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IMPROVING EMR SYSTEM ADOPTION IN CANADIAN MEDICAL PRACTICE: A RESEARCH MODEL AND SURVEY PROPOSAL

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Abstract

Fewer than one in four Canadian doctors use electronic medical record (EMR) systems, although almost all have some form of computer for scheduling and billing purposes. Each year in Canada, more than 100 million physician examinations and 500 million laboratory and radiology tests are performed, and 382 million prescriptions are written. These patient records are scattered and often inaccessible in doctors' offices, clinics, test centres, labs, and hospitals. To properly care for their patients, primary care practitioners must have access to all their relevant medical records. If a physician does not use an EMR system, results may be transferred by fax, telephone, or mail, causing significant delays in diagnosing problems. Even when physicians use EMR systems, incompatible systems create serious problems when a patient's records must be transferred to other settings or when coordination is required among several practitioners. This results in errors or mislaid information, unnecessary delays, duplication of effort, higher costs, and reduced quality of care.

Non-adoption of EMR systems is a highly complex problem that has not been addressed adequately in a comprehensive manner. There are many interdependent factors that influence adoption and these must be considered simultaneously. The first objective of this proposed research is therefore to develop and validate statistically a comprehensive theoretical model of EMR adoption through a national survey of physicians, to attempt to explain why private medical practices in Canada have tended to be slow in adopting electronic medical records and related systems. This paper describes that model and its basis, including the methodology that will be used to analyze the data. A second and dependent objective, arising from results from the first objective, will be to propose and evaluate potential policies that would help to improve the adoption of such systems in a manner that would support their most effective and efficient application by medical practitioners.

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1. Introduction

In 2000, there were 57,800 physicians in Canada, of whom 51.3% (29,650) were General Practitioners (GPs) (CIHI 2001). Today 25% of GPs work in solo practice, and 74% in group practice. Fewer than one in four Canadian doctors use electronic medical record (EMR) systems, although almost all have some form of computer for scheduling and billing purposes. Each year in Canada, more than 100 million physician examinations and 500 million laboratory and radiology tests are performed, and 382 million prescriptions are written. These require documentation and may flow from one part of the circle of care (the practitioners and institutions responsible for a patient's healthcare) to another (Picard June 14 2007). These patient records are scattered and often inaccessible in doctors' offices, clinics, test centres, labs, and hospitals. The lack of EMR systems in use by private practitioners or the existence of incompatible EMR systems creates serious problems when a patient's records must be transferred to other settings (see Figure 1, which depicts the flow of information among the different healthcare settings where a patient might be treated). When these transfers occur, full details of the patient's information must be available at all times so patient care is not disrupted. For example, if coordination is required among several practitioners, mislaid or missing information may result in errors, unnecessary delays, duplication of effort, higher costs, and reduced quality of care.

At the present time, there is a major campaign involving large expenditures of public money to increase the adoption rate of EMR systems to much higher levels in Canada, emphasizing interoperability with other external sources of patient records. The main difficulty in this approach is that it attacks a problem without knowing its root causes and the context of their complex interrelationships.

A number of studies of private practice adoption of EMR systems in Canada and elsewhere have been done, but most of these studies addressed in isolation one or a few relevant obstacles to adoption. The influence of some issues has not been addressed adequately, including system interoperability, the impact of EMR systems on physician-patient relationships, and physician experience with such systems following implementation. Such research may result in healthcare policies that encourage adoption for the wrong reasons, leaving physicians with problems rather than benefits from adopting EMR systems, resulting in abandonment of the systems at a financial loss to the physicians and the loss of advanced information support for them, their staff, and their patients.

The first objective of this research is to develop and validate a comprehensive model that will explain why private medical practices in Canada have tended to be slow in adopting electronic medical records and related systems. A second and dependent objective, arising from results from the first objective, will be to propose and evaluate potential policies that would help to improve the adoption of such systems in a manner that would support their most effective and efficient application by medical practitioners.

The current study proposes an approach that considers simultaneously the many factors that influence adoption, in order to propose policies that consider all the major influencing factors, with solutions that mitigate resistance and bring the maximum benefit to adopting physicians. This will help to develop a full understanding of the adoption issue. Validation of a preliminary

questionnaire will be undertaken initially through detailed interviews with a small number of physicians, with equal numbers of adopters and non-adopters, followed by a national sample survey of physicians with the revised version of the questionnaire, again with equal numbers of adopters and non-adopters. The validated model would help to identify the issues that are the most important, allowing attention to be directed to resolving these issues by mitigating resistance to adoption, through changes in adoption strategies and/or through improved implementation and operational practices.

