ELECTRONIC MEDICAL RECORDS IN CANADIAN FAMILY PRACTICE

ADOPTION AND USAGE OF ELECTRONIC MEDICAL RECORDS IN CANADIAN FAMILY PRACTICE: ARE SMALL PRACTICES AT A DISADVANTAGE?

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TITLE: Adoption and Usage of Electronic Medical Records in Canadian Family Practice: Are Small Practices at a Disadvantage?

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Abstract: Canadian primary care practices lag behind their counterparts in the United States and Europe in adopting Electronic Medical Record (EMR) systems to facilitate care. Although there is a considerable volume of cross-national conceptual literature focused on system design and barriers to adoption, there is little in the way of research on the unique problems faced by Canadian physicians within the publicly financed and privately provided system of healthcare delivery. This study uses a survey of Canadian physicians to investigate differences in perceptions of EMR value between two groups who have implemented these systems: "small practice" physicians, i.e. those with a maximum of 2 full-time physicians and "large practice" physicians, or those with three or more full-time physicians. A Mann-Whitney U Test conducted on survey item responses of the two groups finds that "small practice" physicians feel significantly less positive about EMRs with regards to ease of use, time savings and effective patient management.

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Contents

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List of All Abbreviations and Symbols

CCM	Chronic Care Model
CDM	Chronic Disease Management
CDO	Care Delivery Organization
CDS	Clinical Decision Support
CFPC	College of Family Physicians of Canada
CHI	Canada Health Infoway
CIHI	Canadian Institute for Health Information
CMA	Canadian Medical Association
CPOE	Computerized Physician Order Entry
EHR	Electronic Health Record
EMR	Electronic Medical Record
FP	Family Physician
FTE	Full Time Equivalent
GP	General Practitioner
HIE	Health Information Exchange
HIMSS	Healthcare Information and Management Systems Society
HIT	Health Information Technology
IT	Information Technology
NPS	National Physician Survey
OECD	Organization for Economic Cooperation and Development
OLIS	Ontario Laboratories Information System
PACS	Picture Archiving and Communication System
PHR	Personal Health Record
PITO	Physician Information Technology Office
POMR	Problem Oriented Medical Record
POSP	Physician Office System Program
SNOMED-CT	Systematized Nomenclature of Medicine-Clinical Terms
WHO	World Health Organization
PHP	Personal Health Portal
HMO	Healthcare Management Organization
KP	Kaiser Permanente
LDL-C	Low-density Lipoprotein Cholesterol
FFS	Fee-For-Service
ICD-9	International Classification of Diseases, Ninth Revision
PLIS	Provincial Laboratory Information System
RIS	Radiology Information System
SMA	Saskatchewan Medical Association
SEM	Structural Equation Modeling
TAM	Technology Acceptance Model

Declaration of Academic Achievement

This study adds to the body of literature of Electronic Medical Records in Canadian medical practice by examining barriers to their adoption within the context of existing limitations of these technologies. This has been done by using a proprietary survey dataset of Canadian physicians currently using these systems.

1. Introduction

Of the numerous ideas, customs and systems that make up the fabric of Canadian identity, the right to health care is just as crucial as items like hockey, bilingualism or parliamentary democracy. The influential Romanow Report of 2002 found strong support among Canadians for the publicly financed Medicare system, specifically with respect to the availability of medically necessary services *"on the basis of need as a right of citizenship, not a privilege of status or wealth"* (Commission on the Future of Health Care in Canada, 2002).

The Romanow Report was originally commissioned to assist policymakers in understanding the sustainability of Medicare during a time when the practice of medicine was changing rapidly. A greater emphasis on outpatient care and ballooning prescription drug costs were just some of the characteristics of the new operating environment. The report recognized that the system required a considerable degree of transformation in order to control costs, provide a more comprehensive system of care as well as better accountability for all stakeholders involved. Two key recommendations for achieving this transformation were a greater focus on prevention-based primary care and improving access to health data for care providers by way of health information technology (HIT).

HIT comprises a variety of processes and systems such as Electronic Health Records (EHRs), Electronic Medical Records (EMRs), Personal Health Records (PHRs), Computerized Physician Order Entry (CPOE) systems, Clinical Decision Support (CDS) systems, and electronic prescribing (e-prescribing) systems. This study focuses on EMR adoption in family practice, so a formal definition of the term, as well as a related system, the EHR, is in order.

The EHR, by way of its broader scope, will be defined first. An international systematic review of technical literature on electronic health records defines the term as:

"A repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users. It contains retrospective, concurrent, and prospective information and its primary purpose is to support continuing, efficient and quality integrated health." (Hayrinen, Saranto, & Nykanen, 2008).

This supplements the Canadian definition of the term, as decided by Canada Health Infoway:

"*An Electronic Health Record (EHR) provides each individual in Canada with a secure and private lifetime record of their key health history and care within the health system. The record is available electronically to authorized health care providers and the individual anywhere, anytime in support of high quality care. This record is designed to facilitate the sharing of data – across the continuum of care, across healthcare delivery organizations and across geographies."* (Giokas, 2005).

The US-based Health Information and Management Systems Society (HIMSS) defines the EMR as:

"An application environment composed of the clinical data repository, clinical decision support, controlled medical vocabulary, order entry, computerized provider order entry, pharmacy, and clinical documentation applications. This environment supports the patient's electronic medical record across inpatient and outpatient environments, and is used by healthcare practitioners to document, monitor, and manage health care delivery within a care delivery organization (CDO). The data in the EMR is the legal record of what happened to the patient during their encounter at the CDO and is owned by the CDO." (HIMSS, 2006).

The definition of EMRs, as used in the survey analyzed as part of this study provides a simpler, more intuitive explanation that accurately captures the scope of its use in Canadian medical practice:

*"An **EMR System** is a computer system that provides authorized users with applications that access an EMR database of patient information, including the ability to update, manipulate, transmit, and view the records. EMR records are not necessarily shareable among different systems, but shareability and access to online patient information from other sources may be a highly desirable attribute. The content and granularity of an EMR system may vary widely within*

a given health system between different healthcare disciplines, different healthcare sectors, and different healthcare settings."

In the Canadian context, the difference between the EMR and EHR comes down to the use settings of the technology, the depth and breadth of patient data in each, and the right of ownership of the data. The EMR is characterized by the depth of patient information, but lacks breadth as it provides a cross-sectional look at the health status of a patient only. Information on interactions with other health care providers, such as specialist consultations may not be included. (The Canadian Medical Protective Association, 2008). As in the HIMSS definition, ownership of the EMR falls to the care organization that developed it. An EHR however is technically owned by the patient and is a longitudinal record of health data submitted by different providers.

The rationale for attempting to make healthcare paperless lies in the wealth of benefits it is expected to provide. EMR usage in a primary care setting for example can improve quality of care by helping patients manage chronic conditions by automatically creating reminders for future appointments. EMRs also help ensure that key patient information is highlighted (e.g. medication history) to avoid issues such as adverse drug reactions, by way of a rule-based recall system (Health Canada, 2006). From a financial perspective, much of the administrative hassle with regards to reimbursement for health services (which are usually sought from the government or from insurance companies) can be reduced or eliminated if providers can share relevant patient encounter and claims data with payers.

Ten years on, the debate regarding the quality and viability of Medicare has yet to abate. Issues of healthcare quality, delivery and access have tended to generate more political hay than sound public policy. The voices for reform will grow louder as healthcare expenditure continues

on an upward trend. Between 2002 and 2010, per capita expenditure on health care in Canada rose 54 per cent, from $2,871 to $4,445 in US Dollar Purchasing Power Parity (PPP) terms (OECD, 2012). On this measure, Canada's expenditure ranked lower than the United States ($8,233) and Norway ($5,388), but higher than France ($3,974) and the United Kingdom ($3,433).

As for measures of health system performance, avoidable mortality rates fell by half between 1979 and 2008, from 373 per 100,000 people to 185 per 100,000 people (CIHI, 2012). "Avoidable mortality" is defined by the Canadian Institute for Health Information (CIHI) as *"untimely deaths that should not occur in the presence of timely and effective health care, including prevention."* For an international comparison of health system performance, 2004 data from the World Health Organization (WHO) shows that the avoidable mortality rate in Canada was third lowest among a group of G7 countries, excluding Italy, at 200 per 100,000 people. Only Japan and France had lower rates, while the United States topped the list at 271 per 100,000 people (Ibid).

Research Question and Hypothesis

The purpose of this study is to partially address the two recommendations of the Romanow Report highlighted above. Specifically, this study evaluates the adoption and impact of Electronic Medical Record systems among Canadian general practitioner physicians (GPs) across two groups: "small practices" of two or fewer physicians and "large" practices of three or more physicians. The rationale for dividing physicians this way (discussed in more detail in the "Data and Methodology" section) is based partially on a precedent set in Schoen et al (2009), which exhibited differences in EMR adoption internationally between practices of certain sizes. A second reason for using this division is to identify specific aspects of EMR systems that may

hinder adoption in small practices. Small practices may be disadvantaged in the area of EMR adoption because they may lack the financial and administrative resources necessary for a smooth transition towards effective use of such systems. Although practice size has been found to be a factor affecting adoption rates in the United States (see sub-section V in the literature review for details), no such link has been found for Canadian primary care practices as yet.

It is therefore important to investigate these potential links as such practices make up a significant portion of first-line medical care in the Canadian health system. A cost-effectiveness study of a pan-Canadian EHR conducted by Canada Health Infoway (CHI) and Booz Allen Hamilton estimated that there were 6,148 solo practices across the country out of a total of 13,265 (46.8 per cent) (CHI, 2005). These include both GP and specialist practices. The number of physicians in solo practices was 26 per cent in 2003 and expected to fall further due to provincial incentives to encourage group practice (Solomon, 2008).

The null hypothesis or H_0 in this study is that there will be no differences in the perception of value of EMR systems between the two groups. The alternative hypothesis H_A is that there are differences in perceptions of value regarding certain aspects of EMR systems between the two groups. Based on the available literature (see sub-section V in the Literature Review) there is evidence to suggest that small practices are more likely to perceive lower value than larger ones as they are less likely to have the financial resources and support staff to maintain the systems. They are also likely to have a smaller patient portfolio and thus less likely to realize the gains from scale in using EMR systems.

Contribution of Study to Existing Literature

In addition to synthesizing some of the relevant literature in this field, this study provides an original analysis of a pan-Canadian survey of HIT usage among GPs. Although there has been

considerable research on the barriers to adopting HIT solutions among Canadian physicians, there is considerably less information regarding the effectiveness and utility of such systems once implemented. This study is novel in the sense that it uses survey data from GPs from several provinces to examine a specific research question, namely whether there are differences in attitudes towards and usage patterns of electronic medical record systems among GPs working in small practices or large ones. This question has important implications for policymaking in the following areas: (1) Improving the value proposition of EMR systems in primary care practice, (2) supporting progress towards a nationally interoperable health information exchange (HIE) infrastructure (3) controlling health care costs and (4) improving health outcomes for everyone served through Medicare.

The study is divided into five sections: the introduction is followed by a literature review, a description of the survey data and the methodology of the analysis, discussion of results, analysis and recommendations for addressing gaps and a conclusion.

