Implementation of electronic medical records and preventive services: a mixed methods study

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Abstract

The implementation of Electronic Medical Records (EMRs) may lead to improved quality of primary health care. To investigate this, we conducted a mixed methods study of eighteen Toronto family physicians who implemented EMRs in 2006 and nine comparison family physicians who continued to use paper records. We used a controlled before-after design and two focus groups. We examined five preventive services with Pay for Performance incentives: Pap smears, screening mammograms, fecal occult blood testing, influenza vaccinations and childhood vaccinations.

There was no difference between the two groups: after adjustment, combined preventive services for the EMR group increased by 0.7% less than for the non-EMR group (p=0.55, 95% CI -2.8, 3.9). Physicians felt that EMR implementation was challenging.
I would like to thank my thesis supervisor, Dr Jan Barnsley, and my thesis committee, Drs Rick Glazier, Rahim Moineddin and Bart Harvey, for their support and mentorship during the planning, conduct and analysis of this study. I am also very grateful to my colleagues in primary care who generously provided access to their charts (both paper and electronic) for the study.
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Chapter 1: Background

“Paper records are increasingly becoming obsolete and inadequate. They limit the flow of information, insufficiently document patient care, impede the integration of health care delivery, create barriers to research, and limit the information available for administration and decision making.”

Roy Romanow, 2002

The quality of care provided to patients matters. "If you can not measure it, you can not improve it" (Lord Kelvin); the ability to repeatedly measure and monitor the care that is provided is a prerequisite for quality improvement efforts. Such an undertaking can be laborious and time consuming if data are recorded on paper. Computerized data entry, as part of an Electronic Medical Record (EMR), may overcome some of these difficulties by automating data collection procedures. EMRs have been specifically identified as critical to quality improvement, and are targeted for funding under the American Recovery and Reinvestment Act of 2009. Various policies favouring the establishment of EMRs have been implemented in most Canadian provinces. However, despite much hope for improvement, the effect of the implementation of EMRs on the quality of care provided to patients is currently unclear. In Ontario, family practice has been exposed to several new policies affecting funding since the new millennium: new payment mechanisms (primary care reform), Pay-for-Performance incentives and funding for EMRs have been introduced in rapid sequence within the same practices. This study followed a group of physicians as they responded to these new incentives and began the implementation of an EMR system.

Health care quality and performance

There are serious gaps in the quality of health care; barely half of recommended services are provided to adults. These problems have led to calls for systematic efforts to reform health care delivery. As a result, various policy measures to address the gaps in quality have recently been adopted.
The implementation of policies, especially in complex and chaotic systems such as health care is rarely straightforward; all significant changes can produce unintended consequences. An examination of the effects and consequences of policies can benefit health care policy-makers by adding evidence that can be used through policy analysis to inform the planning of future programs. As well, this evidence can be used by those impacted, to improve the uptake of potentially useful aspects of a policy, to manage implementation of new programs, and to mitigate potentially harmful aspects of the change: “planning for the future requires knowing where you have been”.

This thesis examined the implementation of an innovation (Electronic Medical Records in primary care practices) within the context of two other simultaneous changes in health care delivery and payment in Ontario—primary care reform and Pay for Performance. We measured the association between EMR implementation and the provision of preventive services covered by Ontario’s Pay for Performance program, and explored how physicians experienced EMR implementation.

Electronic Medical Records in the context of system-wide computerization

Information technology (IT) is pervasive in our society; computers, the Internet and IT-enabled communication tools such as smart phones are used on a daily basis by millions of people. It seems intuitive that IT usage should be routine in health care, since there is so much information and communication being managed in this setting.

However, the Ontario health care system is currently still largely paper-based. Patient records are kept in paper charts by various providers and in various locations. Information is exchanged by fax, by mail or through the phone; in some cases, reports are simply carried by patients. Despite the fact that health care is so critically dependent on accurate information, patients have no guarantee that their data will follow them: medical errors, service duplication and unnecessary waits due to missing or incomplete information are common. Coordination of care amongst different providers is poor. Systematic collection of data for quality improvement or research is limited due to the difficulties inherent in manual chart reviews.
Electronic Records have been proposed as a solution to these issues.\textsuperscript{10,12} They are searchable, they may improve patient care,\textsuperscript{13} and they have the potential to improve the efficiency of our health care system.\textsuperscript{14,15} Quality improvement projects become possible, as on-going performance data can be obtained from the electronic databases in practices.\textsuperscript{16} System integration (patient data being shared across different electronic databases, electronic prescribing) is feasible once data are kept in an electronic form.\textsuperscript{17,18}

The Kirby and Romanow reports have both recommended the establishment of electronic health records for all Canadians.\textsuperscript{1,19} The First Ministers committed to accelerating the implementation of these electronic records as part of their 2003 Accord on a 10 year plan to transform health care.\textsuperscript{20}

There is some evidence that the introduction of computerized systems has impacted care: a large US Veteran’s Administration study found significant improvements in quality due to system re-engineering, including integrated Electronic Medical Records (although the specific effect of EMRs was not directly studied).\textsuperscript{21} A recent systematic review found that computerized decision support systems improved practitioner performance, especially with regards to immunizations.\textsuperscript{13} However, most of the software systems reviewed were stand-alone programs, and not commercial off the shelf EMRs similar to those commonly found in primary care practices. Several studies have also found that EMRs may not improve care,\textsuperscript{22-26} or may even be a source of errors: a study of diabetes care in family practices found that EMR-based practices had poorer quality than paper-based practices.\textsuperscript{27} The introduction of computerized records led to medication errors and worsened hospital-based mortality.\textsuperscript{28,29} Many of the studies on the introduction of EMRs have been descriptive, with very few evaluating outcomes.\textsuperscript{30} A recent systematic review noted that much of the evidence on the effectiveness of EMRs came from only four benchmark research institutions, with limited generalizability, and very little data coming from standard commercial systems.\textsuperscript{31} At the present time, the effect of the large scale implementation of commercial off-the-shelf EMRs on quality of care in small, community-based family practices is not known.

What is known is that very few providers in North America have currently implemented Electronic Medical Records.\textsuperscript{32-35} A recent survey found that only 4% of US physicians practicing in ambulatory care used a fully functional electronic system, and 13% had a basic
Only 12.3% of Canadian family physicians use electronic records instead of paper records. The US and Canada were ranked last out of 10 countries in terms of practice computerization.

The most significant barrier to acquiring EMR has been identified as the cost of these systems: providers pay for the electronic records in their practices, while most of the benefits accrue to patients and to the health care system. This barrier results in slow adoption at the practice level. As one physician said, “None of the many beneficiaries of our investment—patients, insurance companies, our specialist colleagues, health plans, our liability carrier—have directly shared in the cost of implementing an electronic health record system.” Countries that fund EMRs for physicians (such as the UK or Denmark) have very high levels of adoption, while Canada and the US lag far behind.

Clearly, subsidies are needed in order for physicians to adopt these systems. In order to further EMR adoption, the Ontario government decided to offer financial support for physician office computerization. In October 2001, the ePhysician Project, jointly managed by the Ontario Medical Association and the Ministry of Health and Long Term Care, was created to oversee the establishment of this project. This eventually led to the formation of OntarioMD, a corporation owned by the Ontario Medical Association.

In 2003, the government transferred $150 million (the Primary Care Information Technology Fund) to OntarioMD. OntarioMD was given responsibility for certifying EMR software applications, thus ensuring that they included necessary components and met standards, and for administering the physician subsidy. In order to receive funding, physicians had to buy their EMR software from the list of vendors certified and approved by OntarioMD; the subsidy amounted to $28,600 per physician, estimated as being about 70% of the cost of adoption. The funding consisted of a $4,500 readiness grant paid once the contract with the vendor was signed, followed by $600 per month for three years, starting once the practice used the new software for scheduling and billing, and a further subsidy of $2,500 when the physician declared that he or she had completed data entry on 600 patients or 2/3rd of the practice (whichever was less) in the electronic patient summary page.

The stage was now set for a significant number of Ontario family physicians to adopt EMRs. However Ontario’s EMR strategy has been intimately tied to primary care reform: only
physicians participating in primary care reform projects, such as Family Health Networks\textsuperscript{45} (described below) were eligible for funding. Therefore, the launch of EMRs in Ontario primary care occurred concurrently and was tied closely to system-wide changes in the payment and organization of primary care.

**Primary Care Reform in Ontario**

Much of Ontario’s health care is provided within primary care; each day, about 137,000 visits are made to family physicians.\textsuperscript{46} In 2004, there were 10,287 general practitioners/family physicians in Ontario;\textsuperscript{47} about 70% were in solo practice.\textsuperscript{47}

Family medicine had been in trouble during the 90’s: it was increasingly viewed as the “poor cousin” to (better paid) specialties, and fewer medical students were choosing to enter this field, in part due to high debt burdens after medical school. The number of family physicians accepting new patients was rapidly declining. Hospitals were closed and the number of inpatient beds reduced, with no increase in community-based medical services. Patients had to be seen in overcrowded emergency rooms, due to the lack of available family physicians. Thus, out of a sense of crisis, long awaited and discussed primary care reform projects rose to the top of the political agenda.\textsuperscript{48}

In 2001, the Ontario Medical Association and the Ontario government offered family physicians the opportunity to take part in primary care reform by forming new groups, called “Family Health Networks”, or FHNs.\textsuperscript{49} To form a FHN, physicians signed a contract with a group of colleagues (a minimum of five physicians), and agreed to change their method of payment. The largest proportion of physician payment was now derived from capitation (a set fee per enrolled patient, per year, based on the patient’s age and sex), with a smaller component of incentives from pay for performance and fee-for-service funding. Patients rostered with a family physician by formally enrolling. This allowed the identification of a practice population; the capitated payment was based on a physician’s roster. Physicians agreed to provide some after-hours services, and to share call. The original FHN contracts included a clause specifying that IT support would start once this program was ready for implementation. The $150 million Primary Care IT fund was specifically tied to, and targeted to support, the new networks; it did not include primary care physicians choosing not to participate in networks, nor specialists.
FHNs were notified in January 2005 that the IT program and subsidy were ready to be implemented, and that the process of choosing a certified vendor could begin. By the end of the program (August 31st 2008) 2,700 physicians had received approval for the subsidy. This represents most of the eligible physicians—about 1,900 physicians participating in FHNs and other eligible primary care reform projects (from a total of about 2,000 eligible physicians), and 800 other physicians, randomly chosen from a pool of 2,400 non-eligible physicians who applied for funding through an “EMR lottery”.

In 2003, primary care reform was expanded, with family physicians being offered the opportunity to join Family Health Groups, or FHGs. These groups rostered their patients and received enhanced fee-for-service payments: they were paid an additional 10% for providing selected services to their rostered patients. The majority of fee for service physicians joined these FHGs, but they were not offered subsidies for EMRs. Instead, these physicians could apply for the subsidy through the “EMR lottery” mentioned above, knowing they would be randomly selected for funding.

There is no doubt that subsidies led to the adoption of EMRs as the majority of physicians eligible for a subsidy actually bought a system; subsidies therefore appear to be an important part of health system computerization. However, EMRs are complex and difficult to learn; simply buying an EMR does not necessarily mean that it will be implemented. The subsidy likely captured some physicians who were not ready to change; they purchased an EMR because they were part of a FHN—all physicians in a group had to agree to purchase a common system. Surveys had shown that partial implementation (hybrid paper and electronic records) was more common than full computerization. Financial subsidies in Ontario targeted adoption and had led to widespread purchases of EMRs (a necessary first step); however, only a small and highly targeted amount of this funding was dedicated to rewarding actual use (implementation) of the EMR ($2,500 for completing 600 patient summaries).

There are very few empirical studies that specifically address implementation of innovations in health care settings, and even fewer addressing EMR implementation. Evidence on EMR implementation using commercial off the shelf (as opposed to home-grown) software in small community-based practices is very sparse. There is literature on business IT implementation: for example, a large study of complex software systems in business organizations found that
31% of all implementations fail, at a median cost of US$2.3 million; the majority of those that
did not fail had time and cost overruns.\textsuperscript{54} Studies on implementation will be reviewed further in
Chapter 2.

The implementation of EMRs may be influenced by other factors and incentives. In the next part
of this chapter, I review an important set of financial incentives occurring concurrently with, and
possibly affecting, EMR implementation: the Pay for Performance movement.

Pay for Performance

EMR systems are complex, and their implementation involves changes in many possible
processes; only some changes will be implemented in the early stages of computerization. We
chose to focus on preventive services targeted by Pay for Performance (P4P) bonuses as markers
of progress during the early stages of EMR implementation because of the financial rewards
attached to meeting practice targets for these services, as well as for the following additional
reasons.

1. Physician agreement that the preventive services targeted by P4P represent good care.

Physicians want to improve the quality of services that they deliver to their patients; providing
good care is an integral aspect of their personal and professional values.\textsuperscript{5, 37} P4P, if linked to
measures that are recognized as benefiting patients, can be well aligned with physician values.
Preventive care can reduce the incidence and severity of some of the leading causes of mortality
and morbidity in North America.\textsuperscript{55, 56} The preventive services used in this study are core
components of primary care,\textsuperscript{57} are well accepted as indicators of quality of care,\textsuperscript{58} and have been
used as measures of the quality of services provided in primary care.\textsuperscript{21, 59} Services that are
perceived as having high value may be more likely to be implemented.\textsuperscript{60} In our previous study
on Pay for Performance, physicians indicated that they would like to implement more effective
processes for the preventive services affected by P4P,\textsuperscript{61} indicating readiness to proceed from
contemplating to preparing for change.\textsuperscript{62}

2. Availability of EMR tools targeting P4P

In order to be eligible for funding in Ontario, an EMR system must include the ability to measure
and manage the provision of preventive services; all physicians implementing funded EMRs
therefore have access to electronic tools targeting P4P services. These tools are integrated with the EMR system, and have been validated through conformance testing, as part of OntarioMD’s funding approval process. Therefore, physicians now have access to new tools to manage preventive services that they regard as important and that are targeted by P4P.

The P4P movement is a recent addition to the culture of quality.63, 64 Older payment systems are often viewed as part of the problem; fee-for-service rewards quantity of services, but not quality. P4P has been proposed as a method of re-aligning payment towards quality.5, 64 In the UK, P4P incentives comprising about 30% of primary care payment have recently been implemented, and have led to very high levels of target achievement in the first year of implementation.59 P4P is increasingly used in the United States as well, with over 50% of Health Maintenance Organizations having implemented this method of payment.65 Congress has mandated the introduction of P4P for Medicare and Medicaid.63

However, there is much debate on the effect of these incentives: studies have found that P4P has a weak and inconsistent effect on quality of care;66-68 the greatest gains occurred where baseline quality was the poorest, but most of the funding accrued to providers who were already providing high quality care.66 Thus, the incremental effect of P4P was limited, in large part due to the difficulties and costs inherent in the implementation of programs designed to increase the services targeted by P4P.69 Small community-based practices have limited funds, knowledge and resources devoted to measuring and improving quality.3 Additional problems with P4P can include unintended consequences, such as increasing health care disparities, discouraging care coordination, limiting the number of “challenging” patients accepted into practices64 and decreasing the provision of unfunded services,70 as well as the challenges of choosing appropriate measures: some services may be difficult to measure.64 P4P funding cannot be allocated to all qualifying services (leaving some patient groups at a disadvantage).70

In Ontario, the provincial government implemented P4P incentives in 2001 for selected preventive services, as part of the primary care reform “package”. Participating family physicians received payments based upon the percentage of their rostered patients meeting targets for five preventive services: Pap smears within 30 months for women age 35 to 69, screening mammograms within 30 months for women age 50 to 69, influenza vaccines in the previous Fall for patients age 65 and over, and primary immunizations for children under two.71
Fecal occult blood (FOB) screening for eligible patients age 50 to 75 was added in 2006.72 These measures were recommended by both the US Preventive Services Task Force and the Canadian Task Forces on Preventive Health Care, with either an A (good evidence for inclusion) or B (fair evidence for inclusion) level recommendation,55, 56 and were widely accepted within the profession as representing good quality preventive care. The maximal amount of incentive was $2,200 per service, representing a total of $11,000 annually per physician if all five targets are reached. Physicians also received a contact payment ($6.86) for reminding patients who were overdue.

The incentives were initially offered only to FHN physicians; contract negotiations between the Ontario Medical Association and the Ministry of Health opened Pay for Performance incentives to physicians in FHGs, starting in 2007.72 A timeline for the changes occurring in primary care is shown in Table 1. The fact that a new model was offered does not mean that it was immediately adopted or implemented by physicians. In Ontario, uptake of FHNs was initially very slow, while the FHG model proved more popular as it involved a smaller degree of change in physician payment mechanisms.

Table 1: Timeline for changes offered to primary care physicians

<table>
<thead>
<tr>
<th>Year</th>
<th>2001</th>
<th>2001</th>
<th>2003</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Health Networks (capitated payment) offered to physicians</td>
<td>P4P for four preventive services available to physicians participating in FHNs</td>
<td>Family Health Groups (reformed fee for service payment) offered to physicians</td>
<td>EMR subsidy available to physicians participating in FHNs</td>
<td>P4P for FOB screening available for physicians participating in FHNs</td>
<td>P4P for all five services available to physicians participating in FHGs (April 2007)</td>
<td></td>
</tr>
</tbody>
</table>

To determine the effect of these P4P incentives in our local setting, we recently conducted an observational before-after study of 18 community-based family physicians in sub-urban Toronto, Ontario.61 These physicians formed two FHNs of 9 members each at the end of 2004 and became eligible for the incentives at that time. We sampled charts from lists of rostered patients using a random number table, for the year before (2004) and the year after (2005) the introduction of incentives. We recorded whether a service was provided within the time frame
recommended for each incentive, as documented on the chart; a note that a service had been
done by another provider was also acceptable. Only patients who were registered at that practice
for at least two years were included. We audited 50 charts per service before and after
incentives, except for children’s vaccinations; due to the low numbers of eligible children per
physician, all charts for eligible children were audited. We compared the provision of each
service before and after incentives using chi-square statistics. We reported rate ratios (RR); due
to the high baseline provision of services, the RR may be inflated and was corrected using
poisson regression.73

None of the physicians were using EMRs at the time of that study. Mirroring studies in the
US,66, 67 we found that the incentives were associated with small increases in the provision of
services (Table 2).61

Table 2: Service provision before and after P4P

<table>
<thead>
<tr>
<th>Service</th>
<th>% serviced before incentives (2004)</th>
<th>% serviced after incentives (2005)</th>
<th>% difference</th>
<th>Rate Ratio, 95% CI (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza vaccination</td>
<td>76.3</td>
<td>83.3</td>
<td>+7</td>
<td>1.10, 1.06 – 1.15 (&lt;0.0001)</td>
</tr>
<tr>
<td>Mammograms</td>
<td>81.9</td>
<td>85.4</td>
<td>+3.5</td>
<td>1.05, 1.01 – 1.10 (0.025)</td>
</tr>
<tr>
<td>Pap smears</td>
<td>84.4</td>
<td>86.1</td>
<td>+1.8</td>
<td>1.02, 0.98 – 1.02 (0.28, NS)</td>
</tr>
<tr>
<td>Children’s vaccinations</td>
<td>93.2</td>
<td>95.8</td>
<td>+3.4</td>
<td>1.04, 0.99 – 1.09 (0.17, NS)</td>
</tr>
</tbody>
</table>

The physicians had high levels of service provision prior to incentives; other studies have
recorded much lower baseline rates of service provision.74-77 Ceiling effects were almost
certainly present: some patients will refuse services, or a service may not be needed for other
reasons (for example, for a terminally ill patient), so reaching 100% provision is not appropriate.
High baseline provision of services has been found to lead to less increase after P4P.66 All of the
physicians within the two FHNs purchased an EMR system by March 2006, thus providing a natural group to study the effect of EMR implementation after the introduction of P4P.

In summary, P4P in Ontario has focused attention on certain preventive services. However, physicians using paper-based records may not have the tools to implement the processes needed to improve service provision, limiting the effect of P4P. These tools include routine audits and feedback, point of care reminders, and recalls of overdue patients.\(^3\), \(^40\), \(^41\), \(^78\)–\(^80\) Ontario’s EMR systems must include these tools in order to be certified and be eligible for a subsidy. We therefore reasoned that physicians implementing certified EMRs would have access to new automated tools that could help them increase their provision of preventive services. Our research questions address the degree of change in these preventive services associated with EMR implementation.

The research that forms this thesis followed the cohort of 18 family physicians mentioned above, as they implemented EMRs in their practices. We examined the change in the provision of preventive services with P4P incentives for the two years prior to EMR, and for the first two years of implementation. To provide a temporal comparison, we also studied a contemporaneous cohort of nine physicians who were not using EMRs. To frame and explain our quantitative results, we explored possible reasons underlying changes related to EMR implementation in this context through qualitative methods. We used focus groups to explore the perceptions of study physicians using EMR about the implementation of their new electronic systems. In other words, while quantitative results provide information about what happened, qualitative findings help to explore and understand why it happened.\(^81\)

The second chapter in this thesis presents theories relevant to the implementation of innovations in health care settings. The third chapter outlines the quantitative and qualitative methods we used. The fourth and fifth chapters present the quantitative and qualitative results respectively. The results are combined and integrated in the sixth chapter. The seventh and final chapter outlines conclusions and discusses the results. We also present a case study describing process changes for preventive services for one group of physicians implementing EMRs in Appendix A.