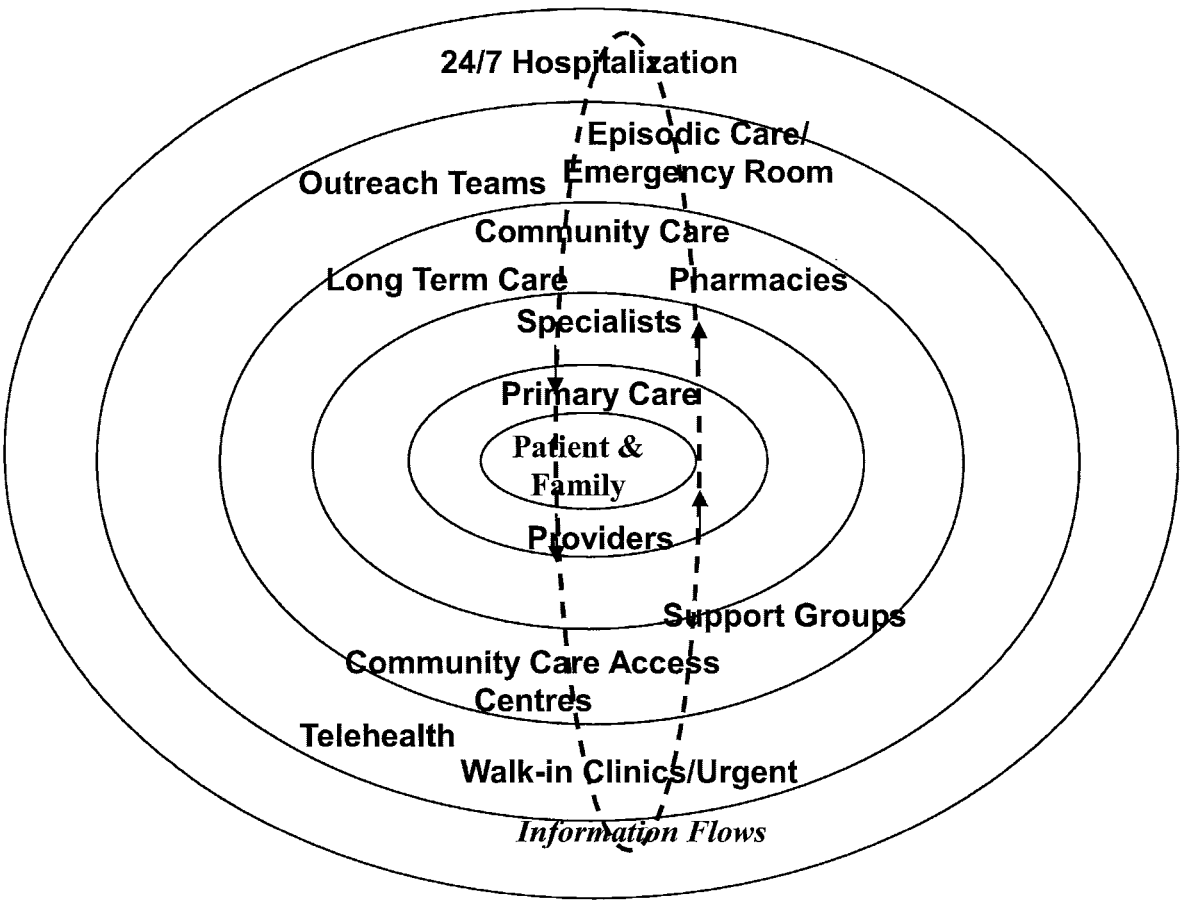

Figure 1. Information Flows in Patient-Centred Healthcare (adapted from (Archer 2005))

2. EMR Adoption

An Electronic Medical Record (EMR) is a repository of information in computer-processable form that is used by a physician to record and access information regarding the health of a patient. An EMR is not necessarily shareable among different systems, but shareability is a highly desirable attribute since most patient information is not at one site but is scattered across multiple sites: primary care offices, acute care facilities, test labs, longterm care facilities, etc. The content and granularity of an EMR may also vary widely between different healthcare disciplines, different healthcare sectors, and different healthcare settings. Currently multiple

competing vendors provide EMR systems, each with a software suite that in many cases is not compatible with those of their competitors or does not adhere to standards for interoperability. This obviously creates a serious problem when one of the main purposes of adopting an EMR is to make it shareable among the multiple systems offered by these vendors.

Although it is generally recognized that the adoption of interoperable EMR systems is an important objective for the healthcare system, large gaps exist in understanding physician resistance to EMR adoption, including:

- Little is known about how to maintain good physician-patient relationships in an office that has installed an EMR system
- There have been few follow up studies of physician experience and satisfaction with installing and using EMR systems, but a recent study (Keshavjee, Bosomworth et al. 2006) has identified implementation issues as a major cause of EMR system adoption failure, estimated to be at a worrisome and consistently high 50%.
- Installation and operating costs are known to be deterrents to adoption of EMR systems, but technical issues that affect adoption, along with potential solutions, have not been studied in detail
- Most studies of EMR systems adoption have indicated little or no effect on patient outcomes. But few if any of these studies have included the potential positive impact on patient outcomes of interoperability with remote sources of patient records, such as laboratories, hospitals, etc.
- There is little agreement, in existing studies of small practice EMR adoption, of what constitutes EMR "adoption". For example, it is quite possible to install an EMR system that has significant capabilities for patient record keeping and decision support and then, due to practitioner apathy or lack of usability, use the system only for scheduling and billing. Does this constitute EMR adoption? To develop a true picture of EMR adoption will require a model that includes several different levels of functionality and use, similar to the seven stage model developed by HIMSS Analytics[1] for EHR adoption in U.S. hospitals.

Across Canada, EMR systems are in use at percentages of primary care physicians that vary widely among the provinces (Chernos October 2007). For example, *OntarioMD* is a subsidiary of the *Ontario Medical Association* that receives Province of Ontario funding, and has supported EMRs for about 1,200 primary care physicians in that province, with a target of 2,700 out a total of 17,500 specialist and family physicians. In this program, primary care doctors must join family health groups to be eligible. Another example is the Province of Alberta's *POSP*[2] (Physician Office Support Program) initiative (subsidized and supported by government) that had enrolled 61% of Alberta physicians as of May 2006. (POSP May 2006). Physicians are using their *POSP* EMR systems for scheduling (86%); billing (80%); communicating (76%); charting (71%); prescriptions (69%); referrals (64%); and clinical decision support (61%). Three-quarters of the physicians said that office automation had improved patient care and 56% said it had enhanced productivity in their clinics. Most physicians reported that they were still seeing the same number of patients, but that they were now able to spend more time with them.