2. Literature Review

I. The Role of Primary Care in Addressing Challenges in Health Care

In the Canadian health care system, primary care practitioners are the first line of defense against illness, injury and death. The Canadian Health Services Research Foundation defines primary care as follows:

"Primary health care recognizes the broader determinants of health and includes coordinating, integrating, and expanding systems and services to provide more population health, sickness

prevention, and health promotion, not necessarily just by doctors. It encourages the best use of all health providers to maximize the potential of all health resources". (CHSRF, 2012)

As mentioned, this study focuses on EMR system usage among family doctors and general practitioners (hereby abbreviated as FPs and GPs). At the end of 2010, FPs comprised just over half of the 69,699 physicians licensed in Canada (CIHI, 2010). While most FPs are involved in the practice of family medicine, many are also employed in hospitals, emergency departments or non-physician office settings such as academic research (IHE, 2010). For more detailed information regarding the number, practice jurisdiction and age groups of family physicians in Canada, Appendix 1.

Services related to primary care delivery include prevention and treatment of common illnesses, basic emergency services, referrals to hospitals and specialist care and palliative and end-of-life care (Health Canada, 2006). An effective primary care practice will have developed a comprehensive knowledge base regarding its patients and the community it serves, will provide evidence-based care by following clinical guidelines and collaborating with other health care professionals by developing and sharing patient information through EMR systems (CHSRF, 2009). According to that report, commissioned by the Canadian Health Services Research Foundation, high-performing healthcare organizations, including primary care practices, are characterized by a clear mission and vision, sustained leadership, stakeholder participation and a focus on patient-centred excellence. Quality improvement at such organizations occurs through regular performance measurement initiatives, change management, incentives for care providers, patient input and the implementation and use of appropriate technology for care provision (CHSRF, 2009).

These characteristics are critical to effectively dealing with the burden of disease in Canada. As shown in Figure 1, the major causes of deaths among Canadians are through chronic conditions that are expensive to treat and would benefit greatly from preventive interventions delivered through primary care. Some conditions like diabetes and cardiovascular disease (including hypertension) can be prevented or at least delayed through regular checkups and health promotion activities such as good nutrition and active lifestyles. Preventive strategies can also tackle conditions such as lung cancer and chronic lower respiratory diseases like emphysema and chronic bronchitis through regular screening and public health education campaigns such as smoking cessation programs. Smoking continues to be the leading cause of premature death in Canada and account for between 6 and 15 per cent of health care spending (Health Canada, 2012).

More worryingly, Canadians today overestimate the degree to which their behaviours protect them from the risk factors behind cardiovascular and respiratory. The Heart and Stroke Foundation combined data from three nationwide surveys conducted between 2007 and 2010 to compare public perceptions of healthy behaviour with actual prevalence of risk factors (Heart and Stroke Foundation, 2011). It found that while 18 per cent of adult survey respondents self-identified as obese, the national prevalence was 24 per cent. There was a larger gap between the number who self-reported as being physically inactive in their leisure time (31 per cent) and the actual prevalence (48 per cent). Half of the survey respondents also noted that their health care providers had not asked them about their dietary habits or family history of heart disease or stroke (Heart and Stroke Foundation, 2011). This was attributed to the tendency of busy physicians to concern themselves mostly with acute cases; unfortunately, this only makes the manageable cases of the present become the acute cases of the future.

Thus, it is not merely enough for individuals to have regular access to care services; care providers must take an active approach to ensure that patients are adequately informed about their own health status and that they are aware of risk factors that may cause illness or disability down the road. A CIHI report found that of those needing routine or ongoing care, 13 per cent encountered difficulties receiving it. However, 40 per cent of adults with three or more chronic conditions spoke to their physicians about specific strategies to improve their health either rarely or not at all (CIHI, 2009).

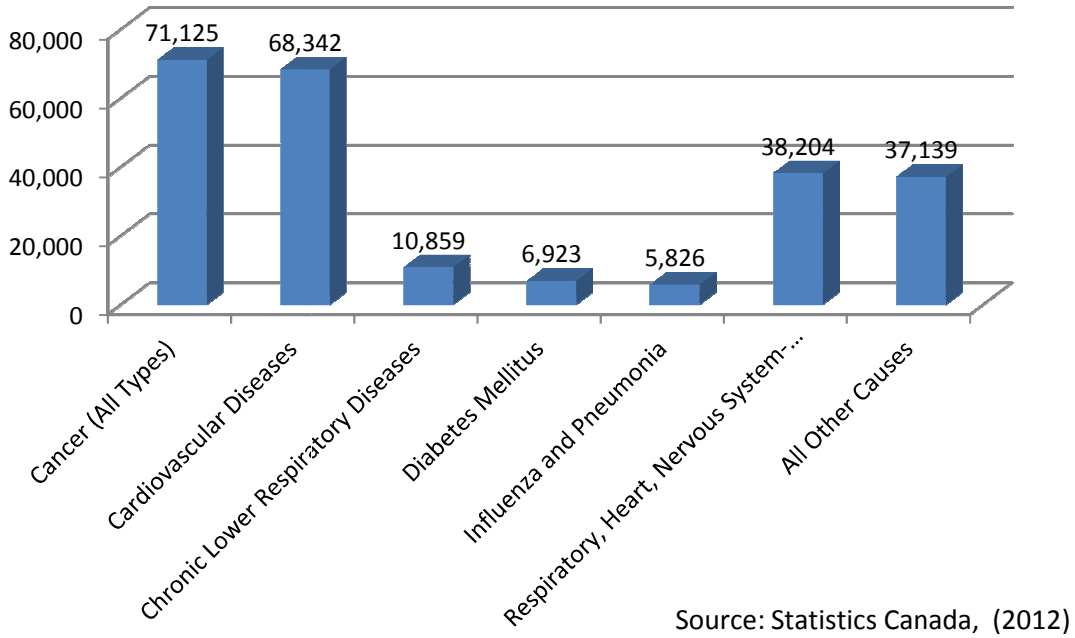

Figure 1: Major Causes of Mortality in Canada, 2009 (Total: 238,418)

One example of a primary care-centred strategy to tackle these challenges is the Chronic Care Model (CCM), which includes the following components, all conducive to EMR-assisted methods of care:

- Workflow management to support proactive care, including activities such as care coordination and follow-up appointment scheduling.

- Clinical Decision Support (CDS) tools such as disease management guidelines
- System-level support for chronic illness care across a network of healthcare providers
- Resources for patient empowerment and self-management.

These components have been adapted from Martin (2007). Recent literature shows evidence of the effectiveness of EMR systems in helping develop these characteristics within primary care systems:

- Workflow Management: an observational study of nine physician practices in Ontario, Manitoba, Quebec and British Columbia found that retrieving, archiving and sorting laboratory reports was 87 per cent faster with electronic reports compared to paper reports and 50 per cent faster compared to scanned reports (Canada Health Infoway, 2011).
- Clinical Decision Support: A group-randomized trial of primary care physicians in Minnesota sought to examine the utility of a CDS system to manage patients with Type 2 Diabetes. The CDS system, entitled "Diabetes Wizard", provides recommendations on medication levels according to haemoglobin, blood pressure or lipid level targets, using evidence-based diabetes management guidelines. It also recommends changes in treatment for patients exhibiting contraindications to existing treatments, appropriate diagnostic tests and follow-up appointments. The results of the trial showed that intervention arm patients exhibited significantly greater improvement in haemoglobin levels than control arm patients, and although both arms exhibited similar decreases in systolic blood pressure, intervention arm patients were more likely to control blood pressure levels than control arm patients. (O'Connor, et al., 2011).

- System-level support for chronic illness care: As mentioned previously, primary health care reform efforts have emphasized a collaborative, multi-organization, multi-disciplinary approach to care provision. EMR systems connected to other HIT systems to share data such as electronic laboratory test reports can improve access to care by reducing the lead time between consultation and specialist referral. The Ontario Laboratories Information System (OLIS) is a province-wide initiative to standardize health information exchange protocols between EMR systems and diagnostic laboratories. To date, four large hospitals in the Greater Toronto Area (GTA) are now connected to three community laboratories, while 12 EMR solutions from different vendors have been certified to access lab results data as part of OLIS (eHealth Ontario, 2012).
- Resources for patient empowerment and self-management: Patients with chronic conditions face barriers to self-management. Those with multiple conditions have reported difficulties in obtaining information necessary to prevent the adverse interaction of multiple drug treatments. The complexity of certain chronic conditions such as heart disease makes it difficult for patients to effectively self-manage (Health Council of Canada, 2012). An example of an approach to this problem is the Alberta-based Personal Health Portal (PHP). In 2011, the provincial government completed Phase I of the PHP, a web-based tool designed to allow patients in the province to access verified health information and support for accessing health services. Phase II, which is currently underway offers personalized solutions by acting as an information and communication portal for patient-specific conditions. This is expected to include personal health alerts and reminders, secure messaging for document exchange and

prescription renewals and a PHR (Personal Health Record) showing symptom tracking over time and provincial clinical data such as lab results and medication history (Government of Alberta, 2011).

II. Ideal Features of EMR Systems

The original concept of an EMR stemmed from Dr. Lawrence Weed's attempt to structure a patient record in medical practice in the United States in 1968. Dr. Weed realized that there was a fundamental disconnect between the often rigidly scientific nature of medical education and the multi-layered, often unstructured nature of patient data in real-life practice (Weed, 1968). His solution framework, titled the "Problem Oriented Medical Record" or POMR was a method of structuring patient data into a format that would allow for analyzing problems in a more scientific way.

The POMR was structured into three discrete components: a repository of the patient's individual and family medical history (called "database"), a dynamic list of patient problems (categorized as "active" or "inactive") and a series of structured progress notes that include the results of time-sorted treatments, categorized by the patient problem they were intended to treat. The major innovation of this model at the time was two-fold: structuring patient data in this way allowed physicians to easily organize their trains of thought and offered third parties an easily comprehensible way to interpret a patient's history and record of care (Brandejs, Kasowski, & Fortin., 1976). The diagram in Figure 2 shows a conceptual layout of a POMR. It has been adapted from Benson (2009) and recreated using Microsoft Visio. The ellipse represents a starting point and the cylinders represent a database. The rectangles represent a process, the parallelograms represent categories of data and the diamond shapes represent decision points.