**Research questions**

The research questions are:
1. Quantitative:

a. Primary question: was there a difference in the change in preventive services targeted by Ontario’s P4P incentives between community-based family physicians implementing EMRs and those using paper-based records?

b. Secondary questions: was there a change in preventive services over time in a group of physicians who purchased an EMR? Was the degree of EMR implementation associated with a difference in the change of service provision? Were there differences in the change between two physician groups implementing the same EMR at the same time? Did physicians with EMRs implement reminder letter mailings to overdue patients?

2. Qualitative: what factors were perceived by physicians as influencing their EMR implementation?
Chapter 2: Theoretical frameworks applicable to the implementation of Electronic Medical Records

The research questions in this study address the first two years of implementation of an innovation, the EMR, in a group of primary care practices. To provide a theoretical context for the changes occurring in these practices, I review theory underlying diffusion of innovations, with attention to studies relevant to implementation in health care settings.

Background

Theory can be defined as “a system of ideas or statements held as an explanation or account of a group of facts or phenomena”. In this chapter, I use theory to frame the possible changes occurring during EMR implementation, and will use theory-driven reflection to discuss the findings of this study in Chapter 6, the integrative chapter.

While there are many empirical studies of adoption, few studies specifically address the implementation of an innovation in health care. In particular, research relevant to theories underpinning EMR implementation in primary health care practices is an understudied area.

Most studies of implementation draw on Rogers’ Diffusion of Innovations theory, a well tested framework that can provide a theoretical basis for some of the processes underlying EMR implementation. However, several processes precede implementation: potential users must first be aware of the innovation; this may be followed by adoption, which is the decision to use the innovation. The decision to adopt may be collective (made by group consensus), optional (individuals decide independently), or authority-based (one individual decides for the group). Once the innovation has been adopted, implementation, which is the process of actually putting the innovation into use in a particular setting, can be initiated.

Theories and studies on health care innovations do not always discriminate between diffusion, adoption and implementation. As previously noted, the EMR is often adopted once financial barriers are removed; all physicians in the intervention group in this study bought systems. EMRs were widely adopted by funded primary care groups in Ontario; however, implementation may not necessarily follow adoption.
For this study, I have applied Rogers’ Diffusion of Innovations framework. Rogers’ innovation theory addresses a wide variety of factors that could affect implementation of an innovation; these include attributes of the innovation, the process of implementation, individual characteristics of, and interactions between, the implementers, and organizational factors.\textsuperscript{7, 53, 88} I will discuss each of these attributes, along with their theorized effects on implementation of innovations.

### Innovation Attributes

What adopters think about the characteristics of an innovation, or its attributes, has been found to be a strong predictor of its adoption and implementation.\textsuperscript{86} For example, in a study of implementation of different health-related technologies in hospitals, the attributes of the innovations explained 37% of the variance in implementation.\textsuperscript{89} Perceptions of the attributes are dynamic and change during implementation;\textsuperscript{53, 90} as well different attributes may be important at different stages of implementation. In health care settings, the attributes that have most consistently been associated with variation in adoption and implementation are relative advantage, compatibility, complexity and observability.\textsuperscript{91} Another attribute, reinvention, has not been well studied but may be an important factor in EMR implementation.\textsuperscript{53}

#### Relative advantage

Relative advantage is the degree to which the innovation is perceived as being better than the previous state.\textsuperscript{7} The dimensions of this attribute are related to costs and benefits including cost advantages (expected profit, low initial cost), increased status, increased efficiency (less time or effort needed to attain goals), and decreased discomfort. As well, the shorter the time lag between initiating the innovation and obtaining benefits, the greater the perceived relative advantage.\textsuperscript{7}

A perception of high relative advantage is one of the strongest predictors of the rate of adoption.\textsuperscript{7, 86} In a study of endoscopic procedures in hospitals, implementation did not begin if there was no perceived relative advantage (that is, endoscopy was not viewed as improving efficiency).\textsuperscript{90} This attribute may therefore be a pre-condition for implementation; however, there are few studies of relative advantage in relation to implementation.\textsuperscript{53}
A critical need in many primary health care practices is efficiency, especially during consultations. The mean length of a primary care visit has been reported as being 10 to 17 minutes. However, physicians report spending 50% more time charting during the first 6 months of EMR implementation. The EMR is not monolithic; it consists of hardware and software features in addition to patient charting (for example, electronic communication, prescriptions, electronic lab results). Some aspects of the EMR may be perceived as having greater relative advantage and therefore may be implemented earlier or more completely. In a study of EMR implementation, the ability to receive lab results electronically and to generate consultation requests electronically were mentioned most frequently as time saving by 18 months of implementation. A survey of US physicians found that some aspects of the EMR (electronic prescriptions) were more commonly used than others (e.g. electronic generation of diagnostic imaging requests).

Older physicians may be less familiar with and, therefore, less efficient with computers than younger physicians who grew up with the technology. The impact of physician age is borne out in the 2007 National Physician Survey: almost 14% of physicians under the age of 35 use EMR instead of paper records, while only 6.4% of those over 65 do so, with clear age gradients. The perception of relative advantage may differ by age, which may be a proxy for experience and efficiency in using information technology.

Incentives are believed to increase the degree of relative advantage at the point of adoption. In other words, the provision of financial incentives for EMRs can make their purchase more attractive to physicians. While EMRs may be perceived as having a high relative advantage during adoption because of incentives and/or efficiency expectations, this can change to a less positive view during implementation, leading to a mismatch in expectations.

**Compatibility**

Compatibility is the degree to which the innovation fits with users’ values, needs and past experiences. More compatible innovations are more likely to be adopted but this attribute may have different effects during implementation. In one survey-based study, clinicians’ belief that the EMR improves quality of care (that is, it was compatible with values) was the factor most strongly correlated with high EMR implementation. However, in a study of guideline implementation in gynecology, guidelines that were initially less compatible with physicians’
values were associated with a greater degree of change in process performance after audit and feedback provided opportunities to improve care.98

Community-based practices include staff and allied health professionals; the distribution of benefits and problems accruing from EMR implementation in a practice and, therefore, the EMR’s compatibility may vary amongst different practice members.99 For example, nurses in both hospital and primary care practices perceived implementation of a system-wide computerized physician order entry system to be more compatible with their workflows than physicians did.100

Implementation of four different health care innovations occurred faster when the innovation mapped onto the distribution of interests, values and power of those involved.101 For example, laparoscopic cholecystectomy was rapidly adopted in Montreal hospitals;101 it led to shorter hospital stays, so that patients began demanding it and insurance companies refused to cover longer stays; surgeons were highly motivated to quickly learn the new technique, or risk losing part of their practice.101 Champagne found that micropolitical power (the ability to control things locally) had the most effect on implementation;102 if the users who have control perceive a greater compatibility and relative advantage during implementation, it may well proceed faster or more completely. As with other attributes, perceptions of compatibility may change during the process of implementation, as the organization evolves along the innovation.

**Complexity**

Complexity reflects the perception that the innovation is difficult to learn and use, and is negatively associated with implementation.7,103 Grilli and Lomas, for example, found that less complex clinical guidelines were more likely to be implemented by physicians.103 In one survey, physicians reported that simplicity and ease of use of an EMR application was a significant positive factor in implementation.104

Several empirical studies have reported that technological barriers were prevalent during EMR implementation.85,105 The complexity of EMR during implementation was possibly increased due to the need to manage complex interconnecting hardware and software systems.85
Innovations that incorporate a large departure from previous routines with few prior implementations can be thought of as being both highly complex and not compatible with past experiences. Rogers calls these “radical” or “disruptive” innovations.\(^7\) In a study on innovation implementation in industry, Dewar and Dutton found that more radical innovations are less likely to be implemented.\(^{106}\) These “radical” innovations require a greater degree of investment in implementation activities than less complex and disruptive innovations.\(^{106}\)

A study of business IT systems implementation found better initial performance with IT systems that were less complex and involved a smaller degree of change from current workflows. However, teams implementing a more radical IT system improved more as implementation continued past the initial stages: they had a greater degree of organizational change and adaptation to the new system.\(^{107}\) Radical innovations may thus entail a greater degree of initial risk and may require a greater degree of organizational change to be implemented successfully.

Observability

Observability refers to the ability of others to see the results of the innovation. Rogers has noted that technology includes both hardware and software. Hardware is easier to observe than software, leading to slower diffusion for software-dominant innovations.\(^7\)

The majority of family physicians in Ontario were solo practitioners,\(^{47}\) (although this is changing, especially for younger physicians),\(^{35}\) so the opportunity to observe the EMR being implemented may sometimes be low within individual practices. The effect of observability on implementation is uncertain; for example, Grilli and Lomas did not find a correlation between observability and implementation of guidelines.\(^{103}\)

Reinvention

Reinvention is the extent to which the innovation can be modified to fit the organization and local context as it is implemented.\(^7,53\) This malleability can be thought of as an attribute of the innovation, but is also part of the process of implementation. Innovations that cannot be modified without making them less effective are less likely to be implemented.\(^{108}\) Gladwin, for example, found that a health information management system needed to be extensively reinvented during implementation to meet the needs of local health units in Uganda.\(^{109}\)
However, if implementers do not perceive a relative advantage during implementation, they may modify the innovation to ensure its failure and discontinuance, as nurses\textsuperscript{110} and physicians\textsuperscript{111} did in case studies of hospital-based EMR implementation. For example, in one implementation, surgeons refused to conform to some prescription patterns in the EMR, while pharmacists insisted on compliance. Conflicts between physicians, nurses and pharmacists escalated and surgeons eventually asked their colleagues not to admit patients to that unit—leading to discontinuance of the system.\textsuperscript{111}

**Process of implementation**

There is a time dimension to implementation, as it occurs through stages.\textsuperscript{89} Rogers has defined these stages as redefining/restructuring, clarifying and routinizing.\textsuperscript{7} At the redefining/restructuring stage, the innovation is reinvented so that it fits the organization and the organization changes as well; these processes require a significant amount of organizational investment for the innovation to be implemented successfully. Clarifying involves more clearly defining the role of the innovation within the organization. During routinization, the innovation becomes part of usual operations; innovations that are successfully reinvented to fit their context are more likely to be sustained.

This process of co-evolution during implementation has been researched by Denis, Hebert, Langley and colleagues.\textsuperscript{101} In a study of the implementation of four different health care innovations, they described innovations as being “composed of a hard core that was relatively fixed and a soft periphery related to the various ways in which it might be implemented.”\textsuperscript{101}(pg 66) A study of the implementation of an innovation (quality standards) in business organizations found that improvements in performance were correlated with both successful reinvention of the innovation and the ability of the organization to transform itself to take advantage of the innovation.\textsuperscript{112} As Denis and colleagues observe, “clear evidence about the appropriateness and conditions for good practice rarely emerges until the innovation has been experimented with for some time precisely because learning is required to optimize it.”\textsuperscript{101}(pg 72) Because of this complexity, some aspects of implementation will always be unpredictable, and will depend on local factors.\textsuperscript{113}

The process of implementation may not occur continuously or smoothly. In a study of new processes in manufacturing and service industries, Tyre and Orlikowski found that there may
only be a brief window for reinvention to occur before the innovation becomes routinized; further reinvention then occurs in fits and starts as problems arise.114

Individual characteristics and interactions between implementers

Rogers has categorized adopters by the timing of adoption of an innovation, as innovators, early adopters, early majority, late majority and laggards.7 While these categories are applicable to adoption of innovations, their effect on implementation is less certain. An important group during implementation may be the early adopters who are also “opinion leaders”.53 Opinion leaders are well integrated in their social systems and exert considerable influence on their peers.7 The presence of local opinion leaders has been found to increase the implementation of evidence based practice115 and to affect prescriptions for antibiotics.116 While opinion leadership means that an individual has influence on peers, it does not indicate the direction of that influence (in favour or opposed to an innovation).53 If an opinion leader is enthusiastic about the innovation, and becomes dedicated to supporting it, he or she may then become its “champion”.117 Ideally, champions are technically knowledgeable about the innovation, have good interpersonal skills and have strong connections within their peer groups enabling them to overcome perceived barriers as they arise.14,118 In a case study of four hospital-based EMR implementations, failures were due to issues such as physician concerns about loss of status (having to do nurses’ work), which the implementation leaders were unable to successfully address.111 In successful implementations in the same study, champions were able to solve problems. For example, a physician tagged all diagnostic imaging requests as “bullet wound” because this was the first item in a drop down list; the champion replied by sending a request for a psychiatric consultation.111 The presence of a champion may be one of the most important factors leading to a successful implementation—possibly even more so for very radical innovations.96,117,119,120

The presence of supportive leadership at the organizational level may be a factor in improving implementation. Effective leadership has been found to improve IT implementation in business organizations;121 supportive CEOs of hospitals had positive influences on the implementation of innovations.89 Leadership style may need to change from adoption to implementation: participatory leadership may be more effective at the selection stage, while more decisive leadership may be needed during implementation, so as to quickly solve problems.122 Effective
leadership and the presence of a champion both had a positive effect on EMR implementation in primary care practices and on the implementation of shared medical records.

**Organizational Attributes**

The attributes of organizations may affect the implementation of innovations. It has been suggested that lower organizational complexity, higher formalization (emphasis on following rules), and higher centralization (decision making being concentrated in one place) favour implementation. However, a meta-analysis of innovations in organizations found that higher organizational complexity was associated with more effective implementation. The literature on the effect of organizational complexity on implementation appears inconclusive.

The size of an organization may affect implementation of innovations. A meta-analysis found that larger size favours implementation; however, a study in health care organizations found that size had a negative association with implementation, and a meta-analysis of innovativeness in organizations found that the impact of size was not significant. A survey of EMR use in US ambulatory practices found that large groups (>50 physicians) were more likely to have a “fully functional” EMR. The size of an organization appears to have an inconsistent association with implementation.

The presence of “slack resources” (or resources beyond those required for the management of daily tasks) is significantly associated with implementation of innovations. Rogers theorizes that larger organizations may have more slack and that it may be slack, rather than organizational size, that is related to innovation implementation. Dijkstra, in a study of diabetes guideline implementation in hospitals, found that lack of slack (too little time, not enough nursing support) was associated with perceived barriers to implementation. Slack may be associated with the availability of training and resources dedicated to implementation (for example, technical support for complex IT implementations). In a randomized controlled trial, intensive teacher training was associated with a doubling of implementation of a health program in schools. In another study, the availability of technical support and training was associated with implementation of a shared health record.

Cooper and Zmud studied IT-based materials requirement planning (a system for predicting what to order for manufacturing goods) in industry. They found that integrated use of the technology
to obtain maximal gains, or “infusion” was difficult to achieve.\textsuperscript{130} Infusion required buy in from different departments, not all of which understood or immediately realized benefits from the new technology, leading to “bureaucratic resistance”.\textsuperscript{130} Senior management support and training could be used by the organization to overcome the resistance.\textsuperscript{130}

**Summary**

Perceptions of the attributes of an innovation have been associated with its degree of implementation. Perceptions of attributes may differ according to the position and characteristics of the implementer, and can change during the process of implementation. As shown in Figure 1, high relative advantage likely has a positive association with implementation. High compatibility and low complexity may also be associated with a greater likelihood of implementation, but with a lesser degree of change in processes (such as the provision of preventive services) if implementation is successful. The role of observability is unclear.

The organization and the innovation co-evolve during implementation; re-invention of the innovation allows this co-evolution to occur. The presence of an enthusiastic opinion leader (or champion) and effective organizational leadership appear to have a positive effects on implementation. Organizational size and complexity have inconsistent effects; however, the availability of slack resources may be correlated with successful implementation.

While I have not generated formal theory-based hypotheses to test as part of this thesis, the concepts examined in this chapter will be applied to the interpretation of findings described in Chapter 5.
Figure 1: Theoretical factors affecting implementation of an innovation

Innovation Attributes positively (+), negatively (-), or inconclusively (0) affecting implementation

Organizational Attributes positively (+) or inconclusively (0) affecting implementation

Innovation implementation over time
Participants

This study followed two cohorts of physicians: a group of eighteen physicians using EMRs, and a second group of nine physicians using paper records (non-EMR cohort). These physicians were community based, were all affiliated with an urban general hospital and were located in the north Toronto area. All physicians participating in this study were members of the local After Hours Clinic (AHC), which was a large cooperative after hours service: 143 family physicians in the local community took turns providing services at the clinic on week-ends and evenings. Physicians in the AHC had their own family practices, but directed their patients to the clinic for after hours care, knowing that it would be staffed by one of their local colleagues and that they would receive a report outlining the care their patients received. Eighteen AHC physicians belonged to one of the two FHNs in this study, while the other 125 AHC physicians, including the nine physicians using paper records, belonged to a single Family Health Group (FHG).

EMR cohort

The EMR cohort was composed of two FHNs, each with nine physicians. Both FHNs formed at the end of 2004, and subsequently started implementing the EMR at similar times: FHN1 in January and February of 2006, and FHN2 in March and April of 2006. They were using the same EMR software and the same hospital-based server. The two FHNs used separate databases within the server; they were able to share patient data and EMR processes within but not across FHNs. All physicians in both FHNs consented in writing to participate in this study.

As previously mentioned, FHN physicians received the majority of their fees from capitation, and were eligible for the EMR subsidy.

The principal investigator was a member of FHN2, and was also a participant in this study. She implemented an EMR within her own practice; she was involved in and directly observed many of the processes described in this study. She kept a chronological record of the progress of EMR implementation, available at http://drgreiver.blogspot.com.
Non EMR cohort

The non-EMR physicians were recruited through a letter of invitation sent to the membership of the AHC from the principal investigator. Peer to peer recruitment has been shown to be the most successful method of enrolling family physicians in studies.\textsuperscript{131} All AHC physicians who were not in one of the two FHNs in this study belong to one FHG.

As previously described, physicians belonging to a FHG were mostly paid through fee for service, with a supplement for rostered patients. FHG physicians were not eligible for the EMR supplement.

These physicians were all affiliated with the same urban general hospital and practiced in the same geographic area of the city as the EMR cohort. The Board of the AHC provided the principal investigator with the names and addresses of the FHG physicians. We sent a letter of invitation and a survey asking these physicians to report the approximate number of patients in their practice, number of days per week that they worked, and whether they had or were planning to implement an EMR within the year (see questionnaire in Appendix C). Twenty four physicians responded (19%). Since none of the EMR physicians practiced part time, one respondent was excluded on the basis of part-time practice (fewer than 2.5 days per week).

Characteristics of the AHC respondents are shown in Table 3 and corresponding characteristics for the EMR physicians are shown in Table 5. The study budget included data collection costs for a maximum of 10 non-EMR physicians.