[1] http://www.himssanalytics.org/images/emr.jpg
[2] http://www.posp.ab.ca/about/

A U.S. study (Anderson and Balas 2006), revealed that between 20% and 25% of primary care physicians reported using EMR systems, in many cases that included e-prescribing, point-of-care decision support tools, and electronic communication with patients. The majority of physicians perceived benefits of IT, but they cited costs, vendor inability to deliver acceptable products, and concerns about privacy and confidentiality as major barriers to implementing IT applications. One-third of the physicians surveyed expressed no interest in these IT applications. This may indicate that educating physicians about the benefits of IT and subsidization of startup costs might improve adoption rates. An empirical study by Vishwanath and Scamurra (2007) revealed nine dimensions to the adoption problem. The first five, in declining order of significance, were: over-customization, perceived cost issues, logistics and regulatory concerns, return on investment, and integration issues. Cases analyzed from EMR implementation in small clinical practices (Randeree 2007) found serious issues, including a lack of planning, anticipated downtime that was longer than expected, workflow disruption, and underestimated maintenance costs.

Although "people-issues" are often blamed for technology implementation failures, research on the human behaviors and attitudes that challenge workplace innovation is scattered across multiple disciplines and lacks an integrated theory. Rizzuto and Reeves (2007) described person-related problem sources, symptoms, and solutions associated with information technology (IT) implementation failure, based on the analysis of scholarly literature from four academic disciplines spanning two decades. Their findings revealed dominant and underrepresented person-related implementation factors over time. Participation and management were two of the frequently researched implementation problem sources. Their framework, which they call the person-implementation framework (Rizzuto and Reeves 2007) identifies linkages among three main components: 1) Problem Sources (management, participation, training, rewards, and feedback - (McAfee 2003)); 2) Failure Symptoms (nonuse, resistance, inertia, misspecification, and misuse – (Sokol 1994)); and 3) Leverage Points (organizational planning, project leadership, management style, project scope, and project timing – (McAfee 2003)).

2.1 EMR Selection

Technology solutions that can play a role in supporting EMR systems vary widely, from Web portals (Giles October 12, 2007 2007) to Application Service Providers (ASPs) that provide online EMR services offsite to healthcare practitioners, on-site EMR office facilities, acute care institutional EHR (Electronic Health Record) facilities, ePrescribing facilities, etc. Most, if not all, of the EMR adoption studies fail to distinguish among the different possible technical solutions, and whether the choice of solution had any impact on the success of the implementation. For example (Brookstone June 18, 2004 2004) ASP solutions may offer the best choice for a solo physician, since they eliminate the need to hire or train on-site technical support. On the other hand, the necessary communications network access speed may be costly. No matter which solution is chosen, the selection process is critical to success of the implementation. An EMR system, if planned, chosen, and implemented carefully, will have a much better chance of long term user satisfaction than one that is chosen with little attention to important stakeholder issues such as, for example, proper training (Keshavjee, Bosomworth et al. 2006).

Canadian provinces that support the adoption of EMRs usually limit their support to vendors that meet certain requirements. Ratings of vendor systems can also be helpful to the prospective adopter. For example, *Canadian EMR*[3] is a private not-for-profit organization that collects data from current EMR users on-line, through their *Canadian Star Rating* system. This rating system uses five high level categories: Purchase Experience, Implementation Experience, Support Experience, Usability, and Satisfaction with the product. Each of these categories is made up of three questions, which are answered according to a 1-5 star rating system. Data from each such evaluation is presented in rating tables for consultation by prospective adopters of EMR systems.

One example of a significant research project in EMR selection involved a multi-disciplinary team with clinical, technical and research expertise that developed and used a rigorous eight stage evaluation process for EMR selection (Holbrook, Keshavjee et al. 2003). The process included direct input from clinical users at each stage, in a sequence that involved a review of EMR specifications and features, live product demonstrations, site visits, and negotiations with vendors to narrow the field of eligible EMR systems. Scoring of the systems was based on three main themes of clinical usability, data quality and vendor maturity issues. Final preferences were found to vary among clinicians and between clinicians and technical specialists, particularly concerning the importance of user interface versus database issues. However, the final EMR system scores indicated a consensus among clinical and technical experts.

3. Adoption Models

Few papers discuss models of user adoption in small medical practices. Findings from studies of EMR adoption in larger institutions are unlikely to be generalizable to small practices because of various fundamental differences (Thong 1999). Small practices tend to have highly centralized structures, with the physician(s) making most of the critical decisions. The central role played by the physician(s) indicates that their characteristics are critical in EMR adoption decisions. Small practices tend to employ general practitioners rather than specialists, although as clinics increase in size they are likely to employ specialists, but these are specialists in medical disciplines and not in information technology (IT). Even if they could afford to recruit IT specialist support staff, it would be difficult to attract and retain skilled IT staff because of the limited career paths available. As a result, small practice managers are less likely to be aware of the benefits of IT and to lack the necessary IT knowledge and technical skills. In addition, small practices lack financial resources and are highly susceptible to short-range planning; they are unlikely to take the longer term view that larger institutions take when considering investments in planning, acquisition, and training that are necessary for successful EMR adoption. These issues relate to a study of medical practices in Massachusetts (Simon, Kaushal et al. 2007) showing that practice size was strongly correlated with EMR adoption rates.