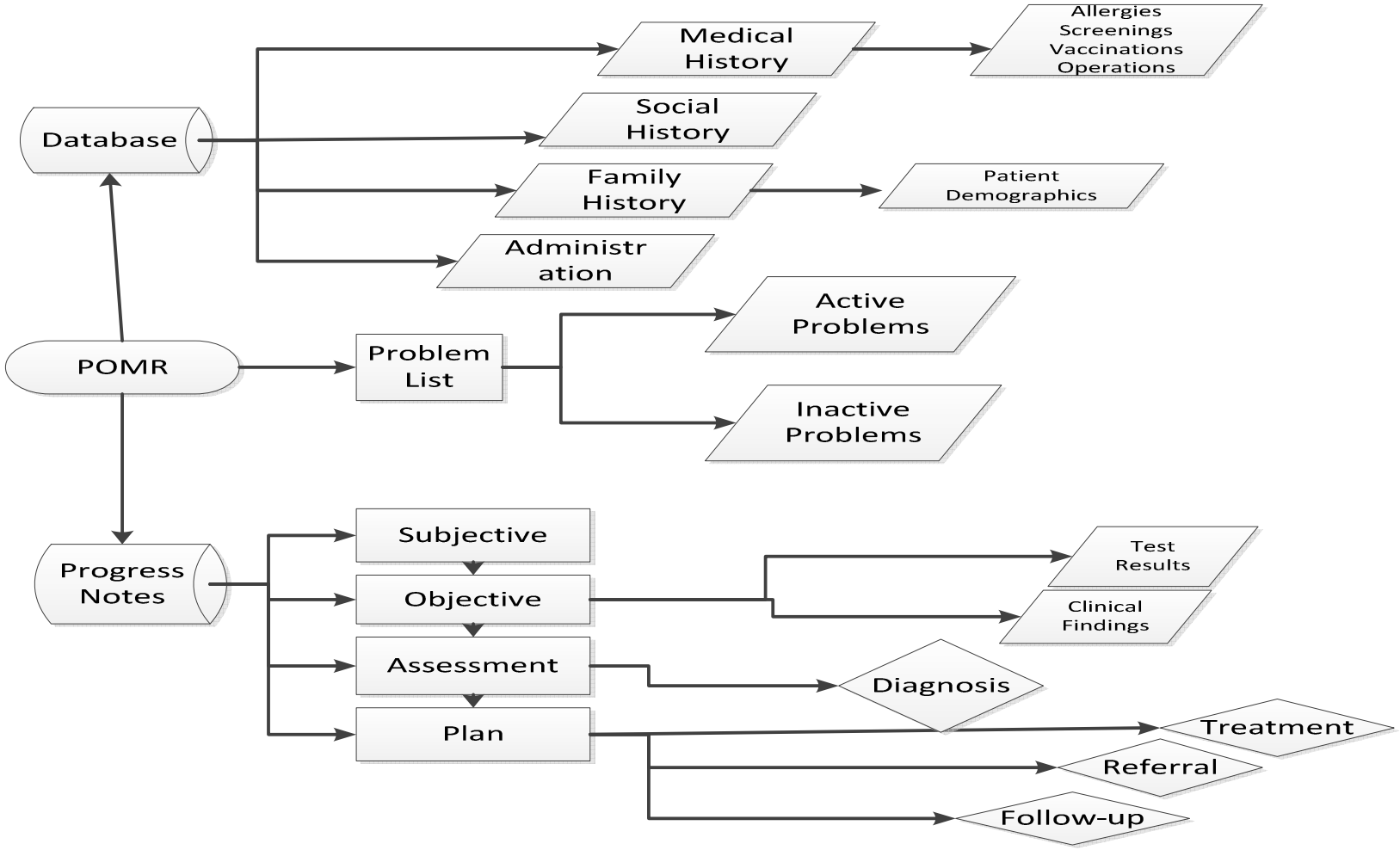

Figure 2: Conceptual Structure of the Problem-Oriented Medical Record (POMR). Source: Benson (2009)

Since then, there has been considerable research conducted on what features EMR systems should contain to make physician uptake inevitable, rather than a chore. Some of the key characteristics of such systems, particularly in primary care practice are:

- **Standardized language of clinical terminology** through which clinical data is generated and read by multiple systems without potentially dangerous changes in definitions between different care providers (The College of Family Physicians of Canada, 2011). In addition to ensuring patient safety, this contributes to efforts to achieve *semantic* interoperability, where data shared between multiple systems are machine-readable or encoded at the level of "formally defined domain concepts" (ISO, 2004). This can occur through the use of a clinical terminology standard such as SNOMED CT (Systematized Nomenclature of Medicine Clinical Terms), which is a multi-language, actively maintained and governed repository of over 300,000 clinical terms (Shaw, 2012).
- **Computerized Physician Order Entry (CPOE):** the purpose of CPOE is to electronically generate orders for diagnostic tests or medication prescriptions and transmit them to other links in the healthcare chain such as laboratories and pharmacies (BCMA, 2004). CPOE systems are ideally used in conjunction with a terminology bank such as SNOMED to ensure common understanding with the end-user as well as a CDS system in order to detect potential drug interaction issues before the order is completed.
- **Data security and patient privacy**: the confidential nature of patient health information has long been one of the cornerstones of modern health care systems. The increased focus on collaborative care and need to eliminate operational inefficiencies

like duplicate diagnostic tests means that patient data will need to be shared among more parties. In addition to maintaining patient trust, ensuring data security also indemnifies care delivery organizations against lawsuits to an extent (Sicotte & Pare, 2010). In terms of certification criteria, EMR systems should offer physicians control over use, disclosure and retention of records, and the system itself should offer security features such as user identity management, data integrity options (such as backups and restoration functions) and data confidentiality (such as anonymizing patient identifiers where necessary) (Canada Health Infoway, n.d.)

- **Secure physician/patient communication:** Kaiser Permanente (KP) is a large health care management organization (HMO) in the United States. HMOs are networks of providers at each stage of care (preventive, acute, long-term care, etc.). The organization is one of the few in the country to have a fully interoperable inter-provider, nationwide EHR system in place. In 2008, a survey of 35,000 diabetes and hypertension patients within the KP provider network was conducted. The survey found that those who contacted their physician via the secure email messaging system built into the KP EHR platform, performed better in health quality measures than those who did not (Zhou, Kanter, Wang, & Garrido, 2010). The benefits were estimated in terms of lower haemoglobin A1c (HbA1c) and LDL-C (Low-density Lipoprotein Cholesterol) levels for diabetes patients and reduced blood pressure levels for hypertension patients.
- **Unstructured text entry:** The appeal of an unstructured data layout in an EMR is that it emulates the traditional filing of clinical notes maintained by physicians. It is unstructured in the sense that it is difficult to draw data from it through an automated

process as the layout is not consistent between different patients. Such layouts, which in EMR systems can include scanned documents or free text fields, serve a purpose as they possess a narrative quality that can be useful when communicating with patients (Ryan, 2011).

The drawback of this layout, as opposed to a structured one with drop-down menus to neatly categorize patient information, is that it will be time-consuming for a different physician to locate crucial patient data as he/she will be wading through someone else's data management methods. From a research perspective, unstructured text entry makes it difficult to aggregate data across multiple patients for use in public health surveillance or disease registry creation. However, it is virtually impossible to design a structured template that will provide for entry or access to every possible piece of data that is generated through patient encounters. Moreover, it is very difficult for physicians to navigate to the appropriate template in order to enter the data (especially if it is data that are rarely entered or accessed). Because interfaces requiring totally structured data entry suffer from these difficulties, physicians generally do not like to use them and will resort to workarounds that avoid their full use, thus making retrieval of needed data intractable because it is virtually impossible to find.

III. International Comparisons of EMR Usage Rates

The table below compares the use of EMR systems in primary care in six countries. The information has been adapted from a 2009 survey of primary care physicians conducted by The Commonwealth Fund (2009) and from Schoen, et al. (2009). The study methodology describes 14 key functionalities of EMRs in primary care. EMR systems featuring 9 to 14 of these functionalities are categorized as "High-Functionality EMRs." The full list of functions include:

the EMR itself, electronic ordering of medications and tests, computer access to test results and medication lists, computer alerts/prompts, and decision support; computerized re-minder systems for prevention and follow-up care; computerized ability to list patients by diagnosis, lab results, and medications; and electronic entry of notes and medical histories (Schoen, et al., 2009).

Table 1: International Comparison of EMR Usage (2009)

		Canada	France	Germany	Netherlands	United Kingdom	United States
Gatekeeper Role?		No	No	No	Yes	Yes	No
Dominant Remuneration Method		FFS	FFS	FFS	Capitation/FFS	Capitation/FFS	FFS
Sample Size (unweighted)		1,401	502	715	614	1,062	1,442
Routine Use of IT for Core Tasks (%)							
Electronic Ordering, Lab Tests		18	40	62	6	35	38
Electronic Access, Test Results		41	36	80	76	89	59
Electronic Prescribing		27	57	60	98	89	40
Electronic Drug Interaction Alerts		20	43	24	95	93	37
Electronic Entry of Clinical Notes		30	60	59	96	97	42
Computerized Capacity to Generate:							
List of Patients by Diagnosis		37	20	82	97	90	42
List of Patients by Lab Result		23	15	56	62	85	29
List of Patients Due/Overdue for Checkups		22	19	65	69	89	29
Full Medication History of Patient		25	24	65	61	86	30
Percent High Functionality EMRs by Practice Size (2)							
Number of FTE Physicians	*<2*	6%	14%	31%	53%	83%	7%
	2 to <5	18*	16	41	55	89*	25*
	≥5	17*	N/A	N/A	N/A	92*	40*

Source: The Commonwealth Fund (2009)

Notes:
Asterisks - Items with asterisks (*) denote statistically insignificant differences between intra-country practices of <2 physicians.
FFS – Fee For Service
N/A - Fields marked N/A denote sample sizes below 30 for practices with 5 or more FTE physicians

IV. Theoretical Frameworks in HIT Research

Existing research on the adoption of health information technology tends to be based on two dominant theoretical frameworks: the Technology Adoption Model (TAM) and the theory of Diffusion of Innovations. A diagrammatic explanation of the TAM, adapted from Moores (2012) is provided below. According to Moores, the key factors within the TAM affecting a user's willingness to adopt a new technology are:

1. Perceived usefulness: the likelihood that the use of the system is directly associated with improved job performance.
2. Perceived ease of use: the extent to which the user believes the system will require minimum effort to use effectively.

Moores helpfully identifies some of the major criticisms of the TAM, all of which are especially relevant to its use in analyzing HIT adoption. First, the concept of 'system use' in the classic TAM is an inadequately narrow definition of technology acceptance. Second, there are multiple version of TAM in the literature today due to the lack of *"the lack of research on the design and implementation-based antecedents"* of the two major acceptance factors defined above. Third, the classic TAM cannot account for the consequences of the system after its implementation, in terms of changing users' behaviours and job performance (Moores, 2012).

These limitations manifest themselves frequently in EMR implementation projects. An influential review article of e-health technologies found weak evidence to support the theory that CDS and CPOE systems improved organizational efficiency (Black, et al., 2011). The authors found that a rigorous evaluation of the costs, risks and benefits of such systems were lacking in

many cases. Sections IV and V of the literature review in this study provide example of Canadian practices where EMR implementation led to benefits as well as unexpected problems.

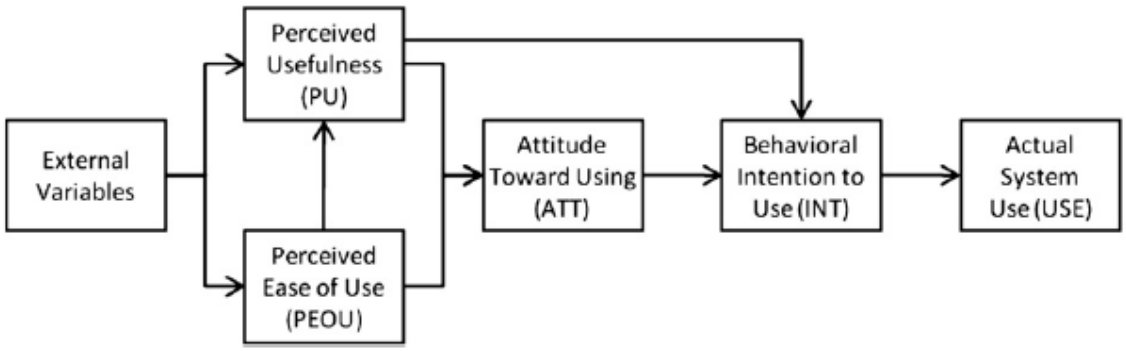

Figure 3: The Technology Acceptance Model (Source: Moores, 2012).