For purposes of comparison, the two cohorts should be as similar as possible. Thus, the following inclusion/exclusion criteria were employed in the selection of the non-EMR physicians. The principal investigator reviewed the size of the practices, physician gender, intent to implement an EMR in the next year and number of days worked reported in the returned questionnaires. Physicians who reported panel sizes or number of working days beyond the ranges for EMR physicians were excluded. The EMR physicians were all community-based with panel sizes ranging from 630 to 2200 patients. Their working hours ranged from 30 to 60 hours, representing approximately three to six days per week. Five physicians who were currently implementing an EMR or planning to start one in the near future were excluded. Four physicians with panel sizes larger or smaller than those of the EMR physicians were excluded. One physician worked in a hospital-based academic practice and was excluded. This left 12
physicians, of which nine (75%) were male. 56% of EMR physicians were male; to approximate the gender frequency of the EMR cohort, two male physicians were excluded, leaving ten physicians. After being contacted by phone, one physician declined and nine agreed to participate. This physician was not replaced to allow some budget flexibility.
Table 3: Physicians included and excluded in non-EMR cohort (N=23)

<table>
<thead>
<tr>
<th>Size of practice (number of patients)</th>
<th>Physician Gender</th>
<th>Number of days worked</th>
<th>Inclusion</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>Female</td>
<td>3</td>
<td>Excluded</td>
<td>Less than 630 patients</td>
</tr>
<tr>
<td>500</td>
<td>Female</td>
<td>3</td>
<td>Excluded</td>
<td>Less than 630 patients</td>
</tr>
<tr>
<td>700</td>
<td>Female</td>
<td>4</td>
<td>Excluded</td>
<td>Hospital teaching practice</td>
</tr>
<tr>
<td>850</td>
<td>Male</td>
<td>4</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>850</td>
<td>Male</td>
<td>4</td>
<td>Excluded</td>
<td>Planning EMR</td>
</tr>
<tr>
<td>850</td>
<td>Female</td>
<td>2.5</td>
<td>Excluded</td>
<td>Less than 3 days in practice</td>
</tr>
<tr>
<td>1000</td>
<td>Male</td>
<td>4</td>
<td>Included</td>
<td>declined</td>
</tr>
<tr>
<td>1000</td>
<td>Female</td>
<td>5</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>Female</td>
<td>4</td>
<td>Excluded</td>
<td>Planning EMR</td>
</tr>
<tr>
<td>1262</td>
<td>Male</td>
<td>5</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>1300</td>
<td>Female</td>
<td>4</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>1350</td>
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<td>5.5</td>
<td>Excluded</td>
<td>Male gender</td>
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<tr>
<td>1450</td>
<td>Female</td>
<td>3</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>Female</td>
<td>5</td>
<td>Excluded</td>
<td>Planning EMR</td>
</tr>
<tr>
<td>1600</td>
<td>Male</td>
<td>4</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>Male</td>
<td>4</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>1620</td>
<td>Male</td>
<td>4</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td>Female</td>
<td>5</td>
<td>Excluded</td>
<td>Starting EMR</td>
</tr>
<tr>
<td>1900</td>
<td>Male</td>
<td>4.5</td>
<td>Included</td>
<td></td>
</tr>
<tr>
<td>Size of practice (number of patients)</td>
<td>Physician Gender</td>
<td>Number of days worked</td>
<td>Inclusion</td>
<td>Reason</td>
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<tr>
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</tr>
<tr>
<td>2000</td>
<td>Female</td>
<td>5</td>
<td>Excluded</td>
<td>Starting EMR</td>
</tr>
<tr>
<td>2000</td>
<td>Male</td>
<td>5</td>
<td>Excluded</td>
<td>Male gender</td>
</tr>
<tr>
<td>2400</td>
<td>Female</td>
<td>5</td>
<td>Excluded</td>
<td>More than 2200 patients</td>
</tr>
<tr>
<td>3000</td>
<td>Female</td>
<td>6</td>
<td>Excluded</td>
<td>More than 2200 patients</td>
</tr>
</tbody>
</table>

The nine physicians in the non-EMR cohort continued to use paper-based records throughout the study period. As noted above, the number of physicians recruited for the non-EMR cohort (nine) and the number of years selected for the chart audit (two) were limited by funding constraints.

A flow chart detailing the process of recruitment for the non EMR cohort is shown on Figure 2.
Figure 2: Flow diagram detailing the recruitment of the non-EMR cohort

125 AHC members that were not part of EMR cohort

Letters mailed

24 physicians willing to participate (19%)

Reviewed by PI

One physician excluded: spends less than 2.5 days per week in practice

23 physicians eligible

Reviewed by PI for similarity to EMR cohort

Thirteen physicians were excluded:
- planning/starting EMR: 5
- Panel size out of range: 4
- Practicing less than 3 days per week: 1
- Hospital based practice: 1
- Male gender: 2

Ten physicians called by PI

- One declined
- Nine agreed to participate and were included in the study
Determination of physician and practice characteristics

We obtained data about physician and practice characteristics through a questionnaire administered to each physician consenting to participate in the study (see Appendix D). Following the methods of Glazier et al., we also obtained and examined aggregated, anonymized data derived from linked administrative databases at the Institute for Clinical Evaluative Sciences (ICES), after review and approval from ICES and Sunnybrook’s Research Ethics Boards. ICES was provided with the participating physicians’ College of Physician and Surgeon’s registration number; this allowed identification of the physicians and their practice populations in the databases. The information provided to ICES indicated whether the physician was in the EMR or non-EMR cohort, which FHN the physician was a member of, and whether the physician was using the EMR during encounters. To decrease risks to privacy, only cell sizes of greater than five were reported. We collected information on physician and patient factors that could impact the provision of preventive services:

- Number of years the physician had been in practice: physician performance may decline with increasing years of service.\(^{133}\)

- Physician characteristics (gender, Canadian vs foreign medical school graduation, certification as a family physician): female physicians\(^{134,135}\), Canadian graduates\(^{136}\) and certifiants in family medicine (CCFP)\(^{137}\) may be more likely to deliver the recommended preventive services.

- Size of practice: low volume practice may be associated with higher quality care.\(^{138,139}\)

- Size of physician group: solo practice may be associated with less preventive care.\(^{136}\)

- Comprehensiveness of care: obtaining more primary care services from the same physician may be associated with greater provision of preventive services.\(^{140}\)

- Patient age: increasing patient age may be associated with the provision of more screening mammograms, but fewer Pap smears.\(^{141}\)
• Recency of immigration and patient incomes by neighborhood of residence: recent immigration and low income has been found to be associated with a lower provision of Pap smears\textsuperscript{142} and mammograms.\textsuperscript{75, 143}

• Associated morbidities and co-morbidities: increasing burden of illness may be associated with fewer preventive services.\textsuperscript{144}

The ICES data were derived from the following sources:

• The ICES Physician Database (IPDB) for information on physician country of graduation;
• The Corporate Provider Database (CPDB) for information on physicians OHIP billing number;
• The Ontario’s Registered Persons Database (RPDB) for patient age (as of August 31\textsuperscript{st} 2007), gender and immigration recency by date of OHIP registration;
• The Client Agency Program Enrolment (CAPE) tables for information on patient enrolment in each physician’s roster;
• Statistics Canada data on neighborhood income, linked to patients’ residential postal code for estimates of income quintiles;
• The Canadian Institute for Health Information’s Discharge Abstract Database for hospital discharge diagnoses;
• The Ontario Health Insurance Plan for billing and diagnostic data to identify patient visits and diagnoses;
• The Ontario Diabetes Database (ODD) for diabetics;
• The Ontario Asthma Database (OASIS);
• The Ontario Congestive Heart Failure Database;
• The Ontario Chronic Obstructive Pulmonary Disease Database;
• The Ontario Hypertension Database;
• The Ontario Myocardial Infarction Database

Comprehensiveness of care was determined by measuring the percentage of bills for 21 commonly provided services that were provided by the patient’s own family physician.\textsuperscript{132, 145}

We report morbidity and co-morbidity using the Johns Hopkins Adjusted Clinical Groups (ACG)
software,\textsuperscript{146} available at ICES, which uses administrative data to categorize patients in terms of morbidity, co-morbidity and resource use.\textsuperscript{147} This software assigns diagnostic codes to one of 32 Aggregated Diagnosis Groups (ADGs);\textsuperscript{148} ADGs are measures of co-morbidity and expected resource utilization.\textsuperscript{147} Another measure, Resource Use Bands (RUBs) aggregate ACGs with similar estimated health care resources utilization, from low (0) to high (5);\textsuperscript{147} this serves as a proxy for morbidity. We also obtained validated ICES data on several important chronic conditions (diabetes,\textsuperscript{149} congestive heart failure,\textsuperscript{150} hypertension,\textsuperscript{151} myocardial infarction,\textsuperscript{152} asthma,\textsuperscript{153} chronic obstructive pulmonary disease,\textsuperscript{154} mental health problems\textsuperscript{155}) as an additional measure of morbidity.

**Study Design**

This study used a concurrent quantitative-qualitative mixed method design. In this design, the emphasis was on the quantitative method, with a limited embedded qualitative method\textsuperscript{156} to explore factors described in Chapter 2 that have been found to be related to the implementation of innovations. The integration of the qualitative and quantitative findings is reported in Chapter 6.

We used a parallel prospective and retrospective observational cohort design (controlled before and after study) for the quantitative aspect of the study. We concurrently conducted two focus groups of physicians implementing the EMR for the qualitative aspect. We also recorded a case study of one group’s implementation of new EMR processes for the management of preventive care.

We already had data for 2004 and 2005 for the EMR cohort as part of a previous study on Pay for Performance.\textsuperscript{61} We retrospectively collected data for 2006, and prospectively collected data for 2007 for both cohorts. The independent variable was the introduction of EMR in one cohort and not in the other one; the dependant variables were measures of the change in the selected preventive services provided to patients and documented in the charts over time.

**Primary and Secondary Outcomes**

The primary outcome was whether or not a preventive service was provided and documented in the chart for an eligible patient within the time frame recommended by the P4P program. The target patient population consisted of all eligible rostered patients in the study physicians’
practices. Rostered patients had formally identified a physician as their family doctor by signing an enrollment form; all physicians in this study had rostered practices.

An eligible patient had been in the practice for at least two years (defined as having a documented encounter with the physician in the chart two years or more prior to the audit). Having been in the practice for two years or more helped to ensure that patients who were transient or who had recently joined a practice (and may not have had a chance to have a service yet) were excluded. We defined a service as having been provided if the chart documented the provision of:

- A Pap smear within 30 months for rostered women age 35 to 69. Women with a hysterectomy were excluded.
- A screening mammogram within 30 months for rostered women age 50 to 69. Women with a history of breast cancer were excluded.
- An influenza vaccination in the Fall (October 1st to December 31st) for rostered patients age 65 and over.
- Five completed primary immunizations (four diphtheria-polio-tetanus-pertussis/haemophilus vaccinations and one measles-mumps-rubella vaccination) for rostered children, by the age of 30 months.
- A fecal occult blood test (FOBT) within 30 months for rostered patients age 50 to 75. Patients with a history of Colorectal Cancer or Inflammatory Bowel Disease were excluded. Patients who had a colonoscopy within the past five years were excluded.

Documentation that the patient received the service through another health care provider, within the same time period, was acceptable.

To provide a measure of performance that included all preventive services studied, we calculated a “composite process score”. The score is calculated by using the total number of charts audited for eligible patients as the denominator, and the total number of services documented on those charts as the numerator. We used this score to compare service provision between groups and within groups over time.

The secondary outcome was a measure of process change. We audited records for documentation of a reminder letter having been sent to patients who were overdue for a service.
Reminder letters have been found to be effective in increasing the provision of immunizations and cancer screening services. These were collected using the EMR software when possible (see Appendix F), or with chart audits (EMR or paper).

Variable Measurement

We tracked preventive services and reminder letters for four years in the EMR cohort:

- 2004: pre Pay for Performance (P4P)
- 2005: post P4P
- 2006: first year of EMR usage (EMR transition year)
- 2007: second year of EMR usage

The non-EMR cohort was tracked for two years:

- 2006: pre P4P
- 2007: post P4P

This second cohort provided a temporal comparison for the first two years of EMR implementation.

The changes over time and an outline of planned comparisons within and between the two cohorts are shown in Table 4.
Table 4: Changes over time for the two cohorts and planned comparisons within and between groups

<table>
<thead>
<tr>
<th>Year</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMR cohort (N=18)</td>
<td>No P4P Incentives</td>
<td>P4P Incentives</td>
<td>P4P Incentives +EMR</td>
<td>P4P Incentives +EMR</td>
<td>Change over time</td>
</tr>
<tr>
<td>Non-EMR cohort (N=9)</td>
<td></td>
<td>No P4P Incentives for FHG physicians</td>
<td></td>
<td>P4P Incentives</td>
<td></td>
</tr>
<tr>
<td>Comparison</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Change with EMR vs no EMR</td>
</tr>
</tbody>
</table>

We sought to explore changes in preventive services between physicians at different stages of EMR implementation. We examined physicians’ patterns of usage at 18 months after adoption of the EMR\(^52\) by calculating the ratio of number of signed off patient encounters in the EMR with the number of encounters booked in each physician’s schedule during October 2007. We reasoned that physicians who used the EMR consistently to record patient encounters would have approximately the same number of signed off encounters as booked encounters (a ratio of 1).

We explored comparisons between the two FHNs that implemented the EMR at the same time, reasoning that social and group interactions may differ between these two FHNs. We sought to explore differences in the changes in preventive services between the two groups implementing EMR at the same time. Lists of the nine physicians belonging to each FHN were available from the previous study.\(^61\)

The Ministry of Health and Long Term Care provided lists of patients eligible for each service to family physicians. We selected charts for audits from these lists using a random numbers table. We recorded the presence or absence of a service within the required time period, the patient’s
date of birth, and their gender, as well as whether a letter was sent to remind a patient overdue for a service. A representative copy of a data recording form is shown in Appendix E. We entered the data into an Epi Info database. We audited paper charts for physicians in the non-EMR cohort and obtained data from EMR charts for physicians in the EMR cohort. When data were missing in the EMR (example: a mammogram done prior to the start of EMR), we retrieved and audited the paper chart as well. Two physicians in the EMR cohort had transferred their paper charts to a commercial storage company; we sought and were granted permission by the physicians and the storage company to access those charts.

Five data auditors abstracted data from the paper charts. Two of these auditors had participated in our previous study on Pay for Performance, and were already familiar with the practices of the physicians in the EMR cohort; the auditing forms and process were similar to those used in the previous study. The research coordinator initially audited ten charts for each service in two practices (five charts in each practice); this was reviewed with the principal investigator to ensure consistency and to address questions. Once both coordinator and principal investigator were satisfied with the consistency and accuracy of the process, the coordinator then trained each data auditor, and reviewed at least ten charts for each service prior to sending the auditor into the field. The research coordinator held meetings with the principal investigator and auditors at least every six weeks to review progress and address concerns; team members regularly communicated via email, and the study coordinator met regularly with each auditor. The data were collected by the auditors on paper forms, and then entered independently in the Epi Info database by two data entry clerks. Each clerk entered a training sample of at least ten charts for each service, and this was reviewed with the coordinator. In order to assess auditing and data entry, a randomly selected 10% sample of data for each service, each year and each physician was re-audited and entered in the database; we used the Kappa statistic to compare the two audits.

We planned to sample data electronically from the entire practices of EMR physicians. The EMR can automatically generate lists of eligible patients, based on age, gender, and rostered status. Physicians could electronically flag patients ineligible for a service, so that they were not included in the denominator. A software application to extract data anonymously from each
practice was programmed by the EMR company, and was pilot tested in the principal investigator’s practice, prior to the study. An example of an electronic audit is shown in Appendix F. Once a service was provided and recorded in the appropriate location of the EMR, the numerator (number of patients having received the service), denominator (number of eligible rostered patients), and percentage having received the service can be automatically generated by the system; if data are entered correctly, these numbers should be identical to the numerator and denominator obtained using individual chart audits. The data were entered in that manner in FHN2’s charts but not in FHN1’s; only FHN2’s data were retrieved using the software application. We retrieved FHN1’s data using individual chart audits. We reviewed the data obtained from the electronic audits of FHN2; some out of range service dates had been incorrectly added by the software; these charts were individually audited, and the service (if present) was manually added. Physicians had to indicate that a service was done by clicking an electronic indicator field in the EMR (see Appendix A); this was not always consistently done, and the research coordinator audited charts for the presence of the service if no information was present. Once the data review and cleaning process was completed, 10% of the charts were manually re-audited for reliability purposes; no errors were found.

To validate our chart abstraction data, we obtained administrative data on the same services for the two cohorts. These data were obtained from ICES, using the same datasets outlined above; we added data from the Ontario Cancer Registry (OCR) and the Ontario Breast Screening Program (OBSP), after approval from ICES. Children’s vaccinations were not examined, as billing codes include vaccinations other than the five used in the study.

The denominators were the number of patients eligible for each service alive and rostered to the physicians in each cohort by March 31st of each fiscal year (for example, March 31st 2005 for the 2004 fiscal year). Physicians report the performance levels they have achieved on March 31st to the Ministry of Health and Long Term Care.

Exclusion criteria for administrative data were the same as for chart audit data. To exclude women with hysterectomies or previous cervical cancer, we obtained diagnostic codes for cervical cancers or procedural codes indicating a hysterectomy. To exclude women with breast cancers, we obtained the diagnostic code indicating this. To exclude patients with previous inflammatory bowel disease, colorectal cancer or a colonoscopy in the previous five years, we
looked for a diagnostic code indicating one of these conditions above, or a procedural code for a colonoscopy.

The numerators were the number of eligible rostered patients having received a service in the 30 months prior to March 31st of each year for Pap smears, mammograms or FOBT testing, or an influenza vaccination from October 1st to December 31st of the prior year. For Pap smears, we obtained physician billing codes and laboratory billing codes for this service. For mammograms, we obtained data from OBSP as well as from radiology billing codes for mammography. For influenza vaccinations, we obtained physician billing codes specific to influenza vaccination, as well as general vaccination codes for patients age 65 and over during the fall (as influenza vaccination may have been miscoded). The rate of service was defined as the proportion of eligible patient receiving a service at least once in the past 30 months (Paps, mammograms, FOBT) or in the previous fall (October 1st to December 31st) for influenza vaccination.

A detailed description of the inclusion and exclusion criteria and codes for the administrative data is provided in Appendix G.

Sample size calculation

To calculate the sample size, we first needed to decide on a minimum clinically meaningful change. A change of 5% in a year is often used in the literature; for example, a large study in the US found a 5% increase in services after the introduction of EMR (although this was in the context of system-wide re-engineering).21 We assumed a similar increase after the introduction of EMR, and calculated the sample size in order to have a power of 80% to detect an absolute increase in service provision of 5% or higher (using rates for influenza vaccination, from 83% to 88%) in the year before EMR compared with the year after EMR, with a 5% type I error. We needed to sample 724 charts per service per year (40 charts per service per provider); to increase power, we oversampled, and audited 50 charts per year, per service, per physician. The entire practices of FHN2 physicians were automatically audited. To avoid overweighing this group, the number of patients recorded for this study was reduced to 50 per year, per physician, per service, by using the statistical software to randomly sample 50 entries for each year/service/physician from the available data.
Physicians who practice in groups may influence each other, which may lead to a clustering effect\textsuperscript{161}. Based on our previous study\textsuperscript{61}, the estimated Inter-Class Correlation\textsuperscript{162} (ICC) was 0.01. If we assume that, on average, the recruited physicians are clustered within groups of size 4, and ICC=0.01, the inflation factor would be \((1+(4-1)x0.01)=1.03\) which would have a negligible effect on the sample size, by increasing the number of charts needed to 41. We oversampled by 25\% (from 40 to 50 charts per service per year), and this would account for the possible clustering effect.

According to our previous study,\textsuperscript{61} family physicians in the EMR cohort look after a mean of 13 eligible children per practice resulting in the audit for children’s vaccinations being underpowered for both the EMR and Non-EMR audits. We could not randomly sample 50 charts per year, per physician, so we audited every child’s chart. We did not audit children’s vaccines for the non-EMR cohort due to an inability to obtain lists of eligible children for 2006.

**Quantitative Analysis**

We compared the change in provision of services between the EMR and non-EMR cohorts. We first compared the change in the composite process score for each group using the chi-squared test. We then used multivariable logistic regression to simultaneously adjust for patient age,\textsuperscript{141} physician gender,\textsuperscript{61} physician experience (time since graduation)\textsuperscript{133} and CCFP vs non-CCFP status.\textsuperscript{137} We used the Generalized Estimating Equation (proc Genmod in the SAS statistical software application) to adjust for the clustering structure of the data in regression models.

We calculated service provision in the EMR cohort for each year. We used the chi-squared test to compare the composite process score with the score for the previous year. We then adjusted for differences in patient age\textsuperscript{163} using logistic regression.

We analyzed the differences in the change in the composite process score between physicians within the EMR group who were or were not using EMR for encounters by 18 months using analysis of variance with repeated measures (random effect model).\textsuperscript{73}

We compared the provision of preventive services by FHN, for each year, using the chi-squared test. We adjusted for patient age,\textsuperscript{141} physician gender,\textsuperscript{61} physician experience (time since graduation)\textsuperscript{133} and CCFP vs non-CCFP status\textsuperscript{137} using multivariable logistic regression.
ICES data could not be used for adjustment, as the data were not collected at the patient level.

We compared the year over year change in administrative data for each cohort using chi-squared. We did not adjust for physician or patient data, as individual level data were not available. The principal investigator was also a participant in the study. We reanalyzed the data within FHN2 after removing her practice’s data.

Analyses were performed with the use of SAS software, version 9.1 (SAS Institute). All tests were two sided and p values less than 0.05 were considered statistically significant.

**Qualitative design**

In order to obtain qualitative data on the factors that promote or impede the implementation of EMRs, we conducted two focus groups with members of the EMR Cohort. Focus groups are particularly suited for collecting information on people’s attitudes and experiences, “how they think and why they think that way”, within a particular context. Each focus group was composed of the members of one FHN only in order to capitalize on interactions that would naturally be occurring within each of the two groups. We invited all physicians in both EMR cohorts to participate. The principal investigator is a member of FHN2; to avoid introducing bias, she did not conduct or participate in either focus group. The interviews were conducted by one of the researchers (JB), who had extensive experience in qualitative and focus group studies in primary care, along with the research coordinator. The focus groups lasted approximately 1 hour each, and were conducted in February 2008. To maximize ease of participation, the sessions were held after office hours or at lunch time in one of the participating physicians’ office. No compensation was offered to participants for attending the group; a light meal was provided. We used a semi-structured guide based on our previous study (which the participants did not see in advance); the guide is shown in Appendix H. We did not specifically ask about preventive care, as the focus group took place during the study, and we did not want to bias practice behaviour by introducing suggestions about preventive processes. The interviewer introduced the topic by stating that the discussion would explore participants’ experiences with EMRs; the initial question was whether participants used only electronic records or a combination of paper and EMR. The interviewer then encouraged participants to talk to each other and guided the discussion. She also encouraged participants to share opposing views on the implementation of EMR in their practices. All physicians signed an additional consent.
form to permit the focus group recording, transcription and analysis (Appendix I). The interviews were audio-taped and transcribed verbatim.

