued improvement to maximize efficiency and decrease frustration of nurses and providers". The department champions would not need extensive additional training or need to know everything about EMR, their job would be to represent the department in its EMR efforts. This would include gathering the problems and concerns of clinicians in their department and conveying them to the correct person (technical support, build team, etc.). The goal is to institute a structure for each department to be able to work together to either resolve problems themselves or be able to more effectively convey their needs to the proper people through their department champions.

→ *Department Champions work with a Build Team to customize their department's EMR interface*

A key issue during the initial launch of EMR at Porter Hospital was the fact that nurses were made responsible for customizing and organizing the Meditech software, with no prior experience and little support or training. This resulted in an inefficient system that is very difficult, time consuming, and frustrating for physicians to use. In addition, from the survey and conversations with doctors and administrators at Porter Medical Center many people feel as though the build team is overburdened. Furthermore, nurses and physicians are currently relied on to do some of the coding customization themselves, which has proven to be an inefficient and frustrating process as they have little to no experience customizing software.

Therefore, we propose the formation of a "build team" that would include the two new experts of Meditech and LSS, in combination with existing members of the IT team. Responses to our survey support this structure, such as, "it would be helpful to survey the different units and categorize them by their units. This would really help us to focus on areas of concern based on specific units".

Further support from this recommendation comes from the Kellermann and Jones (2012) report mentioned above in the empirical research section. The study found that some of the most successful EMR implementations have occurred with active involvement of clinicians. Therefore, we feel that creating partnerships between clinician department champions and the IT build team will get clinicians more involved and increase the success of EMR at PMC.

The IT build team would develop a schedule for the next year and dedicate 2 to 3 weeks solely to one department of the hospital. During these weeks, the IT Team would meet with the department champions to gather the changes necessary in that department. The department champions would come to meetings with an agenda of problems to be solved and ideas for how the software should look and be customized that is representative of the entire department. The clinicians could explain the specific needs of their department, and the IT team could work to implement these changes with their knowledge of the capabilities and nuances of the software. Therefore, this should improve the efficiency of implementation, as the clinicians would be deciding the changes they need and the IT professionals would do the actual coding. Our recommendation would be to begin with the birthing center, since this department has experienced the most difficulty with EMR. After the first round of customizing sessions with each department, the IT team would restart the rotation. However, as months and years progress, these meetings will become shorter and less necessary, until the maintenance stage is reached and the meetings will serve as small updates and improvements to the system.

Overall utilizing Department Champions would accomplish the following goals:

- Reduce reliance on Meditech for support by working in units to solve problems
- Take advantage of the two new hires, experts in Meditech and LSS in the build team
- Integrate the knowledge of the end users, namely nurses and doctors, without requiring them to do any coding themselves
- Specialize the software for each separate department of the hospital to increase efficiency and satisfaction of the users

→ *Incentivizing individuals to be Department Champions*

Due to the fact that clinicians who act as Department Champions will need to put in extra time gathering the EMR problems of their department and conveying them to the Build Team, incentivizing individuals to volunteer may be a problem. To minimize the amount of extra work created for each department champion, we recommend organizing the hospital into as small of departments as possible. This will make each Department Champion responsible for the views of fewer clinicians, as well as their time with the build team will occur less often and be more specific for their department. However, Department Champions may have to receive some form of compensation (pay, extra time off, etc.) if enough individuals do not volunteer.

Recommendation #2: Hold lunch training sessions for individual departments at a time.

Another recommendation is to hold more specialized training sessions. The current training sessions have been met with modest success. We believe the training would be more effective if each session was focused on an individual department, rather than the EMR system in

general. Survey responses cite the need for "better coordination of training opportunities", "less sessions with more information" and training "specific to my area of work". As one individual said, "Make it useful. At the last provider meeting, I learned one new thing in the last 5 minutes. The rest was a waste of time".

Holding training specific for each department at a time would help attract clinicians to attend because they would know the entire time would be spent on their specific issues. A system could be put into place where everyone submits problems and questions they have to their department champion, who could forward them to the IT staff before the training session so the training session could be on the department's specific sessions. This would entice clinicians to attend because they would be assured all material covered would pertain to their interactions with the system.

Recommendation #3: Publish an updated Project Plan to share with the entire organization.

