EHR READINESS AND CLINICAL INFORMATION MANAGEMENT: STAKEHOLDER CONSULTATION AND ANALYSIS

EHR READINESS AND CLINICAL INFORMATION MANAGEMENT: STAKEHOLDER CONSULTATION AND ANALYSIS

A Thesis Submitted to the Graduate Studies in Partial Fulfillment of the Requirement for the

Degree of Master of Science, eHealth

M. Sc. eHealth Graduate Program
McMaster University
Ontario, Canada

By

Basudeb Mukherjee

McMaster University
Hamilton, Ontario

MASTER OF SCIENCE (2012)
eHealth

TITLE: EHR Readiness and Clinical Information Management: Stakeholder Consultation and Analysis

AUTHOR: Basudeb Mukherjee

B.A.

SUPERVISOR: Dr. Norm Archer

NUMBER OF PAGES: ix, 52

DISSERTATION COMMITTEE

EHR Readiness and Clinical Information Management: Stakeholder Consultation and Analysis

By

Basudeb Mukherjee

B.A.

Dissertation Committee

Supervisor	Dr. Norm Archer (Supervisor) McMaster eBusiness Research Centre DeGroote School of Business *McMaster University*
Committee Member	Dr. Ann McKibbon Department of Clinical Epidemiology & Biostatistics *McMaster University*
Committee Member	Dr. Tapas Mondal Department of Pediatrics *McMaster University*

Abstract

Electronic Health Record Systems (EHRs) are an important tool for today's physicians. EHRs (commonly called EMRs in Canada) are used to store, retrieve and leverage patient information to achieve better clinical outcomes for patients. EHRs can also contribute to public policy by helping policy makers track population health data. There are barriers as well as drivers to successful implementation of EHRs. Also, with the introduction of EHRs and their accumulation of patient data physicians face challenges for better extraction and use of data as well as overall management of information within the clinic.

This thesis performs a literature review and presents evidence on the barriers and drivers that exist in the area of EHR (Electronic Health Records) implementation in the US. The thesis also includes a survey that tracks responses of primary care physicians in the US. The responses were analyzed to determine key factors impacting EHR implementation and information management. The key factors included workflow, optimization of information technology (IT) resources that include software, hardware assets and trained personnel, and plan for extraction of data. Our research found, among other things, the need to raise awareness among physicians about optimizing clinical workflow, management of information in the EHRs, the need for additional training on the EHRs and, in case of non-urban physicians, the need for improved levels of IT and Internet expertise in the clinic.

ACKNOWLEDGEMENTS

I wish to thank the following individuals:

Dr. Norm Archer, for offering me invaluable guidance as my teacher and guide of my Master's thesis. I am deeply indebted to him.

Dr. Ann McKibbon, for acting as the director of this wonderful MSc eHealth program, and also for her innovative method of in-class teaching that I find to be most effective.

Dr. Tapas Mondal, for listening to my research issues and offering invaluable advice.

Mr. S. Majumdar, for helping me to understand theories of statistics that empowered me to interpret data in this thesis.

I would like to particularly thank Dr. Karim Keshavjee for teaching me the issues involving primary care informatics, helping me sharpen my focus on the thesis problems, and being a wonderful mentor.

I would also like to thank the American Academy of Family Physicians for co-operating with me in allowing me to conduct the survey among US family physicians that served as the foundation of my research.

Thanks also to Ms. Iris Kehler for supporting me through the duration of the program.

Finally, I want to particularly thank my wife, Runki Basu, without whose support I would not have been able to complete my degree.

Table of Contents

Table of Figures

Table of Tables

GLOSSARY

ACA	Affordable Care Act - A legislation passed by the United States Congress to provide affordable health insurance to Americans
CDSS	Clinical Decision Support Systems - A software system designed to help clinicians diagnose patient conditions based on patient data
CKD Registry	Chronic Kidney Disease Registry - Information repository to store and monitor patients with chronic kidney diseases during the life cycle of their diseases
EHRS	Electronic Health Record Systems - Computer systems that collect, store and help analyze patient and population data (also referred to as Electronic Medical Record Systems – EMRs – in Canada)
HITECH Act	Health Information Technology for Economic and Clinical Health - Act - A legislation passed by the United States Congress in 2009 promoting use of Health Information Technology
SLE	Systemic Lupus Erythematosus - A disease that attacks immune system of human body

List of Abbreviations

AAFP	American Academy of Family Physicians
ACA	Affordable Care Act
CCHIT	Certification Commission for Health Information Technology
CKD Registry	Chronic Kidney Disease Registry
COPD	Chronic Obstructive Pulmonary Disease
CPOE	Computerized Providers' Order Entry - System
EHRs	Electronic Health Record Systems
EMRs	Electronic Medical Record Systems
HIE	Health Information Exchange
HIT	Health Information Technology
HITECH Act	Health Information Technology for Economic and Clinical Health – Act
IT	Information Technology
NS	Non-significant
OLRAQ	Online Readiness Assessment Quizzes
SaaS	Software as a Service
SLE	Systemic Lupus Erythematosus

INTRODUCTION

Stakeholders in the healthcare industry acknowledge the potential for systems enabled by information technology such as electronic health record systems (EHRs), electronic medical records systems (EMRs), and computerized provider order entry (CPOE) systems, to improve the quality of patient care, patient safety, increasing operational efficiency and reducing costs (Thakkar & Davis, 2006). Every year, 98000 patient deaths and many more injuries are caused by medical errors, many of which are due to medication errors (Kohn, Corrigan, & Donaldson, 1999) (Poon, et al., 2004). Such overwhelming evidence has led the Leapfrog Group, a consortium of healthcare businesses, to label deployment of CPOE systems to be one of the three primary goals for ensuring patient safety in the US (Poon, et al., 2004). This paper investigates the role that effective implementation of electronic health record systems (EHRs) in the US for primary care can play in clinical information management. The sample data set used in this study was collected from primary care physicians in the US, and neither Canadian physicians nor data from Canada have been included as part of the study.

Information management through effective utilization of EHRs is now considered a priority for policy makers in the US, which is evident from the recent healthcare reform legislation passed in the United States Congress. This effort is particularly, emphasized by the funding given by the Affordable Care Act 2010 (Kocher,

Emanuel, & DeParle, 2010), passed by the US Congress and signed into law by President Obama. "The combination of the American Recovery and Reinvestment Act and the Affordable Care Act should help address these information gaps. The American Recovery and Reinvestment Act provide about $25 billion in incentives for physicians and hospitals to use electronic health records" (Kocher, Emanuel, & DeParle, 2010). This law has subsequently been validated by the Supreme Court of the United States. There has been a substantial increase in the adoption of EHRs in the US healthcare industry over the past decade. For example, between 2008 and 2011, the state of California saw a major jump in adoption of EHRs (California Healthcare Foundation, 2011). As per this report, about 55% of physicians in California were using EHRs in 2011, an increase from the corresponding figure of 13% in 2008.

However, after the initial success of EHRs acceptance as a standard healthcare technology in North America, there has been an increasing awareness among physicians about the hurdles that exist in the path towards complete adoption of EHRs in primary care practices. Such hurdles, as identified by primary care physicians, have included an increased level of stress caused by changes in clinical workflows in order to accommodate the EHRs. In a typical EHR installation, "The process of radically redesigning 15 years of accumulated work flow in a short interval was extremely stressful." (Baron, Fabens, Schiffman, & Wolf, 2005)

The hurdles faced by physicians while implementing EHRs may be attributed to several factors. In a recent article, "several obstacles have been cited as explanations why EHRs have not achieved more prevalent usage in physicians' offices" (Lorenzi, 2009). Some of these obstacles are listed below.

Cost: EHRs are expensive and require a major investment in hardware, software and employee training, even though there has been a drop in upfront investments recently with the introduction of the Software As A Service (SaaS) model. "SaaS, built on cloud computing technology, is emerging as the forerunner in IT infrastructure because it helps healthcare providers reduce capital investments while implementing an adaptable IT foundation that cuts costs." (Glaser, 2011)

EHRs applications are not standardized: Applications, particularly the user-interfaces, often diverge in terms of look and feel, and systems are not interoperable with other sources of clinical information such as hospitals, laboratory information systems and PACS (Picture Archiving and Communication Systems).

EHRs are more difficult to use than paper-based records: Like any other new systems, EHRs are harder to master initially and expensive. Because they are harder to master initially, the learning curve is steep (Walker, 2005).

Productivity: EHR implementation, with its technically sophisticated processes that require prolonged training, can lead to reduced productivity in the practice. T. K. Landauer studied the co-relation between IT investment and productivity gains between 1973 and 1989 in various industries and found no significant co-relation between the two (Landauer, 1995). Given the complex nature of healthcare, it is unlikely that there will be faster productivity gains in healthcare than in other industries (Walker, 2005).

