

**CANADA HEALTH INFOWAY'S
10-YEAR INVESTMENT STRATEGY COSTING**

Pan-Canadian Electronic Health Record

Quantitative and Qualitative Benefits

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Quantitative and Qualitative Benefits

1.0 Introduction

Pen, paper, and error-prone human memory are the primary information tools by which modern health care is managed. It is paradoxical and cause for deep concern that, in the 21st century, an endeavor as complex and critical as health care is managed by such primitive means. Information technology, which is the cornerstone of quality improvement and efficient management in less complex industries, has been woefully underutilized in the health care sector. It has been estimated that the banking industry spends approximately twice as much on information technology as does the healthcare industry.² Such anachronistic means of managing healthcare information are juxtaposed with the stunning scientific and technological advances that have been made in recent decades. The Romanow report frames it well: “We live in an age of laser surgery and are unlocking the mystery of the human gene, yet our approach to health information is mired in the past. And much of the information we gather cannot be properly analyzed or shared.”³

Healthcare’s failure to harness the power of IT as modern healthcare has become more complex is extracting a high price from industrialized nations around the globe. Costs continue to rise despite widely differing approaches to constrain them.

Faced with an aging population, an ever-broader array of more expensive technologies and pharmaceuticals, and increasingly limited financial resources, the very sustainability of modern health care systems is being questioned. At the same time, there is considerable evidence that there is a failure to meet basic quality objectives on a broad scale— medical errors are a significant cause of death in Canada, the United Kingdom, the United States, and elsewhere. There is wide recognition that health information technologies, particularly electronic health records, will be valuable tools to promote quality, reduce errors, manage the efficient use of other technologies, and control costs. These technologies also have the potential to change the current paradigm of care from a provider-centric environment to a patient-centric environment. Finally, they will be essential to protect the community as we manage traditional threats to the public health as well as emerging threats in this age of global connectivity.

The convergence of opinion and evidence around the importance of leveraging computers to manage health care appears to have made broad implementation of electronic health records not a question of if, but when. The Romanow report reaches this conclusion: “Medicine will only become more complex, and the resulting problems will only become more difficult to manage. To fully realize the benefits and to continue the pace of medical innovation, the infrastructure must be installed to manage this complexity.”

In this paper, we will describe the role of the electronic health record (EHR) as an enabler that promotes patient-centric care while broadly promoting quality and managing cost. We will

“Health care technology, electronic health records and the evaluation of quality, performance and outcomes of the health care system are three areas of Canadian health care infrastructure which must be given priority by the federal government.”

The Kirby Report¹

suggest a 10-year strategy for deploying a desired level of Pan-Canadian EHR functionality and provide an overview of parallel activities in the United Kingdom (UK), Australia, and the United States. Finally, we will estimate the cost for a 10-year Pan-Canadian deployment of specified EHR functionality and estimate the quantitative and qualitative benefits of such an investment. Our goal is to provide a preliminary roadmap to EHR deployment that will keep Canada on course as a global leader in health care, and that will ensure that 10 years hence, Canada will still be able to provide to its citizens the quality of care they deserve, at a cost they can afford.

2.0 EHR: Functional Characteristics, Terms and Definitions

2.1 Functional Characteristics

A single broadly adopted definition of an EHR has not yet emerged. Canada Health Inforoute defines an EHR as “a secure and private lifetime record of an individual’s key health history and care. It creates significant value, providing a longitudinal (i.e., “cradle to grave”) view of clinical information.” Others, such as the Institute of Medicine (IOM), the Healthcare Information and Management Systems Society (HIMSS), Health Information Network for Australia (HINA), National Health Service in the UK, the American Society for Testing and Materials (ASTM), the Computer-based Patient Record Institute (CPRI), and the Gartner Group have definitions that vary in scope and emphasis.

Not only do EHR definitions vary, but also terms to describe the tool vary. For instance, in a paper that examined EHR adoption, David Brailer, the U.S. National Health Information Technology Leader, identified at least 13 different terms for electronic tools that capture clinical information (see box).⁴ To the layperson, each term may seem to express the same concept; but in fact, each connotes a subtle difference in what clinical information is collected and how it is stored and presented. The lack of standard terms and definitions creates confusion in discussions about electronic health records, creating challenges in interpreting the literature or in surveying the current landscape. For instance, it becomes difficult to estimate how many physicians currently use EHRs if different terms are used to describe the tool and the functions it performs. Surveys that probe through a simple query, such as “Do you currently use an EHR (or CPR or EMR)?” may produce misleading results. Included among the providers who answer yes to this question may be those who use rudimentary administrative tools as well as those who use tools with robust clinical capabilities. In either case, frequently there is little indication whether these tools are interoperable with other EHRs—a critical feature in assessing their utility.

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- Automated Medical Record (AMR)
 - Virtual Patient Record (VPR)
 - Electronic Medical Record (EMR)
 - Clinical Data Repository (CDR)
 - Computer Based Patient Record System (CPRS)
 - Computer Based Patient Record-Type System (CPRS)
 - Computerized Medical Record (CMR)
 - Computerized Patient Record (CPR)
 - Electronic Health Record (EHR)
 - Electronic Patient Record (EPR)
 - Lifetime Data Repository (LDR)
 - Virtual Health Record (VHR)
 - Virtual Patient Record (VPR)
-

It thus becomes important to clearly specify the functionality included in each implementation when attempting to gauge the current penetration of EHRs, the cost of future adoption, and the benefits likely to be realized. For instance, tools vary widely in their capability to provide decision support, order entry, data entry, the ability to record clinician notes, and the capability to view clinical data, such as clinician notes, results, and diagnostic images.