Our review of the literature in best practices and through our interviews suggests that it is important to be transparent in the project plan. Keeping physicians, nurses, and pharmacists informed about the current status of the implementation makes them feel more involved and less like the project has been forced upon them against their will. Respondents to the survey said, "The hospital administration is still not transparent regarding the state of the program" and "the medical staff is kept in the dark".

The weekly newsletters have not had a significant impact, as providers still feel disconnected with the project. From our survey, 47% of respondents said the newsletter has had only a neutral impact on making them feel connected to the project, and 40% still feel as though they are not involved with the decision making of the project. Furthermore, 23% said they do not even read the newsletters at all.

We recommend moving forward to institute a monthly bulletin that is oriented more broadly on the project as a whole. Information to include would be any changes to tasks that were accomplished that month, and then the goals and plans for the next month. Keeping everyone involved informed about the current status about the project and the plan moving forward will make everyone feel more connected to what is going on, as well as create positive moral about the progress that is being made.

A key component about the project plan will also be to create and distribute a plan for how PMC will achieve meaningful use guidelines by 2015. As mentioned in the empirical research section, HIMSS Analytics (2013) has reported that only 1.9% of U.S. hospitals have achieved all seven stages of meaningful use guidelines. Furthermore, from the qualitative responses of our survey, we find that some clinicians have expressed the need for increased clarity on what the meaningful use guidelines are and how PMC plans to reach them. This is very important because the financial subsidies received once meaningful use is reached will offer a significant return on the initial investment for the project. Therefore, we recommend that the IT team develop a two-year step-by-step plan for achieving meaningful use. We also recommend that the IT team consider assigning someone to monitor that these steps are achieved, and if not actively revise the plan.

Recommendation #4: Improve user outlook about the EMR project.

Lastly, we recommend making a conscious effort to create a "vision of change". A vision of change is about creating a "can do" attitude about the adoption of EMR. Everyone knows that the process has not gone as smoothly as initially anticipated, however, things are getting better. Right not it appears as though some individuals are still approaching the situation with a negative outlook, focusing on problems in the past rather than looking towards the future. Overall, however, the project is making positive progress. A majority of respondents to the survey (53%) are hopeful for the future of EMR. We believe it is important to share these results with everyone involved to show that the problems in the past are being addressed and progress is being made towards positive results. As one respondent said, "overall the attitude towards implementation is moving in the positive direction". That positive momentum needs to be continued to get everyone on board and believing the system can work.

V. APPENDIX

LIST OF CONTACTS (ALPHABETICAL)

Ms. Kate Boyd, Director of Clinical Transformation at Valley Health (Winchester, VA)

Professor Jessica Holmes, member of Porter Medical Center Board and professor at Middlebury College

Dr. Charles Jung, Administrator and Chief of Orthopedics at Group Health (Seattle, WA)

Dr. Mike Kiernan, Porter Medical Center Emergency Department physician and President of the Porter Medical Staff

Dr. Steven Leffler, Chief Medical Officer at Fletcher Allen Hospital (Burlington, VT)

Kate Lombard, Chief Nursing Officer at PMC

Mr. Nick Lovejoy, Data Management / Analyst at Blueprint for Health (Burlington, VT)

Dr. Sal Morana, COO at Porter Medical Center

Dr. Bob Sideli, CIO of Columbia University Medical Center and Associate Professor in the Department of Biomedical Informatics at Columbia University (New York, NY)

Dr. Ben Rosenberg, Orthopedic Surgeon at Porter Medical Center

David Frazier

REFERENCES

Atwal, PM. (Nov 2011) "Providing quality health care for patients: Dr. Chris Tashjian's Perspective on EHRs and Meaningful Use." *ONC Office of Communications*. Accessed from: <http://www.healthit.gov/buzz-blog/ehr-case-studies/providing-quality-health-care/>
The article displays an interview with a family medicine doctor, Dr. Chris Tashjian, practicing in rural Wisconsin "where there are more cows than people" (quote from Tashjian). He implemented an EMR one year prior to the interview and has had much success. First, one meaningful use requirement that improves patient care is a visit-summary handed to the patient when they leave. This is something that includes medication instructions and instructions for follow-up. Second, he feels that patients are safer because of CPOE. This is the exact opposite of what the Porter physicians are expressing. Dr. Tashjian gives a final anecdote about filling a patient's prescription from Estonia using his iPad. This anecdote draws skepticism from me on the basis of medical record confidentiality had his iPad been stolen or compromised in terms of secure transfer of information.