Lack of benefit for physicians: EHRs benefits often accrue to others (such as society and payers) but not to providers. Often, the introduction of EHRs leads to increased time needed to enter data, thus slowing down workflows in the clinic. While more efficient information management and better clinical outcomes are often found to be direct results of using EHRs, physicians often do not often gain efficiency through the use of EHRs. "Based on our findings for 2,865 U.S healthcare facilities, the relationship between EHR use in hospitals and greater labor efficiency measured across all labor disciplines does not appear to be strong (Helton, Langabeer, DelliFraine, & Hsu, 2012)." Slowing operations down during implementation can reduce revenue. Such loss of revenue is beginning to change in the United States with the introduction of regulations like Meaningful Use legislation, as part of the ACA 2010. This legislation incentivizes physicians

financially, as they reach certain milestones in the use of their EHRs (Bowes, 2010).

New service models of infra-structure have recently emerged, particularly in the cloud domain that have substantially reduced upfront investments of physicians. The cloud model offers shared utilization of resources and maintenance of computing hardware as well as software. Such a model also offers scalability including the ability to expand capacity on very short notice and a "pay-as-you-go" service on a monthly or quarterly payment schedule. As a result, EHRs implemented over the cloud require minimum investment upfront and the physicians and clinics deploying them enjoy the flexibility of quick expansion when needed. One major development example of such consolidated expansion is in the area of combined managed and hosted services by external organizations which " offer a one-stop solution that lets organizations mitigate the technology risks associated with more complex services and architectures, and they reduce the operational cost of employing specialized IT staff. Both solutions help businesses conserve cash in a fragile economic environment through easy-to-absorb monthly payments" (CISCO, 2011). Such savings in turn allow healthcare service providers to concentrate on their core competencies. However, some of the basic impediments concerning better information management at the primary care level still remain, such as work flow problems and lack of trained staff to better leverage the capabilities of advanced EHRs.

EHRs are often dependent on expensive IT infra-structure that can complicate operations of a primary care clinic, acting as a barrier to implementation. According to a study conducted by James M. Walker, the Chief Medical Information Officer of Geisinger Health Systems in Danville, PA, "An EMR implementation that is capable of supporting less error-prone care processes will require substantial resources for workflow analysis, software configuration, testing, and user training. These activities will be critical both before and for years after implementation. An implementation that provides adequate resources for these activities will cost far more than one that is just adequate to meet evolving EMR accreditation requirements"(Walker, 2005). In a study conducted at the University of California at San Francisco, it was found that, "The high up-front financial cost of implementing EMRs is a primary barrier to their adoption. This barrier is compounded by uncertainty over the size of any financial benefits that may accrue over time" (Miller & Sim, 2004). On the other hand, better documentation (Ramaiah, Subrahmanian, Sriram, & Lide, 2012) (Miller & Sim, 2004), and organizational commitment to training on EHRs have also tended to positively impact information management and successful EHR implementation (MacAlearney, Robbins, Kowalczyk, & Chisolm, 2012).

EHR implementation is a major investment for physicians both in terms of finance as well as human resources committed. Helping physicians realize the full

potential of EHRs through financial incentives, improved information exchange, and practice support can contribute to adoption of EHRs and their use to improve quality of care (Miller & Sim, 2004).

As we proceeded to research the issues, we sought to investigate the underlying reasons for some of the problems that EHR implementations and the user community face today by addressing some of the key issues that we have identified above and that have been summarized in Table 1. We have also tried to identify some of the drivers behind these issues and summarized them in Table 2. Our approach was to carefully construct a survey with relevant questions to ask primary care physicians in the US about some of the issues that they are facing. Based on the analysis of the survey data, this research study endeavors to discover the factors that contribute to clinician preparation and acceptance of EHRs and how these factors contribute to overall information management within a clinical setting. The study also examines how EHRs impact a number of clinical service areas within a physician's practice, including chronic disease management, workflows, and information management. However, it is important to remember that the findings of this research are based on the data obtained through the perceptions of the physicians who responded to our survey. Data from clinic operations has neither been obtained nor studied.

Research Question

The research questions explored in this thesis are: What are the barriers against and drivers for successful implementation of EHRs in the United States? How do EHR implementations in the United States contribute to physicians' abilities to better extract data and to manage information and workflows within their practices?

BACKGROUND

Adoption of technology has been the focus of US healthcare policy-makers in the recent past. "Two key pieces of federal legislation support a high-tech transformation. Under the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act, health care providers can qualify for Medicare and Medicaid incentive payments when they adopt certified health record technology. Additional incentives are available for professionals who provide these services in an area that has a shortage of health professionals. As of July 31, 2012 more than 13,000 Medicaid eligible professionals were registered for the program, and Medicaid agencies throughout the states had paid more than $165 million to providers. The Affordable Care Act also supports adoption of new technology, especially for accountable care organizations and patient-centered medical homes" (Boyer, 2011). It is usually assumed that technology can help enhance and optimize workflow and increase clinical productivity. However, it has been

noticed that technology is often not able to deliver on the promises it makes. Failures of EHR implementations have been attributed to, among other factors, risks involved in business engineering and lack of technical support (DePhillips, 2007). Additionally, cost of technology procurement is often high. It is against the background of such impediments to information management through EHR implementation, we set out to find whether EHR implementation can lead to better data extraction and information management at the clinical level for US primary care physicians. Our research and review of literature have revealed the existence of a number of key barriers to the success of implementing EHRs that can have a major impact on future data extraction and information management capabilities of physicians. We have also identified key drivers that are critical in the success of EHR implementations. Such factors may be critical in our analysis of utilization EHRs. In the following section, we will discuss at length the barriers that we have identified.

Barriers to Successful Implementation and Utilization of EHRs:

With the passage of the ACA 2010, states have begun to actively take steps in building health information exchanges (HIEs). HIEs have been created by various State Governments and the Federal Government to set up a marketplace for patients to shop for affordable health care. While this has opened up options for consumers, the Federal Government has also taken steps to incentivize service providers (Tuma, 2012). Federal Meaningful Use grants have also been

encouraging physicians to implement EHRs in their practices by granting financial incentives directly to the physicians.

Table 1: Barriers to Successful Implementation of EHRs for Physicians

Barriers	Description
Cost of the systems	Often, physicians are required to make upfront investments for installing the EHR system. (Gans, Kralewski, Hammons, & Dowd, 2005) (Houser & Johnson, 2008) (Baus, Pollard, Schenk, & Petitte, 2006)
Clinicians' IT skills	Clinicians are often not adequately trained to handle technical aspects of using an EHR system, or they lack trained support staff to manage their EHRs. (Gans, Kralewski, Hammons, & Dowd, 2005) (Amatayakul, 2005) (Houser & Johnson, 2008)
Clinicians' ability to use the new system	The initial learning curve of clinicians and their support staff can be high. (MacAlearney, Robbins, Kowalczyk, & Chisolm, 2012) (Gans, Kralewski, Hammons, & Dowd, 2005)
Insufficient infrastructure	Implementation of EHRs require IT infrastructure including properly cabled and wired offices and adequate hardware devices to run the EHRs. (Amatayakul, 2005)
Procedural weaknesses and inconsistencies	Inadequately defined clinical workflow (Amatayakul, 2005)
Lack of knowledge about vendor capabilities	Physicians and their staff are often ignorant about the capabilities of EHRs (Amatayakul, 2005)
Lack of adequate funding	Physicians, governmental sources or insurance companies are often reluctant to invest in EHRs (Amatayakul, 2005) (Baus, Pollard, Schenk, & Petitte, 2006) (Gans, Kralewski, Hammons, & Dowd, 2005) (Houser & Johnson, 2008)
Lack of support from the medical staff	Staff at a physician's clinic often tend not to support EHRs in fear of adapting to technology, and possible increases in work load. (Houser & Johnson, 2008)
Lack of structured technology	EHRs are often built over diverse non-standard technological platforms making them harder to maintain and to train staff in their use. (Miller R. , 2011)
Lack of employee training	Staff are busy and often are unable to spend adequate time on training. (Gans, Kralewski, Hammons, & Dowd, 2005) (MacAlearney, Robbins, Kowalczyk, & Chisolm, 2012)
Extra time needed to operate thereby potentially losing revenue	Time to train and operate EHRs lead to reduced time spent on treating patients, thereby reducing revenue. (Baus, Pollard, Schenk, & Petitte, 2006)
Lack of standards in data and communications	The issue of interoperability among systems and portability of data has not been adequately addressed. (Baus, Pollard, Schenk, & Petitte, 2006)
Privacy issues	There are issues involving privacy of patient data in EHRs. (Baus, Pollard, Schenk, & Petitte, 2006)
Lack of a physician champion	Physicians are often reluctant to take charge of promoting the utilization of EHRs in their practice. (Baus, Pollard, Schenk, & Petitte, 2006)
Lack of overall commitment to adopting EHRs	Physicians and clinical staff are often uncommitted due to a variety of reasons many of which are described above. (Baus, Pollard, Schenk, & Petitte, 2006)

While there has been an increased effort to implement EHRs, the physician community is likely to experience the same barriers that have often prevented EHR implementations from reaching the desired level of success in the past. We have researched and identified the key barriers in a tabular format (Table 1) and reviewed them as part of our discussion in this chapter. The data we used were in multiple articles.