**Qualitative Analysis**

Two members of the research team (JB, MG) initially independently read and coded the transcripts. The constant comparative method, a method of checking and comparing data to identify categories, was used to identify key words and themes describing the participants’ views about, and experiences with the EMR system. We also searched the data for alternative explanations. Key words and themes were provisionally classified into categories. The coders then met to compare and contrast findings, category mapping and interpretations; we resolved disagreement by consensus. We selected verbatim participant quotes to demonstrate that our findings were grounded in the data.

The study was approved by the University of Toronto’s Research Ethics Board; the Sunnybrook Research Ethics Board approved the use of ICES data. All physicians provided written informed consent. The approval allowed chart review and anonymized data collection without individual patient consent.

The study was funded by the Ministry of Health and Long Term Care of Ontario through a health system linked research grant.
Chapter 4 : Results, Quantitative Analysis

Characteristics of the study physicians

The 18 family physicians in the two FHNs that made up the EMR cohort were located in 9 offices, comprised of two solo physicians, five two-physician practices, a three-physician practice, and a six-physician group practice. Three of the five practices with two physicians were composed of one FHN physician and one non-FHN physician. The non-FHN physicians in these hybrid practices did not use EMR. They did not participate in this study, other than for a single practice where both partners participated in this study, with one physician as part of the EMR cohort and the other as part of the non-EMR cohort. The nine non-EMR physicians practiced in nine different offices, ranging from two solo practices, to a group of six physicians. The characteristics of the study physicians are presented in Table 5 and Table 6.

Table 5: Self reported characteristics of physicians in EMR and non EMR cohorts

<table>
<thead>
<tr>
<th></th>
<th>EMR (n=18)</th>
<th>Non-EMR (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean, median (range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>10 (56)</td>
<td>6 (66)</td>
</tr>
<tr>
<td>CCFP, n (%)</td>
<td>11 (61)</td>
<td>7 (77)</td>
</tr>
<tr>
<td>Number of MDs in</td>
<td>3, 3 (1 to 6)</td>
<td>4, 4 (1 to 6)</td>
</tr>
<tr>
<td>practice: mean,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>median (range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of hours</td>
<td>43.7, 42 (30 to 60)</td>
<td>47.5, 44 (28 to 80)</td>
</tr>
<tr>
<td>worked per week:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean, median (range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients</td>
<td>1323, 1206 (630-2200)</td>
<td>1295, 1200 (850-1600)</td>
</tr>
<tr>
<td>per physician: mean,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>median (range)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6: Physician and practice characteristics in EMR and non EMR cohorts, derived from administrative databases

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>VALUE</th>
<th>EMR</th>
<th>Non-EMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians</td>
<td>N=18</td>
<td>N=9</td>
<td></td>
</tr>
<tr>
<td>Canadian vs foreign graduate</td>
<td>16/18</td>
<td>8/9</td>
<td></td>
</tr>
<tr>
<td>Patients (mean)</td>
<td>N=23,514 (1,306)</td>
<td>N=10,591 (1,177)</td>
<td></td>
</tr>
<tr>
<td>Age as of August 31st 2007</td>
<td>Mean ± SD</td>
<td>43.8 ± 22.1</td>
<td>47.1 ± 21.3</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>45 (27-60)</td>
<td>47 (31-63)</td>
</tr>
<tr>
<td>Patient Gender</td>
<td>M</td>
<td>10,106 (43.0%)</td>
<td>4,767 (45.0%)</td>
</tr>
<tr>
<td>Neighborhood income quintile$^{132}$</td>
<td>Unknown</td>
<td>51 (0.2%)</td>
<td>31 (0.3%)</td>
</tr>
<tr>
<td></td>
<td>Lowest: 1</td>
<td>3,084 (13.1%)</td>
<td>1,594 (15.1%)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3,643 (15.5%)</td>
<td>1,438 (13.6%)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4,345 (18.5%)</td>
<td>1,951 (18.4%)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5,091 (21.7%)</td>
<td>2,414 (22.8%)</td>
</tr>
<tr>
<td></td>
<td>Highest: 5</td>
<td>7,300 (31.0%)</td>
<td>3,163 (29.9%)</td>
</tr>
<tr>
<td>Recent Immigrant$^{132}$</td>
<td></td>
<td>1,398 (5.9%)</td>
<td>1,148 (10.8%)</td>
</tr>
<tr>
<td>Comprehensiveness of Care$^{132, 145}$</td>
<td>Mean ± SD</td>
<td>0.54 ± 0.35</td>
<td>0.50 ± 0.34</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>1 (0-1)</td>
<td>1 (0-1)</td>
</tr>
<tr>
<td>Overall Morbidity (Resource Use Bands)$^{146}$</td>
<td>Mean ± SD</td>
<td>2.73 ± 1.02</td>
<td>2.81 ± 1.14</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>3 (2-3)</td>
<td>3 (2-3)</td>
</tr>
<tr>
<td>VARIABLE</td>
<td>VALUE</td>
<td>EMR</td>
<td>Non-EMR</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>(IQR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1,047 (4.5%)</td>
<td>657 (6.2%)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1,480 (6.3%)</td>
<td>616 (5.8%)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4,778 (20.3%)</td>
<td>1,720 (16.2%)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12,567 (53.4%)</td>
<td>5,344 (50.5%)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2,783 (11.8%)</td>
<td>1,614 (15.2%)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>859 (3.7%)</td>
<td>640 (6.0%)</td>
</tr>
<tr>
<td>Overall comorbidity (Aggregated Diagnosis Groups)</td>
<td>Mean ± SD</td>
<td>4.77 ± 3.04</td>
<td>5.43 ± 3.48</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>4 (3-7)</td>
<td>5 (3-8)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1,046 (4.4%)</td>
<td>657 (6.2%)</td>
</tr>
<tr>
<td></td>
<td>1-4</td>
<td>11,189 (47.6%)</td>
<td>3,962 (37.4%)</td>
</tr>
<tr>
<td></td>
<td>5-9</td>
<td>9,502 (40.4%)</td>
<td>4,615 (43.6%)</td>
</tr>
<tr>
<td></td>
<td>10+</td>
<td>1,777 (7.6%)</td>
<td>1,357 (12.8%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td>1,934 (8.2%)</td>
<td>1,041 (9.8%)</td>
</tr>
<tr>
<td>CHF</td>
<td></td>
<td>386 (1.6%)</td>
<td>300 (2.8%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td>5,594 (23.8%)</td>
<td>2,823 (26.7%)</td>
</tr>
<tr>
<td>MI</td>
<td></td>
<td>311 (1.3%)</td>
<td>193 (1.8%)</td>
</tr>
<tr>
<td>Asthma</td>
<td></td>
<td>3,143 (13.4%)</td>
<td>1,500 (14.2%)</td>
</tr>
<tr>
<td>COPD</td>
<td></td>
<td>1,120 (4.8%)</td>
<td>626 (5.9%)</td>
</tr>
</tbody>
</table>
Physicians in the non-EMR cohort were slightly younger and less likely to be female, but worked similar hours and had a similar size of practice. Non-EMR physicians looked after a population with incomes similar to that of the EMR cohort, but saw a greater percentage of recent immigrants; their patients were slightly older. The practices of the non-EMR physicians were also characterized by a greater proportion of patients with associated morbidities and co-morbidities. Factors affecting service levels which were collected at the physician or patient level were entered in the regression model, and we adjusted for physician gender, CCFP status, and years of practice experience, as well as patient age.

To estimate auditing and data entry quality, we re-audited a randomly chosen 10% sample of charts for all audits, (both electronic and paper-based), and compared the two audits. Overall agreement was excellent (kappa 0.954).

**Comparison between EMR and non-EMR cohorts**

We used chart audits to compare the cohort of physicians using EMR with those not using EMR over a two year period (2006 and 2007).

We present results for individual services on Table 7. We combined the overall results for all services (composite process score) and these are shown on Table 8. P4P incentives for FOBT
were introduced for FHNs in October 2006, for FHGs in April 2007, concurrent with a public health campaign funded by Cancer Care Ontario. FOBT had a much lower rate of provision than the other services. The change in the provision of that service may have been influenced by different factors than for the other services, due to these contemporaneous issues.

Due to the differences between FOBT and the other preventive services we studied, we also calculated results for the two cohorts with FOBT excluded.

Table 7: Service provision in EMR and non-EMR cohorts

<table>
<thead>
<tr>
<th>Service</th>
<th>Cohort</th>
<th>2006</th>
<th>2007</th>
<th>Difference</th>
<th>Difference in change between EMR and non-EMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza vaccine</td>
<td>EMR</td>
<td>70.7%</td>
<td>69.8%</td>
<td>-0.9%</td>
<td>8.3% less in EMR cohort</td>
</tr>
<tr>
<td></td>
<td>Non-EMR</td>
<td>59.2%</td>
<td>66.5%</td>
<td>7.4%</td>
<td></td>
</tr>
<tr>
<td>Pap smears</td>
<td>EMR</td>
<td>76.1%</td>
<td>79.7%</td>
<td>3.6%</td>
<td>1.1% more in EMR</td>
</tr>
<tr>
<td></td>
<td>Non-EMR</td>
<td>75.6%</td>
<td>78.1%</td>
<td>2.5%</td>
<td></td>
</tr>
<tr>
<td>FOBT</td>
<td>EMR</td>
<td>28.7%</td>
<td>32.1%</td>
<td>3.4%</td>
<td>1.4% less in EMR</td>
</tr>
<tr>
<td></td>
<td>Non-EMR</td>
<td>41.1%</td>
<td>45.9%</td>
<td>4.8%</td>
<td></td>
</tr>
<tr>
<td>Mammograms</td>
<td>EMR</td>
<td>75.2%</td>
<td>80.9%</td>
<td>5.7%</td>
<td>6.3% more in EMR</td>
</tr>
<tr>
<td></td>
<td>Non-EMR</td>
<td>78.3%</td>
<td>77.7%</td>
<td>-0.6%</td>
<td></td>
</tr>
</tbody>
</table>
Table 8: Comparison of changes in overall service provision between EMR and non-EMR cohorts

<table>
<thead>
<tr>
<th>Change in composite score between 2006 and 2007</th>
<th>EMR</th>
<th>Non-EMR</th>
<th>Difference in change between the two groups</th>
<th>Adjusted difference between the two groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Including FOBT</td>
<td>From 63.0% to 65.7%: 2.7% increase (95% CI 0.6% - 5.0%)</td>
<td>From 63.6% to 67.1%: 3.5% increase (95% CI 0.5% - 6.6%)</td>
<td>0.8% less increase in EMR, (95% CI -3.0 , 4.6)</td>
<td>0.7% less increase in EMR (p=0.55, 95% CI -2.8 , 3.9)</td>
</tr>
<tr>
<td>Excluding FOBT</td>
<td>From 74.0% to 76.8%: 2.8% increase (95% CI 0.5% - 5.1%)</td>
<td>From 71.0% to 74.1%: 3.1% increase (95% CI 0.2% - 6.4%)</td>
<td>0.3% less increase in EMR (95% CI -3.7 , 4.4)</td>
<td>0.3% less increase in EMR (p=0.53, 95% CI -3.0 , 3.6)</td>
</tr>
</tbody>
</table>

The intracluster correlation was 0.017, which was small and did not affect our results. We examined physician gender, CCFP vs non-CCFP status, physician experience (years since graduation) and patient age, as these variables are predictors of preventive service provision and were collected at the patient and physician level as part of our study (see Appendix D and Appendix E). Female physician gender and younger patient age were positively associated with the likelihood of receiving a service; there was no association with physician experience or CCFP status. There was no clinically important or statistically significant difference between the two groups with respect to the change of service provision.

In order to validate our results, we also obtained administrative data for the services. A comparison of the composite scores for Pap smears, mammograms and influenza vaccinations for the two cohorts is shown on Figure 3. To be consistent with the chart audits, each service in the administrative dataset was assigned an equal weight in the calculation of the composite score.
In the administrative dataset, the EMR and non-EMR cohorts paralleled each other closely. Using administrative data, there was a statistical difference in the change in services between the two cohorts (data not shown); however, this was likely due to the large numbers of patients included and the difference in the change was less than 5%. As such, it was not clinically relevant. The decrease in overall provision seen in both administrative cohorts in 2006 was driven by a decrease in influenza vaccinations (Figure 4).

Comparisons for each service for both chart audits and administrative data are shown in Figure 4, Figure 5, Figure 6 and Figure 7.
The decrease in influenza vaccination observed from 2005 to 2006 in the EMR cohort with chart audits was paralleled by a decrease with administrative data. A similar decrease was found in administrative data for the non-EMR cohort.
Figure 5: FOBT for EMR and Non EMR cohorts, using both administrative data and chart audit data

FOBT had year over year increases in the EMR cohort, evident in both administrative data and chart audits. The non EMR cohort had inconsistent changes over time and the chart audits for that cohort showed an increase between 2006 and 2007 that was not evident in the administrative data.
Figure 6: Mammography for EMR and Non EMR cohorts, using both administrative data and chart audit data

The EMR cohort had small increases in mammography following the introduction of P4P in 2005, while introduction of the EMR in 2006 was associated with a decrease in documented mammography in chart audits. There was no decrease in the provision of this service in administrative data (p=0.48). Provision of mammography in the non-EMR cohort did not change. Based on administrative data, the difference in the change between the EMR and non-EMR cohorts was significant, but this may not be of clinical significance as there was less than a 5% difference: there was a 0.7% increase in the EMR cohort between 2005 and 2006, and a 0.5% increase in the non EMR cohort in the same year, a difference of 0.2%.
Administrative data showed little change in the provision of Pap smears in the EMR and non EMR cohorts. The decline in Pap smear provision in the EMR chart audits associated with the introduction of EMR in 2006 was not reproduced in the administrative data (p=0.52).

Two physicians in the non-EMR cohort switched out of the FHG in 2006, and one additional physician did so in 2007. A reanalysis of the administrative data which included only physicians in a FHG in each year did not change our results (data not shown).

**Service provision in EMR cohort**

Chart audit results for the percentage of eligible patients receiving each preventive service in the EMR cohort are shown in Figure 8.
Figure 8: Individual preventive services for EMR cohort, using chart audit data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza vaccinations</td>
<td>76.2%</td>
<td>83.2%</td>
<td>70.7%</td>
<td>69.8%</td>
</tr>
<tr>
<td>FOB</td>
<td>27.1%</td>
<td>28.7%</td>
<td>28.7%</td>
<td>32.1%</td>
</tr>
<tr>
<td>Mammograms</td>
<td>81.9%</td>
<td>85.4%</td>
<td>75.2%</td>
<td>80.9%</td>
</tr>
<tr>
<td>Pap smears</td>
<td>84.2%</td>
<td>86.1%</td>
<td>76.1%</td>
<td>79.7%</td>
</tr>
<tr>
<td>Children's vaccinations</td>
<td>93.1%</td>
<td>95.7%</td>
<td>66.7%</td>
<td>89.8%</td>
</tr>
</tbody>
</table>

The intracluster correlation for each service was generally small, at 0.036 for influenza vaccination, 0.0197 for FOB screening, 0.0189 for mammography, and 0.009 for Pap smears. Results for children’s vaccinations should be interpreted with caution, due to the very small numbers of eligible children in each practice. We examined physician gender, CCFP vs non-CCFP status, physician experience (years since graduation) and patient age. Only increasing patient age was a significant factor for the provision of a preventive service. The results within the EMR cohort were adjusted for patient age; no adjustment was needed for physician factors in the year to year comparison, as we followed the same physicians longitudinally.

The changes in the composite score for the EMR cohort (excluding FOBT) are shown on Table 9.
Table 9: Comparison of overall composite process score in EMR cohort (excluding FOBT) by year

<table>
<thead>
<tr>
<th>Year</th>
<th>Patients eligible for services</th>
<th>Patients receiving service: n, % (95% confidence interval)</th>
<th>Unadjusted change from previous year (95% CI)</th>
<th>Unadjusted comparison with previous year, p value</th>
<th>Adjusted comparison with previous year, p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004 (pre P4P)</td>
<td>3039</td>
<td>2480, 81.6% (80.2% - 83.0%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005 (post P4P)</td>
<td>2950</td>
<td>2520, 85.4% (84.2% - 86.7%)</td>
<td>3.8% (1.9% - 5.7%)</td>
<td>&lt;.0001</td>
<td>0.0002</td>
</tr>
<tr>
<td>2006 (EMR transition)</td>
<td>2759</td>
<td>2039, 73.9% (72.3% - 75.5%)</td>
<td>-11.5% (-13.6% - -9.4%)</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>2007 (EMR)</td>
<td>2870</td>
<td>2239, 78.0% (76.5% - 79.5%)</td>
<td>4.11% (1.9% - 6.3%)</td>
<td>&lt;.0003</td>
<td>0.02</td>
</tr>
</tbody>
</table>

The initial year of EMR implementation was associated with a statistically significant decrease in the composite score, followed by an increase in the second year which did not reach baseline levels.

To validate our chart audits, we obtained administrative data on the same services; data on children’s vaccinations were not available. The provision of each service derived from administrative data is presented in Figure 9.
Administrative data show a decline in influenza vaccinations from 2004 to 2006, and an increase in FOBT, but no change in Pap smears or mammograms. There was no significant change between 2005 and 2006 for Pap smears (p=0.52) or mammography (p=0.48); there was a change in influenza vaccination (p<0.0001) and FOBT (p<0.0001). While there was a decline in Pap smears and mammography associated with EMR implementation (2006) in the chart audits, this was not present in administrative data.

Composite process scores per year for chart audit and administrative data (mammography, Pap smears and influenza vaccinations) are shown on Table 10. These three services were used as we had chart audit data and administrative data for the EMR cohort for all four years. To be consistent with the chart audit data, each service in the administrative dataset was assigned an equal weight.
Table 10: Comparison of chart audits and administrative data for EMR cohort, composite score for mammography, Pap smears and influenza vaccinations

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of patients receiving service, chart audits</th>
<th>Percentage of patients receiving service, administrative data</th>
<th>Difference within year</th>
<th>Difference in change from previous year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004 (pre P4P)</td>
<td>83.1</td>
<td>78.2</td>
<td>4.9% greater with chart audits</td>
<td></td>
</tr>
<tr>
<td>2005 (post P4P)</td>
<td>84.9</td>
<td>78.0</td>
<td>6.9% greater with chart audits</td>
<td>2% greater increase with chart audits</td>
</tr>
<tr>
<td>2006 (EMR transition)</td>
<td>74.0</td>
<td>75.7</td>
<td>1.7% less with chart audits</td>
<td>8.6% greater decrease with chart audits</td>
</tr>
<tr>
<td>2007 (EMR)</td>
<td>76.8</td>
<td>76.7</td>
<td>0.1% greater with chart audits</td>
<td>1.8% greater increase with chart audits</td>
</tr>
</tbody>
</table>

There was a decline in the composite score for preventive services in 2006, using administrative data (p<0001). The decline in the administrative dataset was driven by a decrease in influenza vaccinations. A greater proportion of patients were found to have received services with chart audits than with administrative data for every year except for 2006 (EMR transition).

**Comparison of service provision in EMR cohort by level of EMR use**

Figure 10 demonstrates the patterns of usage observed for the month of October 2007. This was approximately 18 months after the EMR system was installed in all offices. As detailed in the methods, these patterns of usage were obtained by taking the number of encounters recorded in the EMR and dividing by number of appointments booked in each physician’s schedule in October 2007. A ratio of 1 meant that the physician was entering an encounter in the EMR for each patient booked in their schedule.
Three patterns of usage emerged by 18 months. Two physicians were using the EMR extensively (the “super-users”), one in each FHN. The “super-users” had a ratio of EMR encounters to booked appointments exceeding 1, meaning that they were entering data in encounters outside of booked appointments (phone calls, other EMR related data entry). The “users” had a ratio approximating 1, meaning that they were using the EMR and entering data consistently for most encounters. Six “users” were in FHN1 and four were in FHN2. The “non-users” were seldom using the EMR to record encounter data. Two of the “non-users” were in FHN1 and four were in FHN2.