Campbell, E. M., Sittig, D. F., Ash, J. S., Guappone, K. P., & Dykstra, R. H. (Oct 2006) "Types of unintended consequences related to computerized provider order entry." *Journal of the American Medical Informatics Association*. 13(5): 547-556.
This article lays out the most frequent reasons that CPOE goes awry. They include: greater clinician workflow, continuing system demands / queues with the vendor, persistence of paper process during implementation, alterations in communication practices, negative emotions, novel errors, organizational changes and overdependence on technology. A number of these were self-reported by respondents to our survey, and we hope to identify these concerns in our presentation of results (both quantitative and qualitative). This is a great contribution to the literature on EMRs in that it provides practical recommendations about aspects to be aware of during implementation.

Center for Medicare and Medicaid Services. (May 2005) "National health accounts." Accessed from: < www.cms.hhs.gov/statistics/nhe >
National accounting projections for savings from health information technology, Figure 3.

"Certificates of Needs: State Health Laws and Programs." Accessed from: <http://www.ncsl.org/issues-research/health/con-certificate-of-need-state-laws.aspx>.
Explains Certificates of Needs (CONs): programs to manage costs in hospitals and to plan expansions, new services being provided, and construction. It explains the history of CONs and also highlights some of the pros and cons. Pros: limits health care spending, promotes competition, improved quality of care, and lower costs for treatment services. Cons: effectiveness of cost control is unclear, reduce price competition and keep prices high, not well administered, and grants skewed by political influence. This article also highlights some alternatives to CONs.

Clark, Andrea. (Mar 2013) "Code power! Amplify your ICD10 efforts with data analytics from health information management." *ICD10 Monitor*. Accessed online: < http://www.icd10monitor.com/index.php?option=com_content&view=article&id=846:code-

power-amplify-your-icd-10-efforts-with-data-analytics-for-him&catid=48:icd10-enews&Itemid=106 >

The first is a somewhat technical take on the ICD10 transition written by Ms. Andrea Clark of ICD10 Monitor. This source seems pretty informative. Her article mentions the process information management teams should map ICD10 codes onto the existing ICD9 base in order to save time. The key factor is "coding consistency and continuity", as anticipated.

Crane (Jun 2008), J. "The adoption of electronic medical record technology in order to prevent medical errors: a matter for American public policy". Policy studies. Vol. 29: 2.
This article argues that EMR would be a good way to decrease the number of medical errors in the U.S. because they are very costly and avoidable. EMRs can result in improved communication between clinicians and easier access to patient medical history. Discussions with physicians have also confirmed this since they are able to access patient history from anywhere, from work, from their phones, and from their homes. Additionally, EMRs provide clinicians with increased clarity of any patient allergies, current medications that could create adverse drug reactions, and information about past visits and test results that avoids expensive and unnecessary duplication of tests.

Creswell, J. (Feb 2013) "A digital shift on health data swells profits in an industry." *New* York Times. Accessed from: < http://www.nytimes.com/2013/02/20/business/a-digital-shift-on-health-data-swells-profits.html?pagewanted=all&_r=0 >.
This article mentions the prominence of Allscripts in the industry for digital medical informatics. There is important mention of the political backing, namely lobbying (which is not called such) between the industry and healthcare leaders, in stoking this industry. Economies of scale and first mover advantage come to mind for Allscripts and Epic, two companies which generally cater to larger hospitals. Their technology, software and implementation rigor may be superior, as well. Dr. Sideli shared the article with us on February 19th.

Encinosa, W. E., and Bae, J. (2011). "Health information technology and its effects on hospital costs, outcomes, and patient safety." *Inquiry*, *48*(4): 288-303.
Empirical study researching the effects of EMR implementation on reduction of patient safety events, hospital-acquired conditions (HACs), hospital deaths, readmissions rates, and spending. Results: like many other empirical results, the authors found that EMR does not have a statistically significant impact on the reduction of patient safety events. However, IT could have an impact on patient recovery. Found that EMR systems can reduce excess costs of HACs by 16%, decrease readmissions due to HACs by 39% and reduce excess deaths by 34%. On a national level, EMR adoption could save 4.6% of all surgery deaths per year and save $2.8 billion per year in adult surgeries. Limitations of article is that it doesn't research drug-related errors, diagnostic errors, and errors in choice of therapy, I should try and find a study that focuses on these.