Most articles on barriers identify cost of EHRs, finding the appropriate technology, and lack of IT expertise to be fundamental barriers to EHR implementation. The US Federal Government has addressed some of these issues, by introducing CCHIT (Certification Commission for Health Information Technology), the certification process for technologies to maintain quality, and also through the HITECH (Health Information Technology for Economic and Clinical Health) Act and Meaningful Use regulations for financially incentivizing EHR use (Tomes, 2010).

Given the wide range of vendors available offering a large number of choices, selecting the appropriate technology can be confusing. However, industry standard certification (e.g. CCHIT) has introduced conformity to acceptable standards in recent times. CCHIT was founded as an independent entity in 2004. Under the terms of its contract with the US Federal Government's Department of Health and Human Services, CCHIT developed independent certification criteria

for EHRs and began evaluating vendor products. (Miller R. , 2011) Physicians today are purchasing CCHIT-certified EHRs to qualify for federal incentives, as well as to minimize concerns about product inter-operability and reliability. It is relevant to mention CCHIT's goals for removing technology barriers to EHR adoption which include: reducing the risks of investing in HIT, facilitating interoperability of HIT, unlocking adoption incentives and regulatory relief, and also protecting the privacy of health information. (Miller R. , 2011)

Key drivers behind successful EHR implementation

Table 2: Drivers Promoting Successful Implementation of EHRs

Key Drivers	Description
Establishing a vision for what the EHR means to the organization	It is important to have a defined goal that the physicians and the staff work towards (Amatayakul, 2005).
Performing technical, procedural and skills inventories	This is an important step to identify key resources and procedures already existing within the clinic, thus identifying shortages of needed skills (Amatayakul, 2005).
Surveying clinicians on their knowledge, skills and attitude about EHRs	It is important to gauge the clinicians, who are the primary stakeholders in EHRs, about their approach towards the implementation (Amatayakul, 2005).
Educating the organization on what vendor offerings are available	Making product details about the EHRs available at the clinic level (Amatayakul, 2005).
Plotting a realistic migration path for the organization	Migrating from the existing, often paper-based, methods, to EHRs needs elaborate planning (Amatayakul, 2005).
Introduction of federal financial incentives	Physicians need to be compensated for lost time spent on implementing EHRs. Current Federal Meaningful Use regulation is meant to address it. "A physician may receive incentives as follows: Year 1: $15,000 ($18,000 if the first year is 2011 or 2012); Year 2: $12,000; Year 3: $8,000; Year 4: $4,000; and Year 5: $2,000. The HITECH Act increases these incentives by 25% for eligible practitioners who practice in underserved areas, such as health professional shortage areas" (Tomes, 2010) HITECH Act stands for "Health Information Technology for Economic and Clinical Health Act" which defines Meaningful Use Criteria for Physicians for incentive payments as defined above.

Key Drivers	Description
Promotional laws and regulations favoring deployment of EHRs	The Affordable Care Act 2010 creates a favorable legal framework to support the use of EHRs (Kocher, Emanuel, & DeParle, 2010).
The state of technology and organizational influence	In recent times, technology has improved the quality of EHRs, and the methods to use them have become increasing user-friendly .
Managing expectations of EHRs	It is important to remind users that EHRs do not solve all existing problems and may create new issues. However, the goal would be to improve clinical outcomes for patients (Terry, et al., 2008)
Emergence of an EHR champion	In a clinical setting, a champion for the use of EHRs should be encouraged to promote it. Often, a lead physician takes this role (Terry, et al., 2008).
Healthcare provider readiness to accept the system	Service providers should be encouraged to accept the system as an overall improvement over the present system (Terry, et al., 2008).

While identifying key issues impeding successful implementation of EHRs, research was also conducted to identify key drivers for successful implementation of EHRs. We have identified and summarized a number of key drivers in Table 2. These key drivers are discussed in the following paragraphs.

The drivers for EHR implementation include establishing financial incentives and legal frameworks, training personnel, and acceptability of EHRs among the healthcare workers.

Clinical Workflow and Information Management

According to a 2005 study (Lorenzi, Kouroubali, Detmer, & Bloomrosen, 2009) by the AAFP Center for Health Information Technology, some 50-60% of EHRs projects have failed. "While there is growing evidence that the use of EHRS is associated with improved quality and reduced errors, it is also often shown that poorly planned implementation – without a systematic understanding of users,

tasks and environments – is responsible for unanticipated or unintended consequences. Such consequences could lead to decreased time efficiency, escalated threat to patient safety and jeopardized quality of care."

In order to keep costs down, EHR vendors often try to enforce particular workflow designs rather than introducing innovations that accommodate existing workflows in physicians' practices (McGrath, 2006). Addressing workflow issues properly may determine the fate of an EHR implementation in terms of enhanced information management and improved clinical outcomes. Physicians are often not prepared to handle complexities involving workflow irregularities. Our research is intended to demonstrate that some key implementation factors, if addressed, may lead to better utilization of EHRs.

Some broad similarities have been observed in comparing system implementations in healthcare with other industries. Swanson and Ramiller (2004) suggested that an organization's computerization can be classified into four distinct phases: Comprehension: Evaluating the need for information management, Adoption: Development of clinical requirements and workflow specifications, Implementation: Installation and roll out, and Assimilation: Training and post-implementation user support.

In the context of EHR implementations at a physician's clinic, "a clinical practice will explore its existing IT infrastructure, organizational culture and resources and skills. The outcome is a well-defined plan delineating functional requirements, deployment methods, evaluation metrics and project timeline" (Zheng, 2009). In the current research study, the concept of information management and data extraction from EHRs that could lead to better clinical outcomes falls very much in line with these observations.

On the concept of organizational change, Lippitt, Waton and Westley (1958) introduced what became known as the Lippitt model for managing complex change. The Lippitt model states that a practice must have five particular assets in place concurrently for successful implementation. These five assets are Vision, Skills, Incentives, Resources and Action Plan (see Figure 1). "Assessing a healthcare organization's EHR readiness involves evaluating whether the organization has developed adequate comprehension and adoption of the technology and whether the organization demonstrates adequate execution capability of implementation towards the final assimilation of EHRS" (Zheng, 2009). Figure 1 demonstrates what might happen if all five assets are not in place during the change process.

If the integration of EHRs into everyday clinical workflows and clinical decisions takes place successfully, clinical outcomes may improve, as demonstrated by the

following example. In this example, three physicians from Lucile Packard Children's Hospital at Stanford University, while treating a 13-year old child with systemic lupus erythematous (SLE), a complicated condition, were able to use the university's clinical information management database and "were able to perform an automated cohort review and come to a diagnostically valuable conclusion about the patient in question." (Frankovich, Longhurst, & Sutherland, 2011) In this case, the effective utilization of the university's EHR database led to a positive clinical outcome.