Innovative information technology applications that target individual professionals have been examined by Chau et al (2001) to determine the applicability of existing models. Although it is still unclear what factors contribute to the acceptance of IT support by skilled professionals, Yi et al (2006) developed and tested a model in the context of PDA (Personal Digital Assistant) acceptance by healthcare professionals, explaining 57% of physician intention to accept an innovation. Ford et al (2006) used adoption data from six previous surveys of small practices to

[3] http://www.canadianemr.ca/index.aspx

estimate historic market penetration rates in the United States, and applied technology diffusion theory to predict future adoption. Their results forecast an approximate 60% adoption in this market by 2012.

One small practice adoption paper (Osbourne and Clarke 2006) proposed an unvalidated model that combines the Technology Acceptance Model (TAM), Rogers Innovation Diffusion Theory (IDT), and the Triandis Theory of Interpersonal Behaviour (TIB). A major study by Keshavjee et al (2006) includes three phases: Pre-Implementation, Implementation, and Post-Implementation, based on a framework synthesized and validated from a systematic literature review of existing adoption frameworks. Figure 2 is a proposed model that includes the components derived from the literature survey, the major focus of this paper.

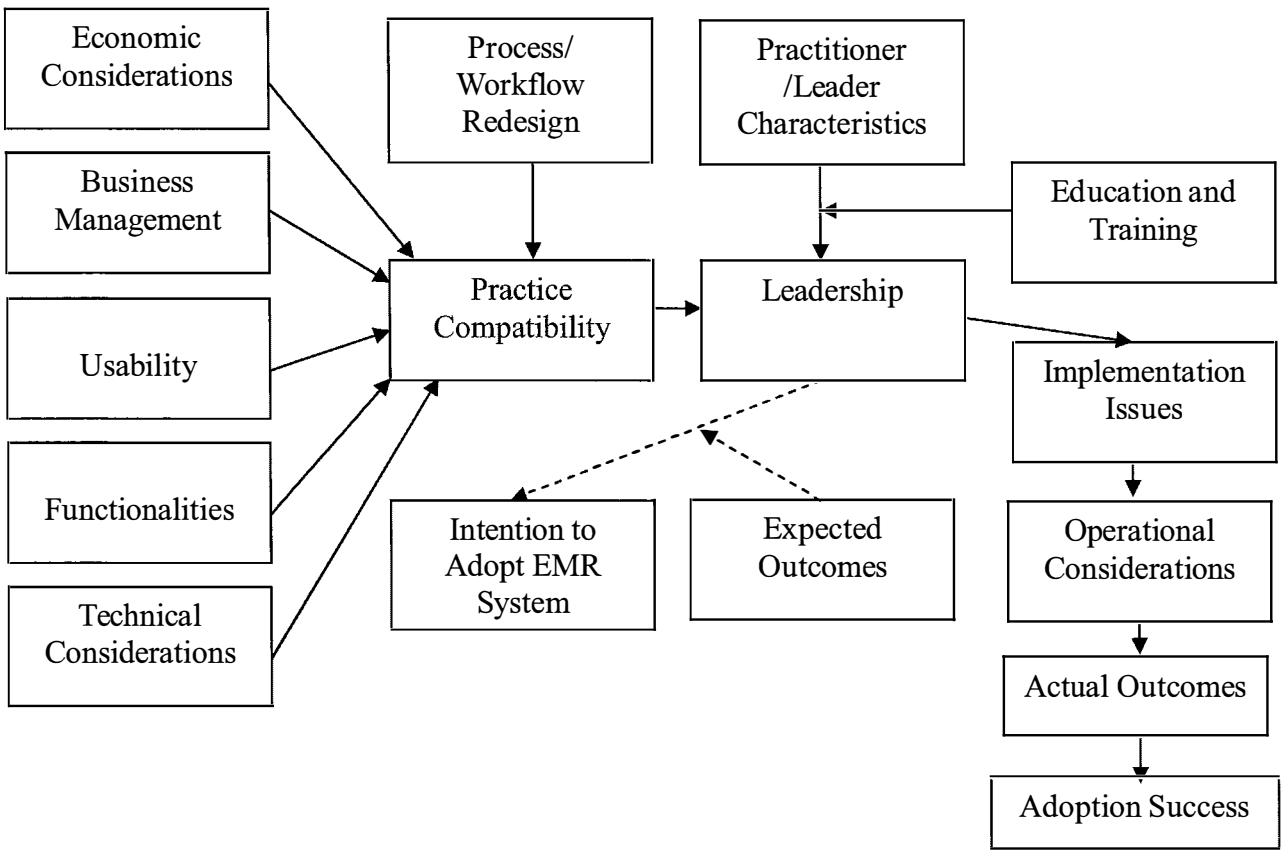

Figure 2. Proposed EMR Adoption Model for Private Physician Practices

The model is based partly on the preliminary work by Osbourne and Clarke (2006), and partly on the implementation model of Keshavjee et al (2006). It integrates components of TAM2 (the organizational version of TAM), Rogers' innovation and diffusion theory, and the people, process, and technology components suggested by Keshavjee et al. The dashed line route in the Figure is for physicians who have not yet adopted, following from the Leadership Attitude factor. The solid line route from this point is shown for physicians who have already adopted, where experience gained through the phases involving Implementation Issues and Operational

Considerations that play a role in perceptions of EMR system adoption. Details of the components of each factor in the model will be reflected in the design of the questionnaire, for non-adopters and adopters respectively, based on the following review of EMR system adoption attributes.