Different providers and provider institutions will have different levels of functionality that imply different capabilities, costs, and benefits. Below we provide brief descriptions of the key functional components of an EHR, both clinical and foundational, and the relative benefits of those components. This list is not exhaustive, and these functional descriptions will vary according to where the tool is used: a physician’s office, a hospital, a public health facility, or a long-term care facility.

EHRs are the “cornerstone of an efficient and responsive health care delivery system, quality improvement and accountability (and that) without it, the prospects for a patient-friendly health care system, optimal teamwork, and efficiency are dim.”

*Fyke Commission Report on
Medicare in Saskatchewan, 2001⁵*

Table 1. Functional Descriptions

Function	Description
Clinical Data Repository	The data repository provides a centralized area to store clinical data. The repository can be thought of as a large “bucket.” When patient information is stored in one area, the entire care team, from inpatient to outpatient to public health clinics, can access the same clinical data. Thus the primary care physician in her office can view an allergy record recorded in the emergency room. The consultant from his office can view the abnormal lab recorded in intensive care. This capability reduces the number of times patients are asked for information, reduces the number of duplicate tests done, improves the quality of care given the patient, and reduces medical errors.
Registries	Registries allow the identification and grouping of people and places. These can be thought of as the “white pages” for care facilities, care providers, and patients. This allows patients to search for a facility and for names of physicians from whom to seek care. Additional types of registries include disease registries and consent registries.
Security	Robust technologies ensure that only those individuals with the right to access patient information have the ability to do so. Furthermore, unlike paper records, EHRs keep accurate audit trails, so patients can have confidence that they can identify every individual who has looked at their information.
Appointments and Scheduling	Appointment and scheduling systems allow for the electronic booking of care visits across the care continuum, and the scheduling of items such as x-rays and surgery. Electronic appointment scheduling and maintenance of schedules for the care team and ancillary services allow for improvements in workflow and utilization. An integrated scheduling system reduces conflicts in schedules, gives the ability to multi-book a series of appointments, and allows for the scheduling of a variety of types of appointments across the care continuum. Throughput is improved because of the better ability to schedule resources and to check for resource conflicts. Combined integrated scheduling vastly improves resource utilization and improves the forecasting of needed resources.
Laboratory	Laboratory systems record the results of blood and microbiology test results electronically. These lab results can be stored in the data repository and viewed by the care team. Test results can thus be viewed across the care continuum and across encounters. Results may also be trended to see whether they are becoming abnormal. Integrated with other types of applications, abnormal results can be sent to electronic inboxes, pagers, and to multiple members of the care team.

Function	Description
Diagnostic Imaging	Diagnostic imaging systems store radiographic images digitally. This reduces storage costs for film, decreases the number of lost films, and allows for remote viewing of images. Remote viewing means that films can be read at far distances, helping to bring radiology services to areas lacking a radiologist.
Pharmacy	Pharmacy systems record the medications prescribed for patients. Pharmacy systems perform drug checking, and when integrated with the data repository, can check against patient labs. When an order system is in place, it is the clinician's exact order that is presented to the pharmacist. These systems can also be integrated with robots that prepare the prescription with the aid of bar coding. Pharmacy systems thus reduce medication errors on a number of levels.
Decision Support	Clinical decision support encompasses a number of vehicles that all lend support to the clinician in the provision of clinical care. Decision support includes drug checking to help prevent medication errors, alerts to guide care, reminders to increase the adherence to preventive care guidelines, embedded ordersets, protocols, and care pathways to help reduce variance of care. Decision support improves quality of care and decreases medical errors.
Clinical Documentation	Clinical documentation is the electronic storage of the documentation of care. This ranges from scanning of paper documents, typed free-text, forms documentation, and structured documentation, to voice recognition and natural language processing. When documentation is stored electronically, others on the care team can view it. Knowledge of care provided in one care setting improves the care in another setting. Patients no longer need to be asked numerous duplicate questions about their previous care, and are no longer expected to be the stewards of the knowledge of their care.
Orders	Clinical care activities begin with a written or verbal order. Ordering systems allow for the entering of orders electronically, decreasing errors that result from illegible handwriting. When integrated with clinical data and decision support, checks on the orders can be made to reduce medical errors.
e-prescribing	e-prescribing takes the writing of prescriptions from the paper world to the electronic world. As with orders, an e-prescription can be checked against rules, and decision support can be invoked. Interfacing with pharmacies allows for the prescription to be transmitted electronically, populating the patient's medication list for future reference and allowing for easy prescription refills in the future.
Reporting	Reporting systems allow mandatory reports to be generated and data queries to be performed. For instance, birth records can be reported automatically when the electronic documentation of a delivery has occurred. A list of patients currently prescribed a recalled medication can be quickly compiled so that those patients can be informed of that recall. Adherence to quality of care indicators can also be measured.
Personal Health Record	The term "personal health record" sometimes conveys the notion that the PHR is separate and distinct from the EHR. Although the term PHR is not well defined, it may be more useful to conceptualize it as merely a different view of the same information that is aggregated in the EHR. Often this view is provided via an Internet portal so that a patient may view his or her own health information. The PHR may also have functions that facilitate scheduling of appointments, prescription refills, and e-communication with the care team. Clinical data collected at home, such as blood sugar levels for a diabetic, weights in a patient with congestive heart failure, and LH surges in an infertility patient, can be recorded electronically and sent to a patient's clinician via this Internet portal.