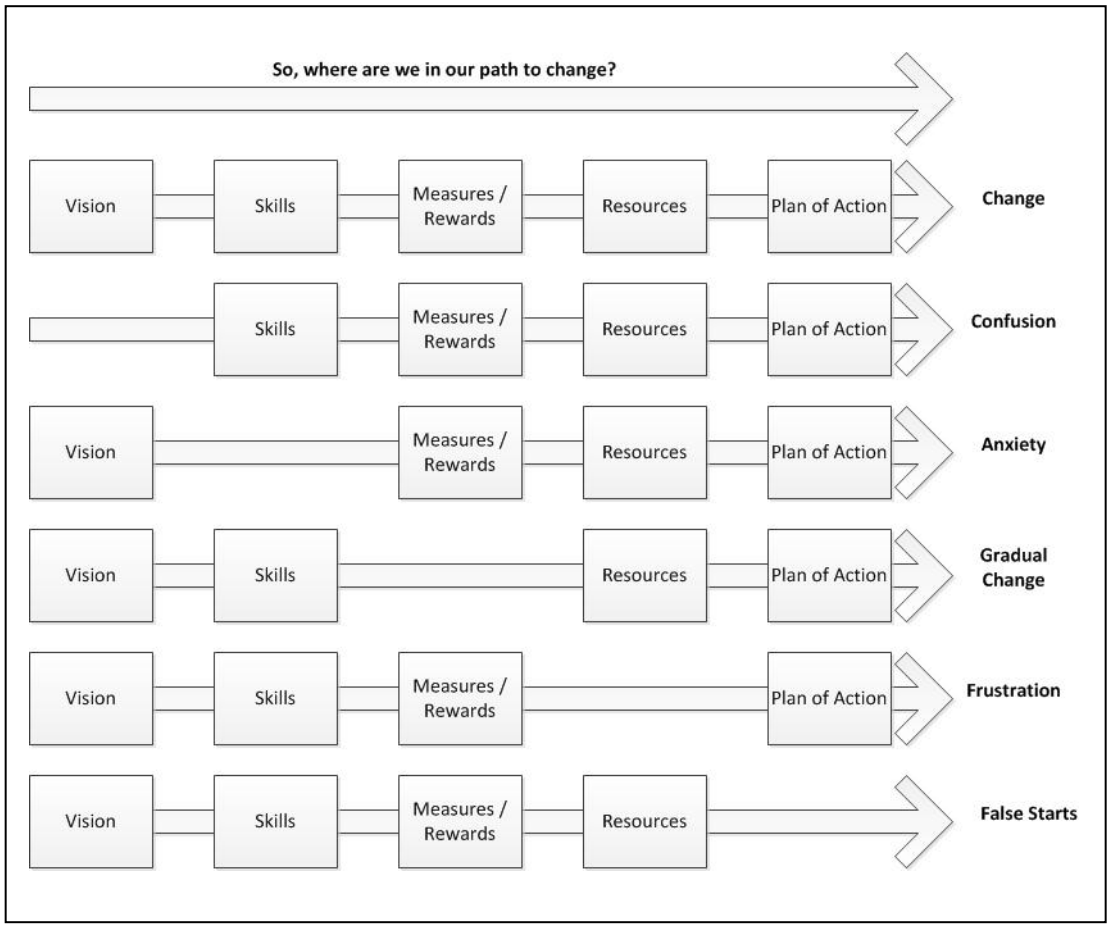

Figure 1: Adapted from the Lippitt Model for Change Management (Zheng, et al., 2009)

Our initial review of literature has revealed a wide selection of research work evaluating how physicians can be helped in implementing EHRs. Implementing such systems may require financial, technical, clinical as well as managerial expertise. In a typical clinic, such resources are often absent. Financial resources can take the shape of government incentives for installation or upon achieving key milestones. This is particularly true in the case of the meaningful use regulations in the United States (Tomes, 2010). However, adhering to such regulations and claiming compliance requires specialized knowledge that the physicians and their staff often do not have. The same can be said about technical as well as managerial skills. The existence of published research points to the need for information management and data analysis skills in primary care clinics.

Health information management has also been increasingly cited as vital to EHR implementations. In one paper, hospital staff respondents were invited to comment on risks, barriers and benefits of EHRs. It was noted that "In a majority of respondents' hospitals, health information and data, results management, and administrative processes were the three core functionalities currently part of or interfaced with the EHR systems" (Thakkar, 2006).

In a recent study, an OB/GYN specialty practice located in Arizona grew from 7 service providers before EHR implementation to 37 providers after EHR

implementation. The bottom-line revenue for the clinic also grew by 26%. The information management features of the EHR system enabled the clinic to organize and report data in a way that could never be done before. "The system now allows the practice to collect data from patients, such as how they heard about the practice and what insurance they have, and track this data to determine the most efficient way to spend marketing dollars" (LaShonza, 2012). This is an example of data extraction and information management where managerial and operational activities are enhanced by the use of EHRs.

In a recent survey (Doyle, et al., 2012), researchers at Brown University found clear evidence of association between EHR implementation, positive user experience and information management. The study researched physicians' "self-reported attitudes and behaviors" regarding EHR pre and post implementation. "Before computer installation and full EHR implementation, physicians expressed concerns about the impact of computer use on patient care. After installation and implementation, however, many concerns were mitigated. Using computers in the examination rooms to document and access patients' records along with online medical information and decision-making tools appears to contribute to improved physician–patient communication and collaboration."

Clinical information management in the form of managing alerts and reminders has measurably increased delivery of treatment. EHRs, particularly those

incorporating clinical decision support (CDSS) systems have been found to have increased adherence to evidence-based clinical guidelines and effective care. In a study conducted at the University of Alabama in Birmingham, "researchers found that computerized physician reminders increased the use of influenza and pneumococcal vaccinations from practically 0% to 35% and 50%, respectively, for hospitalized patients" (Menachemi, 2011).

Clinical information management is particularly important in the area of chronic disease registries. While patient data resides in EHRs, they are often inaccessible to the physicians or are impossible to process for effective use in chronic disease management. In one study (Navaneethan, et al., 2011), researchers stated that they could possibly find positive clinical outcomes from a chronic kidney disease registry at the Cleveland Clinic. As per the researchers, "Development of an EHR-based CKD registry is feasible… and the comorbid conditions included in the registry are reliable. In addition to conducting research studies, such a registry could help to improve the quality of care delivered to CKD patients and complement the ongoing nationwide efforts to develop a CKD surveillance project" (Navaneethan, et al., 2011).

Numerous studies have shown that clinical information management by extracting data from healthcare systems can lead to improved detection of clinical conditions. For example, one study used EHR data for a population health study

(Kudyakov, 2012). The extraction of EHR data resulted in the identification of 3205 new patients with type 2 diabetes mellitus, with a classification accuracy of 70.1%.

The multiple foregoing studies that validated the successful application of information management in clinical settings led to our research to find an answer on how readiness for EHR implementation can lead to better information management and better extraction of data in physicians' clinics.

STUDY METHODOLOGY

To gain a better understanding of the issues that physicians encounter on a regular basis concerning EHR deployment and clinical information management within the practice, we designed a survey for US physicians. The intention was to obtain their responses to a set of questions about the status of information management in their practices. We also sought to explore links between the status of information management and that of EHR readiness and implementation. The survey was hosted online at McMaster University using Lime Survey online software. Recruitment was undertaken through emails sent to primary care physicians who are members of the American Academy of Family Physicians (AAFP).

Initially, the management of AAFP was contacted at the annual convention of AAFP in Orlando, FL in October 2011. Subsequently, Dr. Jason Mitchell, Assistant Director for Center for Health Information Technology of AAFP took the initiative to send out an email recruitment letter to the entire membership of AAFP. The content of the recruitment letter was approved by the McMaster Research Ethics Board (REB).

Ethics Considerations

The McMaster University REB approved the survey. In order to ensure confidentiality of participants, the investigators used participant email addresses for the purposes of providing a link to complete the questionnaire. However, once the questionnaires were completed, the investigators could not link email addresses to completed questionnaires. No compensation was provided. Any partial data collected due to participant withdrawal was destroyed and not used in the statistical analysis. A copy of the REB approval is presented in Appendix A of this document.

Sample Population

The sample population was derived from the primary care physicians within the continental United States. An invitation was sent from the management of AAFP to all its members to participate in the research survey. The recruiting email

contained letters from the researchers the content of which was cleared in advance by the REB of McMaster University.

The email invitation was sent out using the AAFP list-server. The invitation for participation is included in Appendix B along with the survey questionnaire. There were no follow-up emails after the initial distribution.

We used the SPSS package to perform statistical analysis of the data. Data preparation followed standard methods. During the initial analysis, responses were analyzed separately according to whether the participants were urban or non-urban family physicians.

The sample data may be a fair and unbiased representation of the opinions of primary care physicians in the United States, since the invitation to participate was sent to practicing US primary care physicians who were members of the AAFP. Given that participation was self-selected as the physicians were at liberty to choose to take the survey, there may have been self-selection bias based on factors beyond our control.

We performed two sample t tests and non-parametric Mann-Whitney U tests comparing the two data sets (i.e., urban and non-urban) and determined that

there were no significant differences between the two sample populations. Because no significant differences were found between the two sub-samples, they were combined into one sample, and the Pearson correlation coefficients between variable pairs of interest were calculated. With these analyses we sought to determine if any relationships were significant between two given variables in the correlation matrix. These correlations were checked with equivalent calculations using the Spearman non-parametric approach because of the small sample size.

We summarized the findings in the results and data analysis section and included our inferences in the conclusion section.

Designing the Survey

The survey is listed in Appendix B. Participating physicians were asked differing sets of questions depending on whether they were either current EHR users or they were not EHR users and had no plans to use EHRs, or if they were not EHR users but were planning to implement EHRs in their practices.

The survey was designed by me with suggestions and advices from Dr. Karim Keshavjee, a family physician and a researcher and Dr. Norm Archer of McMaster University. I conducted a preliminary literature review in this area and found relevant areas that could be important for our research. These included

drivers, barriers, clinical workflow, information management, and their impact on successful or unsuccessful implementation of EHRs.