3.1 Attributes of Electronic Health Record Systems Adoption

To develop a suitable model of EMR adoption requires consideration of the factors that appear in Figure 2, each of which may play a role in adoption decisions. The following is a discussion of the factors that can affect EMR system adoption, as identified in a review of the relevant literature. The references identified for each of the factors are summarized in the Appendix.

a) Economic Considerations When it comes to implementing EMR systems, cost is most often cited as the primary reason for slow adoption, particularly among smaller practices. However, in some cases another form of resistance, from practices that already have installed systems, is uncertainty about what to do with existing practice management systems (Loehr November 2006). Another concern is the substantial amount of time and the cost to convert paper records to digital and to revising digital records from existing systems to a new system format. Studies of medical practices found that practice size was strongly correlated with EMR adoption (Burt and Sisk 2005; Simon, Kaushal et al. 2007). The most frequently cited barriers to adoption were start-up financial costs (84%), ongoing financial costs (82%), and loss of productivity (81%).

Five ambulatory offices, with a total of 28 providers, within the University of Rochester Medical Center in the United States, participated in a pilot project using an EMR to document the return on investment (Grieger, Cohen et al. 2007). Indicators used included chart pulls, new chart creation, filing time, support staff salary, and transcription costs. In addition, patient cycle time, evaluation and management codes billed, and days in accounts receivable were evaluated to assess impact on office efficiency. Findings were that initial costs were recaptured within 16 months, but there was a neutral impact on efficiency and billing.

b) Business Management A private medical practice is a small business, so an overall research framework developed by Premkumar (2003) to explore the adoption of computer-mediated communication technologies in small business, is relevant. This study revealed that competitive advantage, top management support, and size are important determinants of adoption. In Canada, with its publicly funded healthcare model, competitive advantage is not likely to play such an important role, particularly with the overwhelming and widespread demand for primary care physician services. On the other hand, the size of the company is particularly relevant in EMR adoption, and a solo (single physician) might make different choices than a clinical operation with multiple physicians. For example, fewer functionalities might be selected and an ASP provider might be more likely chosen by a solo operation.

c) Usability Usability issues, in particular "Ease of Use" and "Ease of Learning" (Davis and Venkatesh 1996) can and should enter into every situation where the acquisition, installation, and use of an EMR system is being considered. Organizational considerations of these qualities plus social influences, job relevance, output quality, and result demonstrability can be measured using a form of the widely used Technology Acceptance Model 2 (TAM2) model (Venkatesh and

Davis 2000). This is more suitable for organizational contexts than the original TAM (Technology Acceptance Model) (Davis and Venkatesh 1996). Measures of this nature are particularly important for physician support during consultations, where attention to the computer may distract from the quality of the physician-patient interaction (Coiera 2004; Yi, Jackson et al. 2006). Choosing certain modalities such as hand-held or audio devices to enter and retrieve data may also significantly simplify human-computer interaction and at the same time improve physician-patient interactions. It is important to make technologies disappear into the background so that practitioners can unconsciously apply them to the task at hand, which is to interact effectively with patients. An interesting and useful finding by Van Schaik et al (2004) showed a lack of association between GP (General Practitioner) perceptions of advantages of a proposed system and technology acceptance of computers in general. This indicates that GPs were rating the potential of the advantages of the system on the merits of the system itself, as opposed to applying generalized perceptions based on their broader experience of computer systems. Another study that evaluated the use of the TAM model (Yarbrough and Smith 2007) concluded that time/practice-related issues, organizational issues, personal issues, and system-specific characteristics influence a physician's acceptance of a new technology, with access and response speed being of utmost importance. In addition, a physician's practice environment must have a collaborative organizational culture that emphasizes teamwork, in order to make the necessary process redesign possible. System flexibility is desirable, so it can be customized, and knowledge captured and organized at the local level. There is little incentive for adoption if there is no evidence that EMRs can increase productivity or quality of care.

d) Functionalities Almost all private physician offices have some form of information technology support for scheduling and billing functionalities, along with e-mail and office packages. EMR systems are much more functional and can support a range of useful applications, (Furukawa, Ketcham et al. 2007; Sprague Sept 29 2004) such as information about treatment alternatives or recommended guidelines, formularies, patient notes, medication lists, managing lab and test results, etc. However, functionalities chosen during the implementation phase, along with the system vendor, must be selected according to a detailed requirements analysis (Holbrook, Keshavjee et al. 2003). Any study that considers these functionalities must not just ask whether they are supported by the EMR system, but whether they will actually be used in practice. An important consideration in EMR system choice is the ability of the system to go beyond being just an information storage and retrieval system. It must also be able to use the data to develop and display results that support clinical decision making (e.g. displaying longitudinal results of diabetic tests for a patient) and to generate summaries that can be useful in managing operations (e.g. generate a summary of the diabetic patients seen in the past six months). In the IT world, these functionalities are known as decision support system and management information system functions, respectively.

e) Technical Considerations Potential physician customers for EMR systems have been largely dependent on vendors to tell them what EMR is and what it ought to do (Sprague Sept 29 2004). Government agencies, professional associations, and independent consultants can provide the technical expertise and negotiation clout to guide standards development, system selection, installation, and maintenance for private physicians (POSP May 2006). This is particularly important for solo practices. The development of standards for networking and interoperability requires government intervention to ensure that vendors meet minimum requirements and that

privacy and security standards are met (POSP May 2006). The choice of onsite systems or offsite Application Service Provider (ASP) systems (Schoenman, Keeler et al. August 2006) is also an important decision for small practices.