Encinosa, W.E. and Bernard, D.M. (2005) "Hospital finances and patient safety outcomes." Inquiry. 42(1): 60-72.
This study finds that declining hospital profit margins are associated with an increase in adverse patient safety events. There has been greater financial pressure on hospitals especially from the

impetus to undertake transformations to electronic data collection. This highlights the patient safety questions from the survey as pertinent and paramount to consider. We find that Meditech, more than LSS and MedHost, is associated with less optimism about the prospects for patient safety.

Forbes (Jan 2013). "Less than two percent of hospitals are paperless as Medicare penalties loom." Accessed from: <http://www.forbes.com/sites/brucejapsen/2013/01/16/less-than-two-percent-of-hospitals-are-paperless-as-medicare-penalties-loom/>
Article discussed the slow progress on EMR implementation nationwide despite federal incentives. Key stat: only 1.8% of all hospitals have completed the seven stages of meaningful use. However, 176,000 healthcare providers have received over $9 billion in government subsidies for achieving meaningful use.

Green Mountain Care Board. "Certificate of Need". Accessed from: <http://gmcboard.vermont.gov/certificateofneed>
Explains that CONs will as of January, 2013 be submitted to the Green Mountain Care Board rather than the Commissioner of the Department of Financial Regulation. The webpage also explains that in order to apply for a CON, there must be a letter of intent and a health resource allocation plan.

Grubb, Laura K. (April 4, 2013) "Lessons from Vermont's Health Care Reform." New England Journal of Medicine. 368(14): 1276-7.
This is a fantastic article! The best part is that it speaks highly of Vermont as one of the states showing the most successful health reform initiatives. This complements the theme of lectures we have had in the last few weeks from Dr. Leffler, Mr. Slusky and Mr. Daily. The first theme of the article is that 'local coordination' (i.e. PCMH model) works for health reform. Second, the multiple areas of health services over which the Green Mountain Care Board oversees is highlighted as a positive. The two ACOs are explained: Accountable Care Coalition (physician groups) and OneCare (hospitals, physician groups). Lastly, it is mentioned how Vermont won't have much to change in setting up a health insurance exchange given how generous the state already is with subsidizing access to health care. The article also considers Gov. Shumlin's single-payer legislation and financing outlooks.

Hancock, J. "Health Technology's 'Essential Critic' Warns of Medical Mistakes". The Philadelphia Inquirer. Feb. 18, 2013.
This articles argues that EMR implementation in hospitals is very dangerous for patients and hospitals are incentivized to implement them because of government subsidies. However, the government does not require them to report mistakes that lead to patient harm and death.

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R., and Taylor, R. (2005). "Can electronic medical record systems transform health care? Potential health benefits, savings, and costs." *Health Affairs*, *24*(5): 1103-1117.
This article cites the projected efficiency and safety gains from interoperable EMR systems. The key is that these systems are interoperable. Comparisons are drawn between IT revolutions in other industries than health care delivery. The paper concludes that positive effects could be confounded for care of chronic disease, for which efficiency gains from EMR use would provide

a positive externality and greater social benefit than that which is realized by the individual patient.

HIMSS Analytics. (2013) "Electronic Medical Record Adoption" Accessed from: <http://www.himssanalytics.org/emram/>
Great website with up-to-date stats on the progress of EMR. Key facts: 1.9% of all U.S. hospitals have achieved all 7 stages of meaningful use. 20% of U.S. hospitals are in the final 3 stages of meaningful use.

"History of the Cooperative." Accessed from: <http://www.ghc.org/about_gh/co-op_overview/history.jhtml>
Group health has a super efficient EMR system. They even have a mobile app so members of Group Health can schedule appointments, email doctors, refill prescriptions, check lab and test results, review after-visit summaries, and more. Also, they have same-day appointments for primary care, self-schedule specialty care appointments, and group visits.