2.2 The Importance of Interoperability

The ability for computer applications across the care continuum to share information seamlessly, i.e., to be able to “talk” to one another, is referred to as interoperability. An EHR is not just a patient record on electronic paper. That narrow interpretation overlooks the enormous potential EHRs offer through sharing and reuse of health data. EHRs offer the potential for primary care physicians to share information seamlessly with specialists at other locations. In the emergency room, quick access to outpatient records in critically ill patients can literally save lives. Interoperable EHRs allow patient information to be combined with specific medical research to support personalized medicine. Interoperability also facilitates multisite research using automated data extraction tools to lead to the improvement in care of all patients. Data sharing directly decreases the incidence of unnecessarily repeated tests and can help to decrease drug abuse by patients by making it difficult for them to obtain multiple prescriptions from multiple physicians. Without achieving interoperability, a critical component of an EHR’s ability to improve quality of care and reduce medical errors is lost. Interoperability also has an impact on vendors. It leads to an increase in vendor competition, leading to a decrease in technology costs, and encourages vendors to include technology migration strategies to reduce technology obsolescence.

Electronically connecting health care communities, both internally and externally, is essential to maximizing high-quality patient-centric care, as well as the public health. Despite the modern mobility that brings exotic diseases to our doorstep and sends us to medical Meccas in search of rare expertise, most health care is local. Connecting physicians, individuals, hospitals, pharmacies, independent labs, diagnostic imaging centers, long-term care sites, and public health authorities ensures that each point in the care network has the right information at the right time to make appropriate decisions. The more nodes in the network, the more valuable the network is to all who participate.

The importance of local connectivity should not overshadow the importance of regional and national connectivity. Citizens should feel secure that wherever they travel, their health information travels with them. A woman from Montreal who is on vacation in Vancouver, or on business in Toronto, should know that if she goes to a local emergency department the physicians there will be able to immediately access her critical health care information. When she returns home, her local physician should have immediate electronic access to the lab tests, x-rays, and physician notes from her unplanned encounter. Furthermore, public health and syndromic surveillance data from all the jurisdictions should roll up to the regional and national levels so that concerning trends and outbreaks can be identified and tracked across the country in real time. Individual health and community health thus require robust connectivity and interoperability, both on the local and national levels.

2.3 E-Health EHRs and Telehealth

EHR and telehealth describe complementary and overlapping technologies that are subsets of the larger domain of e-health. Like EHR, the term telehealth has come to mean different things to different people. Telehealth is sometimes defined as follows: the use of communications and information technology to deliver health and health care services and information over large and small distances.⁶ If a primary function of the EHR is to electronically aggregate health information recorded at different places and times, and make that data available at the point of care, the parallel objectives of these technologies become clear.

Telehealth can be best understood by describing some of the functions for which it is used. Teleconsultations create a voice-video link between a patient and/or primary provider and a specialist. Teledermatology and telepathology send images of skin and pathology specimens so that experts may analyze them remotely. Telepsychiatry/psychology has been used extensively to provide mental health services. Although many telehealth services are transmitted from facility to facility, home telehealth services also exist. Home health care providers can use electronic links to transmit data collected with monitoring devices from the home, back to the office or facility. On the basis of this information, the home health provider may be directed by the monitoring nurse or physician to make an intervention, such as increasing a medication dose. In some cases, the patient or family member may transmit voice, video, or monitoring information electronically to receive direct feedback and instruction from the care team. Home telehealth can be a powerful means of implementing a disease management or surgical follow-up strategy, allowing the practitioner to detect symptoms and correct problems early to prevent unnecessary emergency room visits or hospitalizations. Telehealth technologies have also been used extensively to educate providers, especially those in remote locations, and even to supervise surgical procedures.

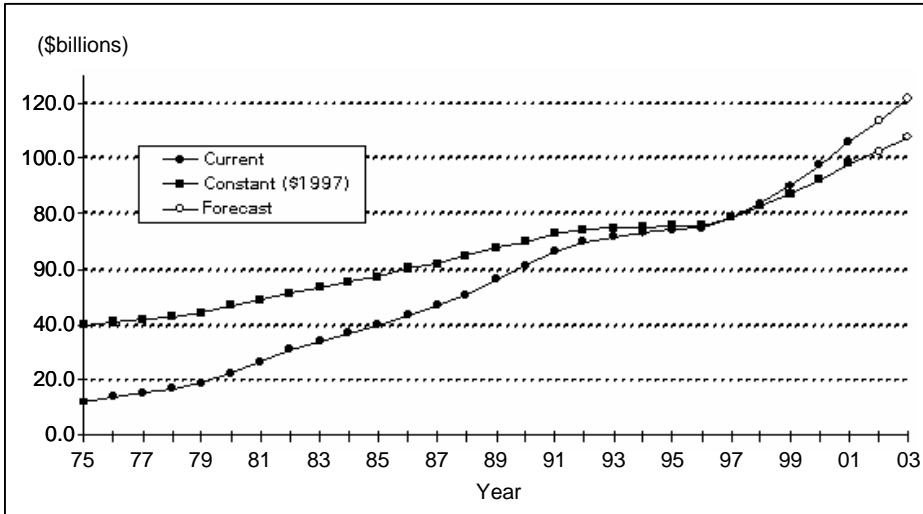
Canada has been a world leader in applying telehealth technology to address health care challenges. The NORTH Network in Northern Ontario is perhaps the world's largest and most robust telehealth service. This network connects more than 100 hospitals and has performed over 10,000 consultations in over 70 specialties since its creation in 1998. The NORTH Network has leveraged the secure integrated provincewide IT infrastructure provided by Smart Systems for Health Agency (SSHA). When fully operational, SSHA will connect more than 150,000 health care providers across 24,000 sites throughout Ontario. More than 80% of Ontario's hospitals are already connected to SSHA's network.