Dr. Karim Keshavjee is a family physician as well as a researcher. Given Dr. Keshavjee's background and reputation as a family physician as well as a researcher, I found it to be most appropriate to have the questionnaire validated by him to measure the suitability of the questions to be asked to the family physicians in the US. Dr. Norm Archer has much experience in academic research and statistical analysis. He validated the questions and made suggestions..

RESULTS & DATA ANALYSIS

Approximately 1500 physicians received email invitations to participate in the survey. It must be noted that only a limited number of members out of the entire membership base of AAFP were contacted through the AAFP email list as many members of AAFP do not have their email addresses available for communication. These physicians were members of AAFP. The AAFP actively helped us in reaching out to their membership base. At our request, Dr. Jason Mitchell, Assistant Director of AAFP for the Center for Health IT, used the AAFP list server to distribute the email, according to Dr. Jason Mitchell, to approximately 1500 members of the organization who are all family physicians in

the US. The effective response rate was approximately 2% of the total population who received the email invitation.

A total of 33 physicians participated in the survey. Of the 33 physicians who responded, 8 responses were removed due to incompleteness of data and an additional 4 responses were left out from physicians who have not implemented EHR in their practices, giving a pool of 21 responses from physicians who have already implemented EHRs in their practices. Out of these 21, the data were broadly subdivided into 15 urban physicians and 6 non-urban physicians.

The data received from the survey reveal a variety of factors that impact transition to and implementation of EHRs in US primary care setting. In the subsequent paragraphs, I interpret the data and describe its importance for future users of EHRs and health informatics policy makers. Tables 3, 4, and 5 summarize the demographics of the sample. Note that the percentages may not total to 100% due to approximation.

Table 3: Demographics of 21 Family Physicians by Age

Age Group	#/% (approx.) Sample
30 – 39	2 (9.5%)
40 – 49	5 (23.8%)
50 – 59	10 (47.6%)
> 60	4 (19.1%)

Table 4: Demographics of 21 Family Physicians by Sex

Age Group	#/% (approx.)Sample
Male	13 (61.9%)
Female	6 (28.6%)
No Answer	2 (9.5%)

Table 5: Demographics of Physicians by Their Specialization

Age Group	% Sample
Primary Care	17 (80.9%)
Specialist	2 (9.5%)
No Answer	2 (9.5%)

Solo practitioners (about 30%) and physicians in smaller practice sizes of 2 to 6 physicians (about 33% of the respondents) constituted most of the respondents (Figure 2). Nine percent of the respondents represented larger practices of 26-100 physicians, and 15% worked in practices of between 7 and 25 physicians.

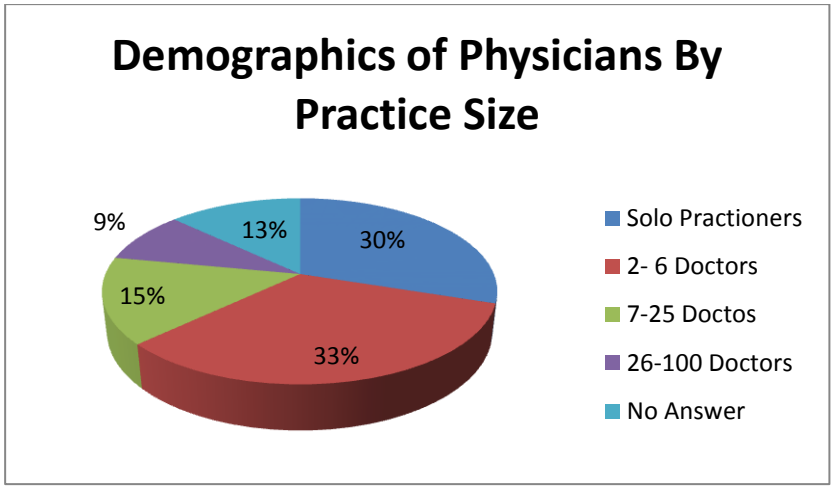

Figure 2: Demographics of Physicians by Practice Size

The variables displayed in Table 6 were selected as representative measures of EHRs readiness and clinical information management. Each variable represents a statement in the survey with answers on a scale of 1 to 5. These variables were selected based on their perceived relevance to the research question. The variable results are displayed Table 6.

Table 6: Variables Representing Selected Questions Used For Data Analysis

Variable	Statement in the Questionnaire
#1	My practice was well prepared for EHR implementation
#2	My practice hired a consultant for EHR implementation
#3	We searched in the internet to prepare for EHR implementation
#4	We should have prepared more for the EHR implementation
#5	If available, we would buy a customized web-based report to be helped in EHR implementation
#6	Our practice has not got the workflow right
#7	Our practice is not extracting information from the EHR effectively
#8	We are interested in chronic disease management
#9	We need additional training on the EHR
#10	We need help in getting our workflow right
11	We need help in data extraction and information management in our practice
#12	Our practice is run efficiently
#13	Our practice is generally IT savvy

The respondents were asked to read the statements and then rate on a scale of 1 through 5 whether they agreed or disagreed with the statement. The readings on

the scale were: 1: Strongly disagree, 2: Moderately disagree, 3: Neither agree nor disagree, 4: Moderately agree and 5: Strongly agree.

Table 7 contains descriptive statistics of the 15 urban physicians who responded to the survey.

Table 7: Responses to 13 Variables from 15 Family Physicians Located in Urban Areas.

Descriptive Statistics										
Variables	**1***	**2****	**3*****	**4******	**5*******	**Sample Size (N)**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
#1	-	4	3	4	4	15	2	5	3.53	1.187
#2	8	2	-	1	4	15	1	5	2.40	1.805
#3	-	3	1	4	7	15	2	5	4.00	1.195
#4	5	2	4	2	2	15	1	5	2.60	1.454
#5	4	6	2	-	1	13	1	5	2.08	1.115
#6	3	4	3	2	3	15	1	5	2.87	1.457
#7	1	5	1	4	4	15	1	5	3.33	1.397
#8	13	1	1	-	-	15	1	3	1.20	.561
#9	8	6	1	-	-	15	1	3	1.53	.640
#10	12	3	-	-	-	15	1	2	1.20	.414
#11	9	4	2	-	-	15	1	3	1.53	.743
#12	-	1	3	4	7	14	2	5	4.21	.975
#13	1	2	2	5	5	15	1	5	3.73	1.280

***Strongly Disagree ; **Moderately Disagree; ***Neither Agree nor Disagree; ****Moderately Agree; *****Strongly Agree**

Table 8 contains descriptive statistics of the 6 non-urban physicians who responded to the survey.

Table 8: Responses to 13 Variables from 6 Family Physicians Located in Non-Urban Areas.

Descriptive Statistics										
Variables	**1***	**2****	**3*****	**4******	**5*******	**Sample Size (N)**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
#1	1	1	3	1	-	6	1	4	2.67	1.033
#2	3	1	-	1	1	6	1	5	2.33	1.751
#3	1	1	3	1	-	6	1	5	3.33	1.506
#4	1		3	2	-	6	1	5	3.33	1.506
#5	2	1	-	2	-	5	1	5	2.80	2.049
#6	1	-	-	4	1	6	2	5	3.83	.983
#7	1	-	1	3	1	6	1	5	3.50	1.378
#8	5	-	1	-	-	6	1	3	1.33	.816
#9	3	1	1	-	-	5	1	3	1.60	.894
#10	5	-	1	-	-	6	1	3	1.33	.816
#11	4	2	-	-	-	6	1	2	1.33	.516
#12	1	-	2	3	-	6	1	4	3.17	1.169
#13	1	1	1	-	3	6	1	5	3.50	1.761

***Strongly Disagree; **Moderately Disagree; ***Neither Agree nor Disagree; ****Moderately Agree; *****Strongly Agree**

Two-sample T-test Comparing the Sample Means of Urban Physicians and Non-urban Physicians

Table 9 contains the results of a two sample two tailed t-test comparing the sample means of urban physicians and non-urban physicians, based on a significance level of 0.05 (ns denotes non-significance).