Japsen, B. (Jan 2013) "Less than two percent of hospitals are paperless as Medicare penalties loom." *Forbes, Pharma and Healthcare*. Accessed from: < http://www.forbes.com/sites/brucejapsen/2013/01/16/less-than-two-percent-of-hospitals-are-paperless-as-medicare-penalties-loom/ >
This article cites data from the Health Information and Management Systems Society (HIMSS) showing that only 1.8 percent of hospitals have complete electronic medical record systems. Many have incomplete, or pre-stage 7, implementations. The first seven stages of 'meaningful use' must be met by 2015 in order for hospitals to receive funds from HITECH legislation passed in 2009. This is in the wake of Kellermann and Jones (2013) which delves into the reasons for 'sluggish' health IT adoption.

Kellermann A.L, and Jones, S.S. (Jan 2013) "What it will take to achieve the as-yet-unfulfilled promises of health information technology." *Health Affairs*. 32(1): 63-68. Accessed from: < http://content.healthaffairs.org/content/32/1/63.abstract >
This article follows up on the projections from a 2005 RAND study that health information technology would be taken up quickly and result in sizeable annual savings. These projections have not materialized. The dearth in health IT growth is from implementation of systems which do not communicate among one another (i.e. interoperability), are themselves built on archaic software technology and lack patient-control of health data. The authors also find the shift to ACOs and Medicare's payment reform efforts to fuel better health IT growth in the future.

Kniffin F, Morana S, Lombard K and Cotner J [email distribution newsletter]. (Mar 2013) "EMR weekly update." Porter Medical Center. Issues 2-6.

Kimbell, S. (2012) "Statement of Decision". State of Vermont Department of Financial Regulation. Docket No. 12 – 017 – H.
Statement describing Porter's Hospital implementation of EMR and its request for an increased budget proposal due to an overhead in costs of 63%. Useful information about the legal and financial process for Porter Hospital's implementation of EMR and the problems and setbacks in reports and financial planning.

Landro, L. (Mar 2009) "Online Records Get Patients Involved in Care". Accessed from: <http://online.wsj.com/article/SB123733342732563543.html>
Discusses the implementation of EMR with Kaiser Permanente and Group Health. Explains that online records leads to improved quality care and also put medical decision-making and more information in the hands of patients since websites easy-to-understand medical terms. One doctor explained that even with government financial incentives buying the system would be too costly.

Larsen, K. [presentation]. (Apr 2013) "Quality Measurement and Improvement with Health IT" in Health System Innovation, Practice and Policy: The Long View." *Blueprint for Health Conference*, April 17, 2013.
This was the presentation that we attended during the Blueprint for Health Annual Conference in mid-April 2013. It was pretty interesting and (overall) spoke to how well Vermont is doing in terms of advancing health IT. He mentioned that a National Library of Medicine website is already publicly available, and searchable, for finding the tree of ICD-10 codes for "broken leg." This would be very helpful for Porter physicians and build teams creating dictionaries and/or interfacing with billing.

Linz, A. et al. (May 2008) "Public perceptions regarding the impact of electronic medical records on health care quality and medical errors". Journal of Controversial Medical Claims 15. 2. 10-15. Accessed from: <http://search.proquest.com.ezproxy.middlebury.edu/docview/213833773>
This research study includes perspectives on EMR effects on medical errors from four different perspectives: public, medicine, computers, and legal. It tested the different effects of age, education, profession, and personal computer literacy on reactions to EMR. The results found that age ranges, annual family income, and personal assessments of health status had no significant influence on perceptions of EMR on improving the quality of health care. This is interesting because the previous article found that age was an important factor. However, this article found that education levels had a significant effect on the perception of EMR improving the health care quality and the likelihood that EMR can eliminate medical errors. The study also found that one in four respondents believe that at the present moment, EMRs do not improve quality of medical care and virtually eliminate medical errors. I think this will be important to consider when analyzing the results of our survey with patients.

Loes, J., et al. [presentation slides] (2009) "Staff perception survey before and after Genesis[10] EHR/CPOE implementation [at Trinity Health]" in Agency for Helathcare Research and Quality (AHRQ) Annual Conference. Accessed from: < http://www.ahrq.gov/news/events/conference/2009/loes/index.html >.
The authors presented a three-wave survey they conducted of the implementation of CPOE with Genesis EMR system. This was given at the AHRQ annual conference in 2009. A key finding was a difference in response from physicians than mid-level providers.