The theory of diffusion of innovations was developed and applied across multiple organizations by Everett Rogers. He defined 'diffusion' as the process through which an innovation spread between members of a social system. He also realized that there may well be a lag between the availability of the innovation and its broad adoption. The types of individuals and organizations most likely and least likely to adopt innovations were categorized as innovators, early adopters, early majority, late majority and laggards, in that order (Rogers, 2003). Geibert (2006) provides an instructive conceptual application of Rogers' theory to the implementation of an EHR in the context of nursing practice; the bulk of the article applies to EMR implementation in family practice as well. Rogers identifies five key characteristics of innovations that may explain their differing rates of adoption; Geibert applies these to the implementation of EHRs in the following way:

1. Relative advantage: Is this product or service better than what came before it?

2. Compatibility: Does the innovation align with the intended users' values and needs?
3. Complexity: What might be the resource cost of effectively exploiting the innovation?
4. Trialability: Can the intended user experience the innovation hands-on for a limited time?
5. Observability: Will the outcomes be visible to individuals outside the core user group?

A survey on CPOE adoption among Swedish nurses and physicians was developed using the principles of the diffusion of innovations theory (Rahimi, Timpka, Vimarlund, Uppugunduri, & Svensson., 2009). The findings showed that expectations of relative advantage prior to implementation were high, while expectations of complexity were low. More physicians than nurses reported that the system was not adequately customized for their practice and that they would have preferred to retain the old system. As part of the analysis, this study explores the "complexity" and "trialability" aspects of the diffusion of innovations theory by exploring the nature of 'vendor lock-in' with regards to EMR adoption. These are discussed in detail in the "Results" section.

Due to the fact that the dataset for this study was originally developed for a different type of analysis (discussed in the "Data and Methodology" section), this study does not explore the results of the quantitative analysis through the lens of a specific theoretical framework. However, as noted above, theories of IT adoption are far from being set in stone and are likely to encounter significant changes due to the multi-setting, multi-purpose applications of technological innovations as well as the fast-moving nature of technological development.

V. Barriers to EMR Adoption

A 2007 survey of almost 1,000 physicians in British Columbia identified some key barriers to the implementation and meaningful use of EMR systems (Lai, Lau, & Shaw., 2009). The

majority of physicians that had already implemented such systems at the time of the survey (86 per cent) had been using them for over a year. The authors reported that physicians found the cost, time and effort involved in implementing such systems to be the biggest hurdles. For those who had not implemented EMRs, non-adoption was attributed to the above factors, as well as the unsatisfactory quality and suitability of existing solutions in the market. Today, physicians and healthcare professionals can access free EMR comparison-shopping resources such as CanadianEMR, which contain evaluations of vendors and EMR solutions as rated by participating physicians (CanadianEMR, 2012).

A case study of a successful transition to an EMR system at a 15-person, multi-disciplinary family medicine group in Quebec found that modifications to workflow management were the biggest challenge to overcome (Gagnon, et al., 2010). In the interim, there was a considerable time cost associated with scanning documents to store electronically as well as what staff perceived to be duplication of effort in creating online records as well as maintaining paper records before the system was fully online.

The Canadian Medical Association funded a set of 20 case studies of successful EMR adoption in practices across the country in 2008. A review of data from those studies conducted by Paterson, et al. (2011) found that physicians were concerned about adapting to workflow changes, the possibility of insufficient interoperability and thus low system utlity and the need for on-call technical support to maintain problem-free operations. Additionally, they expressed concerns regarding productivity loss, particularly in areas such as data entry mistakes, scanning documents, and initial delays caused by the need to populate the EMR system. Interestingly, they also noted the prevailing fee-for-service remuneration model as a barrier to adoption.

Despite the logic of Dr. Weed's proposed solution to the problem of unstructured clinical information, physicians are often reluctant to adopt computerized solutions as they realize that doing so is likely to involve changes to their workflows. Unless EMR systems are demonstrably intuitive to use,exhibit benefits quickly and are interoperable with IT systems across the healthcare spectrum, physicians may well consider them as a time-consuming distraction from their core responsibility of providing healthcare.

VI. Variance of IT and EMR Use Across Practice Sizes.

There is a growing body of case-based evidence to suggest that EMR and EHR systems are more challenging to implement in small practices than large ones. Much of the evidence cited in this section focuses on practices in the United States, rather than Canada. That said, the information is still applicable to Canadian medical practice given the similarly low rates of EMR adoption in both countries relative to other nations like the United Kingdom.

A survey of 4,200 physicians in the state of Florida (756 of whom were family physicians) found that routine EHR use in solo practices (13.8 per cent) was significantly lower than in practices of 2-9 physicians (20.4 per cent), 10-49 physicians (45.2 per cent) and more than 50 physicians (72.8 per cent) (Menachemi & Brooks, 2006). The definition of EHRs used in that survey was nearly identical to that of an EMR used in this study.

Similarly, a nationwide survey of American physicians found a widening gap in health IT usage between physicians in small and large practices (Grossman & Reed, 2006). For example, in 2005, there was a statistically significant difference in the use of IT solutions for the exchange of clinical data between solo/two-physician practices (29 per cent) and practices of 3-9 physicians (43 per cent), and 10-50 physicians (61 per cent). The authors posit that lower

adoption levels may be explained by the greater availability of financial and administrative resources among larger practices, as well as the ability to spread implementation costs across more physicians and achieve economies of scale across a larger base of patients.

Finally, a more recent qualitative case study of six small primary care practices (with a total of 14 physicians) in the Commonwealth of Virginia found that EHR implementation (again synonymous with EMRs as defined in this study) introduced both benefits and challenges (Goldberg, Kuzel, Feng, DeShazo, & Love., 2012). EHRs improved the organization and accessibility of patients' medical histories, but also created problems in terms of inadequate system support in practices without in-house IT staff or dedicated EHR specialists.

VII. EMR Systems in Canada

HIT policy in Canada has been driven by both provincial and federal initiatives, beginning in the 1990s. While HIT systems have been in use before then, they were generally used for billing and scheduling purposes, rather than for directly facilitating the provision of care. In those cases, clinical data would be coded using international standards like ICD-9 (the ninth revision of the International Classification of Diseases, published by the World Health Organization) but largely in order to comply with reimbursement protocols set by local, provincial or federal health authorities (Brookstone, 2011). According to the 2010 National Physician Survey (NPS), 58.9 per cent of FPs/GPs used HIT systems for electronic billing, but only 41.3 per cent used it to enter and retrieve clinical notes (National Physicial Survey, 2010). A summary of relevant data gathered through the NPS is provided in Table 3.

A 2010 strategy document by the Canadian Medical Association outlined problems in HIT implementation and put forward a five-year plan to realize the benefits of such systems faster. A

major criticism of federal HIT initiatives (discussed below) it leveled was the disconnect between the predominantly local nature of care and the highly centralized, top-down solution favoured by Canada Health Infoway. The report recommended that HIT investments should focus on improving local-level infostructure in order to encourage faster adoption and effective use of EMRs and other HIT solutions, rather than diverting the bulk of resources towards the pan-Canadian vision of interoperable EHRs that CHI is attempting to achieve by 2016 (CMA, 2010).

The report provides an implementation and funding framework to accelerate HIT adoption that could be expected to realize benefits within 12 to 18 months following implementation. With a budget of $923 million phased over five years, the CMA believes that HIT can be effectively leveraged to tackle the financial and health burden of chronic disease. The funding amount it proposes is a fraction of the combined annual cost of conditions like diabetes, heart disease, hypertension, asthma, mental illness and cancer, which it estimates to be $65.6 billion (CMA, 2010). A summarized version of the CMA's funding framework is shown below

Table 2: 5-Year Funding Framework for CMA HIT Strategy

Funding Objective	Funding Item	Investment ($ Millions)		Total
		Years 1-3	Years 4-5	
Significant EMR Adoption in Primary Care	EMR Solutions	240	170	**$735M**
	Transition Support & Change Management	200	110	
	Functional Requirements for Specialists	6	4	
	Data Migration Costs	5	-	
Increase Effective Use of EMRs and HIT Solutions	Applied Research	9	11	**$37M**
	Consumer Research	5	-	
	EMR Decision Support Tools	2	-	
	Natural Language Processing	6	4	
Accelerate Health Information Exchange	Regional Interoperability Solutions	65	35	$151M
	Interoperability Standard	1	-	
	Telehealth	50	-	
TOTAL		589	334	**$923M**
Source: Adapted from CMA (2010)				

Funding these specific areas will allow health authorities to effectively engage physicians, patients and other stakeholders in developing broader chronic disease management (CDM) strategies. It does so by supporting the implementation of cheaper, smaller-scale activities such as:

- Preventive health plans, including screening and vaccinations. In 2006, 72.8 per cent of women aged 20-69 underwent screening for cervical cancer. In the United States, that number was 83.5 per cent in 2011 (The Commonwealth Fund, 2011).

- Medication management to ensure patient adherence to medication regimes and to prevent adverse drug reactions.
- Continuity of care by coordinating activities with other healthcare professionals.
- Patient involvement: encouraging the use of tools to inform patients about health risks and encourage patients to take on more of the responsibility of ensuring their well-being.
- Public health: using HIT solutions such as prescription information databases to generate real-time population health surveillance data to quickly identify disease outbreaks or mass adverse drug reactions.

All of these were identified within the CMA report and strongly supplement elements of the Chronic Care Model discussed earlier.

Table 3: Selected HIT Usage Data from the 2010 NPS (Canada-wide)

Usage of Computerized Patient Care Functions, FP/GPs	PC/Laptop	Handheld Device	Plan to Adopt in next 2 years
Patient appointment/scheduling system	51.9%	1.1%	6.4%
Billing	58.9%	0.6%	4.1%
Entry and retrieval of clinical patient notes	41.3%	1.0%	12.0%
Reminders for recommended patient care	27.9%	1.7%	10.7%
Warning for adverse prescribing and/ or drug interactions	28.1%	8.4%	11.2%
Interface to external pharmacy/pharmacist	9.9%	0.7%	14.3%
Interface to external laboratory/diagnostic imaging	41.5%	0.6%	11.3%
Online disease management tools	34.5%	0.5%	4.0%
None of the Above	5.5%	5.5%	5.5%
No Response	11.0%	74.6%	65.0%
Population (N) = 33275 Population-weighted Sample Size *(n)*= 6345 *Source: NPS (2010), Q. 29*			

At the provincial level, Alberta and Ontario were the first to formally implement initiatives to move HIT adoption forward. At present, provincial programs that provide funding for EMR transition also exist in British Columbia, Saskatchewan, and Nova Scotia (Canadian Medical Association, 2012).

Alberta

Since 2001, the Physician Office System Program (POSP) in Alberta has been providing financial assistance and change management services for physicians looking to implement EMR solutions in their practices. The initiative is funded by the provincial Ministry of Health, which also provides vendor certification for its province-wide EHR known as Alberta NetCare. This provides additional value to physicians as there is assurance that the training and cost associated with EMR systems include a guarantee of interoperability with provincial HIT systems such as the Pharmaceutical Information Network (a CPOE system) as well as Alberta NetCare, which is designed to include a top-to-bottom repository of patient data including laboratory test results, diagnostic imaging reports and immunization and medication history.

Eligible physicians can receive funding up to a maximum of $35,000 to cover the cost of implementing a province-certified EMR solution. This includes a maximum reimbursement of $14,000 for one-time expenses, and a total of $21,000 for recurring expenses (POSP, 2012). Currently, 90 per cent of diagnostic imaging reports and prescription information for provincial residents are available through the NetCare portal (Alberta NetCare, 2012a). As of June 2012, the POSP has funded EMR implementation programs for 1,632 of the provinces 4,820 eligible physicians (34 per cent) (POSP, 2012c, 2012d), (Alberta NetCare 2012b, 2012c).