f) Process/Workflow Redesign To achieve maximum positive impact from EMR systems, office workflows or processes should be examined (Lee and Shartzer April 2005). Automating manual processes can make complex tasks simpler, more efficient and less costly, but automating an existing inefficient process is self-defeating. On the other hand, there can be a downside due to any resulting workflow disruption: redesigning work processes and learning new technologies consume time and resources. A study of primary care internal medicine practices (Lee and Shartzer April 2005) found that computerized order entry systems required more time per patient initially. But the study also found that, as practitioners developed experience with these systems, they could save time (Lee, Cain et al. 2005). IT integration is not merely a matter of automating current practices. System redesign is needed to fulfill a variety of goals: simplify processes for patients, providers, and clinical staff; encourage HIT (Health Information Technology) adoption by adapting systems to current workflows; and solve privacy concerns. Quality improvement was not an automatic consequence but needs to be explicitly considered. It is important for the physician to focus on the vision, not of universal IT adoption, but of health care delivery transformation. It is also critical for the physician to know what is needed to do the job better and to make the clinic run better, before embracing a technology. Successful adoption requires close attention to office workflow, or how tasks are organized and resources used to achieve outcomes.

g) Practice Compatibility Practice compatibility with the adoption of an EMR system revolves around the practice's service philosophy, staff experience, attitude to the adoption of innovative technologies, and willingness to change work patterns and flows. An EMR should be able to help realize the vision of increased multidisciplinary cooperation, increased standardization of clinical decision making, increased flexibility of physician preferences for system interfaces, and increased interdependence of practitioners and staff through EMR system operation (Davidson and Chismar 2007). EMR adoption requires more than structuring, designing, or buying a system. It involves organizational change, which requires strong leadership, clear formation of objectives, solving existing organization and interpersonal problems, and establishing psychological ownership from all staff. Adoption without the necessary change management activities may result in disuse or worse still, sabotage. Communication and active change management are keys to organizational culture change. An EMR can promote higher quality care, lower costs, and increased patient and clinician satisfaction (Lee, Cain et al. 2005). This can be supported by customizing IT systems to match and support desired office workflows and health care outcomes. Successful organizational change can also be motivated, for instance, by a "killer application" that practitioners will want to use, thus helping to move the practice toward higher quality and efficiency.

h) Practitioner/Leader Characteristics Interpersonal relationships and information are essential to good healthcare (Weiner and Biondich 2006). Inattention while managing health information can undermine relationship-centred care. Good general practice consultation should be patient-centred, and certain verbal and non-verbal behaviours have been identified as important to establish a good relationship with the patient. Introducing a technology into a consultation affects not only the users it is specifically intended for, but also the patient being examined (and

sometimes an accompanying relative) (Coiera 2004; Cain and Clancy 2005; McGrath, Arar et al. 2007). An EMR must be implemented in ways that preserve and uplift relationships in care, while at the same time attending to deficiencies in managing information and making medical decisions.

i) Education and Training This factor is expected to play a role as a moderator of Practitioner Personal Characteristics. The leader must understand the general issues involved, which requires some knowledge of system characteristics. Adoption requires more than structuring, designing, and acquiring a system. It involves organizational change, which requires strong leadership, clear formation of objectives, solving existing organization and interpersonal problems, and establishing psychological ownership from all staff members (Lee, Cain et al. 2005). The leader might delegate staff training and education to experienced consultants who may also be involved in installation and follow-up activities as required, thus addressing one obstacle to adoption (Simon, Kaushal et al. 2007).

j) Leadership The success or failure of an organization's efforts to adopt new technology often rests less with the quality of that technology and more with the quality of the organization's leadership (Still and St.Amant 2006). A strong leader champions the productive change that technology can bring to an organization, but weak leadership promotes resistance to such change by not providing the vision and message necessary to keep internal divisions within the organizational culture from fomenting the failure that can result from departmental infighting, inadequate planning, poor communication, and other negative influences from organizational dysfunction. Wixom and Watson (2001) indicate that user participation, team skills, and resources are the most important implementation factors for project success. User participation is enhanced when users are assigned project roles and tasks leading to better communications. Team skills include both technical and interpersonal abilities.

k) Expected Outcomes This factor is expected to be a moderator of Intention to Adopt. The impact of EMR systems on cost and process measures of quality of care has been found to have no significance on 14 of 17 quality indicators (Linder and Middleton 2007). These were similar to findings in a study of diabetic care in practices that had adopted EMR systems (Crosson, Obman-Strickland et al. May/June 2007). EMR advocates argue that EMR systems lead to reduced errors and reduced costs. A contrary report (Sidorov July/August 2006) suggests that EMR use often leads to higher billings and declines in provider productivity with no change in provider-to-patient ratios. Error reduction is inconsistent and has yet to be linked to savings in malpractice premiums. As interest in patient-centredness, shared decision making, teaming, group visits, open access, and accountability grows, the EMR is better viewed as an insufficient yet necessary ingredient. Other outcome considerations include: Interactions among the health care team, Patient-physician communication, Patient privacy, and Clinician access to up-to-date knowledge (Simon, Kaushal et al. 2007).

l) Intention to Adopt EMR System This is a key outcome of the TAM2 (Technology Acceptance Model – organizational version) developed and validated by Venkatesh and Davis (2000), and used extensively in studies of technology adoption. This construct reflects user intentions to adopt and use the system under scrutiny.

m) Implementation Issues have been addressed in detail by Keshavjee et al (2006). These researchers integrated existing conceptual frameworks into a comprehensive framework to explain factors which lead to successful EMR implementation, based on the EMR implementation literature. Their framework included stakeholder involvement, software selection, choice of on-site versus off-site location and support, governance, project leadership, conversion, feedback and dialogue, and implementation assistance. Inadequate attention to these issues may result in partial or total rejection of the system, with such failures occurring in 50% of new EMR installations (Craig January 2007).

n) Operational Considerations that also arose from the Keshavjee et al study (2006) include user involvement, system enhancements, vendor support, and user groups that are needed to maintain practitioner support and involvement.

o) Actual Outcomes must be positive if there is to be any incentive to begin and to continue using EMR systems. Considerations include (Simon, Kaushal et al. 2007): Controlling costs of health care; Quality of health care; Interactions among the health care team; Patient-physician communication; Patient privacy; Clinician access to up-to-date knowledge; Efficiency of providing care; and Medication errors. Additional positive incentives (Keshavjee, Bosomworth et al. 2006) include: Faster access to clinical information at the point of care; and More efficient outcome assessment.

p) Adoption Success This final overall measure of success is linked to the Actual Outcomes factor delineated above. This will help in determining the relative weights that respondents place on the measures included in Actual Outcomes, and should be useful in developing a multi-level characterization of successful (or not) EMR implementation.