Both telehealth and EHR systems can share a common IT infrastructure and should be interoperable at the national level. As telehealth and EHR technologies mature, they will increasingly converge; and the foundation for each should facilitate that convergence so that digitized voice, video, imaging, monitoring, lab, pharmacy, and written documentation data are aggregated in a manner that makes all necessary information available when needed at the point of care.

3.0 Quality, Sustainability and the EHR

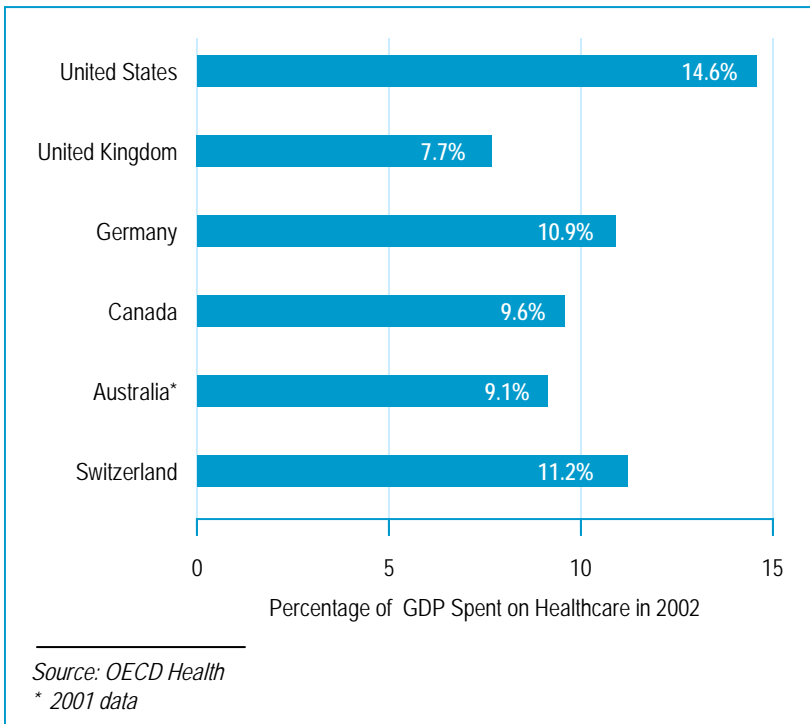
Industrialized countries are experiencing unrelenting cost pressures as medical technologies proliferate and their populations age. Over the past several years, Canadian medical costs have risen by 7 to 8% each year (Figure 1) and now command a historic high of 10% of the country's GDP.⁷ Although Canada's medical costs are not as high as those of the United States at 14.6% Canada does spend more of its GDP on health care than many European countries, including the UK (Figure 2). The inexorable rise in costs has called into question the very sustainability of modern health care systems. Prince Edward Island Premier Pat Binns asserts, "our current system is not sustainable, the principles of the Canada Health Act are at risk, and health care as we know it will not survive the end of the decade."⁸ Furthermore, the Commission on the Future of Health Care in Canada states that the risk to sustainability is likely to rise in the future.⁹

Figure 1. Total Health Expenditure, Canada, 1975–2003



Source: Canadian Institute for Health Information

Figure 2. Percent GDP Spent on Healthcare in 2002



It is unlikely that Canada and other industrialized countries will meet their objectives of increasing access, quality, and safety simply by “working harder” because many providers and care systems are already working at their limit. The Institute of Medicine warns that significant improvements in safety are beyond the capability of individual providers to achieve. Widespread failures in safety are the result of inadequate systems and processes. Information technologies, so woefully underutilized in health care, hold the best hope of simultaneously improving quality while maximizing efficiency.

The notion that technology can simultaneously improve quality while constraining cost may be counter-intuitive to some. Experience suggests that new healthcare technologies generally add cost. Fifty years ago, organ transplants, MRIs, CAT scans, angioplasties, and colonoscopies were unimagined. Today these procedures are routine and represent significant added cost to the care commonly provided. Mounting evidence suggests that information technologies are unique because they help providers manage the explosion in information that other medical technologies and scientific advances generate. It is through this knowledge management function that information technologies have the potential to improve safety and quality while reducing costs.

The Ottawa Hospital implemented a multi-site Picture Archiving and Communication System (PACS) system. Filmless, digital images allow for the remote viewing of images by the entire care team regardless of physical location. The hospital noted a \$754,000* decrease in film costs and a 37% increase in volume of exams performed after implementing this technology.