Ontario

EMR transition programs in the province are led by OntarioMD, an organization established by the Ministry of Health and Long-Term Care and the Ontario Medical Association. OntarioMD is a subsidiary of the latter organization. Like POSP in Alberta, the EMR Transition Support Program at OntarioMD subsidizes EMR implementation and provides change management consulting services on the demand side (medical practices). On the supply side, it provides EMR specification and standards certification services for vendors. Its funding program began in 2005, with current Early Adopter programs running until March 2014. Total funding for eligible physicians is a maximum of $29,800, divided into a one-time grant of $3,500, a performance grant of $2,000 and a monthly payment of $675 over 36 months. To be eligible for funding, physicians must use EMRs for a range of services, such as writing all prescriptions, electronic receipt of lab results (from at least one provincial laboratory) and use EMR-generated alerts to check drug interactions, as well as support preventive care management and schedule patient appointments. (Wong, 2010).

Another key organization tasked with solving Ontario's EMR puzzle is eHealth Ontario, which sets EMR standards as well as coordinates the province's broader EHR strategy through regional initiatives such as ConnectingGTA. More than 3,000 primary care physicians have implemented EMR systems in the province, with a further 4,900 in the process of doing so (eHealth Ontario, 2012). This information may not be current however, as an alternative source suggests that OntarioMD's target for March 2012 is to have 7,000 family physicians using the system, of a provincial total of 10,500 (Northern Ontario Medical Journal, 2012).

OntarioMD conducts a rolling end-user survey, but detailed results appear to be open only to participating physicians and affiliated health care organizations (OntarioMD). The latest

information available is from survey data from 1,750 physicians collected between February 2009 and September 2010 (OntarioMD, 2010). 90 per cent of these physicians reported using the certified EMR solutions to write and renew prescriptions, compared to 82 per cent in 2008. Similarly, 92 per cent of respondents reported filling out patient encounter notes exclusively in the EMR program, compared to 73 per cent in 2008. It should be noted however that respondents are required to complete the survey as part of the application process for receiving performance-based funding.

British Columbia

The provincial EMR adoption program is known as the Physician Information Technology Office, or PITO. It was established by the British Columbia Medical Association and funded by the provincial Ministry of Health Services. The program ran from April 2006 to March 31, 2012 with a total budget of $108 million. The program provides 70% reimbursements for HIT implementation, up to a maximum of $22,250 in the first year, with an additional $4,494 for annual EMR maintenance costs (or 70 per cent of the maintenance cost, whichever is lower) (PITO, 2011). Like the other programs profiled, PITO also involves a vendor and standards certification process as well as change management services, provided via 11 provincial relationship managers and 24 local physician champions (Canadian Medical Association, 2010).

At this time, implementing certified EMR solutions allows physicians to access lab results and pathology reports electronically from 40 public labs across the province (PITO, 2012). The outcomes of the PITO program in terms of adoption and integration progress with the provincial e-health strategy have not yet been made public. Based on the latest available information (December 2011), 65 per cent of the province's eligible physicians have adopted

EMRs in their practices (Smith, 2011a). An earlier report estimated the number of eligible physicians at 5,500 (Smith, 2011b).

PITO is one of eight projects in the province's overall e-health strategy. Some of the other projects include an interoperable EHR, or iEHR, the eDrug Project to provide electronic prescribing solutions, the Connecting Diagnostic Imaging project to provide digital access to diagnostic images, and the Provincial Laboratory Information Solution, or PLIS, which acts as a secure access point for all lab test results for provincial residents (British Columbia Ministry of Health, 2010). According to a policy document developed by the Ministry, PITO is expected to be the first phase of the EMR strategy, with successive phases having the objective of moving physicians into using e-prescribing and electronic lab reporting solutions exclusively, followed by using EMR systems to develop cohesive strategies for chronic disease management (British Columbia Ministry of Health, 2011).

Manitoba

The EMR Adoption Program in Manitoba was launched in October 2010 as a partnership between Manitoba Health, Manitoba eHealth and Canada Health Infoway, the federally funded eHealth body. Like other provincial programs, it is designed to offset 70 per cent of the cost of certified EMR systems in primary care practices in the province. Funding was made available for up to 1,000 physicians and nurse practitioners. For early adopters, i.e. those who had begun implementation prior to April 2009, a maximum of $10,000 would be paid in reimbursement for participating physicians, with an extension to $20,000 for each clinician added to the practice after April 2009. For new EMR purchasers, the terms are more generous, with a $3,000 advance to be paid per participating clinician in addition to a cumulative total of $20,000 per participating clinician. Funding disbursements are made in phases, and to receive the full amount of subsidies,

participants must show proof of effective clinical use, including the submission of the data set from the EMR to aid population health surveillance activities and comply with patient privacy requirements. (Manitoba eHealth, 2010).

Similar to projects in other provinces, the Manitoba program offers a Peer-to-Peer network of local leaders to act as advisors and advocates to encourage usage among provincial care providers (Manitoba eHealth). The EMR Adoption program is being rolled out concurrently with a broader EHR initiative known as eChart Manitoba, which is expected to created a standardized, interoperable and comprehensive EHR with ancillary services such as the provincial Laboratory Information System (LIS) for e-prescribing and drug interaction database development as well as a Radiology Information System (RIS) and Picture Archiving and Communication System (PACS) Project for the development of a diagnostic imaging repository. As of December 2010, both RIS and PACS integration was completed for 58 sites across the province (Manitoba eHealth, 2011).

Saskatchewan

The Saskatchewan EMR Program was launched by the Saskatchewan Medical Association (SMA) and the provincial Ministry of Health (MoH) in 2010. Like other provincial EMR programs, it provides a combination of funding, change management, peer network and certification services to incentivize physicians in implementing EMR solutions. Funding obligations are divided between the SMA and the provincial MoH on a 30-70 basis (SMA, n.d.). Unlike other provincial programs, this one requires physicians to already have a system in place before payments can be made; a monthly fee of $300 is paid if the physician can document 50 per cent of approved consultations through the EMR. For funding to continue beyond the first year, the physician must be able to document 95 per cent or more of patient visits through the

system. As an encouragement to adopt while interoperability work continues on the provincial EHR, an additional $100 will be paid per month until the second major leg of the EHR system is in place (SMA, n.d.). Information on physician adoption rates is not publicly available at this time.

Federal eHealth Initiatives

Canada's HIT strategy has been devised and implemented by Canada Health Infoway (CHI), a non-profit, government-funded group created by national First Ministers in 2001. CHI is responsible for developing interoperability standards but is also in charge of evaluating investment projects and allocating funding to get them started. CHI contributes up to 75 per cent of the cost of approved projects (which involve partnerships with the relevant provincial or territorial healthcare departments) and is involved in the implementation, monitoring and assessment of project deliverables. The provinces and territories are responsible for maintaining EHR systems; since CHI's contribution is capped when projects are approved, the province/territory are accountable for project cost overruns.

According to CHI, a 'full health infostructure', (where 100 per cent of Canadians will have EHR-based care) between 2006 and 2015 will cost $10-12 billion in capital with $1.5-1.7 billion in annual operating costs (CHI, 2006). As of March 2009, CHI had spent 29 per cent of the $2.1 billion in funding allocated to it since 2001 (CHI, 2009) (OAG, 2010). At the time of writing, 26 out of 30 nationwide HIT-related projects have been completed. These include key projects such as privacy and security architectures, EHR standards, and drug messaging standards (CHI, 2011a).

Given the single-payer nature of the Canadian health system and the resulting financial leverage of the government vis-à-vis providers, one might expect that CHI would have an easier time encouraging HIT adoption within interoperable standards than in largely privately-financed systems in countries like the United States. Unfortunately, Canada's adoption of HIT among primary care practices actually appeared to lag that of the US in 2009, and is well behind that of many European countries whose healthcare systems are similarly structured, as Table 1 showed.

A recent survey (Rozenblum, et al., 2011) of national and provincial stakeholders in the area of HIT found that CHI's strategy for interoperability was well-received among respondents, as were its considerable financial resources and its development of provincial patient registries and medical imaging systems. However, respondents said that CHI's strategy did not sufficiently engage clinicians, who would be the main users of the systems. Adoption could also improve if financial support were changed from the subsidy-only model to one that rewarded improvement in patient outcomes from HIT usage. The focus on national interoperability from the outset was found to be problematic, as respondents suggested that adoption rates would improve if interoperability initiatives addressed local needs first. It was also recommended that the national EHR blueprint was too rigid and needed to be adaptable to feedback from implementation experiences.

3. Data and Methodology

Survey Design and Quality of Data

This study uses a subset of data from a pan-Canadian survey of physicians across multiple practice specializations. The original study for which the survey was designed (Archer & Cocosila, 2011) applied Structural Equation Modeling (SEM) techniques to develop a

theoretical framework to identify behavioural factors encouraging or discouraging the use of EMR systems in Canadian practice. The results of the model suggested that ease of use of EMR systems was a key factor in motivating continued use of such systems. For physicians already using these systems, the perceived overall risk associated with EMR adoption was a key factor limiting the uptake of these systems among other physicians.

The survey was carried out in December 2009 by a commercial firm with a panel of nearly 67,000 registered physicians, including both FP/GPs and specialists. The survey used in this study was made available in both English and French. Physicians were approached once by the survey firm via e-mail. The full list of survey items analyzed for the purpose of this study can be found in Appendix 2. The survey was originally pre-tested by three PhD students at McMaster University and later by three practicing physicians before it was distributed to survey respondents. Responses were collected through a cross-sectional survey conducted online.

The sample was stratified with a pre-set maximum stratum size. Sampling therefore terminated when the stratum size was reached. The defined strata were:

- 25 family physicians in small group practices and were not using EMRs.
- 25 family physicians in small group practices and were using EMRs.
- 25 family physicians in larger group practices who were not using EMRs.
- 25 family physicians in larger group practices who were using EMRs.

The same 4 strata was defined for specialist physicians. The defined strata size was the minimum necessary for the SEM model to generate estimates that could be tested for statistical validity. As each respondent was compensated for participating, using this minimum size allowed for some degree of cost-effectiveness.

The specified total therefore consisted of 200 physicians. 220 physicians participated due to an error as the survey firm ran the test for longer than specified; some strata therefore consisted of more than 25 respondents. Of the 67,000 sampled, we can assume that approximately 51 per cent were family physicians, based on their distribution across Canada. This percentage has been calculated from the totals in the tables in Appendices 1a and 1b, which show the number of registered family physicians and registered physicians (all specializations) respectively, in Canada as of December 31, 2010. The representativeness of the final sample is somewhat limited as the online nature of the survey excluded physicians lacking Internet access. Additionally, the response rate of 0.33 per cent in this survey is noticeably lower than comparable nation-wide surveys such as the 2010 NPS, which achieved a response rate of 2.0 per cent for the online version of the survey and 17.5 per cent for the paper version (NPS, n.d.). With that said, it should be noted that the sample size was intentionally limited to 200 as that was adequate for the original purpose of the survey.

Survey Structure

Respondents could be expected to complete the survey in approximately 20 minutes. The survey had one set of questions for physicians who had not yet adopted an EMR system and a nearly identical set of questions for those who had. The difference between questions in the two categories was in the use of tense in phrasing the questions. For example, a physician who had not adopted an EMR system might respond to a question phrased as:

"I would find the system easy to use – Strongly Agree"

However, a physician who had already adopted an EMR system would respond exclusively to the second category of questions, one of which would be phrased as:

"I find the system easy to use – Strongly Agree"

Each of the questions dealing with physician perceptions of EMR (i.e. those questions without specific answers such as specialization, geographical location of practice, age range, etc.) are scored on a seven-point Likert scale, ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"). The statistical analysis in this study will focus on questions scored in this manner.