3.2 Model Validation

A set of propositions have been designed that are based on the proposed model (Figure 2). These include:
i) Practice Compatibility will be affected by a) Economic Considerations, b) Business Management, c) Usability, d) Functionalities, e) Technical Considerations, and f) Process/Workflow Redesign;
ii) Leadership Attitude to Adoption will be influenced by g) Practice Compatibility and h) Practitioner Personal Characteristics (moderated by i) Education & Training); and
iiia) For physicians considering EMR adoption, the dependent variable l) Intention to Adopt will be influenced by j) Leadership Attitude (moderated by k) Expected Outcomes).
iiib) For physicians who have already adopted EMRs, Implementation will have been influenced by j) Leadership Attitude, and n) Operational Considerations will be in turn by influenced by m) Implementation Issues. The dependent variable o) Actual Outcomes will be influenced by n) Operational Considerations, and o) Actual Outcomes will in turn determine p) Overall Adoption success.

4. Methodology

The study will proceed through four phases. In Phase 1, the adoption model in Figure 2, and the corresponding preliminary instrument that has been developed, will be refined, tested, and modified through an interview and focus group process with four to six private physicians, including several EMR system adopters and several non-adopters. Respondents will be asked to suggest any factors not in the survey questionnaire that they consider important, and, if necessary, alternative terminology. This will contribute to the enhancement of the content validity of the instrument. Respondents will also be asked to identify problems with the length of the instrument, question ambiguity, and other factors considered important (Karahanna, Straub et al. 1999). This will support further testing for reliability, construct validity, item consistency, and ease of understanding (Liaw 2002).

In Phase 2, the final version of the structured questionnaire will be used to survey a sample of approximately 200 private physicians in Canada. The intent will be to devise a 2x2 sample stratification, according to the number of physicians in the practice (1-2, versus more than 2) on one dimension and EMR adoption versus non-adoption on the other. There are two reasons to stratify by number of physicians in the practice: 1) adoption rates tend to be higher in larger practices, and 2) larger practices are more likely to employ a staff member with experience and understanding of computer systems use in medical practice. A maximum of one physician per practice will be surveyed. An Internet panel survey will be used if possible, implemented through a professional medical association or through a commercial Internet survey company. Besides model-related data, additional data collected will include the number of physicians in the practice and the level of adoption of IT by the practice.

In Phase 3, data will be analyzed using descriptive statistics and Structural Equation Modeling (SEM) techniques. The first step in data analysis is Cronbach's alpha measure of reliability of the multi-item scales to assess the quality of the instrument (Bontis 1998). Since SEM techniques can assess reliability as well, and the constructs are adapted from previously validated research, Cronbach's alpha will be calculated for comparison purposes (Jarvenpaa, Shaw et al. 2004).

The next step in data analysis will be to develop a factor analysis with the purpose of reducing and summarizing data (Bontis 1998) and to ascertain that the theoretical model constructs are distinct (Karahanna, Straub et al. 1999). The results will indicate clearly either an association or a lack of association between the observed variables and the underlying factors (Hair, Rolph et al. 1987). Harman's one-factor extraction test (Harman 1967) will be applied to check that neither a single factor emerges from the factor analysis nor a 'general' factor accounts for the largest part of the covariance in the independent and dependent variables (Podsakoff and Organ 1986).

Measurement model and structural model analysis through the use of SEM techniques will follow. The Partial Least Squares (PLS) method will be used for the main data analysis because of its suitability for this research. PLS is more appropriate for complex models and when the goal of the research is exploratory (rather than confirmatory) (Bontis, Crossan et al. 2002). PLS makes no assumptions about the distribution of the sample data (Jöreskog and Wold 1982). A characteristic of PLS is that it works well with relatively small samples (Chin and Newsted 1999).

In Phase 4, as PLS can be used for both theory confirmation and "to suggest propositions for testing later" (Chin 1998), the final model will be examined for significant results, and further studies of these results will be prioritized based on the findings from the survey. These findings will help to lead to an examination of existing government policies for encouraging EMR adoption, and the development and evaluation of suggestions to modify these policies so they encourage adoption at the same time as implementing and using EMR systems more effectively.

5. Discussion

The adoption and use of online clinical records by Canadian physicians is a critical issue that must be resolved to the satisfaction of all the stakeholders (physicians and other healthcare providers, citizens, government agencies, and healthcare institutions) before significant improvements can be realized from the use of information technology in supporting healthcare. Unfortunately, this is a very complex issue, as seen by the many studies that have appeared in the literature that point to the many inter-related causes for the low rate of adoption. In order to understand these issues and their causes, it is important to examine the issues through the perceptions of physicians. The first objective of this research is to develop and validate a comprehensive model that will explain why private medical practices in Canada have tended to be slow in adopting electronic medical records and related systems. This paper has suggested such a model and has reviewed the literature to determine what questions should be addressed to physicians to get closer to the fundamentals of the situation. It is necessary to ask the appropriate questions through a statistically valid survey of physicians, to get meaningful results that will lead to a better understanding of the adoption problem.