In 2003, Wang and Middleton at the Center for Information Technology Leadership (CITL) in Boston, MA, performed a cost-benefit analysis of electronic medical records in primary care.¹⁰ Quantified benefits included decreased chart pulls, decreased transcription costs, fewer adverse drug events, alternative drug suggestions, decreased laboratory testing/redundancy, and decreased diagnostic imaging (x-ray)/redundancy. The estimated 5-year net benefit of EHR implementation was \$86,000 USD (\$110,768 CAN)** per provider. The benefits were also related to the sophistication of the EHR implemented—implementations with only the most basic functions, such as online patient charts, yielded the most modest gains; those with electronic prescribing yielded more significant gains; and those with a full suite of capabilities that included lab, radiology order entry, and electronic charge capture yielded the most robust net financial benefit.

As we confront the reality of resource limitation at a time when new medical technologies are introduced at an ever-increasing pace and populations are achieving previously unattainable longevity, we must find innovative solutions to improve the cost efficiency of the care we provide. EHRs represent an important part of that solution—they have great potential to enhance efficiency and to promote savings.

* Unless otherwise specified, all dollar amounts are in Canadian dollars.

** One USD equals 1.2881 CAN.

4.0 Benefits of the EHR: Quality, Access, Cost Control and Contributions to Public Health

The EHR holds the key to ensuring both the quality and sustainability of the national healthcare system. Furthermore, like many other networks, the benefits of EHRs grow exponentially as they become more widely adopted and technologically more advanced.¹¹ Stand-alone electronic pharmacy systems are valuable, but when connected to the EHR with order entry systems and clinical data repositories, they become even more valuable. The benefits that can be achieved are far-reaching, and include the following:

- **Quality:** By providing support to clinicians at the point of care, EHRs can promote best medical practices to improve quality and reduce medical errors for every patient who receives treatment.
- **Access:** EHRs also expand access to high-quality care. Through telehealth, care is brought to patients with limited access due to geography, limited mobility, or other circumstances. Scheduling and appointment systems can help to reduce wait lists by improving resource utilization
- **Cost Control:** EHRs reduce waste, avoid unnecessary costs, and improve productivity. Unlike many other medical technologies, EHRs control costs while improving quality, supporting the sustainability of the healthcare system.
- **Public Health:** EHRs provide the fundamental data required for effective management of the public health. Both acute and chronic diseases can be effectively managed over the entire population; outbreaks can be detected early and managed more effectively.

4.1 EHRs and Quality Improvement

EHRs improve quality and safety through a variety of ways. Below we examine how EHRs improve safety and quality by three well-documented mechanisms.

- Improve patient safety by reducing medical errors
- Improve clinical decision-making and management
- Promote patient-centric care

4.1.1 Improve Patient Safety by Reducing Medical Errors

In 1999, the Institute of Medicine created a firestorm of controversy when it released the now familiar report “To Err is Human: Building a Safer Health System.”¹³ This report estimated that medical errors occur in up to 3.7% of all hospitalizations in the United States, and that between 44,000 and 98,000 Americans die each year from medical errors. The report was challenged, but even the more conservative estimates suggested that more than 100 people died weekly from medical errors. More recent studies not only have corroborated these estimates but have suggested that the incidence of deadly errors may even be as high as 200,000 a year in the United States.¹⁴ One of the central points made in the IOM report was that solutions were

Serious adverse drug reactions have been reported to occur in over 10,000 people a year in the UK.¹²

largely beyond the reach of individual providers. Much of the problem was rooted in flawed processes and archaic means of managing information. To make medicine safer, new information systems would be required. These errors are not isolated to the United States. Chart reviews done in a number of countries have shown that this problem is universal (see Table 2).

Table 2. Chart Review Studies on Patient Safety

Country (Year)	Number of Charts Reviewed	% with any Adverse Event	% of Total Adverse Events Considered Preventable
Canada (2000-2001)	3,745	7.5%	37%
France (not indicated)	778	14.5%	28%
New Zealand (1998)	6,579	12.9%*	37%
England (1999)	1,104	10.8%	48%
Denmark (1998)	1,097	9.0%	40%
U.S. – Utah & Colorado (1992)	14,700	2.9%	N/A
Australia (1992)	14,179	16.6%	51%
U.S. Harvard Medical Practices Study (NY, 1984)	30,195	3.7%	N/A

* Adverse events were associated with 12.9% of admissions samples. The incidence rate (only incidents recording during the sampled admissions) was 11.2%

Source: Canadian Institute for Health Information¹⁵

An emerging body of evidence shows that Canada, like other countries with advanced health care systems, also has an inordinately high rate of medical errors. Although direct comparison of the data is problematic, the landmark Canadian Adverse Event Study (CAES) showed that the overall incidence rate of adverse events in Canada was 7.5%.¹⁶ This figure suggests that approximately 185,000 adverse events occur each year, and that about 70,000 of these are potentially preventable. Extrapolating these figures across the country, between 9,250 and 23,750 people die every year due to medical errors in Canada. The average of these estimates would make it the third leading cause of death in Canada, just shy of lung cancer. Stated another way, more people die from medical errors in Canada than from HIV, breast cancer, and motor vehicle and transport accidents combined.