Lynn, A. (Jan 2013) "Editorial: Porter Hospital's miscalculations." *Addison Independent*. Accessed from: < https://www.addisonindependent.com/201301editorial-porter-hospitals-miscalculations >

This is an editorial in the Addison Independent reflecting on the McCright (2013) article about the EMR implementation at Porter Medical Center. Angelo Lynn does not cite mismanagement of the EMR implementation, but rather too low of an initial cost estimate, which led to the cost-overrun. In all, the author comments on how such a cost overrun with "complex IT installations" is near ubiquitous and congratulates Porter, and the DFR, for allowing the project to continue.

Mandl, KD and Kohane, IS. (Apr 2008) "Tectonic shifts in the health information economy." NEJM. 358(16): 1732-1737.
The article touches upon the interest of corporations taking part in the transformation in care delivery. Specifically, computer platforms are designed so that patients can access and manage their health information. One key functionality is that patients can authorize distribution of their health records to third parties in addition to their medical home. A second important aspect is the availability of this data for clinical research, which also brings confidentiality concerns. The article draws on the proper way to securely manage this increased "data liquidity." It is notable that the article mentions NY-Presbyterian Hospital as one of the first organizations to make data available by PCHR.

McCarthy, D. Mueller, K., Tillmann, I. (Jul 2009) "Group Health Cooperative: Reinventing Primary Care by Connecting Patients with a Medical Home". The Commonwealth Fund.
Explains how advanced information technology implemented at Group Health is its key strategy for improving communication with patients and their physicians, engaging them in evidence-based care, and reducing fragmentation. GHC has invested more than $25 million since 2003 in its electronic health record system. By 2009, 50% of Group Health patients were using the online system. 94% were satisfied with the system. Mostly successful implementation. Few negatives: some physicians reported increased workload and decreased work-life satisfaction.

McCright, J. (Jan 2013) "Porter struggles with electronic records system, sees big cost overrun." *Addison Independent*. Accessed from: < https://www.addisonindependent.com/?q=node/14893 >
They news article gives a great cursory review of the 63 percent overrun of the initial budgeted cost for the implementation of an EMR system at Porter Medical Center. Our project focuses what has happened subsequent to the amendment and increase in budget for the EMR implementation, and our report is forward-looking.

Muir Gray. (Feb 2012) "Value: operations research and the new health care paradigm." *Operations Research for Health Care*. 1: 20-21.
This article by Muir Gray of the British National Health Service provides a broad survey of international health care. It is published in the first volume of a fairly new journal: Operations Research in Health Care. Underdeveloped nations are in a situation where more medical care is better, while the developed countries have had 'revolutions of care' which emphasize 'evidence' (1970s), then 'quality' (early 2000s) and most recently 'value' (present). He highlights the role of operations research (OR) in creating value in health care.

Natale, Carl. (Mar 18, 2013) "ICD-101: Add some drama to your ICD-10 training." *HealthcareIT News, ICD10 Watch*. Accessed online: <http://www.icd10watch.com/blog/icd-101-add-some-drama-your-icd-10-training >

The second article is by Carl Natale from HealthcareIT News and mentions three specialty-specific, comical means to train providers on ICD10 coding. For example, one of the resources shows how to code each diagnosis from an episode of the TV show House. This article may be helpful for specialists (gastrointestinal, infectious disease) and internists (diabetes).

Nussbaum, A. (Mar 2013) "Cerner, McKesson lead alliance to let doctors share data." Bloomberg. Accessed from: <http://www.bloomberg.com/news/2013-03-04/cerner-mckesson-lead-alliance-to-let-doctors-share-data.html>
Explains that 5 of the major EMR software companies are forming a nonprofit dedicated to establishing a system for being able to transfer data between the systems. Also mentions that the Obama administration is considering making new standards so different EMRs can communicate with each other.