Table 9: Two Sample T test for the Urban Physicians and Non-Urban Physicians in the US

Variables	Computed Value of T	P value
#1	0.749	ns
#2	0.0813	ns
#3	1.084	ns
#4	0.327	ns
#5	1.052	ns
#6	1.479	ns
#7	0.253	ns
#8	0.423	ns
#9	0.203	ns
#10	0.492	ns
#11	0.602	ns
#12	2.101	0.05
#13	0.335	ns

ns – Non-significant

From Table 9, no significant difference is seen between the responses of the non-urban and urban physicians for every statement except for variable 12. Variable 12 states that the physician's practice is IT savvy. Because only one of 13 of the comparisons was significant, this might be a Type I error (false positive). Because the sample sizes were small, and because the distributions may not be normally distributed, possibly skewed, or include outliers, the non-parametric Mann-Whitney U test was also used to compare the two samples. This non-parametric analysis gave a non-significant result for all variables. The t-

test comparison for response 12 that showed significance may therefore be an aberration or, it may signify that physicians in the urban areas are better equipped in terms of knowledge and skilled staff and can have a higher degree of confidence in the operational efficiency of their clinics. Because the analysis does not appear to indicate a significant difference between the responses from the two sub-samples, we suggest that physicians in the two samples, irrespective of the location of their practice, appear to represent a general population of physicians in the US who have similarities in background, work patterns, and operational parameters.

Most Significant Pearson's and Spearman's Correlations for Significance Level 0.05 or less:

Because we have shown that the urban and non-urban physician populations are similar in nature, the samples from these two populations were combined to carry out an analysis of correlations between pairs of variables for variables 1 through 13. Because of the small sample size, both the Pearson correlation coefficients and Spearman's non-parametric rank correlation coefficients were calculated to confirm the two sets of correlation results. If coefficients calculated by both tests were significant for a particular pair of variables, then we concluded that there may be a significant correlation between these variables that bears explanation.

Table 10: Most Significant Pearson's and Spearman's Correlations for Significance Level 0.05 or less

Variables	Statements	Pearson's r	Spearman's ρ	r^2
#6	Our practice has not got the workflow right	0.711***	0.732***	0.506
#7	Our practice is not extracting information from the EHR effectively			
#4	We should have prepared more for the EHR implementation	0.700***	0.689***	0.490
#6	Our practice has not got the workflow right			
#9	We need additional training on the EHR	0.684***	0.636**	0.468
#10	We need help in getting our workflow right			
#1	My practice was well prepared for EHR implementation	0.542*	0.480*	0.294
#12	Our practice is run efficiently			

Note: *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$

Variables 1 and 12: Variable 1 represents the survey statement whether the clinic was well prepared for EHR implementation and Variable 12 represents the survey statement whether the clinic was run efficiently. Here, the value of r^2 = 0.294. That is, 29% of the variability in whether a practice is well-prepared for EHR implementation is dependent upon how efficiently the practice is run.

Variables 6 and 7: Variable 6 represents the survey statement whether the respondent's clinic got the workflow right, and variable 7 represented the survey statement whether the respondent thought that his/her clinic was able to extract information from the EHRs effectively. Both Spearman coefficient and Pearson's coefficient for this pair of variables are significant at the 0.001 level, and Pearson's r^2 = 0.50. It can be said that 50% of the variability in this correlation is

explained, indicating that the physicians in this study tend to think that their data extraction capabilities from the EHRs are related to the state of their clinical workflow.

Variables 4 and 6: Variable 4 represents the survey statement whether the clinic should have prepared more for the EHR implementation and variable 6 represented the survey statement whether the respondent's clinic did not get the workflow right. Both Spearman coefficient and Pearson's coefficient for this pair of variables are significant at the 0.001 level, and Pearson's $r^2 = 0.49$. It can be said that 49% of the variability in this correlation is explained, indicating that 49% of the physicians in this study who thought that they should have prepared more for the EHR implementation also tend to think that their clinic did not get the workflow right.

Variables 9 and 10: Variable 9 represented the survey statement whether the respondent needed additional training on the EHRs and Variable 10 represented the survey statement whether the respondent thought that his/her clinic was getting the clinical workflow right. Spearman's correlation coefficient is significant at the 0.007 level, and Pearson's coefficient is significant at the 0.001 level. Pearson's r^2 is 0.46 indicating that 46% of the variability between the two variables is explained, and that physicians who need additional training in their EHRs would also like help in getting their clinical workflows right.

From the analysis of the combined data set that includes both urban and non-urban physicians, it can be said that physicians who needed additional training on their EHRs during implementation are also likely to require additional help in getting their clinical workflow right and are also likely to need additional help in data extraction and information management in their clinics.

A similar analysis suggests that the physicians who do not get their clinical workflow right and need help in this area also need additional training in the use of their EHRs. The physicians who had flaws in their workflow also thought that they needed more preparation for implementations of their EHRs.

From the analysis above, the areas that have stood out to require in-depth review include additional training on EHRs that have been implemented. Physicians and staff tend to need extended training that can have impact on their job performance. There also seem to be issues involving the clinical workflow, extraction and utilization of data from the EHRs. Utilization of extracted data from EHRs can have impact on detection and treatment of chronic diseases.

CONCLUSIONS

Initially this research sought answers to the question of whether implementation of EHRs can contribute to more perceived enhanced extraction of relevant clinical

data and better information management in US primary care clinics. The answer to this question is a definite yes, but with a number of caveats.

Our data suggest that the physicians surveyed agreed to the need to have EHRs and they were also aware of different government initiatives and subsidies to help physicians adopt EHRs.

We noticed a similarity between what we have found and other researchers in the area have measured as documented in the literature review section of this thesis. For example, other researchers have found that better information management in clinics requires elevated levels of IT skills among the staff of the clinic. This matches our findings.

Additional product training may be needed: It may prove to be important for EHRs vendors to make additional product training on EHRs available for non-urban physicians so they can be more productive with their systems.

Work flow problems may need to be addressed: In this study of 21 family physicians, it appeared that all clinics, both at the EHR and pre-implementation and post-implementation stages had substantial work-flow related problems that needed to be addressed before a better quality of information management and use of extracted data could be achieved.

Awareness of data extraction and data utilization: It is important to note that a widespread problem in understanding and using data extraction tools was found in our study sample. This awareness probably needs to be addressed to improve successful extraction and utilization of patient data.

Awareness of chronic disease management using EHR data: It may be important to educate physicians on what appears to be the close association of efficient information management, extraction of patient data from EHRs, and management of chronic diseases.

FUTURE RESEARCH

Based on the evidence from this study, the scope of future research can be classified into a number of areas. However, given the limited number of participants in this study, it is important to greatly increase the sample size in any future study to ensure validity of the findings.

EHR readiness: From the research we have done, it is clear that many of the physicians sampled did not feel that their practices had the desired level of IT expertise to be able to deploy and use EHRs efficiently. Many also felt that the workflow processes that they followed in their clinics were not optimized and therefore, could have been improved. Some expressed a desire to have web-based readiness tools to help them in EHRs readiness, while others indicated the

need to have customized workbooks. Future researchers could consider the area of EHR readiness to investigate the area including workflow enhancement and IT training for clinical staff.

Information Management: Some of the participating physicians noted that they were not able to utilize the data in their EHRs. They also felt that being aware of IT capabilities or lack thereof contributed to their inability to leverage EHRs in their practices. Future researchers could consider the development of information management strategies of physicians lacking in expertise in this area.

Chronic Disease Management: Participating physicians indicated that they had a limited ability to extract and use patient data from their EHRs. This can limit the ability to improve clinical outcomes. For example, monitoring chronic diseases is particularly important for patients with diseases such as diabetes and COPD. Monitoring of patient data can also be important in the public health domain. EHRs of primary care physicians are likely to be the most readily accessible repositories of patient data available to public health professionals and policy makers.

REFERENCES

Ajam, S., Ketabi, S., Isfahani, S., & Heidari, A. (2011). Readiness assessment of electronic health records implementation. *Acta Informatica Medica, 19*, 224-227.

Amatayakul, M. (2005). EHR? assess readiness first. *Healthcare Fianncial Management, 59*, 112-113.

Baron, R., Fabens, E. L., Schiffman, M., & Wolf, E. (2005). Electronic health records: just around the corner? or over the cliff? *Annals of Internal Medicine, 143*, 222-226.

Baus, A., Pollard, C., Schenk, P., & Petitte, T. (2006). *West Virginia federally qualified health center readiness for electronic medical records*. Retrieved August 04, 2012, from West Virgina University : http://www.hsc.wvu.edu/som/cmed/ohsr/presentations/WV%20FQHC%20Readiness%20for%20EMRs%20(09-2006).pdf.

Bowes, W. (2010). Assessing readiness for meeting meaningful use: Identifying electronic health record functionality and measuring levels of adoption. *AMIA Annual Symposium Proceeding 2010*, 66-70.

Boyer, K. (2011). The technology promise: widespread use of electronic medical records promises to transform health care. But can we afford it? *State Legislatures, 37*, pp. 20-21.

California Healthcare Foundation. (2011, May). *The state of health information technology in California*. Retrieved September 04, 2012, from California Healthcare Foundation: http://www.chcf.org/publications/2011/05/health-information-technology-california

Chun-Ja, K., & Kang, D. H. (2006). Utility of a web-based intervention for individuals with type 2 diabetes. *CIN: Computers, Informatics, Nursing, 24*, 337-345.