Other studies suggest that the rate of adverse events in Canada may even be higher. A study published in 2004 revealed that 12.7% of patients admitted to Ottawa Hospital experienced an adverse event, and 4.8% of those were judged to be preventable.¹⁷ However, neither CAES nor the Ottawa Hospital study included adverse events that occurred after discharge from the hospital. In another Canadian study, the incidence of adverse events after discharge was 25%, of which half were estimated to be preventable.¹⁸ This data is not an anomaly—at the Hospital for Sick Children in Toronto, a prospective study of pediatric surgical patients noted that two-thirds of patients experienced medical errors, while one-third had an adverse outcome secondary to those medical errors.¹⁹ At the Wellesley Central Hospital, a prospective study of general surgical patients noted that 39% suffered a complication, 1% were fatal, and 7% were life threatening.²⁰ In sum, there is growing consensus that the Canadian experience with regard to patient safety is similar to that documented in the established international body of literature.^{21,22,23}

Deadly medical mistakes may be the result of circumstances as mundane as illegible handwriting. Information systems that merely eliminate handwritten orders have a significant impact on reducing medication errors. Placing a decimal point in the wrong place can be lethal—it can make the difference between giving an infant 1 milligram of morphine or a deadly dose of 10 milligrams. Robust EHR pharmacy systems automatically detect when an inordinately high dose of medication has been prescribed for a patient and immediately alert the physician to the error. There are other common oversights and errors, including failing to properly correct a medication dose for kidney failure; being unaware of a patient’s allergies; being unaware of all drugs taken by the patient which might adversely interact with a newly prescribed medication; being unaware of the potentially dangerous interactions that could occur with a new medication; being unaware of abnormal lab results that would make a medication dangerous to administer; and ordering a medication on the wrong patient. An “intelligent” EHR can detect these errors before they are carried out and before they cause harm to a patient.

The most robust hospital EHR systems rely on a chain of unbroken electronic events that carry the physician’s order to the pharmacy, where the appropriate drug and dose are procured. The software automatically checks for kidney function, allergies, relevant laboratory results, drug interactions, appropriate dose for a given weight, and other important parameters. The drug is delivered to the patient’s room, where the nurse scans a bar code on the patient’s wrist to verify the patient’s identity and match that patient with the intended drug. These systems are part of an ordering capability called computerized physician order entry (CPOE) and have been associated with dramatic reductions in medication errors and adverse events.

Table 3. Physician Computerized Order Entry Sequence

Step	Possible Source of Error	Process Improvement
Physician decides to order a medication	Physician is unaware of latest clinical evidence supporting the use of a different medication	Active or passive alerting promotes adoption of best clinical practices
Physician tailors the order to a specific patient	Physician is unaware of the most recent laboratories, allergies, drug interactions	Automated alerting avoids these common sources of error
Physician writes the order in the order book	Illegible handwriting leads to wrong medication delivered (e.g., Cerebyx instead of Celebrex) or wrong dosing	Clear typeface and automated data transfer remove possibility of illegible handwriting
Order is transcribed and sent to the pharmacy, and medication is dispensed	Delay in the order being picked up leads to missed dose of medication	Order is automatically delivered to the pharmacy
Nurse confirms the dosing, timing, and route of the medication and administers the medication	Medication is delivered to the wrong patient	Bar coding or other reminders facilitate delivery of medications to the proper patient

The evidence for the benefit of an EHR in preventing medical errors is strong. Specific examples include:

- Research from McGill University showed that by merely providing computer-based access to complete drug profiles and alerting physicians to potential prescribing problems, the rate of inappropriate prescriptions was reduced by 18%.²⁴
- Bates and colleagues showed that after implementing a computerized order entry system, medication errors decreased by 55% and there was a 17% reduction in preventable adverse drug events (ADEs).²⁵ In a follow-up study by the same group, rates of serious medication errors fell by 88%.²⁶
- A study conducted at LDS Hospital in Salt Lake City demonstrated a 70% reduction in ADEs after the implementation of a CPOE system.²⁷
- Extrapolating from their own research, Raschke et al. in 1998 estimated that a hypothetical 650-bed hospital with a fully functional CPOE system would avoid 500 ADEs a year, leading to 36 lives saved, for a cost savings as high as \$3M USD (\$3.86M CAN) a year.²⁸

As discussed below, we believe, based on modeled projections, that a Pan-Canadian EHR will produce a strongly positive return on investment. However, even if there were no financial benefit to be realized, one could make a compelling argument that there is an ethical obligation to make this investment. Medical errors have become a leading cause of death in industrialized countries. There is now unequivocal evidence that EHRs, especially those with CPOE, can dramatically decrease medical errors and save a significant number of lives. On the basis of this evidence, many would argue that EHRs should be implemented on a broad scale and at an aggressive pace as soon as possible.

4.1.2 Improve Clinical Decision-Making and Management

Deliver the needed information to the right place at the right time

EHRs can help improve clinical decision-making in a variety of ways. First and most important, they can provide the caregiver with all the relevant information needed to make an informed clinical judgment. In the paper world, an endocrinologist caring for a complicated diabetic patient would not be able to easily access the most recent notes of other specialists, such as the cardiologist or vascular surgeon, because these notes reside in the charts in those offices. Neither the discharge summary from a recent hospitalization nor the results of the hemoglobin A-1C test drawn at an outside lab 2 days before would be available. The endocrinologist would have to make a management decision with incomplete information. This would not be the case, however, if an electronic medical record were accessible. Studies show that in ambulatory clinics, more than 80% of clinical decisions were either delayed or based on incomplete information because on average four pieces of important clinical information were not available to clinicians at the time of the encounter.²⁹

Use alerts and reminders to promote prevention, screening, and better disease management