O'Neill, L. et al. (Jun 2009) "Physician characteristics associated with early adoption of electronic medical records in smaller group practices". International Journal of Healthcare Information Systems and Informatics. Access from: <http://search.proquest.com.ezproxy.middlebury.edu/docview/223589784>
Surveyed 482 physicians in Kentucky about implementation of EMR in their practices. The results found that young physicians were significantly more likely to use EMR. For physicians in there 30s, they were 45% more likely to have implemented EMR compared to 15% of physicians about the age of 60. I found this interesting because it relates to the age correlation that Dr. Jung mentioned to us when we interviewed him and how older doctors tend to be the most frustrated with EMR. This is why we have asked questions in our survey about age and the amount of other new technologies that doctors use in their daily lives including cell phones, texting, etc. I think it might be important to consider if it would be useful for Porter to have training sessions based on age or self-assed comfort with electronic technologies. For example, if young people are quick to learn, perhaps they will not need a large training session. But it may be important to identify people with more trouble, and maybe even the older group of doctors, to have their own training session that could be more elaborate so they are at the same level as the young doctors.

Palen, T. et al. (Nov 2012). "Association of online patient access to clinicians and medical records with use of clinical services." *American Medical Association*. JAMA V: 308. No. 19.
This article finds that with access to online medical records, there is actually an increase in telephone calls and medical services. This is because patients have more information, find it quicker, cheaper, and easier to contact their clinicians, and because they become more concerned with their health. Overall, the study estimated that in a health system with 100,000 patient members, a switch to online clinical record access for patients increases clinical visits by 50,000 and telephone calls by 30,000.

Porter, M. (Dec 2010) "What is value in health care?" *NEJM*. 363(26): 2477-2481.
This article published in the New England Journal of Medicine touches upon the focus on improving patient health outcomes with proper measurement and benefits of 'big data.' This was theme was presented in a similar manner by Dr. Larsen from the Office of the National Coordinator on Health Information Technology at the annual Blueprint for Health Conference, April 17, 2013. The key point is that outcome measurements should be "patient centered" and

cover the "full cycle of care." This brings to bear the importance of managed transfer and documentation across a multitude of providers from whom patients seek care. Developing a working EMR infrastructure does not stop at the individual hospital, and benefits will only be realized once the communicability between multiple systems (e.g. between Meditech, Epic and other vendors) is resolved.

Rauber, C. (Apr 2011) "CIO Ben Williams departs Catholic Healthcare West." San Francisco Business Times. Accessed from: < http://www.bizjournals.com/sanfrancisco/print-edition/2011/04/15/cio-ben-williams-departs-chw.html >
This is one example of a large, tertiary-care hospital firing their CIO subsequent to a failed Meditech EMR implementation. In all, we congratulate Porter for undertaking such a large investment in hopes to improve quality and efficiency of care in line with national health reforms.

Reddy, V. (Feb 2013) "A digital shift on health data swells profits in an industry".
This talks about EMR companies power over government and new policies that are increasing implementation of EMR in hospitals and creating booming business for them.

Reid, R. et. al. (May 2010) "The Group Health Medical Home at Year Two: Cost Savings, Higher Patient Satisfaction, and Less Burnout for Providers". Health Affairs.
Article focused mostly on the medical home model at Group Health and had a bit of of information on the benefits to EMR. Group Health's main strategy for engaging patients is through the use of EMR, adding continuity and improving access. Argued that EMR promotes transparency, communication, and coordination

Shurtz I. (Mar 2013) "The impact of medical errors on physician behavior: Evidence from malpractice litigation." *Journal of Health Economics.* 32: 331-340.
This article identifies a causal link between medical errors that involve malpractice litigation and treatment patterns. The outcome is specifically C-section rates for obstetricians, for which they find a 4 percent increase subsequent to medical errors even four years hence. There is little spillover effect: changes in C-section rates are relevant to the obstetrician and do not translate to more C-sections hospital-wide. Furthermore, the authors Currie and MacLeod (2008) explain the sensitivity of treatment patterns to medical errors for obstetricians in their article published in Quarterly Journal of Economics. This could underpin the necessity of the paper process for providers in this specialty, which is why labor and delivery has had more opposition than elsewhere the CPOE (as mentioned at the Medical Staff meeting in February 2013 at Porter Medical Center).

Valdes, I., Kibbe, D., Kunik, M. and Petersen, L. (2004) "Barriers to proliferation of electronic medical records." 12: 3-9.
This article addresses the adoption of EMR among family practice offices in the U.S. in a 2003 cross-section. The authors find many different types of EMR (fragmentation) and cost of implementing EMR systems to impede adoption. The solution they propose is open source software (FOSS). We could integrate this into an extension of not just Porter's implementation but critical-access hospital EMR adoption in general.