Data Selection and Definitions

This study focuses exclusively on the responses of FPs and GPs who were using EMR systems at the time the survey was conducted. The dataset was filtered to select only those who responded to the survey item "Q2. Please Select your Medical Specialty" as "Family Medicine or General Practice." This reduced the sample size from 220 respondents originally to 104 respondents, with 50 responding to the "non-EMR" category of survey items and 54 responding to the "EMR" category of survey items.

This study's subset of the 54 "EMR" respondents was further subdivided into two categories: those practicing in "small" organizations and those in "large" organizations. The definition of a small organization used in this study is where there are a maximum of two (2) full-time physicians in the respondent's practice. A "large" organization is one where there are three (3) or more full-time physicians in the practice.

These categorizations were based on those used by Schoen, et al., (2009) which appeared earlier in Table 2, as well as the evidence on lower EMR adoption among smaller practices summarized in sub-section V of the literature review above. Dividing the sample this way also allows for a more balanced distribution between the two groups, which is helpful when using

statistical methods to identify differences in perceptions of utility of EMRs. The final sample used in the analysis contains 22 physicians in the "small" practice group and 32 in the "large" practice group. The figures below show some key characteristics of the samples.

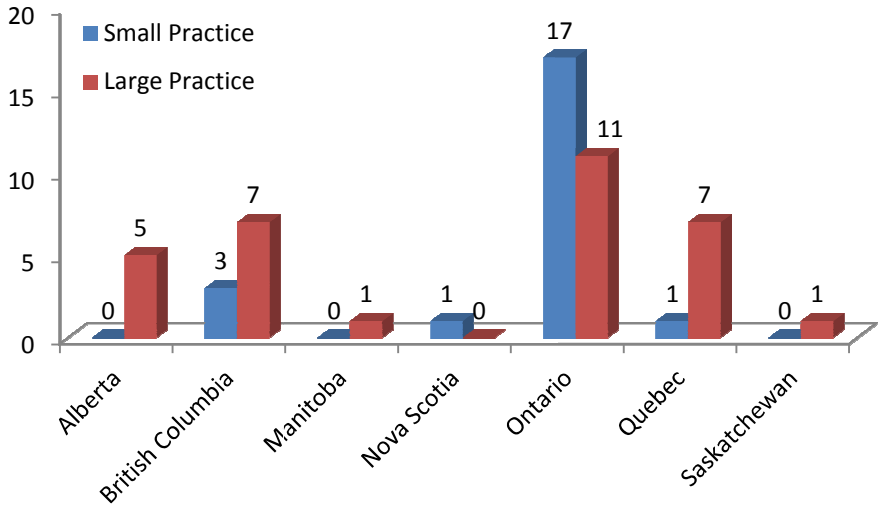

Figure 4: Geographic Distribution of Sample (n=54)

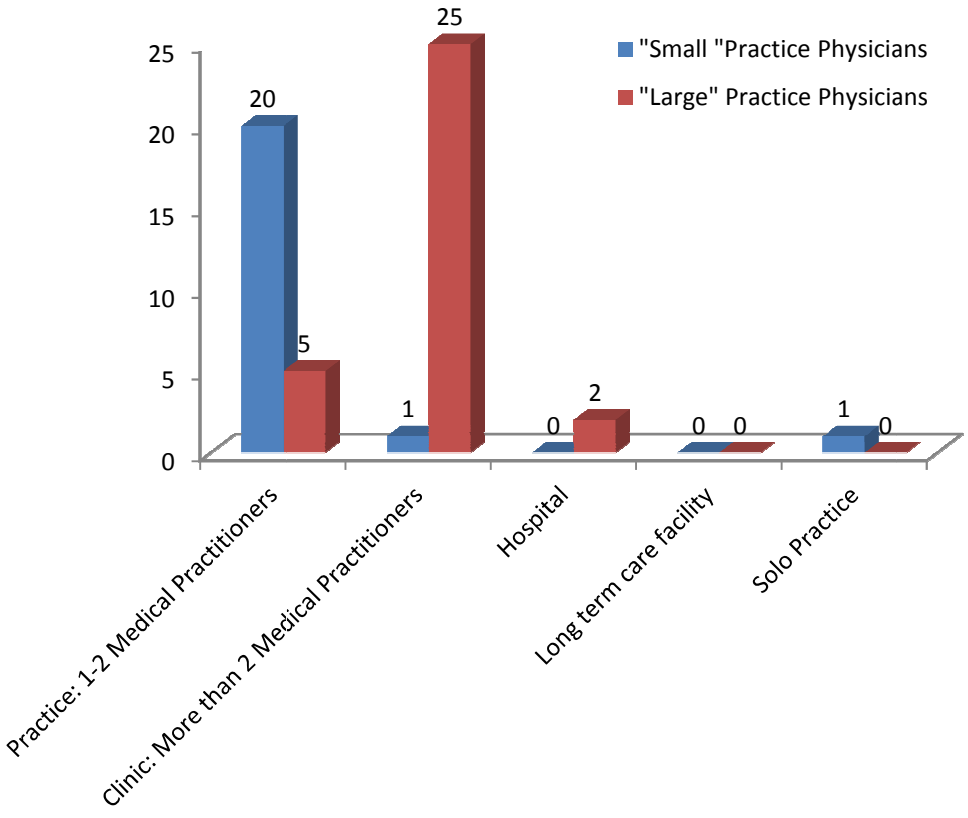

Figure 5: Practice Setting of Survey Respondents

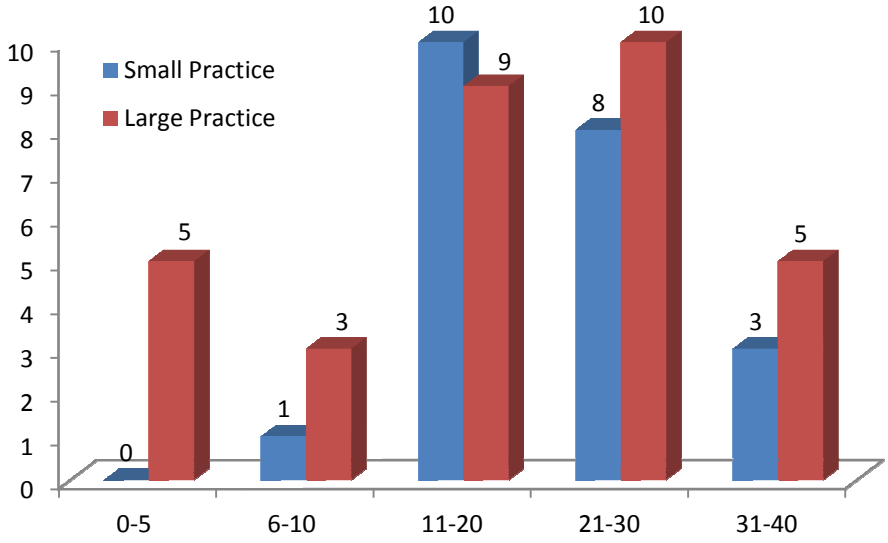

Figure 6: Years of Experience in Practice (x-axis)

Statistical Analysis Method

A common technique for estimating whether differences in mean outcomes between two groups are statistically significant is the *t*-test. The nature of this sample however violates certain core assumptions of the *t*-distribution. Such tests can be legitimately used if the distribution of scores is continuous; the Likert scale used to score the survey items is discrete. The small size of the sample may also violate the assumption of normality that characterizes a *t*-distribution, thus making the *t*-test unsuitable for analysis.

Therefore, the technique used in this study is the non-parametric Mann-Whitney U test, which is suitable for non-normal distributions. Additionally, the *U* test is suitable in cases where data are ordinal, but the interval between data points cannot be assumed to be equal. For instance, there is no way to tell the difference in the strength of an opinion between "Strongly Agree - 7" and "Agree – 6" versus that of "Agree – 6" and "Somewhat Agree – 5" as these are subjective measures. In this survey, the two samples are assumed to be independent, i.e. responses from one group are assumed to not be influenced by responses from the other. The Mann-Whitney U Test was previously used in an EMR adoption study to compare survey item scores (rankings) of barriers and incentives between two subgroups of physicians (Lai, Lau, & Shaw., 2009). The computations in this study were performed using IBM SPSS Statistics 17.

Ethics Statement

The original survey and study were approved by the McMaster University Research Ethics Board. As this study is effectively using secondary data and not using any sort of confidential clinical information, it does not require similar approval from an institutional ethics board.

4. Results

Description

SPSS conducts Mann-Whitney U tests as two-tailed tests, which is to say that it measures the statistical significance of a greater or lesser difference between one group and the other. The focus of this study will be on a negative difference between the scores of physicians in "small" practices and "large" practices, so it is effectively a one-tailed test. The test was run once for each of the 54 survey items pertaining to EMR value perception and usefulness. The minimum number of responses in the "small" group was 18 and 27 in the "large" group.

The two samples were first tested to check if significant differences existed in gender makeup, years spent in practice and dominant remuneration models; none were found.

With a one-tailed significance threshold of 0.05, 7 of the 54 survey items were detected to have significant differences in the scores between the two groups. In each case, H_0 was rejected and the outcomes confirmed the alternate hypothesis outlined above. Table 4 displays the results for the survey items found to exhibit significant differences between the two samples.

Based on the results shown, there is some evidence that GPs/FPs in "large" practices are significantly more comfortable in their use of certain aspects of EMR systems than their counterparts in smaller practices (Items 6A5, 6A7, 6F30, 6J51). They also rate their own effectiveness in using the system to provide patient care higher than their small-practice counterparts (6J52).

On the other hand, a significantly larger proportion of physicians in small practices feel that they are not working as quickly with their EMR systems as they were before its implementation (6D24). This appears to be in spite of the fact that people they consider

influential encourage the use of such systems to a greater degree than their counterparts in larger organizations (6H45).

Discussion

Study Limitations

Prior to commencing a discussion of the results, it is helpful to recall that the survey sample is small and geographically skewed towards heavily populated provinces like Ontario, Alberta and British Columbia. The division of the groups into the "small" and "large" categories may not fully reflect real-world practice as Canadian family physicians often operate as part of a network and share responsibility for after-hours care. Additionally, the survey results provide only a snapshot of physicians' perspectives as of December 2009; trends in HIT usage may have changed substantially since then. Thus, the analysis provided here should be considered as exploratory at best; the limitations of the study methods and available data prevent terming the findings as conclusive. Other limitations of the study are noted in the Conclusion section.

Table 4: Selected Results from Survey Analysis

Survey Item #	Degree of Agreement with the following statement (1)	Sample Type (2)	*n (3)*	Mean Rank	Sum of Ranks	M-W U (4)	*z*-Score	*p*-Value (5)
6A5	It has become easy for me to become skilful at using the system	S	21	21.62	454.00	223.000	-0.196	0.025
		L	31	29.81	924.00			
6A7	Learning to operate the system has been easy for me	S	21	21.38	449.00	218.000	-2.065	0.020
		L	31	29.97	929.00			
6D24	It is now taking longer to perform my regular work duties	S	21	30.88	648.50	233.500	-1.738	0.041
		L	31	23.53	729.50			
6F30	I have the knowledge and training necessary to use the system	S	21	21.02	441.50	210.500	-2.358	0.009
		L	32	30.92	989.50			
6H45	People who are important to me think that I should use the system	S	21	28.74	603.50	194.500	-1.890	0.030
		L	27	21.20	572.50			
6J51	I am comfortable using the system	S	21	20.95	440.00	209.000	-2.251	0.012
		L	31	30.26	938.00			
6J52	I use the system effectively during patient encounters	S	21	22.12	464.50	233.500	-1.790	0.037
		L	31	29.47	913.50			

Notes:

1 - Agreement is scaled from 1 ("Strongly Disagree") to 7 ("Strongly Agree")

2 - S: small practices. L: large practices

3 - *n :* observations per group

4 - Mann-Whitney U Statistic

5 - SPSS calculates P-values for 2-tailed tests. The values displayed have been halved due to the one-tailed nature of the hypothesis.