Routine laboratory and screening tests are used to promote health and prevent disease. Many of these routine health maintenance tests have a regular schedule, and an EHR provides automated reminders of these tests to the clinician at the point of care. For example, childhood vaccinations,

annual pap smears for woman, annual colon cancer screening for men and women over 50, and yearly flu shots for at-risk seniors may fall through the cracks without appropriate and persistent active reminders. The same is true for managing chronic diseases like diabetes, where reminders to perform eye exams may delay blindness, foot examinations may prevent amputations, and careful monitoring of blood sugar may prevent heart attacks, metabolic crises, strokes, and other complications. Such reminders can improve acute care as well. An ER physician may be reminded to give a patient with chest pain an aspirin if it has been overlooked, and a resident working in the coronary care unit may be prompted to consider ordering a beta blocker to a patient after an acute myocardial infarction. Clinician compliance with these well-established recommendations is poor in the paper world. For instance, in a study published by the Manitoba Centre for Health Policy, it was found that there was poor compliance in meeting quality indicators (see Table 4). Compliance can be vastly improved through the use of electronic alerts, reminders, and other electronic decision-support in EHRs.

Table 4. Proportion Patients for Whom Physicians Met Quality Indicator Target *³⁰

Quality Indicator	Winnipeg	Brandon
Cervical Cancer Screening	71%	71%
Childhood Immunization	64%	68%
Post-MI Care: Beta-Blocker Prescribing	63%	62%
Influenza Vaccination	63%	65%
Asthma Care	59%	61%
Antidepressant Prescription Follow-up	49%	51%
Diabetes Care: Eye Exams	37%	48%

* Proportion of eligible patients allocated to a given physician who met the target

Help manage knowledge complexity and promote evidence-based medicine

The prospective randomized clinical trial is the gold standard by which medical evidence-based knowledge is generated, and then assimilated into the clinical canon of high-quality care. This type of study examines the impact of different treatment interventions on two or more randomly selected groups of research participants. The proliferation of the randomized trial and other statistically sound approaches to research have accelerated the shift from the anecdotal practice of medicine, in which senior physicians transferred to apprentices knowledge based on accumulated medical memory, to an evidence-based approach that is based on statistically valid findings.

However, the imperative to practice evidence-based medicine can present a daunting challenge to even the most motivated physician. More than 150,000 new medical articles are published in over 20,000 biomedical journals each month, and there are more than 300,000 randomized controlled trials available to physicians.³¹ The informed clinician must not only read studies relevant to his or her domain but also evaluate them, sort out the strong evidence from the weak, and apply the appropriate evidence to the care of a specific patient. Not surprisingly, digesting this enormous volume of information leads to a long lag between the discovery of better treatments and their incorporation into routine practice.^{32,33}

A robust EHR with knowledge management and robust decision support not only facilitates the incorporation of biomedical research into standard practice;³⁴ it also allows that information to be

integrated easily with information about a specific patient.³⁵ This is an emerging capability of EHRs and one that will become more robust with time. It holds significant promise to reduce the variability of the cost and quality of care. Many believe that the greatest potential for cost control lies in this emerging capability; however, more research needs to be done to quantify the magnitude of that benefit.

4.1.3 Promote Patient-Centric Care

As noted above in the sample visit to an endocrinologist, medical information and hence medical care is organized around providers. In the paper world, information is located in many different places. It can be exceedingly difficult to locate and move that information to the appropriate place at the appropriate time. As an individual sees an increasing number of providers, it becomes more difficult to marshal the needed information from the paper record, or more precisely, records. Even within a single institution, multiple clinician-centric records may exist. For example, there may be both an inpatient record and an outpatient clinic record, or even separate records in the cardiology clinic, dermatology clinic, and oncology clinic. If community-based physicians are involved, as is often the case, each one has a separate record for a given patient. In addition, a paper record can be accessed by only one user at a time, leaving nurses, therapists, physicians, schedulers, clerks, and billing staff all competing for the one paper chart. Most frustrating, the paper chart is frequently lost.

These are issues that are noted with concern by patients. In a 2002 Health Policy Survey, 26% of patients in Canada reported having seen five or more different doctors over 2 years; only 13% had seen just one. Forty-nine percent reported that they had had to tell the same story to multiple health professionals; 31% reported having received conflicting advice from three or more doctors; up to 16% reported that their test results had not reached the office in time for their appointment; and up to 16% reported having been sent for duplicate tests (Table 5).³⁶

Table 5. Multiple Physicians and Care Coordination Among Sicker Adults in Canada 2002

Question Asked		Percent
Number of different doctors and other health professionals seen in past 2 years:	One	16
	Two	23
	Three	17
	Four	13
	Five or more	27
Care coordination experiences in past 2 years:	Had to tell same story to multiple health professionals	50
	Records/results did not reach doctor's office in time for appt.	19
	Sent for duplicate tests/procedures by different health professionals	20
	Received conflicting information from different doctors or health professionals	23
Tests did not reach office in time for appointment	1–2 doctors	12
	3 or more doctors	25
Sent for duplicate tests	1–2 doctors	9
	3 or more doctors	28

Source: Commonwealth Fund/Harvard/Harris Interactive, 2002 Commonwealth Fund International Health Policy Survey of Sicker Adults.

Conversely, in a patient-centric environment, the information follows the patient as the patient moves through the system. Complete information is available to all providers as needed. This process not only promotes better care for the patient, it is also respectful of the patient's time. No longer will the patient have to repeat the same story many times to multiple providers. No longer will patients have to lug bags of pills from provider to provider to show what medicines they take. No longer will patients have to endure repeated needle sticks and x-rays because a clinician cannot access needed information that is in an unavailable paper chart. In each case, the information will be readily accessible in the electronic record.