Vermont Department of Financial Regulation (DFR). (Feb 2010) "Certificate of Need from Porter
   Medical Center." Accessed from: < http://www.dfr.vermont.gov/con-poc/porter-medical-center-
   1 >
   Original filing for proposed capital expenditure of 4.3M in EMR system that should produce
   long-term cost savings, increase efficiency and quality of care. This was approved by the DFR in
   June, 2010.

Vermont Department of Financial Regulation (DFR). (Dec 2012) "Amendment to Certificate of
   Need from Porter Medical Center". Friday, December 14, 2012. Accessed from: <
   http://www.dfr.vermont.gov/conpoc/porter-hospital-material-change-hisemr-project >
   Amendment to the original CON for up to 7.1M dollars until an unspecified date of project
   completion.

   Vermont Information Technology Leaders (VITL). Accessed through: <http://www.vitl.net/>
   Non-profit organization that assists Vermont health providers with adopting and using health
   information technology to improve patient care. Mission: to collaborate with all stakeholders to
   expand the use of secure health information technology to improve the quality and efficiency of
   Vermont's health care system. Vision: a transformed health care system where health
   information is secure and readily available when people need it, positioning Vermont as a
   national example of high quality, cost effective care.

   Vermont Information Technology Leaders (VITL) (Jan 2013). "2012 Annual Report." Accessed
   from: <http://www.leg.state.vt.us/reports/2013ExternalReports/286138.pdf>
   Great report with a lot of information and stats about EMR adoptions rates in Vermont, progress
   over the past few years, and outlook of EMR in Vermont in the future. Includes many case
   studies of healthcare providers in Vermont and the effect of EMR.

Vermont Information Technology Leaders (VITL). (2012) "Case studies: Middlebury Area Health
   Care Providers Getting Connected, with Help from VITL"
   Article writing during start of implementation at Porter. Talks about the benefits for Porter for
   implementing EMR. VITL receives funding from both the state and federal government to carry
   out mission. Priscilla Phelps, on of VITL's implemenation specialists, was spending 2 to 3 days a
   week working with Porter's team on the project. VITL provided services including: mapping out
   workflow processes and determining where interactions between the hospital and practices take
   place, developing detailed training plans, and documenting computer hardware requirements.
   Perhaps it would be good to contact Priscilla Phelps to interview.

Vermont Information Technology Leaders (VITL). (Aug 2011) "First Vermont Practice Achieves
   Meaningful Use" *Middlebury Family Health.*
   This article talks about how VITL assisted the implementation of EMR at PMC. Quote from Dr.
   Cochran: "Addison County is well on the way to becoming one of the most connected
   communities in Vermont for medical records...patients in the Middlebury area will experience
   better health care because of the increased use of health information technology, everything
   from smoother check-in at the front desk to greater information sharing among authorized
   providers, which will result in fewer duplicated tests and quicker diagnoses of medical
   problems."

Vermont Information Technology Leaders (VITL). (Oct 2010) "Vermont Health Information Technology Plan (VHITP)." 4th ed. Accessed from: < http://hcr.vermont.gov/sites/hcr/files/Vermont_HIT_Plan_4_6__10-26-10__0.pdf > *This is VITLs Health IT plan from two years ago. This provide a great basis for detailing the standards in Vermont regarding health IT and recommendations for future outlook.*

Walker et al. (2011). "Inviting patients to read their doctors' notes: patients and doctors look ahead: patient and physician surveys." Accessed from: <http://www.ncbi.nlm.nih.gov/pubmed/22184688> *Sited by Kellermann and Jones (2013). Surveyed patients about their access to doctors' notes. Main finding: 90% of patients report they would like full access to medical records, only about 42% of patients actually sign up for online access, and fewer than half reviewed online clinical records.*

Wu, S., Chaudhry, B., Wang, J., Maglione, M., Mojica, W., Roth, E., ... & Shekelle, P. G. (2006) "Systematic review: Impact of health IT on quality, efficiency and costs of medical care." *Annals of Internal Medicine.* *This is an original meta-review from the health information technology literature that we cited in our mid-term presentation to the class. The authors expect that efficiency gains from EMR to be through lower utilization and are optimistic about better quality care with EMR.*