Further, it is not only necessary to understand the problem but to address the underlying causes. The second objective of the study will be to propose and evaluate potential policies that would help to improve the adoption of such systems in a manner that would support their most effective and efficient application by medical practitioners. For example, suppose an important aspect of the problem turns out to be physician concerns that interacting with EMR systems during client examination tends to interfere with physician-client relationships, thus lessening the amount and quality of information that is forthcoming from the client. In this case, the indication would be that more research is needed to find ways that EMR support could be made less visible, allowing the physician to interact with the client in a more natural way. Or suppose that it is found that physicians have difficulty making proper and rapid diagnoses without being able to quickly access client histories, test results, and other records stored at other sites. One would then be led to believe that a major effort should be made to ensure that all EMR systems have links to external information sources that could be used for rapid retrieval of other relevant client information. Both these examples would involve the solution of major technical problems, requiring substantial injections of funding for research and implementation, but at least by identifying the appropriate solutions, the healthcare system could begin to improve by moving more rapidly in the right direction.

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Appendix. Adoption of EMR Systems in Primary Care Practice

Factor	Element	References
a) Economic Considerations	Startup cost	(Irvine May 2007) (Schade, Sullivan et al. 2006; Simon, Kaushal et al. 2007; Loehr November 2006) (Sidorov July/August 2006)
	Maintenance cost	
	Conversion/integration with existing owned practice management systems	
	Fear of choosing wrong system	
b) Business Management	Size of firm	(Premkumar 2003) (Burt and Sisk 2005; Simon, Kaushal et al. 2007)
	Competitive advantage	
c) Usability	Perceived control	(Yi, Jackson et al. 2006) (Chau and Hu 2001; Lee, Cain et al. 2005)
	Result demonstrability	
	Perceived usefulness	
	Perceived ease of use	
d) Functionalities	External connectivity e.g. e-mail, other record sources	(POSP May 2006) (Schade, Sullivan et al. 2006) (Furukawa, Ketcham et al. 2007) (Gross and Bates 2007)
	Treatment alternatives or recommended guidelines	
	Formularies	
	Patient notes, medication lists, problem lists	
	E-Prescribing	
	Clinical data, image exchange with other physicians	
	Decision support	
e) Technical Considerations	Choice of system support approach (ASP, on-site, etc.)	(Schoenman, Keeler et al. August 2006) (Premkumar 2003) (Schade, Sullivan et al. 2006; POSP May 2006) (Brailer 2005) (Sprague Sept 29 2004)
	Vendor/consultant support/outsourcing	
	Standardization	
	Interoperability	

	Security and privacy	
f) Process /Workflow Redesign	Workflow analysis/ Process redesign	(POSP May 2006) (Lee and Shartzer April 2005) (Lee, Cain et al. 2005)
	Organizational change management	
g) Practice Compatibility	Service philosophy	(Davidson and Chismar 2007)
	Staff experience	
	Willingness to change work patterns and flows	
	Willingness to increase multidisciplinary cooperation	
	Acceptance of increased standardization of clinical decision making	
	Flexibility of physician preferences for system interfaces	
h) Practitioner/ Leader Characteristics	Compatibility with work style	(Chau and Hu 2001) (Yi, Jackson et al. 2006) (Wolf, Hartman et al. 2007) (Weiner and Biondich 2006) (Coiera 2004) (de Lusignan, Wilson et al. 2003)
	Personal innovativeness	
	Physician-patient relationships	
	Relationships with staff	
i) Education and Training	Change management	(Lee and Shartzer April 2005) (Simon, Kaushal et al. 2007) (Sprague Sept 29 2004)
	Education	
	Technical knowledge	
j) Leadership	Management support	(Still and St.Amant 2006) (Wixom and Watson 2001) (Davidson and Chismar 2007)
	Strong champion	
	Resource availability	
	Team skills	
	User participation	
	Clear formation of objectives	
	Solution of existing organizational and interpersonal problems	
	Establishment of	

	psychological ownership by all staff	
	Communication skills	
	Active change management	
k) Expected and o) Actual Outcomes	Increased productivity	(Irvine May 2007) (Simon, Kaushal et al. 2007; Lee and Shartzer April 2005) (Sidorov July/August 2006) (Schade, Sullivan et al. 2006) (Crosson, Obman-Strickland et al. May/June 2007) (Linder and Middleton 2007) (Welch, Bazarko et al. 2007)
	Improved communication with colleagues, patients	
	Chronic disease care and health promotion	
	Quality of care	
	Guideline adherence	
	Reduction in errors	
	Record legibility & good documentation	
	Efficiency (savings in physician time)	
	Efficiency in practice operations	
	Efficiency (reduction in downtime, duplication, waiting for information)	
	Job satisfaction	
l) Intention to Adopt EMR System	Intention to use	(Venkatesh and Davis 2000)
m) Implementation Issues	Stakeholder involvement	(Keshavjee, Bosomworth et al. 2006) (Wixom and Watson 2001)
	Software selection	
	On-site vs. off-site location	
	On-site vs. off-site support	
	Governance	
	Project leadership	
	Conversion	
	Feedback and dialogue	
	Implementation assistance	
	Quality of data resources (standards for technology and data)	

n) Operational Considerations	User involvement	(Keshavjee, Bosomworth et al. 2006)
	System enhancements	
	Vendor support	
	User groups	
p) Adoption Success	Overall perceptions of successful implementation and operation	

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