The characteristics of these groups are shown in Table 11 and Table 12.
Table 11: Self reported characteristics of physicians by usage of EMR

<table>
<thead>
<tr>
<th></th>
<th>Non User (n=6)</th>
<th>User/super user (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean, median (range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>4 (66)</td>
<td>6 (50)</td>
</tr>
<tr>
<td>CCFP, n (%)</td>
<td>3 (50)</td>
<td>8 (67)</td>
</tr>
<tr>
<td>Number of MDs in practice:</td>
<td>3, 2 (1 to 6)</td>
<td>4, 3 (1 to 6)</td>
</tr>
<tr>
<td>mean, median (range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of self-reported hours</td>
<td>42.4, 40 (30 to 60)</td>
<td>44.3, 45 (32 to 60)</td>
</tr>
<tr>
<td>worked per week:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean, median (range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients per</td>
<td>1140, 1206 (780 to 1425)</td>
<td>1415, 1350 (630 to 2200)</td>
</tr>
<tr>
<td>physician (self-reported):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean, median (range)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 12: Physician and practice characteristics by usage of EMR, derived from administrative databases

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>VALUE</th>
<th>EMR-nonusers</th>
<th>EMR-users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians</td>
<td>N=6</td>
<td>N=12</td>
<td></td>
</tr>
<tr>
<td>Canadian vs foreign graduate</td>
<td>5/6</td>
<td>11/12</td>
<td></td>
</tr>
<tr>
<td>Patients (mean)</td>
<td>N=6,837 (1,140)</td>
<td>N=16,677 (1,390)</td>
<td></td>
</tr>
<tr>
<td>Age as of August 31, 2007</td>
<td>Mean ± SD</td>
<td>48.1 ± 22.0</td>
<td>42.1 ± 21.8</td>
</tr>
<tr>
<td>Gender</td>
<td>M</td>
<td>3065 (44.8%)</td>
<td>7,041 (42.2%)</td>
</tr>
<tr>
<td>Income quintile</td>
<td>16 (0.2%)</td>
<td>35 (0.2%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1005 (14.7%)</td>
<td>2079 (12.5%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1052 (15.4%)</td>
<td>2591 (15.5%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1252 (183%)</td>
<td>3093 (18.5%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1479 (21.6%)</td>
<td>3612 (21.7%)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2033 (29.7%)</td>
<td>5267 (31.6%)</td>
<td></td>
</tr>
<tr>
<td>Recent Immigrant</td>
<td>556 (8.1%)</td>
<td>842 (5.0%)</td>
<td></td>
</tr>
<tr>
<td>Comprehensiveness of Care</td>
<td>Mean ± SD</td>
<td>0.52 ± 0.35</td>
<td>0.55 ± 0.35</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>1 (0-1)</td>
<td>1 (0-1)</td>
</tr>
<tr>
<td>Overall Morbidity (RUB)</td>
<td>Mean ± SD</td>
<td>2.80 ± 1.05</td>
<td>2.69 ± 1.01</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>3 (2-3)</td>
<td>3 (2-3)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>317 (4.6%)</td>
<td>730 (4.4%)</td>
</tr>
<tr>
<td>VARIABLE</td>
<td>VALUE</td>
<td>EMR-nonusers</td>
<td>EMR-users</td>
</tr>
<tr>
<td>---------------</td>
<td>-------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>348 (5.1%)</td>
<td>1132 (6.8%)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1274 (18.6%)</td>
<td>3504 (21.0%)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3643 (53.3%)</td>
<td>8924 (53.5%)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>894 (13.1%)</td>
<td>1889 (11.3%)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>361 (5.3%)</td>
<td>498 (3.0%)</td>
</tr>
</tbody>
</table>

| Overall comorbidity (ADGs) | Mean ± SD | 5.05 ± 3.20 | 4.65 ± 2.96 |
|                           | Median (IQR) | 5 (3-7) | 4 (2-6) |
| 0                         | 316 (4.6%)   | 730 (4.4%) |
| 1-4                       | 2939 (43.0%) | 8250 (49.5%) |
| 5-9                       | 2883 (42.2%) | 6619 (39.7%) |
| 10+                       | 699 (10.2%)  | 1078 (6.5%)  |

| Diabetes       | 681 (10%)   | 1253 (7.5%)  |
| CHF            | 167 (2.4%)  | 219 (1.3%)   |
| Hypertension   | 2134 (31.2%)| 3460 (20.7%) |
| MI             | 127 (1.9%)  | 184 (1.1%)   |
| Asthma         | 832 (12.2%) | 2311 (13.9%) |
| COPD           | 497 (7.3%)  | 623 (3.7%)   |
| Mental Health  | 1534 (22.4%)| 3403 (20.4%) |
The group of physicians that had EMR but did not use it for encounters by 18 months had fewer female physicians, fewer CCFPs, fewer years in practice and smaller practices. They looked after older patients with greater morbidity and co-morbidity levels, and more recent immigrants.

Composite scores for chart audits for both groups are presented in Figure 11, and comparisons are presented in Table 13.

Figure 11: Overall service provision by EMR usage (excluding FOBT)

<table>
<thead>
<tr>
<th>Preventive services</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Users</td>
<td>79.2%</td>
<td>83.8%</td>
<td>70.1%</td>
<td>72.2%</td>
</tr>
<tr>
<td>Users</td>
<td>82.7%</td>
<td>86.2%</td>
<td>75.7%</td>
<td>80.1%</td>
</tr>
</tbody>
</table>
Table 13: Comparison of changes in overall service provision (excluding FOBT)

<table>
<thead>
<tr>
<th></th>
<th>Non-users</th>
<th>Users/super-users</th>
<th>Difference in change between the two groups</th>
<th>Adjusted p value for difference between the two groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change after EMR introduction (from 2005 to 2006)</td>
<td>-13.7% (95% CI -9.9% - -17.5%)</td>
<td>-10.5% (95% CI -8.0% - -13.0%)</td>
<td>3.2% greater decrease in non-users</td>
<td>0.46</td>
</tr>
<tr>
<td>Change in second year of EMR (from 2006 to 2007)</td>
<td>2.1% (95% CI -2.1% - 6.2%)</td>
<td>4.5% (95% CI 1.8% - 7.1%)</td>
<td>2.4% smaller increase in non-users</td>
<td>0.16</td>
</tr>
<tr>
<td>Overall change 2005-2007</td>
<td>-11.6% (95% CI -7.9% - -15.4%)</td>
<td>-6.1% (95% CI -3.7% - -8.4%)</td>
<td>5.5% greater overall decrease in non-users</td>
<td>0.04</td>
</tr>
</tbody>
</table>

We adjusted for physician gender, CCFP status, physician experience (years since graduation), and patient age. The decrease in services found in chart audits associated with EMR implementation affected physicians who used the EMR to record patient encounters and those who didn’t. There was a greater decrease (which was non-significant) and less increase in the second year of EMR for the physicians who did not use EMR to record encounters. Overall, there was a statistically significant greater decrease in preventive services for the non-user group.

**Comparison of the two FHNs**

FHN1 was composed of a large (6 physician) office and a three physician office, while FHN2 was scattered across several small solo or two physician practices. The Principal Investigator was a member of FHN2. Physician and practice characteristics for the two FHNs are presented in Table 14 and Table 15.
Table 14: Self reported characteristics of physicians by FHN

<table>
<thead>
<tr>
<th></th>
<th>FHN1 (n=9)</th>
<th>FHN2 (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, n (%)</td>
<td>6 (66)</td>
<td>4 (44)</td>
</tr>
<tr>
<td>CCFP, n (%)</td>
<td>6 (66)</td>
<td>5 (56)</td>
</tr>
<tr>
<td>Number of MDs in practice: mean, median (range)</td>
<td>5, 6 (3 to 6)</td>
<td>2, 2 (1 to 2)</td>
</tr>
<tr>
<td>Number of self-reported hours worked per week: mean, median (range)</td>
<td>43.1, 42 (30 to 60)</td>
<td>44.4, 43 (35 to 60)</td>
</tr>
<tr>
<td>Number of patients per physician: mean, median (range)</td>
<td>1336, 1160 (780 to 2200)</td>
<td>1311, 1211 (630 to 2200)</td>
</tr>
</tbody>
</table>
Table 15: Physician and practice characteristics by FHN, derived from administrative databases

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>VALUE</th>
<th>FHN1</th>
<th>FHN2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians</td>
<td></td>
<td>N=9</td>
<td>N=9</td>
</tr>
<tr>
<td>Canadian vs foreign graduate</td>
<td></td>
<td>8/9</td>
<td>8/9</td>
</tr>
<tr>
<td>Patients (mean)</td>
<td></td>
<td>N=12,147 (1,350)</td>
<td>N=11,367 (1,263)</td>
</tr>
<tr>
<td>Age as of August 31, 2007</td>
<td></td>
<td>Mean ± SD 42.2 ± 21.5</td>
<td>45.6 ± 22.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median (IQR) 43 (25-58)</td>
<td>46 (28-62)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>M 5,492 (45.2%)</td>
<td>4,614 (40.6%)</td>
</tr>
<tr>
<td>Income quintile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>27 (0.2%)</td>
<td>24 (0.2%)</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1,749 (14.4%)</td>
<td>1,335 (11.7%)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2,071 (17.0%)</td>
<td>1,572 (13.8%)</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2,287 (18.8%)</td>
<td>2,058 (18.1%)</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>2,562 (21.1%)</td>
<td>2,529 (22.2%)</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>3,451 (28.4%)</td>
<td>3,849 (33.9%)</td>
</tr>
<tr>
<td>Recent Immigrant</td>
<td></td>
<td>699 (5.8%)</td>
<td>699 (6.1%)</td>
</tr>
<tr>
<td>Comprehensiveness of Care</td>
<td></td>
<td>Mean ± SD 0.55 ± 0.36</td>
<td>0.53 ± 0.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median (IQR) 1 (0-1)</td>
<td>1 (0-1)</td>
</tr>
<tr>
<td>Overall Morbidity (RUB)</td>
<td></td>
<td>Mean ± SD 2.68 ± 1.01</td>
<td>2.78 ± 1.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median (IQR) 3 (2-3)</td>
<td>3 (2-3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 550 (4.5%)</td>
<td>497 (4.4%)</td>
</tr>
<tr>
<td>VARIABLE</td>
<td>VALUE</td>
<td>FHN1</td>
<td>FHN2</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>838 (6.9%)</td>
<td>642 (5.6%)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2,600 (21.4%)</td>
<td>2,178 (19.2%)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6,486 (53.4%)</td>
<td>6,081 (53.5%)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1,341 (11.0%)</td>
<td>1,442 (12.7%)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>332 (2.7%)</td>
<td>527 (4.6%)</td>
</tr>
<tr>
<td>Overall comorbidity (ADGs)</td>
<td>Mean ± SD</td>
<td>4.64 ± 2.95</td>
<td>4.90 ± 3.13</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>4 (2-6)</td>
<td>4 (3-7)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>549 (4.5%)</td>
<td>497 (4.4%)</td>
</tr>
<tr>
<td></td>
<td>1-4</td>
<td>5,985 (49.3%)</td>
<td>5,204 (45.8%)</td>
</tr>
<tr>
<td></td>
<td>5-9</td>
<td>4,813 (39.6%)</td>
<td>4,689 (41.3%)</td>
</tr>
<tr>
<td></td>
<td>10+</td>
<td>800 (6.6%)</td>
<td>977 (8.6%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td>977 (8.0%)</td>
<td>957 (8.4%)</td>
</tr>
<tr>
<td>CHF</td>
<td></td>
<td>166 (1.4%)</td>
<td>220 (1.9%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td>2,687 (22.1%)</td>
<td>2,907 (25.6%)</td>
</tr>
<tr>
<td>MI</td>
<td></td>
<td>135 (1.1%)</td>
<td>176 (1.5%)</td>
</tr>
<tr>
<td>Asthma</td>
<td></td>
<td>1,638 (13.5%)</td>
<td>1,505 (13.2%)</td>
</tr>
<tr>
<td>COPD</td>
<td></td>
<td>511 (4.2%)</td>
<td>609 (5.4%)</td>
</tr>
<tr>
<td>Mental Health</td>
<td></td>
<td>2,721 (22.4%)</td>
<td>2,216 (19.5%)</td>
</tr>
</tbody>
</table>
As compared to FHN2, FHN1 physicians were working in larger groups, had more CCFPs, fewer female physicians, more years in practice and larger practices. They had younger patients with lower morbidity and co-morbidity levels, and fewer patients in the upper income stratum. We adjusted for physician gender, CCFP status, and years of practice experience, as well as patient age.

The overall rate of services documented in chart audits for each FHN is presented in Figure 12, and the differences between the two FHNs are presented in Table 16.

Figure 12: Service provision by FHN (excluding FOBT)
Table 16: Differences in overall service provision between FHNs (FHN2 - FHN1), excluding FOBT

<table>
<thead>
<tr>
<th>Year</th>
<th>Unadjusted difference between FHN1 and FHN2, % (95% CI)</th>
<th>P value (adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>0.4% (-3.1%, 2.4%)</td>
<td>0.75</td>
</tr>
<tr>
<td>2005</td>
<td>4.3% (1.7%, 6.8%)</td>
<td>0.02</td>
</tr>
<tr>
<td>2006</td>
<td>1.2% (-4.4%, 2.1%)</td>
<td>0.50</td>
</tr>
<tr>
<td>2007</td>
<td>7.9% (4.9%, 10.9%)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

The intracluster correlation was 0.0112, which was low and did not impact the results. The p value for the results was adjusted for physician gender, CCFP status, years of practice experience and patient age. There was a statistically significant and clinically important difference between the two FHNs in 2007.

We audited charts of patients who were overdue for a service for the presence of a note indicating that a reminder letter had been sent; the number of patients being reminded by group and by year is shown in Table 17. Some patients who were overdue had been sent more than one reminder letter; each patient was treated as a single count, regardless of the number of reminders they had been sent.

Table 17: Number of patients being reminded by letter about overdue service

<table>
<thead>
<tr>
<th>Year</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHN1</td>
<td>2</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FHN2</td>
<td>6</td>
<td>23</td>
<td>265</td>
<td>677</td>
</tr>
<tr>
<td>Total EMR</td>
<td>8</td>
<td>32</td>
<td>265</td>
<td>677</td>
</tr>
<tr>
<td>Non EMR</td>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Few reminder letters were sent by FHN1 or by the non-EMR physicians. FHN2 sent out an increasing number of reminders following EMR implementation (2006 and 2007). Seven to 82 patients per physician were reminded in 2006 and 66 to 109 patients per physician in 2007. Some patients were sent more than one reminder letter if they did not respond to the first letter; FHN2 sent a total of 393 letters in 2006 and 977 letters in 2007.

We reanalyzed the results with the Principal Investigator (who was also a participant in the study) removed, and the results remained unchanged (Figure 13).

Figure 13: Documented service provision by FHN, with investigator removed
Five out of nine eligible members of FHN1 and seven of eight eligible members of FHN2 participated in a focus group. The principal investigator was a member of FHN2, and did not participate in the interviews. It was clear from the quantitative data that some physicians were “non-users” of the EMR; however, it could not be determined whether the EMR was never implemented or was implemented and then abandoned. Physicians mentioned that the decision to adopt was tied to the EMR subsidy, and was collective (made as a group); the decision to implement may have been optional, and may have been responsive to peer influences.

“I think one of our driving forces was the availability of funding”.

“It was part of our agreement as a group to go ahead. Initially I think some of us thought we would just do billing and scheduling on the EMR, but gradually we sort of pulled each other into it.”

While the majority of the physicians had implemented aspects of the EMR, participants in the focus groups agreed that they continued to use both paper and EMR, and were in effect running hybrid systems.

“I carry the chart to look things up because not all patients are fully integrated into the EMR system”.

Participants also indicated that, despite the difficulties inherent in EMR implementation, they were not willing to go back to paper-based records.

Several themes associated with the first two years of EMR implementation emerged from the focus groups and were categorized as barriers, and facilitators or benefits of EMR implementation.

### Barriers

Participants described problems during EMR implementation; we grouped these into the following themes

- Lack of compatibility and high complexity
• Increased workload and costs; delayed benefits
• Technological barriers: lack of interoperability, lack of technical support and infrastructure failures
• Lack of ongoing training and education

Lack of compatibility and high complexity

Participants perceived the EMR system as complex (difficult to use) and inflexible, and thus, not highly compatible with their current needs. Some of this was felt to be due to software interface issues and perceived software immaturity. Participants recognized that these were not issues isolated to their setting.

“It (the EMR software) is not intuitive and none of them out there are. I was at a big meeting, and other people are using other systems and they have the same complaints as we do”

“If you flip back in business and look at the programs 20 years ago they didn’t have excel spread sheets and this and that and the other and I think we have to evolve. It has to be intuitive and have the flexibility and that is just not in the existing software. There won’t be until they have the volume of people”

“When you go and put in the medications there is not a lot of flexibility. It will only give you certain options”

Increased workload and costs; delayed benefits

A common theme was the enormous amount of time required for data entry by physicians, clearly far more than they had expected. Physicians had limited time during the work day to implement EMR—the additional time was sometimes taken out of their personal lives. Participants thought that EMRs would eventually lead to increased efficiency, but this had not yet happened. There was a long perceived time lag between effort and reward, leading to disappointment after almost two years into implementation.
“It is taking me longer when I am seeing them, I am staying later, I am working weekends, it is like ok I like this why? And that is the most discouraging thing to me, this work load thing. I didn’t mind the data entry; I just thought suck it up for a year, you know, you will be here every night and every weekend. But now I am really not feeling very good about it.”

“The biggest frustration is the amount of work we had to do and in retrospect only if I was starting a brand new practice with zero patients would I even consider doing EMR.”

“It is all front-end loaded. So, it is time, money and energy all up front, and then we are just dribbling out the other end. But when faced with this ongoing thing it is hard for us to really keep sight of why we were doing it.”

Participants felt that there were unexpected costs for the technology and for human resources required to implement the innovation.

“I think it <the incentive funding> is a little amount compared to the overall costs and the costs that we are now spending on IT and how we had to change the office and hire a new staff person. So, these costs that we didn’t foresee are now part of what we have.”

The EMR appeared to have different effects for different staff positions:

“We are freeing up our front staff, but we are causing lots more work for our nurses because we find the nursing function is more labour intensive; but the front staff love it.”

Technological barriers: lack of interoperability, lack of technical support and infrastructure failures

Several physicians mentioned the decrease in efficiency due to technological barriers such as lack of system interoperability. All paper based materials coming from specialists, hospitals or diagnostic imaging facilities need to be scanned in; in effect, the practice-based EMR functions as an “electronic island”. Physicians also talked about the lack of ability to audit this paper-based data, and about the effect of having to learn to operate in several different health care IT environments. These barriers made it more difficult to adapt the EMR to office workflows.
“My secretary spends an hour or two every day scanning this stuff in and then I have to look at what they scan.”

“So I can envision instead of using the fax that it emails and goes into the patient chart directly. I can, down the road that is what they promised me, that will save me time, but it will only save me time if it is in a retrievable form meaning I can see it and retrieve it. That software is not here. So when things come in not only do I have to scan them but then I have to write a summary of that and then I have to put it in various parts of the chart and all of that is my time. I don’t know what you are up to but I am up to an hour and a half to 2 hours after the last patient”

“The hospital should have the same systems so that when I go on the floor and try to learn the system I can’t find half of the information so I am used to my system.”

“The analogy I keep using is it is like having a Bank card and you can only use it at your branch and no where else. That is basically what we have.”

Several participants mentioned IT structural failures, lack of redundancy and lack of technical support. Participants clearly had the impression that they were simply left to fend for themselves, with little knowledge, time, or resources to manage a complex IT infrastructure. Solving common IT problems was left to physicians, as offices initially lacked technical support or non-physician personnel familiar with IT technology; there was no routine way to manage problems, so that many issues escalated into larger problems. Dealing with IT issues had to be done instead of seeing patients, and was learned “on the job”; participants found this to be extremely stressful. There was no unified access point in case of problems with hardware, software, or connectivity; participants often simply did not know who to contact and there was no “disaster recovery plan” to deal with the inevitable equipment failures. Participants felt that there was a lack of leadership needed to deal with the problems they were facing. Because of all the failures, the system was perceived as being inherently faulty.

“We had huge connectivity issues so this gets into the mechanism. We had to institute our own (connectivity) system, actually getting wiring through all of this, negotiate endlessly so it really took up an awful lot of time and money”
“The system breaks down and you have to have all these recovery plans that are throwing us all awry at a time when we are very stressed.”

“We need an office manager who could handle the printer going down, the scanner problems that we have been having, the connectivity issues, then it would be ok; but one of us is always running like a chicken with their head cut off crazily trying to put the finger in and nothing ever happens.”

“I was broken into and my laptop was stolen the first few months. It was a great consternation. I got a new one and just before Christmas I flipped the screen open and there was a blue screen that says ‘contact your hardware vendor’. So I assumed <the EMR company> covered us for hardware and software. So I phoned them and they sent me an email of two places that I could take my laptop to be repaired.”

“Our monitors have gone down. It is not their responsibility and I had to buy a new monitor. I just came in one day, and it was dead. Our printer also went.”

“We have bugs in some of our systems; we have printers that don’t work so we have become increasingly dependent on something that is faulty.”

“We need to have a body that is really listening to us and can represent us, at the grassroot level... All I see around us is continuing chaos.”

Lack of on-going training and education

Several participants described a lack of knowledge about basic computer operations and common programs (IT skills). Some are unable to type, which can interfere with data entry into the computer—yet they did not discuss taking a typing course.

“I have a huge problem because being older than everybody, I did not learn how to type.”