Analysis of Results

It is difficult to determine the reasons behind the difference in EMR value perceptions between the two groups using the survey data alone. The analysis here attempts to link the findings with issues identified in the existing research literature.

Usability Issues in Existing EMR Solutions

One of the reasons behind the lower scores for users' confidence in using the EMR system among small practice physicians may be the unsatisfactory usability of existing EMR solutions. The complexity and volume of clinical information that led to the development of the POMR has also led to EMRs that resemble flight cockpits, with a multitude of features and options that can disorient even the most technologically savvy physicians (Ludwick & Doucette, 2009). A systematic review of best practices in EMR implementation found that so-called "silver bullet" technologies such as voice recognition and mobile computing could make such systems less daunting to use (Keshavjee, et al., 2006), Leonard, et al. (2008). However, voice recognition as it exists today will still transcribe voice notes into free text. As discussed before, the unstructured nature of free text notes makes it difficult to search for specific information, or categorize data for multiple patients for the purposes of public health surveillance.

A report by HIMSS recommends that physicians or organizations attempting to solicit tenders from EMR vendors should clearly specify usability questions when developing Requests for Proposals (RFPs) (HIMSS, 2010). Before a vendor is selected, physicians and staff should also perform usability tests to get an idea of how their workflows will change if the solution being tested is adopted. Unfortunately, this is much easier said than done in small practices where physicians are more likely to juggle roles of care provider, purchasing manager and IT technician.

The survey also included a "Comments" section that allowed physicians to provide more detailed and open-ended perspective on EMR adoption or provide information that would otherwise not have been captured in the survey. The comments are summarized below. It should be noted that the comments should not be considered to represent a definitive indicator of physician perceptions as there is an element of selection bias present, i.e. physicians with exceptionally good or exceptionally poor experiences in implementation or feel particularly strongly about HIT policy are more likely to comment than those who have neutral opinions on these topics.

Table 5: Synopsis of Free-form comments from Survey Data

Comment Theme	Practice Size	Province	Total Comments
Dissatisfaction with EMR Vendor product, cost and/or support	S, L	ON	4
Provincial/Federal EMR programs unsatisfactory	S, L	ON, AB, QC	6
EMRs found useful in practice	L	ON, AB	3
EMR usability found lacking	S, L	AB, BC	4

Abbreviations: S – Small, L-Large, ON-Ontario, AB-Alberta, QC – Quebec, BC-British Columbia

The Role of EMR Vendors in Influencing Adoption

The table above displays some issues physicians have with the state of EMR systems that are also reflected elsewhere in the available literature. Problems with vendors have been a common barrier to encouraging EMR uptake. There is a lack of transparency with regards to pricing options and features; often doctors cannot obtain a quote without arranging for a sales visit or via e-mail (Dawes, 2010). Both options are time-consuming and prevent customers from effective comparison shopping. Resources such as CanadianEMR while helpful, are unlikely to provide the full scope of information on key issues like pricing, which varies according to the practice size and complexity of implementation. One of the survey comments also point to the problem of

vendor lock-in; essentially, it is difficult to assess the quality of an EMR system until it has been in use for some time, at which point the benefits and costs become clearer. However, the time and financial cost associated with initial implementation and workflow management modifications serve as a disincentive to scrap the system and start from square one. This ultimately may leave some physicians in a worse position than they were before they had adopted; paying money for a system that they consider to be inadequate for their use.

This problem becomes even more acute as provincial EMR funding is generally contingent upon implementing a solution that has been certified by the program body. This essentially gives a select group of EMR vendors oligopolistic power over physician practices in the province. Certification requirements, although necessary for the development of content standards for the ultimate goal of interoperability, hinder competition. Not only does this provide certified vendors with a guaranteed revenue stream from physicians purchasing their solutions (to qualify for funding) but also provides little incentive to compete on price or improve the quality of the product or after-sales service. As mentioned, vendor lock-in makes it difficult for physicians to switch EMR products, even if the vendor's certification is revoked. The table below shows market share among certified EMR vendors in Ontario. With four vendors controlling over 70 per cent of the market, the remaining players have little choice but to fight for a piece of a shrinking pie. That said, another valid perspective on this issue involves the relatively small size of the Canadian EMR market; smaller vendors may only have a limited number of installations to maintain, which may not generate enough income for them to continue innovating and providing intuitive tools that physicians require. In that scenario, it may be more beneficial to have a few vendors controlling a large install base in terms of achieving the transition to interoperability.

Table 6: Funded EMR Offerings in Ontario as of July 31, 2012

Rank	Vendor	# Local Funded Physicians	# ASP Funded Physicians	Total	Market Share %
1	Nightingale On-Demand (Nightingale)[1]	6	1063	1069	21.70%
2	PS Suite (MDPSS)	882	133	1015	20.60%
3	OSCAR (McMaster)	861	-	861	17.50%
4	HS Practice (QHR/Healthscreen)*	556	-	556	11.30%
5	Accuro (QHR/Optimed)	323	-	323	6.60%
6	ABELMed (ABELSoft)	247	-	247	5.00%
7	Clinic Information System (P & P)	247	-	247	5.00%
8	Bell EMR (Bell)	-	199	199	4.00%
9	JonokeMed (Jonoke)	147	-	147	3.00%
10	EMR Advantage (CHS)	141	-	141	2.90%
11	YMS (YMS)	72	-	72	1.50%
12	Elitecare (QHR/Clinicare)**	19	-	19	0.40%
13	Globemed (Alpha Global iT)	16	-	16	0.30%
14	Med Access (Med Access)	7	-	7	0.10%
	Subtotal	3524	1395	4919	100%
	Total		4919		

Source: OntarioMD (2012)

[1]*Nightingale includes 427 CHC & AHAC physicians funded by eHealth Ontario.*

[*]*HS Practice was acquired by QHR*

[**]*Elitecare was acquired by QHR*

Even if new vendors are prepared to undergo certification testing, the payoff for them is highly uncertain as the big players have likely established their presence already and have gained they bulk of the business due to funding eligibility requirements and word-of-mouth between physicians and peer network leaders. Small vendors have previously voiced their dissatisfaction with the funding requirements, which in their opinion pay physicians to procure solutions from their larger competitors (Talaga, 2009). Each province also has different certification requirements, which means that small vendors looking to gain economies of scale by operating

in multiple provinces will be hindered by significant transaction costs associated with non-uniform requirements (Brookstone, 2011).

Ultimately, both sets of problems are likely to hamper efforts by small practices to implement EMRs. Despite the efforts of provincial programs to make the transition less inconvenient, a great deal of the burden remains on physicians with regards to using the systems effectively. Several case studies of successful EMR implementation have noted the importance of project leaders or organizational "champions" that possess both the clinical knowledge and managerial expertise to effectively communicate the benefits of EMR systems and motivate colleagues and staff to adopt the system wholeheartedly (Sicotte & Pare, 2010) (Leonard, et al., 2009).

Additionally, physicians in larger practices can leverage their extensive peer networks more to evaluate EMR options (price, usability, features etc.) to a more detailed extent than community physicians (Ludwick, Manca, & Doucette, 2010). Additionally, physicians in larger practices often collaborate with interdisciplinary teams to coordinate care and by extension, practice logistics. The larger the organization, the more feasible it is to hire in-house staff to focus exclusively on training staff to use the EMR systems, troubleshoot problems and conduct maintenance work to reduce downtime and the likelihood of unexpected technical issues. This creates possibilities for sharing resources, both human and financial and thus helps to partially offset the time and money associated with major projects such as EMR implementation. Interviews conducted by the study's authors found that physicians had a better sense of strategic planning necessary for working in those settings, and EMR implementation was often planned well in advance, allowing them to account for risks and reduce complications by rolling out the new system gradually (Ibid).

Effective Change Management for Successful EMR Adoption

In May 2011, Canada Health Infoway released a detailed framework for managing change and adjusting workflows for implementing EMR/EHR solutions (CHI, 2011b). The framework comprised six core elements, shown in the figure below.

Figure 7: CHI representation of A Change Management Framework in eHealth. Source: CHI (2011b).

Although the core elements identified above all play a role in ensuring successful transition and meaningful use of EMR system, some elements stand out as key success factors in the

existing case study literature. A review of three qualitative studies of EMR implementation in primary care practices in Ontario suggested that governance and leadership was critical to making the transition (Terry, et al., 2008). "Governance" is defined within the context of e-Health as the *'strategic view that links project tasks together – the "what are we doing" and "why are we doing it"'* (CHI, 2011b). Leadership within the organizations were tasked with communicating objectives and supporting change activities (Ibid). In Terry et al. (2008), organizational leaders also bore responsibility for setting expectations regarding the effort required for project success and the short and long-term benefits to be accrued through successful implementation.

Similarly, training and education has also been a major factor in ensuring meaningful use of such systems. A qualitative study of twelve Ontario-based community physicians using EMRs for at least 18 months found that implementation provided uneven benefits (Greiver, Barnsley, Glazier, Moineddin, & Harvey., 2011). While service efficiency increased due to administrative improvements such as quicker prescription refills, physicians themselves were not able to commit the time necessary to use the systems optimally; the benefits were found to accrue to what the authors termed 'superusers'.

Recommendations

The findings of this study and resultant implications for policymakers are limited by gaps in the available data. The survey was originally designed for a different purpose, and did not ask about some of the aspects of practice specific to primary care that might shed further light on how practice size is related to EMR perceptions such as (all of which could have potentially been framed in the seven-point "disagree/neutral/agree" categories as the other survey items):

- The extent to which financial assistance offset total cost of implementation.
- The awareness levels of physicians regarding regional and federal HIT implementation incentive programs.
- Whether the practice is located in an urban or rural setting.
- The availability, cost and skill of technical support in dealing with EMR-related troubleshooting.
- Ratings of EMR vendors in terms of price competitiveness, product quality and after-sales support.
- Physician expectations of benefits and usage: were they looking to merely streamline their appointment and billing processes, or use the system more extensively to improve disease registries, clinical decision support tools and diagnostic image viewing.

The above queries could have also served to explore differences in organizational culture, resources and workflow processes between the two groups and examine whether such differences affect physician attitudes and perceptions of EMR systems. These queries could add value as part of future survey research into EMR/EHR adoption issues. More effort should be made to gather information from physicians working in remote areas and First Nations communities, who face a different set of health challenges; it is well worth investigating whether EMR systems can aid CDM and public health surveillance efforts in those regions.

Given the rate at which EMR technology and features are changing and adoption rates are increasing, it may make sense for the CFPC and CMA to conduct a national survey of health IT usage on an annual basis rather than bundle it as part of the National Physician Survey which is administered every three years. Additionally, the CMA would do well to provide updated case studies of EMR implementation across Canada, now that provincial incentive programs are well

established; the 20 case studies it originally funded (CMA, 2008) are nearly four years old at the time of this writing. If new case studies are not feasible at this time, the medical community could still benefit from the dissemination of follow-up interviews on the practices originally profiled to assess the long-term benefit of EMR adoption and gain valuable information on solving implementation challenges.