CISCO. (2011). *New business models drive opportunities for service providers and vendors*. Retrieved August 07, 2012, from Cisco USA: http://www.cisco.com/en/US/solutions/collateral/ns341/ns524/ns546/ns776/ns1028/white_paper_c11-663763.pdf

DePhillips, H. (2007). Initiatives and barriers to adopting health information technology. *Disease Management and Health Outcomes, 15*, 1-6.

Doyle, R., Wang, N., Anthony, D., Borkan, J., Shield, R., & Goldman, R. (2012). Computers in the examination room and the electronic health record: physicians' perceived impact on clinical encounters before and after full installation and implementation. *Family Practice—The International Journal for Research in Primary Care, (to appear)*.

Frankovich, J., Longhurst, C., & Sutherland, S. (2011). Evidence-based medicine in the EMR era. *New England Journal of Medicine, 365*, 1758-1759.

Gans, D., Kralewski, J., Hammons, T., & Dowd, B. (2005). Medical groups' adoption of electronic health records and information systems. *Health Affairs, 24*, 1323-1333.

Glaser, J. (2011). Cloud computing can simplify healthcare information management. *Healthcare Financial Management, 65*, 52-55.

Hagland, M. (2012, January). Harnessing EHR derived data. *Healthcare Informatics, 29*, pp. 28-29.

Helton, J., Langabeer, J., DelliFraine, J., & Hsu, C. (2012). Do EHR investments lead to lower staffing levels? *Healthcare Finance Management, 66*, 54-60.

Houser, S., & Johnson, L. A. (2008). Perceptions regarding electronic health record implementation among health information management professionals in Alabama: a statewide survey and analysis. *Perspectives in Health Information Management, 5:6*. Retrieved September 04, 2012, from http://www.ncbi.nlm.nih.gov.libaccess.lib.mcmaster.ca/pmc/articles/PMC2394577/

Kocher, R., Emanuel, E. J., & DeParle, N. A. (2010). The affordable care act and the future of clinical medicine: the opportunities and challenges. *Annals of Internal Medicine, 153*, 536-540.

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (1999). *To Err Is Human : Building A Safer Health System.* Washington D.C.: National Academy Press.

Kudyakov, R., Bowen, J., Ewen, E., West, S. L., Daoud, Y., Fleming, N., & Masica, A. (2012). Electronic health record use to classify patients with newly diagnosed versus preexisting type 2 diabetes: infrastructure for comparative effectiveness research and population health management. *Population Health Management, 15*, 3-11.

Landauer, T. K. (1995). *The Trouble with Computers: Usefulness, Usability, and Productivity.* Cambridge, MA: MIT Press.

LaShonza, A. (2012). An EHR that delivers results. *Health Technology Management*, pp. 18-23. Retrieved September 04, 2012, from Health Management Technology: http://www.healthmgttech.com/articles/201202/an-ehr-that-delivers-results.php

Lippitt, R., Watson, J., & Westley, B. (1958). *The Dynamics of Planned Change.* New York, NY: Harcourt, Brace and World.

Lorenzi, N., Kouroubali, A., Detmer, D. E., & Bloomrosen, M. (2009). How to successfully select and implement electronic health records (EHR) in small ambulatory practice settings. *BMC Medical Informatics and Decision Making, 9*.

MacAlearney, A., Robbins, J., Kowalczyk, N., & Chisolm, D. S. (2012). The role of cognitive and learning theories in supporting successful EHR system implementation training: a qualitative study. *Medical Care Research and Review, 69*, 294-315.

Marks, B. P. (2002). Web-based readiness assessment quizzes. *Journal of Engineering Educaiton, 91*, 97-102.

McGrath, D. (2006). How to motivate physicians and develop a physician champion. *Journal of American Medical Practice Management, 13*, 13-16.

Menachemi, N., & Collum, T. H. (2011). Benefits and drawbacks of electronic health record systems. *Risk Management and Healthcare Policy, 4*, 47-55.

Miller, R. (2011). Electronic health record certification in oncology: role of the certification commission for health information technology. *Journal of Clinical Oncology, 4*, 209-213.

Miller, R. H., & Sim, I. (2004). Physicians' use of electronic medical records: barriers and solutions. *Health Affairs, 23*, 116-126.

Navaneethan, S., Jolly, S., Schold, J., Arrigain, S., Saupe, W., Sharp, J., Lyons, J., Simon, J., Schreiber Jr, M., Jain, A., Nally Jr, J. V. (2011). Development and validation of an electronic health record–based chronic kidney disease registry. *Clinical Journal of American Society of Nephrology, 6*, 40-49.

Poon, E., Blumenthal, D., Jaggi, T., Honour, M., Bates, D. W., & Kaushal, R. (2004). Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Health Affairs, 23*, 184-190.

Ramaiah, M., Subrahmanian, E., Sriram, R., & Lide, B. (2012). Workflow and Electronic Health Records in Small Medical Practices. *Perspectives in Health Information Management, 9*, 1-16.

Shanedling, J., Van Hees, A., Rodriguez, M., Putnam, M., & Agel, J. (2010). Validation of an online assessment of orthopedic surgery residents' cognitive skills and preparedness for carpal tunnel release surgery. *Journal of Graduate Medical Education, 2*, 435-441.

Terry, A., Thorpe, C., Giles, G., Brown, J., Harris, S., Reid, G., Thind, A., Stewart, M. (2008). Implementing electronic health records - key factors in primary care. *Canadian Family Physician, 54*, 730-736.

Thakkar, M., & Davis, D. C. (2006). Risks, barriers, and benefits of EHR systems: a comparative study based on size of hospital. *Perspectives in Health Information Management, 3*, 1-19.

Tomes, J. (2010). Avoiding the trap in the HITECH Act's incentive timeframe forimplementing the EHR. *Journal of Healthcare Finance, 37*, 91-100.

Triola, M. (2006). *Elementary Statistics* (10th ed.). New York, NY: Pearson Addison-Wesley.

Tuma, P. (2012). An overview of the intentions of the healthcare reform. *Journal of the Academy of Nutrition and Dietetics, 112*, 556-561.

Walker, J. (2005). Electronic medical records and health care transformation: EMR supported health care transformation is too immature for credible estimates of its costs or benefits. *Health Affairs, 24*, 1118-1120.

Zar, J. (1972). Significance testing of the Spearman rank correlation coefficient. *Journal of the American Statistical Association, 67*, 578-580.

Zheng, K., McGrath, D., Hamilton, A., Tanner, C., White, M., & Pohl, J. (2009). Assessing organisational readiness for adopting an electronic health record systems. *Organisational Self-Assessment for IT Innovation, 18*, 117-140.

APPENDIX A – Ethics Approval

MREB Clearance Certificate

Page 1 of 1

McMaster University
Inspiring Innovation and Discovery

McMaster University Research Ethics Board (MREB)

c/o Office of Research Services, MREB Secretariat, GH-305/H, e-mail: ethicsoffice@mcmaster.ca

CERTIFICATE OF ETHICS CLEARANCE TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

Application Status: ☑ New ☐ Addendum | **Project Number:** 2011 146

TITLE OF RESEARCH PROJECT:

Stakeholder Consultation and Utility Analysis of a Web-based EHR Readiness Preparation Report for a Primary Care Physicians

Faculty Investigator(s)/ Supervisor(s)	Dept./Address	Phone	E-Mail
N. Archer	Business	23944	archer@mcmaster.ca

Co-Investigator(s): K. Keshavjee

Student Investigator(s)	Dept./Address	Phone	E-Mail
B. Mukherjee	Business	416-875-9010	mukherb@mcmaster.ca

Co-Investigator(s):

The application in support of the above research project has been reviewed by the MREB to ensure compliance with the Tri-Council Policy Statement and the McMaster University Policies and Guidelines for Research Involving Human Participants. The following ethics certification is provided by the MREB:

☑ The application protocol is approved as presented without questions or requests for modification.

☐ The application protocol is approved as revised without questions or requests for modification.

☐ The application protocol is approved subject to clarification and/or modification as appended or identified below:

COMMENTS AND CONDITIONS: Ongoing approval is contingent on completing the annual completed/status report. A "Change Request" or amendment must be made and approved before any alterations are made to the research.