“I am not very sophisticated in terms of computers in general so for the newbie like myself everything has been an adventure. So learning about not just our software but just how <Microsoft> Office works or whatever application we are using. So we had to learn everything and that slowed us down immeasurably.”
EMR training was offered prior to EMR start-up, but there were no formal sessions scheduled later on. Participants recognized their need for on-going training in EMR use. They felt frustrated, as they were often unable to even formulate the right question; they were truly out of their “comfort zone”.

“I don’t even know what I could learn. I know there are buttons there that I am not using efficiently so it would be nice if you could follow me around for 2 or 3 patients to see how I am doing it and tell me probably how I can use it better”

“We should also have upgrades in terms of education. The education sessions were at a time when too much was coming and now we do need to know how to use it.”

“I am still doing my own method that I learnt initially. There must be a faster way of bypassing certain things.”

Facilitators and benefits

Participants talked about facilitators of EMR implementation and discussed their perceptions of current and expected benefits of the system. We classified these as

- Availability of an EMR champion
- Increased efficiency for some practice processes
- Perception of time for the eventual pay-back of the investment
- Physicians’ perceptions of patient reaction
- Perceived improvements in quality

Availability of an EMR Champion

Physicians in one focus group (FHN2); mentioned the availability of a champion. The champion provided support, helped solve some problems, and was perceived as facilitating and maintaining enthusiasm for the transition.

“She (the EMR champion) makes sure that you understand the value of it and she is so enthusiastic”
“She is very patient; she probably answered the same question five times.”

Increased efficiency for some practice processes

Participants found that some aspects of the EMR made them more efficient, once they had learned the system. Prescription refills and consultation letters in particular were much quicker. This occurred after an initial decrease in efficiency, once some data entry was completed. Physicians felt that their administrative personnel were more efficient.

“I always put charts aside, particularly my physicals and did them later on and I don’t do that. I don’t leave charts on my desk at the end of the day. They are done, they are done on time and to me it is work it right then and there. Rather than remembering and writing it all out, I do it right then. That part has been good.”

“I find that prescription renewals are great especially if you have someone on 10 medications and you have to start writing it out. It is a real pain, once it is in the system it is kind of nice.”

“I found if I am doing a consult, it is easy to just click on medications in the consult letter or past health or insurance forms. I just do a CPP and add it to the forms. I am not going back and looking up things. It is all there.”

“Less paper shuffling when the person is in your office, it is compiled nicely and the prescription printing clarity of physician names, patient’s name, the pharmacist can read when we print off the scripts.”

“It saves huge amounts of time for the staff. They don’t have to pull them and refile them. Prescriptions don’t have to be pulled; labs don’t have to be filed, so there is a lot of time saved there for our staff.”

Perception of time for eventual pay-back of the investment

Participants felt that starting an EMR was becoming a necessity; however, they perceived that there is an eventual benefit that decreases with increasing physician age. The transition was viewed as extremely challenging; younger colleagues have more opportunity for the initial investment in time, money and effort expended during the initial EMR implementation to
eventually pay dividends. As well, younger colleagues are more familiar and comfortable with the technology, decreasing the amount of initial investment needed; new physicians, in particular, are faced with much less workload, as they do not have to input large amounts of data from old charts.

“I don’t think there is any future for paper charts. Ten years from now it will not be considered standard care. For anybody going into practice now who didn’t start with EMR would be a total mess.”

“I have gone and spoken to different groups, and doctors over 45 have no interest. So those with established practices who have been in practice 10 or 15 years and around age 45, not always true, but the people that are under say 15-20 years of practice are those people that are willing to invest the time. I was at a symposium and the 50+ said are just are you nuts and why would I do that because they are not ready for us, it is not ready for Prime Time.”

Physicians’ perceptions of patient reaction

Physicians worried about their patients’ perceptions of the new technology. However, they felt that patient reaction ranged from neutral to positive. Patients sometimes even encouraged their physician.

“Actually it is not bad because I always thought that there wouldn’t be that much eye contact but I really try and make an effort. I am not typing all the time so I don’t think they mind it.”

“I think patients are pleased. You know, oh finally you are in the modern age I see, good for you.”

However, some physicians felt that the EMR interfered with the visits. Some of the difficulties were related to data entry problems, such as being unable to type:

“It interferes between my relationship with my patients. I find that I want to look at them and they want to look at me, they don’t want to see the back of my head or back and unfortunately I cannot talk to them and make notes at the same time. I talk to them, I do everything and then I walk out of the room and then I put my notes in.”

Some physicians were interested in giving patients greater access to their own charts:
“So it is far better that 2500 patients that I look after look after their own CPP than I try to keep up to date and make sure it is current. That would be a huge benefit for all of us”

“Hospitals are working and testing some of the patient folders for chronic diseases like diabetes and cancers. Where the patient can go and look at their own file”

However, physicians have found that there is a downside to some of these early attempts at patient access to the chart. The coding system that is in common use for charting can lead to misunderstandings.

“Lately, when I do referrals, I give the forms directly to the patients themselves. So, now when I am printing that, I have to put (in the) past medical history and the problems are sometimes very, like if you do a code for anxiety or depression and then the patient goes home and starts reading it--and I get a call back, and they say ‘I don’t have this’, and I say ‘it is a whole category because you just have to whip them all together’, and I have had one or two patients get very upset about it.”

Perceived improvements in quality

Physicians felt that the EMR implementation had improved the quality of their records: the chart was better organized, and they were able to find data quickly. Legibility had improved as well. Participants commented on the ability to generate reports, which was tied to their expectation that the EMR would help them provide better care.

“It is nice to be able to find reports. If somebody comes in and says they had a mammogram and I don’t remember I just look back and see the results. If they have seen a specialist it is so much easier than trying to leaf through a chart.”

“The extraction is amazing. I can create lists to find out my hypertensive, if there has been a drug recalls, just my elderly if I wanted to do something. I mean down the road I can really see if I have got smokers then I can create that list and then use services to bring them in for that or people with BMI’s of 30 and over if I am going to start.”

“I think the patients are benefiting; I am not sure I am, but patient care, I think, is enhanced.”
Overall, participants expressed a lot of ambivalence about the EMR; while some of the promised benefits were starting to be realized, there was certainly a feeling that the implementation was much more difficult than anticipated.

“I want to go on record saying I hate the computer...I hate the tablet, which everybody else seems to have. It makes mistakes like crazy and I spend more time correcting it. It was wonderful if I needed a summation to send the patient to the hospital, fantastic retrieval within a couple of minutes and I see the benefits. Once it is on the computer, once the integration is loaded it is a remarkable tool. Hopefully once we have connectivity with the hospital.”

“His first sentence is I hate it and then too I love it (laugh)”

In conclusion, participants identified several barriers to EMR transition; amongst those, key factor were the lack of technical support and system immaturity, and the lack of training (general computer use as well as EMR specific training). Physicians were aware of but not well prepared for the large time investment and additional funds needed for data transfer from paper to EMR charts, leading to a mismatch between expectations and reality. Participants felt that age and IT skills affected their ability to implement the EMR.

Some factors mitigated the difficulties, such as the presence of a champion. Physicians were still hopeful about the benefits of EMR at this early stage of the transition, and often adopted the strategic position that a certain number of years left to practice was needed to realize the benefits. Some benefits, such as a well organized chart, positive patient reaction, or the ability to extract some data were perceived to be present at this early stage.
Chapter 6: Integrating theory, qualitative and quantitative results

We used mixed methods for this study of EMR implementation. Mixed methods studies integrate different approaches, and seek to give a more complete assessment of the issues; this may be particularly relevant to the implementation of health information technology, due to its highly complex nature. In this chapter, we reflect on the theoretical concepts examined earlier and integrate our qualitative and quantitative results.

In our qualitative findings, physicians perceived several factors as influencing EMR implementation. They noted a low relative advantage during EMR implementation as compared to the paper records previously used. This was described as a decrease in overall efficiency, because of the substantial amount of time being spent on implementation. There were technological barriers such as lack of interoperability and infrastructure failures interfering with efficiency. There was also an unexpected increase in costs, and a lack of immediacy of reward for the effort expended. Physicians felt that the relative advantage was greater for younger physicians; perhaps younger age was a proxy for greater familiarity with computers, and therefore greater efficiency. Younger physicians also have a longer time to benefit from possible future efficiencies. However, in this study, the median year of graduation was 1978 for EMR non-users, and was 1976 for users, indicating little differences between these two groups. Physicians felt that relative advantage differed by staff role: it may have been greater for their front office staff, but less so for the nurses and physicians.

There were, however, some perceived relative advantages to the EMR during implementation. Physicians described some gains in efficiency after an initial decrease due to data entry, specifically for prescription refills and generating consultation letters. As well, there was an increase in efficiency for several administrative processes managed by the front staff. There was a perception that relative advantage would improve over time, as more data were added and the system became routinized.
There was limited compatibility, as implementers described a poor fit with most of their needs and past experiences. For example, users described the need for ongoing and timely training during implementation to address the multiple problems that arose; physicians felt that this was not provided. A physician described a poor fit with his needs, as he could not efficiently enter data due to an inability to type. Physicians also described limited past experiences and familiarity with general computer use. However, there was some compatibility with values: physicians felt that the quality of charting was improved: records were more legible and some participants stated that they completed charts in a timelier manner. The chart was better organized and patient data were easier to find. Physicians were able to generate some reports for their practice; they felt that this would lead to improved quality of care. Physician perceptions of patient reactions were mixed: while some physicians felt that patients approved of their use of the new technology, others felt that the EMR interfered with their ability to interact with patients.

Observability was not mentioned during the focus groups. There was a high degree of perceived complexity during implementation; the system was seen as difficult to learn and use. Reasons mentioned for this were lack of software flexibility and difficulties with hardware management. Initial expectations of usability were not met during this implementation.

The new system provided little in the way of a roadmap to implementation, and was likely a radical departure from usual routine; physicians felt they did not have the knowledge, training or assistance they needed to successfully reinvent the EMR or their practices. Implementation was particularly challenging at early stages, during which time the organization restructures to adapt to the EMR and simultaneously reinvents the EMR. There may not have been sufficient organizational investment to ensure a smooth integration of the system into office routines. There were some successes, as physicians described being able to routinely generate patient summaries and retrieve information once sufficient data had been entered.

Physicians in one group described the presence of a champion; this was viewed as being a significant facilitator. There was a perceived lack of leadership and support at the system level to assist with implementation activities, described as difficulties with connectivity and a lack of help with integration with other IT systems. At the practice organizational level, physicians did not feel that they had sufficient capacity (or organizational slack) to enable them to learn and test the new skills needed to effectively use the technology—in fact, they described being highly
stressed by the large additional time demands caused by data entry into the new EMR. This lack of slack may have affected perceptions of complexity and compatibility as the EMR was being implemented: if an innovation is initially viewed as being radical, it may be difficult to change that perception without training and resources dedicated to implementation. For example, some physicians mentioned that their familiarity with basic computer skills was lacking; however, they did not appear to avail themselves of additional training—perhaps due to lack of time.

The fact that there continued to be some degree of perceived relative advantage and compatibility in terms of improved quality of care, selected office efficiencies, future benefits and some positive patient reactions to the EMR may help to explain why this group did not discontinue EMR despite the many difficulties.

The experiences described in our qualitative results may provide some insights into our quantitative results. We found that EMR implementation was not associated with an increase in the provision of preventive services. This could be explained by the fact that there were multiple perceived barriers to implementation. In other words, the simple presence of an EMR may be insufficient. It is possible that effective implementation of the system may first be needed in order to then produce a change in processes resulting in improved outcomes.

Our results show divergence in services between the two EMR-based physician groups using the same software by the second year of implementation. There was a difference in processes: physicians in FHN2 had sent reminder letters to patients overdue for a service, while physicians in FHN1 had not. This was due to an internal decision to implement several EMR processes to improve the provision of preventive services as detailed in the case study (Appendix A). Consistent with theory, the change in processes appears to have occurred in a group with a champion to drive the preventive project as well as some organizational “slack”: funds and resources such as an administrator and data entry clerks were invested in this project.

Our qualitative and quantitative results reflect some of the theoretical propositions discussed earlier. To summarize, EMR implementation in these small family practices was associated with low relative advantage especially early in the implementation process and high complexity. Views on compatibility were inconsistent. The EMR was perceived as being a relatively inflexible innovation; technological barriers were prevalent. There was a lack of resources, time or training to devote to implementation activities and address barriers, resulting in limited
change. The presence of a champion was perceived by colleagues to affect some implementation processes; there was a perceived lack of leadership at a system level to address the lack of interoperability. Due to these factors, practices had limited success in restructuring both the EMR and their workflows to take advantage of the system’s potential.

Some of the theoretical factors discussed in chapter 2 were not addressed here; these include perceptions, degree of control and influences of non-physician practice team members; perceptions of attributes over time and correlation with specific stages of implementation (the focus groups were conducted at a single point in time, approximately two years into implementation); individual adopter categories and their perceptions and influences on implementation. It is also possible that EMR implementation will be perceived as less radical over time, as more primary care groups use these systems. Procedures, training and support for implementation activities may become more routinized; technological barriers may decrease if the systems mature and interconnectivity increases. Further studies of EMR implementation should consider this wider context.
Chapter 7 : Discussion and Conclusions

Discussion

We found that the implementation of EMRs was not associated with an improvement in the provision of the selected preventive services for the group of physicians we studied. There was no difference in the change of service provision between physicians using EMR and those using paper-based records. This mirrors other studies of EMR implementation and quality of care.\textsuperscript{23, 31, 170} A longitudinal study of diabetes care found no differences in A1c or LDL improvement between practices using EMR (after two or four years of EMR implementation) and practices using paper records.\textsuperscript{23} A systematic review identified no improvement in care when electronic guideline implementation systems were used in ambulatory care as compared to paper-based reminder systems.\textsuperscript{170} Another systematic review found that very few studies evaluated standard EMRs in community-based care. The studies evaluating such software did not find any consistent improvement in quality of care: there was a decrease in radiology services in one study, which was not found in another study and there was no difference in care for depression.\textsuperscript{31}

Poon found no relationship between the use or non-use of EMR and health care quality, but did find a relationship between some quality measures (e.g. cancer prevention measures) and the implementation of some EMR functions such as the use of an EMR-based problem list.\textsuperscript{171} The lack of improvement may be due to the challenges encountered during EMR implementation. Previous studies have shown limited use of more advanced EMR functions in individual practices,\textsuperscript{25, 172, 173} and no improvement of care as additional experience with EMR accrues over time.\textsuperscript{23, 25, 27}

It may be very difficult and expensive for small practices using EMRs to implement the many changes required to improve performance. For example, Halladay found substantial costs associated with the reporting of performance data in primary care; these were related to data entry, staff training and IT modification and maintenance.\textsuperscript{174} The highest costs were incurred by small practices using EMR, as those physicians spent more than their counterparts practicing in larger groups for assistance with EMR software modifications. Physicians in small practices also needed more time for set-up and data gathering.\textsuperscript{174} Some conditions that may enable the implementation of EMR-based quality improvement strategies in small practices may not be
widespread: physicians may not have time to modify their practice, there may be no local EMR champion, EMR software systems with the flexibility to easily and accurately measure service provision may not be available, and technical assistance to overcome software and hardware problems may not be easily accessed.

In this study, we categorized barriers to implementation as a lack of compatibility with physicians’ needs and prior experiences, high system complexity, increased workload and unexpected additional costs, delayed benefits, technological barriers and lack of ongoing training and education. Facilitators were the availability of an EMR champion in one group, some increases in efficiency, perceptions of eventual pay-back for the effort invested, some positive patient reactions and perceptions of improvements in quality. These are broadly similar to findings for small primary care practices described in the literature. Terry and colleagues used qualitative methods to study small primary care offices implementing EMRs in south western Ontario. Participants found that the time required for implementation was far greater than expected; prior expectations of usability were not met; training was an important factor; and the presence of a champion helped with implementation. A qualitative study of innovators and early adopters of EMRs in small community practices in California found that initial costs were higher than expected, with benefits not always being realized; physicians felt that the EMR led to increased quality of care; the distribution of benefits was uneven with super-users benefiting the most; and the presence of a champion was critical to implementation. Another study found that several barriers to EMR implementation in community practices were present: high initial costs, additional time requirements and immaturity of the technology, difficulties with the ability to customize and adapt the EMR, inadequate interoperability with external data sources and differing physician attitudes towards the EMR. A recent review of studies on barriers to EMR implementation found that these could be broadly categorized as concerns about costs, technical issues (including lack of interconnectivity, high complexity, and lack of customizability), lack of time, psychological factors such as lack of belief in EMRs, social factors such as a lack of support from colleagues, legal issues such as concerns over privacy and security, differing organizational size and type (hospital vs community practice) and difficulties with change management.

The difficulties we found with EMR implementation led to problems with reinventing workflows to take advantage of the new technology; these may be ultimately mitigated over time. We
found some increase in preventive services in the EMR cohort by the second year of implementation, but this had not reached baseline levels. However, in a cross-sectional study, Zhou et al found no association between the duration of EMR usage and performance, suggesting that EMR-based process improvements may not necessarily occur over time.

It is possible that performance improvement depends on careful implementation, reinvention and integration of different aspects of the EMR, such as clinical decision support systems or point of care alerts, into routine patient care and practice workflows. Physicians in this study perceived that this integration was challenging. In a randomized controlled trial, Eccles found that a computerized decision support system for asthma or angina embedded into the EMRs of fully computerized primary care practices had no effect on care as measured by adherence to the guidelines. A companion qualitative analysis found that the computerized system did not fit well within the context of family practices; it was too difficult to use, it did not always present relevant information, and there were too many alerts. It could be that integration into routine care was challenging in that study, possibly leading to a lack of effectiveness of the intervention.

Baron described the implementation of a mammography recall program within an innovative, fully computerized primary care group practice. The system was initially unable to properly audit mammograms and to produce accurate lists of patients to be recalled; mammograms were scanned in but were not recognized by the EMR. As Baron described, the change first required awareness that this was an issue, then a decision to use new processes, then development and implementation of a change in workflow to “tag” incoming mammograms so that patients could be properly categorized as having or not having had a mammogram within the previous two years. This process of “awareness to decision to implementation” has been described in the literature. Although the authors do not describe the factors underlying the successful change process, some of the theoretical factors discussed in chapter 2 (Figure 1) could be used to complement and explain similar case studies in primary care.

In this study, physicians in the EMR cohort who did not use the EMR to record encounters had a greater decrease in preventive services. As an explanation for this finding, it is possible that those physicians may not have been aware of a point of care alert if the EMR was not used during encounters. However, in a cross-sectional study, Keyhani and colleagues found no association between implementation of various EMR components and functions (such as
electronic physician notes or reminder systems) and quality measures for the management of chronic health conditions. A meta-analysis of point-of-care computerized reminders found that these produced small effects (median 4.2% improvement). The authors commented on the need to identify features that reliably predict improvement, but the process of implementation and the ways in which providers use the EMR may be just as important as the software. While we do not have data on what aspects of the EMR beyond recording encounters were implemented by this group, it is possible to speculate that the receipt of electronic lab results, scanning of documents or some data entry into health profiles may have occurred. This would disperse data across paper records and EMR and may negatively affect the physician’s ability to find needed information (such as the date of a last Pap smear) during clinical encounters.

We found that preventive services changed at a similar rate in the first year of computerization for the two groups of physicians implementing EMR. However, there was a difference in the second year (2007), with FHN2 having a greater increase. By that year, FHN2 had implemented an organized audit, recall and point-of-care reminder program, as detailed in our case study (Appendix A) and the group was collectively mailing reminder letters. All physicians were mailing letters, regardless of their stage of EMR implementation. There is a fee ($6.86 per patient) for contacting patients who are overdue for a P4P preventive service. A recent population-based study of Ontario primary care groups found that very few fee codes for this contact service had been submitted and that the rate of submission was not increasing.

Several of the processes in FHN2, such as chart audits and reminder letters, were implemented at the group rather than the individual level. It is possible that collective actions may overcome some of the challenges and costs that Halladay found at the small individual practice level.

Our chart audits found a decrease in the proportion of Pap smears and mammograms in the EMR cohort associated with early EMR implementation (2006), but there was no decline found in the administrative data. Chart audits have traditionally been considered as the “gold standard” for certain medical services, and have been used to validate administrative data. The administrative data we used to determine the rates of preventive services have not been validated and cannot be used as an accurate estimate of the rates of preventive services. However, chart audits were previously done on paper and EMR audits represent a new field of research with its
own challenges. EMR-based data may need to be validated. Good data may not always be available or be readily accessible from the EMR. For example, Roth\textsuperscript{185} found that only a third of the indicators needed for a quality assessment program could be easily extracted from EMRs, and that there were difficulties associated with provider data entry habits and differences across different EMR applications.\textsuperscript{185} The structure of the EMR is more complex than that of the paper chart: physicians may not be entering data in consistent or expected locations, making it difficult to extract.\textsuperscript{185} Physicians and auditors may have challenges in navigating the chart. Data from external sources may be scanned in and may not be extractable electronically.\textsuperscript{181} Physicians may continue to use both paper charts and EMR,\textsuperscript{35} scattering data across two different systems and possibly increasing the amount of incomplete or duplicated data in audits. Research and quality improvement projects using EMR data will need to consider the quality of data entered in the EMR, as well as issues specific to the EMR application used.\textsuperscript{185}

While there is uncertainty regarding administrative data, we studied the change in the proportion of services provided, rather than the actual proportion provided. It is possible that administrative data were less sensitive to variations in data quality and availability than EMR audits during the transition. That is, there is no reason to suspect that the proportion of services varied from year to year: for example, if 75% of influenza vaccinations were available in administrative data in 2006, we would expect that approximately 75% would be available in 2007. Our inclusion and exclusion criteria for administrative data were held constant from year to year, as detailed in Appendix G.