As mentioned in Section 2.IV, this study does not analyze the survey data within the context of a specific theoretical framework due to the auxiliary-use nature of the dataset. Given the current limitations of the dominant models used today however (identified in the aforementioned section), researchers should continue efforts to refine existing conceptual approaches, perhaps by including levels of detail to account for the idiosyncrasies of the organizational and practice setting in which the technologies are implemented. This will allow for for more rigorous evaluations of HIT projects.

5. Conclusion

The limitations of the study listed above mean that the analysis provided here is largely exploratory and the findings of the study should be used to develop further research in the field, rather than directly inform policymaking. This study provides some evidence that small physician practices perceive the benefits of EMR systems significantly less positively than large practices. This is primarily due to issues with the user-friendliness of EMR systems as well as the continued uncertainty surrounding the procurement process with regards to cost and ultimate effectiveness. Provincial EMR programs as they stand today appear to stifle competition in the vendor market by maintaining non-uniform standards for EMR certification. EMR adoption rates among smaller practices may therefore be improved by tackling these specific issues.

While provincial EMR adoption programs appear to have accounted for these issues by providing financial subsidies and peer networks to encourage adoption and provide advice, the lack of publicly available and regularly updated information on the outcomes of these programs hinder our understanding of the effectiveness of these measures.

There is unlikely to be a "golden bullet" solution to the EMR implementation puzzle across Canada. The "Big Bang" approach favoured by organizations like CHI has come under criticism for the right reasons; namely, that primary care is delivered locally and thus the value of EMRs should be demonstrable at that level as well. The Canadian Medical Association strategy document provides a good starting point for revamping EMR adoption by focusing on key health priorities identified by patients and physicians alike: prevention, medication management, continuity of care, greater patient involvement and public health surveillance.

The profiles of provincial initiatives presented in this study use the latest publicly available information to give an idea of the relative success of the programs in increasing EMR adoption as well as completing phases of their EHR programs. Extensive interoperability is necessary before physicians can be fully convinced of the value of EMRs. Thus, it is encouraging to see that major strides are being made in connecting EMRs with diagnostic imaging systems and pharmacies. Unfortunately, provincial health authorities have not been sufficiently forthcoming with regards to maintaining an up-to-date summary of their results, making it difficult for policymakers and stakeholders to assess the extent to which goals have been achieved, and areas in which improvement is necessary. This must be resolved before EMRs become as commonplace in Canada as they are in the United Kingdom and northern Europe.

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APPENDIX 1a

Family Medicine Physicians, by Sex, Jurisdiction and Age Group, 2010

	<30	30–39	40–49	50–59	60–64	65–69	70–74	75–79	80 and Older	Unknown	Total
N.L.	16	181	153	147	47	41	12	7	0	0	604
P.E.I.	0	28	33	34	13	8	5	0	1	5	127
N.S.	6	187	319	339	119	61	20	15	10	1	1,077
N.B.	36	194	221	229	64	54	10	7	3	1	819
Que.	476	1,521	2,271	2,768	930	457	212	129	48	2	8,814
Ont.	155	2,254	3,533	3,412	1,336	826	382	170	102	0	12,170
Man.	13	227	370	346	97	65	33	12	8	46	1,217
Sask.	22	221	251	221	96	61	42	18	13	52	997
Alta.	238	951	1,122	1,054	317	193	82	37	18	53	4,065
B.C.	127	1,020	1,561	1,568	629	323	94	41	16	1	5,380
Y.T.	0	11	23	21	5	1	1	0	0	0	62
N.W.T.	0	5	11	4	4	0	0	0	0	0	24
Nun.	2	4	2	1	0	1	0	0	0	0	10
Canada	**1,091**	**6,804**	**9,870**	**10,144**	**3,657**	**2,091**	**893**	**436**	**219**	**161**	**35,366**

Source: (CIHI, 2010)

Appendix 1b

Total	Younger Than 30	30–39	40–49	50–59	60–64	65–69	70–74	75–79	80 and Older	Unknown	Total
N.L.	18	298	325	306	96	64	29	13	3	0	1,152
P.E.I.	0	37	59	77	23	15	10	2	1	12	236
N.S.	7	377	619	665	228	137	51	28	13	1	2,126
N.B.	36	383	460	384	121	101	38	14	7	2	1,546
Que.	499	3,669	4,498	4,886	1,821	1,170	705	388	159	2	17,797
Ont.	186	4,807	6,935	7,019	2,699	1,758	978	433	228	1	25,044
Man.	14	457	639	672	229	135	64	31	18	52	2,311
Sask.	25	393	465	422	151	115	64	27	18	98	1,778
Alta.	269	2,016	2,172	2,084	637	371	168	75	36	54	7,882
B.C.	138	1,928	2,649	2,851	1,126	650	220	109	36	1	9,708
Y.T.	0	13	26	22	8	2	1	0	0	0	72
N.W.T.	0	5	16	7	4	2	0	0	0	0	34
Nun.	2	5	3	2	0	1	0	0	0	0	13
Canada	**1,194**	**14,388**	**18,866**	**19,397**	**7,143**	**4,521**	**2,328**	**1,120**	**519**	**223**	**69,699**

Source: CIHI (2010)

Appendix 2

Survey Questions

You have indicated that your practice or clinic has either begun the acquisition and implementation of an EMR system, or that it has already done so. Given your experience with EMRs to this point, the following statements ask your opinion about electronic medical record systems (EMRs) and computerized office functions in medical practice, on a scale of 1 = strongly disagree through 4 = neutral through to 7 = strongly agree with the statement. Please click on the number that reflects your opinion in each case. If you don't know or have no opinion, click on ***DK****. If this statement is not applicable to you and/or your practice, click on* ***NA.***

Table 7: Survey Questions

	1=Strongly Disagree 4=Neutral 7=Strongly Agree
Performance Expectancy	
I find the system useful in my job	1 2 3 4 5 6 7 DK NA
Using the system improves my productivity	1 2 3 4 5 6 7 DK NA
Using the system increases my chances of getting ahead	1 2 3 4 5 6 7 DK NA
Using the system helps me to make fewer errors	1 2 3 4 5 6 7 DK NA
Effort Expectancy	
It has been easy for me to become skilful at using the system	1 2 3 4 5 6 7 DK NA
I find the system easy to use	1 2 3 4 5 6 7 DK NA
Learning to operate the system has been easy for me	1 2 3 4 5 6 7 DK NA
Using the system takes too much time from my normal duties	1 2 3 4 5 6 7 DK NA
Perceived Resource Risks	
My organization has had to use significant additional resources to acquire and operate the system	1 2 3 4 5 6 7 DK NA
My organization has shared its risk through government agency	1 2 3 4 5 6 7 DK NA

support to acquire and/or operate the system	
My organization has used additional resources to convert to the system	1 2 3 4 5 6 7 DK NA
My organization relied on outside support to help decide on a suitable system	1 2 3 4 5 6 7 DK NA
Perceived Performance Risks	
My organization had to develop innovations in internal practices in order to effectively use the system	1 2 3 4 5 6 7 DK NA
I have had concerns about risks from inability to get immediate assistance from the vendor if we experience system difficulties	1 2 3 4 5 6 7 DK NA
I have had concerns about risks arising from day to day operations of the system	1 2 3 4 5 6 7 DK NA
I have had concerns that the system will not work as expected	1 2 3 4 5 6 7 DK NA
Perceived Psychological Risks	
I have resisted the use of the system	1 2 3 4 5 6 7 DK NA
I am concerned that others in my organization are resisting the use of the system	1 2 3 4 5 6 7 DK NA
I was concerned about the stress placed on myself, colleagues, and staff during system acquisition and implementation	1 2 3 4 5 6 7 DK NA
Perceived Privacy and Legal Risks	
I am concerned about patient privacy with the system through unauthorized access	1 2 3 4 5 6 7 DK NA
I am concerned about liability issues with the system, if data are lost, mislaid, or stolen	1 2 3 4 5 6 7 DK NA
I am concerned about liability issues with the system, if practitioners make the wrong decisions based on its recommendations	1 2 3 4 5 6 7 DK NA
Perceived Time Risks	
I lost a lot of valuable time during the implementation process	1 2 3 4 5 6 7 DK NA

It is now taking longer to perform my regular work duties	1 2 3 4 5 6 7 DK NA
I lose valuable time when the system is unavailable due to system failure	1 2 3 4 5 6 7 DK NA
Perceived Overall Risk	
On the whole, considering all the potential risks, it has been very risky to adopt the system	1 2 3 4 5 6 7 DK NA
Adopting the system to support our practice was risky	1 2 3 4 5 6 7 DK NA
Based on my understanding of the risks associated with adoption, and other information about similar systems, the risk of adoption has been acceptable	1 2 3 4 5 6 7 DK NA
Facilitating Conditions for Users	
I have the resources necessary to use the system	1 2 3 4 5 6 7 DK NA
I have the knowledge and training necessary to use the system	1 2 3 4 5 6 7 DK NA
The system is not compatible with other systems I use	1 2 3 4 5 6 7 DK NA
Using the system fits well with my work style	1 2 3 4 5 6 7 DK NA
Job Functions. **The system supports the following functions:**	
Basic office functions, including e-mail, scheduling, billing	1 2 3 4 5 6 7 DK NA
Ability to generate lists of patients for recall and treatment for prevention and chronic disease management	1 2 3 4 5 6 7 DK NA
Health information and data capture (demographics, medication lists, problem lists, clinical notes, medical history, follow up)	1 2 3 4 5 6 7 DK NA
Order entry management (prescriptions, lab tests, radiology, referrals)	1 2 3 4 5 6 7 DK NA
Orders sent electronically	1 2 3 4 5 6 7 DK NA
Data received electronically from other sources (lab tests, radiology results, etc.)	1 2 3 4 5 6 7 DK NA
Results management (viewing lab results, imaging results)	1 2 3 4 5 6 7 DK NA
Clinical decision support (warnings of drug interactions, out of range test levels, guideline based interventions or screening)	1 2 3 4 5 6 7 DK NA

Job Relevance	
In my job, usage of the system is important	1 2 3 4 5 6 7 DK NA
In my job, usage of the system is relevant	1 2 3 4 5 6 7 DK NA
In my job, usage of the system is frequent	1 2 3 4 5 6 7 DK NA
Social Influence	
People who influence my behaviour think that I should use the system	1 2 3 4 5 6 7 DK NA
People who are important to me think that I should use the system	1 2 3 4 5 6 7 DK NA
People in the organization who use the system have more prestige than those who do not	1 2 3 4 5 6 7 DK NA
Having an EMR system is a status symbol for my organization	1 2 3 4 5 6 7 DK NA
Personal Information Technology Innovativeness	
If I hear about a new information technology, I look for ways to experiment with it	1 2 3 4 5 6 7 DK NA
Among my friends and colleagues, I am usually the first to try out new information technologies	1 2 3 4 5 6 7 DK NA
I like to experiment with new technologies	1 2 3 4 5 6 7 DK NA
Behavioural Intention To Use The System	
I use the system multiple times every day	1 2 3 4 5 6 7 DK NA
I am comfortable using the system	1 2 3 4 5 6 7 DK NA
I use the system effectively during patient encounters	1 2 3 4 5 6 7 DK NA
I use the system effectively for population based management for panels of my patients	1 2 3 4 5 6 7 DK NA