Reporting Frequency:	Annual:	Other:

Date: **Chair, Dr. B. Detlor:**

http://iserv.mcmaster.ca/ethics/mreb/print_approvalPI.cfm?ID=2682 8/18/2011

APPENDIX B – Survey Questionnaire and Invitation for Participation

Norm Archer, Ph.D.
Professor Emeritus
Information Systems
McMaster University
Hamilton, ON L8S 4M4
Phone: 905-525-9140 X 23944
e-mail archer@mcmaster.ca

Co-Investigators
Dr. Karim Keshavjee, MD, CCFP, CPHIMS-CA
CEO, Infoclin Inc.
15 Atlantic Avenue, Toronto, ON M6K 3E7
Phone: 416-538-9898
e-mail: karim@infoclin.ca

Basudeb Mukherjee
Graduate Student
McMaster University
Hamilton, ON L8S 4M4
Phone: 416-875-9010
E-mail: mukherb@mcmaster.ca

Objective of the study: This study is designed to determine the state of preparedness of Primary Care Physicians for implementing EHR systems in their practices. Information gathered during the study will be synthesized into a report. Findings from the study will help to develop an understanding of problems and needs of physicians interested in implementing EHR systems in their practices. It will also help vendors to provide services more tailored to the physician community, and help to address problems and needs of the physician community.

Description: Identifying information will not be collected from participants. Information collected centers around current physician practices and readiness for implementing Electronic Health Record Systems.

Risks: It is unlikely that your participation in this study will cause any discomfort or harm. Some of the questions may cause you to reflect on issues or decisions that may be a source of concern or worry for you. Any responses you provide will be treated confidentially by researchers.

All information collected will be kept in strict confidence. Only the researchers named above will have access to the data. Participation is anonymous and participants will not be identified individually in any reports or analyses resulting from this research project.

Thank you for agreeing to participate in this study. The study is designed to help us better understand preparedness for EHR implementation within the primary care physician community. Whether you have already implemented, or are planning to implement an EHR, your input will be valuable to this research.

If you would like to see the overall results of this research, a working paper will be published upon completion of the study within the next six months on the following web site http://merc.mcmaster.ca/.

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
c/o Research Office for Administrative Development and Support
E-mail: ethicsoffice@mcmaster.ca

You must be eighteen years or older to participate. Continuing on to complete this survey signifies your agreement to participate in the study.

Before we begin, please tell us a little about yourself;

Age: <30, 30-39, 40-49, 50-60, >60

Gender: Male/Female

I am a: Primary Care Practitioner Specialist: _____ (Please specify).

Practice type: Solo 2-6 Doctors 7-25 Doctors 26-100 Doctors >100 Doctors

Practice location: Urban Rural Remote

Practice is located in (State): _____ (drop down list)

I am eligible for Federal Meaningful Use Incentives: Yes / No

Main Questionnaire:

a) Are you currently using any type of EHR system in your practice? YES / NO

If you answered NO, please go to Question d): (automated skipping to question d) based on the answer to question a).

What is the vendor and model number of your EHR? : _____

b) Please select the response that best represents your level of agreement with the following statements: Answer according to whether you : strongly agree (5), moderately agree (4), neither agree nor disagree (3), moderately disagree (2), strongly disagree (1)

My practice and I were well prepared for the transition to EHR: 1 2 3 4 5

We hired a consultant to prepare for the EHR transition 1 2 3 4 5

We searched the Internet and read available information to prepare for EHR transition
1 2 3 4 5

Our vendor assisted us in preparing for the EHR transition: 1 2 3 4 5

We used a workbook to prepare for the EHR transition 1 2 3 4 5

We should have spent more time preparing for the EHR transition: 1 2 3 4 5

If a customized report had been available on how to prepare for implementing an EHR, I would have purchased it: 1 2 3 4 5

If a consultant had advised me on how to prepare for EHR, I would have been more successful: 1 2 3 4 5

My practice is still struggling with getting our workflows right: 1 2 3 4 5

My practice is still struggling with extracting information we need from the EHR: 1 2 3 4 5

We have regular staff meetings: 1 2 3 4 5

Our patient records are up to date: 1 2 3 4 5

My/Our staff members have good keyboarding skills: 1 2 3 4 5

Our practice is generally IT savvy: 1 2 3 4 5

Our practice is run efficiently: 1 2 3 4 5

c) Please indicate if you are interested in any of the following areas:

Introducing or increasing Chronic Disease Management in my practice:
Yes/No
Additional training on my EHR:
Yes/No
Advice on meeting Meaningful Use Criteria:
Yes/No
Advice on improving Workflow and Efficiency in my practice:
Yes/No

Advice on improving Information Management and Data Discipline with my EHR:
Yes/No

Your contribution to this study is greatly appreciated.

Submit your survey answers and exit

d) Are you currently planning to implement an EHR system in your practice?
YES / NOT SURE / NO *** Branch appropriately based on their answers to this question.

If you answered "No" to Q d) above, please answer the following questions :

Why have you decided not to use an EHR system? Please select the response that best represents your level of agreement with the following statements: Answer according to whether you : strongly agree (5), moderately agree (4), neither agree nor disagree (3), moderately disagree (2), strongly disagree (1)

The cost is prohibitive. 1 2 3 4 5

EHR systems are not yet mature enough. 1 2 3 4 5

I am concerned about privacy issues. 1 2 3 4 5

EHR systems lack interoperability with other systems that I need to access online for information.

1 2 3 4 5

There is no incentive for me to use an EHR. 1 2 3 4 5

I am concerned that using an EHR will slow me down. 1 2 3 4 5

My practice is not ready for implementing an EHR. 1 2 3 4 5

Others: _____ (Please specify)

Please answer the following: Please select the response that best represents your level of agreement with the following statements: Answer according to whether you : strongly agree (5), moderately agree (4), neither agree nor disagree (3), moderately disagree (2), strongly disagree (1) ?

We have regular staff meetings: 1 2 3 4 5

Our patient records are up to date: 1 2 3 4 5

My/Our staff members have good keyboarding skills: 1 2 3 4 5

Our practice is generally IT savvy: 1 2 3 4 5

Our practice is run efficiently: 1 2 3 4 5

Please indicate if you are interested in any of these services to assist you to increase your readiness for EHR use:

Self-paced training materials on the web or through published books. Yes/No
On-site consultant. Yes/No
Workbook with questions to help me to work out my own answers. Yes/No

Reports customized for me by an expert based on a questionnaire I respond to. Yes/No

Your contribution to this study is greatly appreciated.

Submit your survey answers and exit

If answered "Not Sure" to Q d) above:

Why have you decided not to use an EHR system? Please select the response that best represents your level of agreement with the following statements: Answer according to whether you : strongly agree (5), moderately agree (4), neither agree nor disagree (3), moderately disagree (2), strongly disagree (1) ?

The cost is prohibitive. 1 2 3 4 5

EHR systems are not yet mature enough. 1 2 3 4 5

I am concerned about privacy issues. 1 2 3 4 5

EHR systems lack interoperability with other systems I need to access online for information.
1 2 3 4 5

There is no incentive for me to use an EHR. 1 2 3 4 5

I am concerned that using an EHR will slow me down. 1 2 3 4 5

My practice is not ready for implementing an EHR. 1 2 3 4 5

Others: _____ (Please specify)

Please answer the following questions: Please select the response that best represents your level of agreement with the following statements: Answer according to whether you : strongly agree (5), moderately agree (4), neither agree nor disagree (3), moderately disagree (2), strongly disagree (1)

We have regular staff meetings: 1 2 3 4 5

Our patient records are up to date: 1 2 3 4 5

My/Our staffs have good keyboarding skills: 1 2 3 4 5

Our practice is generally IT savvy: 1 2 3 4 5

Our practice is run efficiently: 1 2 3 4 5

Please indicate if you are interested in any of these services to assist you to increase your readiness for EHR use:

Self-paced training materials on the web or through published books. Yes/No

On-site consultant. Yes/No

Workbook with questions to help me to work out my own answers. Yes/No

Reports customized for me by an expert based on a questionnaire I respond to. Yes/No

Your contribution to this study is greatly appreciated.

Submit your survey answers and exit

If you answered YES to question d) above, Please answer each of the following questions; Please select the response that best represents your level of agreement with the following statements: Answer according to whether you : strongly agree (5), moderately agree (4), neither agree nor disagree (3), moderately disagree (2), strongly disagree (1)

Our practice has regular staff meetings:	1	2	3	4	5
Our patient records are up to date:	1	2	3	4	5
Our staff has good keyboarding skills:	1	2	3	4	5
I have good keyboarding skills:	1	2	3	4	5
Our practice is generally IT savvy:	1	2	3	4	5
Our practice is run efficiently:	1	2	3	4	5

Please indicate if you are interested in any of these services to assist you to increase your readiness for EHR use:

Self-paced training materials on the web or through published books. Yes/No

On-site consultant. Yes/No

Workbook with questions to help me to work out my own answers. Yes/No

Reports customized for me by an expert based on a questionnaire I respond to. Yes/No

Your contribution to this study is greatly appreciated.

Submit your survey answers and exit