Administrative data for **Pap smears** were based on billing codes submitted by laboratories and physician billing codes as detailed in Appendix G. Laboratory billings would not have been affected by EMR implementation. It is possible that physicians use different workflows for billing (example, day sheet lists used for billing) and for entering data in the chart. Physician billings and chart entry may be affected in different ways by EMR implementation, although our study does not provide information on this.

Administrative data for **mammograms** were based on radiology billing codes and data from the Ontario Breast Screening Program, as shown in Appendix G. These were independent of EMR implementation.
In our context, it is possible that administrative data suggest year over year changes in service provision for Pap smears and mammograms while chart audits may suggest changes in the availability of data documented in the EMR. Thus, it is possible that the decrease in Pap smear and mammograms found in chart audits (but not administrative data) for the first year of EMR implementation represent difficulties with EMR data entry rather than a true decline in service provision.

The change in influenza vaccinations was similar in chart audits and in administrative data, perhaps reflecting fewer problems with documentation. Documenting an influenza vaccination does not require looking two years back for the presence of the service, as mammography or Pap smears do; therefore, there may be a less complex workflow associated with recording this service during the transition to EMR. Our chart audits showed a consistently higher provision of influenza vaccinations than administrative data. Administrative data for influenza vaccines are based on physician billings. They have limited sensitivity as they do not capture vaccinations given in settings where the service is not billed such as pharmacies. Previous studies on EMRs and documentation of influenza vaccinations have shown high specificity and lower sensitivity, with most of the missing vaccines having been administered at sites other than where the EMR record was kept. Physicians in this study received P4P incentives for their rates of influenza vaccinations (regardless of who provided the service), and may therefore have recorded this service in the chart if a patient informed them that an influenza vaccination was received elsewhere. This may have led to higher service provision levels in chart audits when compared to administrative data. There were delays in vaccine delivery in 2006 and 2007, which could account for the lower levels of vaccination found in both chart audits and administrative data during the fall season of those two years.

The quality of information (accuracy, reliability, completeness) has been found to be associated with empirical measures of success in implementing IT in the business literature. It is possible that poorer information may make the system less usable and less useful, impacting implementation efforts and decreasing the net benefits that could be obtained from the technology.

Measuring performance depends on accurate documentation. Once accurate data have been entered into the EMR, interventions that have been found to increase performance, such as
audits and feedback to clinicians, point of care prompts for needed interventions, and reminder letters to patients can then be implemented. Our quantitative results show a lack of improvement in preventive service provision associated with early stages of EMR implementation. It is possible that elements of those negative results were due to problems with EMR data entry and data quality.

Limitations

This study was limited to a group of selected physicians in Toronto and as such, the findings may not be generalizable to practices outside of this area, especially rural settings. However, all physicians in this study were practicing in community-based settings, and many were in solo or two physician offices—similar to the majority of family physicians in Ontario. 19% of paper-based physicians responded to the study invitation, and we do not know if their characteristics differed from the non-responders.

The characteristics of physicians and patients in FHNs (Capitation) and FHGs (Enhanced fee-for-service) in Ontario are shown in Appendix I (Table 18 and Table 19). The physicians in the EMR cohort were members of a FHN, and those in the non-EMR cohort were members of a FHG. Compared with their colleagues in major Ontario urban centres, physicians in our cohorts had higher rates of some characteristics that may be associated with fewer preventive services: being in practice for longer, having larger numbers of patients, and having patients with higher morbidity and co-morbidity levels. They also had higher rates of some characteristics that may be associated with more preventive services: fewer foreign graduates and greater percentage of patients in the upper income stratum. Glazier found that FHG physicians looked after patients with greater morbidity and co-morbidity levels than their FHN colleagues, similar to what was found in our study. Physicians in this study were reasonably similar to their colleagues in Ontario urban centres.

The physicians in our EMR cohort initially provided preventive services to a very high proportion of their eligible patients, and may therefore not be representative of the general physician population with respect to these measures. It is possible that physicians more focused on quality may be more likely to self-select as earlier EMR adopters, since EMRs may
be viewed as a way to maintain or further increase quality. Physician attitude towards both quality of care and EMRs could be an unmeasured confounder.

We studied a single EMR system; results may differ for physicians using other EMR systems.

This was an observational cohort study, and is therefore subject to both measured and unmeasured confounders. In this study, we measured confounders that have been reported in the literature to affect preventive services\(^75, 133-144, 163\) and used statistical adjustments to control for some of these factors. In addition to chart audits, we also used administrative data to assess differences between groups. However, these could not be linked at the patient level, and therefore could not be used for adjustment. The groups mainly differed with regards to levels of morbidity and co-morbidity. However, higher levels of morbidity and co-morbidity were found in groups that had older patients and, therefore, may be related to patient age; we adjusted results for patient age.

Physicians in our non-EMR cohort were introduced to incentives in 2007; pay for performance incentives may increase the provision of preventive services\(^59, 66, 184\) and may have confounded our results. However, the incentives payment was introduced as of April 2007 for targets reached in the prior year, meaning that these physicians knew in fiscal 2006 that they would be eligible for payments and may have changed their practices earlier in anticipation of the expected payment. A recent Ontario population-based study\(^184\) found that physicians exposed to P4P had greater rates of increases in Pap smears, mammograms and colorectal cancer screening when compared to physicians not exposed to P4P. However, there were no significant differences between the two groups for influenza vaccination or child vaccinations. For the majority of physicians, the payment started in 2007, but the difference in the change in performance started in 2006.\(^184\)

In this study, the non-EMR physicians had higher rates of some personal and practice characteristics possibly associated with less provision of preventive services (more male physicians, more recent immigrants, more morbidities and co-morbidities)\(^75, 134, 135, 142, 144\) than their EMR colleagues, along with some factors possibly associated with greater provision of services (more CCFPs, fewer years in practice).\(^133, 136, 137\) We adjusted for physician gender, CCFP status and years of practice, as well as patient age. We could not adjust for factors which were not collected at the patient level, such as patient morbidities, co-morbidities or immigration
recency. However, greater morbidity and co-morbidity levels may have been related to higher patient age, which we adjusted for. We used similar methods to adjust when comparing subgroups.

The group of physicians that had EMR, but did not use it by 18 months, had characteristics possibly associated with fewer preventive services: there were fewer female physicians, fewer CCFPs, and practices with more older patients with greater morbidity and co-morbidity levels. The non-user group also had some characteristics possibly associated with the provision of more services, such as fewer years in practice and smaller practices. We compared two groups of physicians using EMR. FHN1 physicians had some characteristics possibly associated with more provision of preventive services (working in larger groups, more CCFPs, and practices with younger patients with lower morbidity and co-morbidity levels). They also had characteristics possibly associated with fewer preventive services, such as more years in practice, fewer female physicians, larger size of practice, and fewer patients in the upper income stratum.

We were limited to only two years of chart audits for the paper-based group; we used administrative data to address this. We audited very small numbers of children’s medical records in the EMR group due to the limited number of children in each practice, and were unable to audit children’s vaccines in the parallel cohort. Administrative data on the children’s vaccinations were not available. Due to the limitations in data collection methods, we used different composite process scores for different comparisons. We did not have administrative data to compare service provision between the two FHNs or between the EMR users and non users.

There were differences between our two cohorts in terms of physician funding mechanisms. Physicians may have self-selected on the basis of their preferences for either payment system and these preferences may be associated with unmeasured differences in their attitudes towards preventive care. However, a recent study using administrative data did not find any consistent difference in the provision of preventive services between physicians in FHNs and FHGs. The provision of Pap smears and mammograms did not change after joining either group; FOBT performance improved more in FHNs than in FHGs. In our study, administrative data showed little difference between the EMR group (FHN) and the non-EMR group (FHG) with respect to
influenza vaccinations and mammograms. The EMR group provided more Pap smears and FOBTs. The difference in funding mechanism between the group using EMR and the group using paper records may not have affected the change in the provision of preventive services.

A large number of Ontario physicians switched from reformed fee-for-service to capitated payment methods during the years studied; we could not obtain longitudinal population level administrative data comparing preventive services between FHGs and FHNs due to this instability, although a recent study on P4P provides some of these data.184 Some physicians changed funding group in the paper-based cohort; however, a reanalysis of administrative data including only physicians in a FHG in each year did not show any differences. Changing to a different group may not make an initial difference in service provision.196 Physicians in the paper-based group were inconsistently exposed to P4P due to changes in groups, and we could not adjust for these differences.

Delays in the delivery of influenza vaccines to family practices in 2006 and 2007 likely affected our results. However, the effect was similar for all physicians studied.

Our qualitative data were limited to two focus groups held at one point in time during implementation. To avoid leading questions, we did not ask directly about the impact of EMR on preventive services. It would have been valuable to explore any changes in documentation of these services and to collect data on participant use or non use of EMR during the focus groups. However, we were limited due to the concurrent qualitative and quantitative design of this study.

Policy suggestions

Government can influence behaviour through funding and/or regulations.197 Current subsidies in Ontario appear to target the adoption of EMR systems by funding their purchase, rather than their implementation into daily practice. Policies could address the disruption indicated in this study during the initial stages of implementation, support the work of electronic data entry, and promote the implementation of advanced EMR functions that have been shown to improve the quality of care provided to patients.2, 21, 191, 193 For example, American physicians demonstrating “meaningful use” of EMRs, which includes recording structured data and submitting information on quality improvement measures and care coordination, are slated to receive financial incentives as part of the American Recovery and Reinvestment Act.4
Improving practice IT infrastructure

Qualitative results from this study as well as others point to weaknesses in IT infrastructure (hardware and connectivity failures) and IT management, leading to difficulties during implementation. Physicians perceived that they were responsible for overseeing and managing these complex IT systems in their practices. Reallocating some adoption funding towards IT support may be of benefit. Possible strategies could include allocating funds for professional IT managers for groups of physicians, funding hardware management (ongoing maintenance and upgrades of computers and peripherals, server maintenance), and improving connectivity speed and stability.

Supporting EMR implementation

Policies could be targeted at increasing the amount of electronic data and improving data quality. Policies could also support interventions that improve practice workflows.

Findings in the literature as well as from the qualitative results of this study, point out that the lack of system-level interconnectivity impedes implementation by interfering with practice workflows. Policies that could promote electronic connections between practices and other members of the health care system could include: promoting the use of forms generated through the EMR system; adopting electronic referrals, prescriptions and laboratory requisitions; supporting interoperability projects; decreasing regulatory barriers to interoperability; promoting common standards so that data generated by different organizations can be shared and collated within the EMRs and between different systems, and monitoring the amount of scanning needed in practices (scanning may be a proxy for poor interoperability).

Physicians noted that the bulk of training occurred just prior to EMR implementation, with limited on-going education. Possible strategies to address this could include accrediting and funding on-going EMR training and mandating plans for ongoing, post implementation training as part of the EMR certification process.

Physicians also valued peer support and EMR champions. Identifying and supporting local champions may be worthwhile; for example, Canada Health Infoway’s Peer to Peer program funds visits and support from experienced and proficient local EMR users.
Physicians in this study noted the very large time demands required for data entry. Support for data entry in the EMR could include incentives such as supplementary payments for patient encounters that are charted electronically and financial incentives to encourage good data quality such as consistent coding for health conditions.

**Promoting the measurement and improvement of outcomes**

Evidence from the literature\textsuperscript{23, 27, 200, 201} as well as from this study shows that advanced EMR-based tools such as audits or patient reminders for overdue services may not be routinely used in some practices. Without such tools, quality improvement efforts cannot be fully implemented. Incentives and policies could target important quality outcomes, through initiatives such as extending the number of P4P outcomes that can be measured, monitored and improved once advanced EMR-based processes are implemented, and ensuring that incentives adequately reward the work done.\textsuperscript{174} The Quality and Outcomes Framework (QOF) in the U.K. currently comprises about 35\% of family physicians’ incomes and requires reporting on a very large number of outcomes.\textsuperscript{202} The program has been associated with consistent annual improvements.\textsuperscript{59, 203} The QOF initiative strongly encourages the use of electronic systems and tools to efficiently record data and achieve improvements in outcomes.\textsuperscript{202}

As well, financial support could be targeted towards implementing registries (such as the Ontario Diabetes registry)\textsuperscript{204} and including additional chronic disease registries. The generation and maintenance of registries requires consistent, accurate and complete EMR data entry habits and processes.

**Practice suggestions**

Our results suggest that improvements in the provision of preventive services may not be associated with the implementation of EMRs. A possible reason for this may be difficulties with data quality in the EMR record.

Physicians planning to implement EMRs may wish to consider data entry issues from the outset. Assistance from the EMR vendor and from experienced colleagues may be of value. Issues to consider may include: consistency of data entry (coding when appropriate, entering data in consistent areas, workflows related to data entry for scanned documents); completeness of data
entry (medications, avoiding non-electronic external sources if an electronic source is available); and accuracy of data entry.

Practicing physicians may wish to consider some of the policy suggestions outlined earlier. Hiring an IT professional and investing in good quality hardware may help with some of the technical issues that were problematic. Systematically informing and redirecting patients away from non-electronic external data providers such as non-electronic labs may be possible. Scheduling regular, ongoing EMR training as well as training in ancillary IT skill such as keyboarding (if needed) may be of value. Physicians may wish to hire qualified personnel to assist with data entry to reduce the time demands they face with initial EMR implementation. Several of these suggestions have costs in terms of money or time; physicians could periodically review costs and benefits of various interventions.

In this study, a group of physicians used collective resources to manage preventive services and this was associated with the implementation of reminder letters to patients who were overdue. Physicians may consider associating with colleagues in order to leverage group resources for selected EMR implementation activities.

**Research suggestions**

In this study, there was no improvement in preventive care associated with EMR implementation. We suggest that difficulties with implementing the EMR may be an underlying factor for this. Theory-informed interventional studies could address some of the barriers and facilitators to EMR implementation and could measure the effect of interventions on both implementation of various aspects of the EMR and on the quality of care provided to patients. For example, a study could add personnel specifically trained and tasked with furthering implementation of various aspects of the EMR, therefore supporting reinvention and adding slack. A recently funded study (the BETTER project) in Toronto and Calgary has randomly allocated Practice Facilitators to help promote improved use of EMRs; the study will measure chronic disease screening and prevention (current controlled trial number ISRCTN07170460).

Our results also suggest that problems with data quality in the EMR may be contributing to the lack of improvement in services. Studies could help discover and quantify common difficulties with data entry and could assess the feasibility, costs and impact of using different interventions.
and incentives to correct problems. Research is also needed to validate data abstracted from EMRs. It cannot be assumed that data obtained from EMR audits is identical to data from paper charts.

Research identifying and targeting the stage of EMR implementation and the implementer categories may be of value. Interventions targeting some quality improvement activities (such as electronic audits and point of care alerts) may need to selectively enroll physicians who have already entered structured data relevant to the intervention in the EMR. Given the limited number of physicians reporting full use of EMR functions and the high current proportion of hybrid practices in the Canadian setting, these interventions may be targeting a minority of physicians using EMR at the present time. Researchers may consider addressing the needs physicians at different stages of implementation.

Interventions targeted at physicians at earlier stages of implementation may first need to address EMR processes that may be problematic, such as workflow changes, data quality or IT support. Interventions targeting physician performance during early EMR implementation may be less effective. Interventional studies measuring patient outcomes using EMR during the transition may need to address possible difficulties with chart documentation. Studies defining the duration of the transition for various aspects of the EMR may be helpful.

Several non-users in our EMR cohort shared offices with colleagues who were actively implementing the EMR; it is possible that the differing workflows within practices may have exacerbated the implementation difficulties. The effect of having implementers at different stages within the same setting could be explored further.

Our case study and exploratory analysis of the differences in preventive services between the two FHNs indicates that some improvements may be possible through interventions at a group level. The changes appeared to occur in the presence of an incomplete transition at the physician level (four out of nine physicians in FHN2 were not entering encounters in the EMR by 18 months), and may warrant further study. Some of the electronic tools used in our case study, such as shared databases used by groups of physicians, make data entry and management at the group level rather than at the individual physician level possible. Quality improvement initiatives and research targeting larger primary care groups or organizations using a common EMR database may represent a new avenue for knowledge translation efforts using EMR technology.
Finally, research in small community-based primary care practices using commercial off-the-shelf EMRs is feasible. A large proportion of patient care occurs in these small practices, improving generalizability. Studies pointing the way to improved EMR data quality, consistency and quantity could impact the ability of clinicians to use their data for quality improvement projects; as well, this could improve the availability and ease of data extraction from primary care practices for research and surveillance projects.

**Conclusions**

In this group of practices, the implementation of EMRs was not associated with an increase in the provision of the preventive services targeted by Ontario’s pay for performance incentive when compared to the continued use of paper records. There was no improvement within the group of physicians using EMR, and there may have been some difficulties with data entry for these preventive services in the EMR during initial implementation. Physicians who had EMR but were not using it to record encounters by 18 months may have had a greater degree of decrease in preventive services than those who were using EMR for encounters. There appeared to be a greater degree of increase in preventive services in the second year of EMR implementation in one group of physicians using EMR; this group was mailing out reminder letters to overdue patients.

Physicians generally felt that their EMR implementation was problematic. The EMR was perceived as having a lack of relative advantage, high complexity and low compatibility. Physicians had difficulties with adapting the system to their practices and reinventing their workflows to take advantage of the EMR during implementation.

In conclusion, it should not be assumed that EMRs improve care. In this study, the first two years of EMR implementation were not associated with any improvement in the provision of preventive services.
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Appendices

Appendix A

Case study of a Quality Improvement project using EMR

Organization of preventive care in FHN2

A physician (the principal investigator for this study) took the lead in organizing the preventive services. She mapped and tried several possible processes using tools available in EMR software, using repeated Plan-Do-Study-Act cycles. She refined and tested these within her own practice in the first year until she was satisfied, and then spread what she had learned to her FHN.

An important implementation factor was the availability of funding. The FHN maintains a common account to receive Ministry payments associated with the provision of after hours care, so funds are available for projects if approved by the group. Another factor was resources (administrative assistance): the government funds a part-time FHN administrator. A staff member was hired to manage the preventive services project.

Group processes and cohesiveness were also present. Physicians participating in a FHN can function as a group (even if they do not co-locate), and the implementation of a common, EMR-based preventive services process was discussed and agreed upon by the group, through FHN meetings and emails. The FHN has a Lead and an Associate Lead physician; both supported and approved funding for this project.

Finally, the structure of the EMR was a factor. All physicians in this group use a common EMR database; this has involved difficulties in terms of speed of access to the EMR (the database is accessed remotely from each practice) and increased complexity. However, the common database also facilitates the implementation of group projects; it would have been more difficult to conduct this if data was in several different servers, requiring separate log-ins for each practice.
Description of processes

The initial step in the process was to “clean up” the group’s EMR database; only rostered patients are eligible for incentives, and the EMR tracks services according to roster status. Demographic data had been transferred from older software applications to the new EMR in 2006; the older programs often did not have a field to record roster status. Data on rostering was rarely entered within practices once the EMR was started, and therefore the recorded roster status in the EMR was incomplete and inaccurate. Students were hired as data entry clerks to generate accurate EMR rosters, by entering roster status in the correct field using the paper roster lists sent by the Ministry of Health to each provider.

Once this was done, the data entry clerks were then trained to use the paper list of preventive services sent by the Ministry of Health, and to transfer the data from those lists to the appropriate field of the EMR (Figure 14). They added the fact that the service was done, along with the date the service was provided. We then hired medical students to audit both paper and EMR charts for all remaining services, and they systematically entered the date of the last service in the correct field in the EMR. The physician lead for this project periodically audited the data for accuracy.
Once the data entry was finished, the group had a list of overdue patients. In order to enable a mailing to those patients, templates for reminder letters for each service were sent to all physicians for approval and corrections. After approval, the templates were uploaded to each physician’s EMR application; the system then used the list of overdue patients to generate personalized letters on individual physician’s letterhead (Figure 15). Letters were printed and mailed by the preventive services coordinator.
After the initial mailing, physicians and their staff were reminded that it was their responsibility to keep the roster and preventive services EMR lists up to date. The preventive services coordinator sent out regular emails to that effect, and conducted a training session for all FHN front staff. She also gave practices the opportunity to fax over the monthly roster list updates sent by the Ministry of Health so that the EMR database could be maintained.

Physicians were regularly reminded by email to record the fact that a preventive service was provided in the correct area of the EMR. All physicians agreed to have their EMR set up so that the area containing the reminders was visible at each encounter. In some practices, the front staff took the lead in ensuring that data were entered.

The Preventive Coordinator routinely audited the charts of overdue patients every three months, as a backup to staff and physician data entry, and to ensure that no data were missing. After the audit, she mailed letters to overdue patients, to a maximum of two letters per patient. During the summer, we hired additional staff to call overdue patients who had already received two letters.
This process is still ongoing; overall service provision for 2008 (excluding FOBT) was 87%; services had improved from the previous year for every physician. The EMR Company enabled FOBT tracking in 2008, and the same process has now been implemented for this service, starting in the summer of 2009.

At the end of each fiscal year (after March 31st), all physicians receive a report detailing their performance as well as the group’s overall performance; the report also includes the previous results at the individual and group level. Physicians can use their individual results to bill for the incentives, or they can have the FHN administrator bill this on their behalf.

This initiative had funding, agreement and participation from all those involved, leadership to implement and drive the project, a champion, training and reminders to use EMR tools consistently, an administrator responsible for overall project management, and data entry clerks to relieve physician and practice staff from repetitive data entry duties. This made the project successful and sustainable. EMR can provide tools for Quality Improvement projects; however, change management tools are needed for implementation. The presence of EMR is a necessary but not sufficient condition for larger scale Quality Improvement projects.
Appendix B

Literature search strategy

Database: Ovid MEDLINE(R) <1996 to February Week 2 2010>

Search Strategy:

--------------------------------------------------------------------------------
1    emr.mp. (1417)
2    exp Medical Records Systems, Computerized/ or emr.mp. (14741)
3    electronic health records.mp. or exp Electronic Health Records/ or exp Medical Informatics/ (176542)
4    exp Electronic Health Records/og, td, ut [Organization & Administration, Trends, Utilization] (34)
5    2 or 4 (14741)
6    limit 5 to (english language and yr="2008 -Current") (2967)
7    implement*.mp. (107729)
8    6 and 7 (565)
9    purpose.mp. (390856)
10   6 and 9 (211)
11   benefit*.mp. and 6 (209)
12   innovations.mp. (4881)
13   theor*.mp. and 6 (110)
14   12 and 6 (18)
15   innovation*.mp. (28853)
16   13 and 15 (17)
17   emr.mp. (1417)
18   exp Medical Records Systems, Computerized/ or emr.mp. (14741)
19   exp "Diffusion of Innovation"/ or innovation* theory.mp. (9139)
20   18 and 19 (1090)
21   limit 20 to english language (1085)
22   innovation* theory.mp. (86)
23  18 and 22 (5)
24  from 23 keep 1-5 (5)
Appendix C

Letter of invitation and survey of AHC physicians

Effect of electronic medical records (EMRs) on the provision of preventive services in a Pay-for-Performance environment

Michelle Greiver, Jan Barnsley, Val Rachlis, MD, Jan Kasperski, Bart Harvey, Rick Glazier, Rahim Moineddin

University of Toronto (Health Policy and Management Evaluation; Department of Family and Community Medicine; Department of Public Health Sciences); North York General Hospital (Department of Family and Community Medicine); Ontario College of Family Physician; ICES

Dear Colleague:

Our government has recently introduced incentives for preventive services; these are payments for reaching targets for mammograms, Pap smears, influenza vaccinations and children’s vaccinations. As well, several physicians in our area have started to use Electronic Medical Records (EMRs). At the present time, we do not know to what degree the incentives are making a difference to our quality care, and we do not know the effect of EMRs on preventive services.

We are conducting a study on the effect of financial incentives and Electronic Medical Records (EMRs) on preventive services in our community. We are doing this study because it is important to determine the extent to which the incentives and EMRs influence the provision of preventive services, and the best way to do this is to study our own practices. We are asking you to answer the questions below to indicate your interest in this study and to help us determine whether you are eligible to participate in the study.
Effect of electronic medical records (EMRs) on the provision of preventive services in a Pay-for-Performance environment

Your name:

Size of your practice (approximate number of active patients in your practice):

Number of days you work in your office per week:

Do you have or are you planning to implement an Electronic Medical Record (EMR) in your practice in the next year?

Would you be interested in participating in this study?

Please fax the questionnaire to 416-xxx-xxxx, or return in the postage-paid envelope.

We thank you for considering this study!
Appendix D

Baseline survey of participants

Effect of electronic medical records (EMRs) on the provision of preventive services in a Pay-for-Performance environment

Please fax back to 416-xxx-xxxx

Yourself:

Name:

Year of graduation:

Gender: Male Female

CCFP member? Yes No

Your practice

Number of family physicians in your office:

Are there any other health professionals in your office (eg, specialist, physiotherapist, chiropractor etc)? Yes No

If yes, which ones?

Do you employ a practice nurse (RN or RNA)? Yes No

Number of hours you normally work per week (excluding on-call coverage) providing direct patient care (e.g. office visits, hospital rounds, telephone advice) and indirect patient care (e.g. reviewing laboratory results, telephone prescriptions):
Approximately what percentage of your patients (directly under your care) are in each of the following age groups?

- Children (0-12 years) _____ %
- Adolescents (13-18 years) _____ %
- Adults (19-64 years) _____ %
- Seniors (65+ years) _____ %
- Total 100 %

How many patients are on your roster?

**Your preventive tracking system**

How are you planning to track, or are currently tracking preventive services in your practice?

**Services you provide**

Are you accepting new patients into your practice?

- No _____  Yes _____  Yes, with some restrictions ______

(please specify type of restrictions) :
Do you provide prenatal/antenatal care?  Yes  No

Do you provide intrapartum care (deliveries)?  Yes  No

Do you provide palliative care?  Yes  No

Are you a member of the Freeman Centre for Palliative Care?  Yes  No

Do you provide in-hospital care to your patients?  Yes  No

Do you do housecalls for your patients?  Yes  No
Appendix E

Data recording form

Effect of electronic medical records (EMRs) on the provision of preventive services in a Pay-for-Performance environment

Mammogram recording form: Non-EMR cohort, 2007 (year end March 31st 08)

Patient number:

Date recorded (DD-MM-YYYY):

Date of birth (DD-MM-YYYY):

Age (years):

Inclusion criteria:

1. Is this woman age 50 to 70?  Y / N

2. Is she a patient in this practice for two years or more?  Y / N

3. Does she have a history of breast cancer?  Y / N
If YES to first TWO and NO to THIRD, patient is Eligible, please record data

Is patient Eligible?  Y / N

Data:

Physician number:

Mammogram done in past 30 months (report in chart, or note that it was done by another provider written in chart):  Y / N

Mammogram report:  Y / N

OR  Note that it was done through another provider:  Y / N

If more than 24 months since last mammogram, was patient contacted to remind her to have a mammogram (letter/phone call documented in chart):  Y / N

Letter:  Y / N

Phone call:  Y / N
Appendix F

Example of electronic audit: Pap smears

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<th>Patient</th>
<th>DOB</th>
<th>Sex</th>
<th>Serviced</th>
<th>Not Serviced - Declined</th>
<th>Not Serviced - No Response</th>
<th>Letter</th>
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<td>3831343</td>
<td>Dec 7 1943</td>
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<td>Dec 15 2005</td>
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<td>3831822</td>
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<td></td>
<td></td>
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<td>3831799</td>
<td>May 6 1947</td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3831820</td>
<td>May 1 1971</td>
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<td>Sep 26 2006</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3831013</td>
<td>Aug 24 1937</td>
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<td>Mar 17 2006</td>
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<td>3830756</td>
<td>Aug 31 1967</td>
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<td>3830792</td>
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<td>3831723</td>
<td>Sep 9 1969</td>
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</table>

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Appendix G
Inclusion and exclusion criteria for administrative cohorts

Pap smears

Inclusion: Women 35-69 by January 1st of each year of interest rostered to physicians in the EMR cohort (N=18) and non-EMR cohort (N=9) on March 31, in each of the years of interest (2005-2008 – fiscal 2004-2007). For each woman identified as of March 31st 2005, 2006, 2007 and 2008, their pap smear claims traced back for the past 30 months. Any woman who had at least one of the following tests will be deemed to have been screened:

- OHIP claims G365A, G394A, E430A
- OHIP claims L812, L716, L733

Exclusion:
1. Previous diagnosis of cervical cancer (ever)
   - ICD-9 180.0, 180.1, 180.8, 180.9
2. Women with hysterectomy (ever)
   - OHIP claims S810, S757, S758, S759
3. Died before December 31st 2007

Mammograms

Inclusion: Women 50-69 by January 1st of each year of interest; women rostered to physicians in the EMR cohort (N=18) and non-EMR cohort (N=9) on March 31, in each of the years of interest (2005-2008 – fiscal 2004-2007). For each woman identified as of January 1st 2004, 2005, 2006 and 2007, their mammography claims traced back for the past 30 months. Any woman who had at least one of the following tests will be deemed to have been screened:

- Client screened (SCREENED, from Ontario Breast Screening Program) – where equal to 2 (mammogram only) or 3 (yes, both physical breast exam and mammogram), OR
- OHIP radiology claim X185

Exclusion:
1. Breast cancer diagnosed ever
   - ICD-9 code: 174
• Data sources:  a)CIHI, Same Day Surgery (use discharge dates) or  b)Ontario Cancer Registry (Ices Key Number linked)

2. Died before December 31st 2007

**Influenza vaccinations**

Inclusion: Persons age 65 or more by January 1st of each year of interest; persons rostered to physicians in the EMR cohort (N=18) and non-EMR cohort (N=9) on March 31, in each of the years of interest (2005-2008 – fiscal 2004-2007). Any person with at least one code for influenza vaccination in the Fall (October 1st to December 31st) of each year of interest (2004, 2005, 2006, 2007) was deemed to be vaccinated:

- OHIP claims G590, G591, G538, G539

Exclusion:

- Died before December 31st 2007

**Fecal occult blood testing**

Inclusion: Persons age 50-74 by January 1st of each year of interest; persons rostered to physicians in the EMR cohort (N=18) and non-EMR cohort (N=9) on March 31, in each of the years of interest (2005-2008 – fiscal 2004-2007). For each person identified as of March 31st 2005, 2006, 2007 and 2008, their fecal occult blood test claims traced back for the past 30 months. Any person who had at least one of the following tests will be deemed to have been screened:

- L181

Exclusion:

1. Cases diagnosed with any colorectal cancer between January 1 2000 and December 31st 2007 (using Ontario Cancer Registry, ICES Key Number linked).

- ICD-9 codes: 153.0 to 153.4, 153.6 to 154.1

2. Cases diagnosed with any severe inflammatory bowel disease between January 1 2000 and December 31st 2007 (using CIHI, Same Day Surgery and Discharge Abstract Database (use discharge dates))

- ICD-9 codes: 556, 556.0 to 556.9 and 555, 555.0 to 555.9
• ICD-10 codes: K50, K50.0, K50.1, K50.9, K51, K51.0-K51.9


• OHIP claims Z555 plus one of E740 or E741 or E747 or E705 on the same day

4. Died before December 31, 2007
Appendix H

Focus Group Questions

EMR study Focus Groups

February 5 and 7, 2008

1. Are you currently using only EMR system or a combination of both EMR and paper charts?

2. What motivated you to implement the EMR system?

3. What have been the most positive aspects of implementation? Please explain what has worked for you? Why?

4. What have been the biggest negatives? Would you return to paper charts?

5. What have been the biggest barriers to implementation?

6. What have been the patients’ reactions to the introduction of the EMR?

7. Would you recommend EMR implementation to colleagues?

8. What would you tell your colleagues who are considering the introduction of an EMR?

9. What supports are needed to make the transition to an EMR easier?

10. What else would you like to tell us?
Appendix I

Characteristics of physicians and patients in FHNs and FHGs in Ontario

Table 18: Characteristics of physicians in FHNs (capitation) and FHGs (enhanced fee-for-service) in Ontario

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All locations</th>
<th>Major urban centres</th>
<th>Non-major urban centres</th>
<th>Rural centres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enhanced fee-for-service</td>
<td>Capitation</td>
<td>Enhanced fee-for-service</td>
<td>Capitation</td>
</tr>
<tr>
<td>No. of physicians</td>
<td>3553</td>
<td>507</td>
<td>2646</td>
<td>233</td>
</tr>
<tr>
<td>No. of groups</td>
<td>274</td>
<td>53</td>
<td>179</td>
<td>21</td>
</tr>
<tr>
<td>Male, no. (%)</td>
<td>2267 (63.8)</td>
<td>319 (62.9)</td>
<td>1657 (62.6)</td>
<td>130 (55.8)</td>
</tr>
<tr>
<td>Age, yr, mean (SD)</td>
<td>49.4 (9.9)</td>
<td>47.5 (9.3)</td>
<td>49.7 (9.9)</td>
<td>47.9 (9.1)</td>
</tr>
<tr>
<td>No. of years since graduation, mean (SD)</td>
<td>23.9 (10.3)</td>
<td>21.8 (9.8)</td>
<td>24.4 (10.2)</td>
<td>22.4 (9.6)</td>
</tr>
<tr>
<td>Foreign graduate, no. (%)</td>
<td>682 (19.2)</td>
<td>47 (9.3)</td>
<td>558 (21.1)</td>
<td>29 (12.4)</td>
</tr>
<tr>
<td>Total no. patients enrolled, mean (SD)</td>
<td>708.6 (566.9)</td>
<td>960.8 (617.7)</td>
<td>716.5 (559.7)</td>
<td>1007.6 (705.3)</td>
</tr>
<tr>
<td>No. of months in group, median (IQR)</td>
<td>25.3 (16.5)</td>
<td>25.7 (14.0)</td>
<td>24.4 (17.3)</td>
<td>25.3 (15.0)</td>
</tr>
</tbody>
</table>

Type of visits, %

<table>
<thead>
<tr>
<th></th>
<th>All locations</th>
<th>Major urban centres</th>
<th>Non-major urban centres</th>
<th>Rural centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>86</td>
<td>76</td>
<td>90</td>
<td>85</td>
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<tr>
<td>Inpatient</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Emergency department</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Note: IQR = interquartile range, SD = standard deviation.
*Physicians who were consistently part of the same enhanced fee-for-service or capitation group from Sept. 1, 2005, to Aug. 31, 2006.

---

Table 19: Characteristics of patients in FHNs and FHGs in Ontario

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Location / physician group; no. (%) of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All locations</td>
</tr>
<tr>
<td></td>
<td>Enhanced fee-for-service</td>
</tr>
<tr>
<td>No. of patients</td>
<td>2 517 527</td>
</tr>
<tr>
<td>Age as of January 2006, yr, mean (SD)</td>
<td>41.2 (23.0)</td>
</tr>
<tr>
<td>Age group, yr</td>
<td></td>
</tr>
<tr>
<td>&lt; 2</td>
<td>45 434 (1.8)</td>
</tr>
<tr>
<td>2-64</td>
<td>2 027 088 (80.5)</td>
</tr>
<tr>
<td>≥ 65</td>
<td>445 005 (17.7)</td>
</tr>
<tr>
<td>Male</td>
<td>1 111 376 (44.1)</td>
</tr>
<tr>
<td>Neighbourhood Income quintile</td>
<td></td>
</tr>
<tr>
<td>1 (lowest)</td>
<td>364 470 (14.5)</td>
</tr>
<tr>
<td>2</td>
<td>443 833 (17.6)</td>
</tr>
<tr>
<td>3</td>
<td>509 274 (20.2)</td>
</tr>
<tr>
<td>4</td>
<td>564 544 (22.4)</td>
</tr>
<tr>
<td>5 (highest)</td>
<td>582 441 (23.1)</td>
</tr>
<tr>
<td>Missing data</td>
<td>52 965 (2.1)</td>
</tr>
<tr>
<td>Previous acute myocardial infarction</td>
<td>36 577 (1.5)</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>57 213 (2.3)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>227 718 (9.0)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>635 629 (25.2)</td>
</tr>
<tr>
<td>Resource Utilization Band, t mean (SD)</td>
<td>2.4 (1.1)</td>
</tr>
<tr>
<td>No. of Aggregated Diagnosis Groups§</td>
<td></td>
</tr>
<tr>
<td>&lt; 5</td>
<td>79.3</td>
</tr>
<tr>
<td>6-9</td>
<td>17.9</td>
</tr>
<tr>
<td>≥ 10</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Note: SD = standard deviation.
*Patients enrolled to a physician who was consistently part of the same enhanced fee-for-service or capitation group from Sept. 1, 2005, to Aug. 31, 2006.
†Unless stated otherwise.
‡Resource Utilization Bands categorize patients according to their morbidity and corresponding expected use of health care resources; they range from 0 (lowest expected health care costs) to 5 (highest expected health care costs).
§Aggregated Diagnosis Groups indicate a patient's level of comorbidity, ranging from 0 (no diagnosis group) to ≥ 10 (at least 10 distinct diagnosis groups).

Appendix J

Research Ethics Board Approval

University of Toronto
Office of the Vice President, Research
Office of Research Ethics

PROTOCOL REFERENCE #21162
November 12, 2007

Dr. Jan Barnsley
Health Policy Management & Evaluation
155 College St.
Toronto, ON M5T 3M8

Dr. Michelle Greiver
Health Policy Management & Evaluation
155 College St.
Toronto, ON M5T 3M8

Dear Dr. Barnsley and Dr. Greiver:

Re: Your research protocol entitled "Effect of electronic medical records (EMRs) on the provision of preventive services in a Pay-for-Performance environment"

We are writing to advise you that a member of the Health Sciences Research Ethics Board has granted approval to the above-named research study, for a period of one year, under the REB's expedited review process. Ongoing projects must be renewed prior to the expiry date.

The following consent documents (received October 30, 2007) have been approved for use in this study: Study Information Sheet for Physicians with Electronic Medical Records, Study Information Sheet for Physicians with Paper-Based Records, Physician Focus Group Consent, Consent to AudioTape Focus Group, Physician Key Informant Consent Form and Consent to AudioTape Key Informant Interview. Participants should receive a copy of their consent form.

During the course of the research, any significant deviations from the approved protocol (that is, any deviation which would lead to an increase in risk or a decrease in benefit to participants) and/or any unanticipated developments within the research should be brought to the attention of the Office of Research Ethics.

Best wishes for the successful completion of your project.

Yours sincerely,

Jenny Peto
Research Ethics Coordinator

Murchison Building, 12 Queen's Park Cres, W, 3rd Floor Toronto, ON M5S 1C0
TEL: 416-946-3673 FAX: 416-946-0763 EMAIL: ethics.research@utoronto.ca
Appendix K

Physician Focus Group Consent Form

I understand that I am agreeing to participate as a member of a focus group of physicians organized for a study on “The Effect of Electronic Medical Records (EMRs) on the Provision of Preventive Services in a Pay-for-Performance environment.” The focus group will discuss experiences with the Electronic Medical Record that was introduced into the family health team in 2006.

I understand that, with my permission, the focus group will be audio-taped and that the audio-tapes will be transcribed verbatim. The information from the focus group will be used for the sole purpose of research and will not be used for any other purpose either during or after the completion of this study. The focus group will be conducted by an experienced facilitator and will last approximately one hour.

The risks to the study participants are considered to be minimal. The greatest risk to participants is the disclosure of information provided during the focus group in a manner in which the participant can be identified. All information obtained in the focus group will be kept strictly confidential by the research team and the following steps will be taken to maintain the anonymity of the participants. During the focus group, only first names will be used. During transcription, identification codes will be used in the place of names and practice settings so participant names and their practice setting will not be identified. Only research team members will be able to decipher these codes. Information from the focus group might be included in reports, publications or presentations; however, individual participants will not be identified at any time.

During the project, the master code sheet (linking names to codes), the audiotapes, and the transcriptions will be stored in a locked filing cabinet in the Co-Principal Investigator’s office at the University of Toronto. All audiotapes will be destroyed upon completion of the data analysis. The master code sheet and the transcriptions will be destroyed seven years after the completion of the study. While focus group participants will be instructed that the content of the focus group discussion is confidential, the research team cannot guarantee that this confidentiality will be maintained by all participants. However, only factual questions about experience with the EMR will be asked; none of the questions will be of a personal nature. Further, you are under no obligation to participate in the focus group and may refuse to discuss any topic or withdraw as a participant at any time without penalty or loss of benefits to which you are otherwise entitled. If a participant withdraws from the study, all material provided to the research team previously will be destroyed.

There is no compensation for participation in the focus group.

I have been provided the opportunity to ask questions. For any additional questions or concerns about the study, I can contact the study investigators, Dr. M. Greiver at 416 222-3011 or Dr. J. Barnsley, at 416 978-1782. All conversations will be confidential. Any concerns about my rights as a research subject may be directed to Ms Jill Parsons, University of Toronto Research Ethics Board, 416 946-3273 or ethics.review@utoronto.ca).

I have read the above description of the focus group, I understand what my participation will involve and that I will be given a copy of this signed consent for my records.

Name (print)       Witness Name (print)

Signature   Date   Signature   Date
Copyright Acknowledgements