Digitized health information also promotes patient centricity through the creation of a personal health record (PHR). The PHR is a personal version of the EHR, giving the patient control over his or her information and the capacity to personally present it to a clinician. Furthermore, it can be used as a tool to help the patient manage his own disease, especially if it is a chronic condition such as diabetes. By providing personalized information, guidance, prompts, and reminders, the personal health record is a patient-centric tool that can improve health outcomes by more effectively engaging the patient in self-care.

By promoting patient centricity, the EHR has the potential to fundamentally alter the paradigm of modern health care delivery. This shift will have a significant impact on the way health care is experienced by the patient. It will engage patients in a way that may lead to more accurate collection of health information. It will inform patients and may improve compliance with treatment regimens. It will empower patients and may be a significant source of improvement in patient satisfaction.

4.2 Improve Access

Because the single payer system in Canada provides coverage to all citizens, access issues do not revolve around unequal insurance penetration among citizens. Obstacles to access are manifest in the challenges associated with delivering care to rural and remote populations and in managing waiting times. Given the shortage of providers in Canada, access is compounded in areas in which there are not enough primary care providers for the population that they cover. And, like all industrialized countries with aging populations, there are also access issues related to impaired mobility of the chronically ill.

A digitized medical information system has long been recognized as a means to improving access and quality to remote populations. This can be achieved through a variety of complementary electronic approaches. As was discussed previously, telehealth is a critical part of this strategy. Through a telemedicine link in a primary care provider's office, a patient can be interviewed and observed by a specialist from a remote location, providing backup to primary care physicians.

The EHR can also be a valuable tool for managing health care for rural populations. By creating an intelligent record that helps guide the provider in the decision-making process, primary care physicians and specialists can receive expert evidence-based support in real time at the point of care. If necessary, the patient's entire chart can be viewed electronically by a specialist thousands of miles away so that a second opinion may be rendered.

One need not live in a remote location to face challenges in getting to the doctor. Aging patients with multiple chronic illnesses can face great challenges in accessing their providers. Telemedicine links in the home along with adjunctive monitoring devices, such as pulse oximetry to monitor patients with emphysema, scales to track water retention in patients with congestive heart failure, glucometers to check blood sugars in a diabetic, and other devices can be used to relay information to providers so that patients can be evaluated and managed remotely. In some cases, a visiting nurse or home health aide can use more sophisticated devices, such as EKGs, spirometers, or otoscopes, to relay information to a physician's office. This improves the quality of care and promotes a patient-centric paradigm.

4.2.1 Use of Appointment and Scheduling Systems

Appointment and scheduling programs can improve access by improving workflow and utilization. Jurisdictional appointment and scheduling programs, as opposed to institutional systems, can provide data on the geographic distributions of patients and available resources. This facilitates planning and the more efficient use of resources in relatively short supply. For instance, such data can help plan the appropriate specialty mix and facility requirements for a given geographical location. A regional system that matches needs to resources will increase the probability that all cancellations will be detected immediately and that alternative patients will be promptly identified to fill these openings.

An integrated scheduling system provides the ability to multibook a series of sequential appointments for a given patient. For instance, a pregnancy test is automatically scheduled prior to an IVP on a female patient, or a physical therapy appointment is automatically coordinated with visits to the orthopedist. The program automatically detects conflicts in complex scheduling scenarios and suggests viable alternatives. Integrated scheduling reduces the numbers of no-show appointments, increases the probability that cancellations will be filled, and increases throughput by more appropriately matching needs to resources. A scheduling program integrated with clinical information may also remind the physician that the patient who comes in unexpectedly because of acute back pain is also due for a flu shot and a mammogram. Electronic scheduling also decreases cost by rendering the scheduling endeavor less labor intensive.

4.2.2 Health Human Resources

EHRs also help to address health human resource issues, particularly regarding the shortage of physicians, nurses, and pharmacists, by helping to increase efficiencies in the workplace and by improving job satisfaction. While efforts are underway to increase recruitment and the number of seats in education programs, these efforts cannot solve shortages on their own. It is commonly accepted that computerized health systems lead to an increase in efficiencies in healthcare. A particularly significant issue is the nursing shortage being experienced in Canada, which is directly impacting access to care. A confluence of forces has conspired to create this shortage, including an aging workforce, an increase in the number of retiring nurses, a reduction in the number of enrollees in nursing programs, an increase in work dissatisfaction leading to high absenteeism and poor retention, and insufficient funding to hire the number of nurses needed.³⁷ Many believe that the trend in the shortage of nurses began with funding cuts that occurred in the 1990s and a shift to more part-time work. As a group, nurses are not only important to healthcare, but because they make up a large sector of the Canadian workforce, critically important to the economy of Canada as well.

Nurses find that using EHRs increases their efficiency in clinical documentation. This not only enables nurses to devote more time to patients, thereby increasing clinical productivity, but also helps improve job satisfaction. As job satisfaction improves, recruitment and retention are likely to improve. Increased nursing efficiency combined with enhanced recruitment and increased retention is an important strategy to address the nursing shortage, as well as access issues and waiting times related to nursing resource limitations. This scenario likely applies to other shortages in health human resources. Thus the EHR plays an important role in strategies to address these issues.

4.3 EHR and Cost Control

Cost and quality are inextricably related. They are often viewed as being at odds, but efficiency can be an important vehicle to promote the quality of care in the system. If high-quality care is provided at lower cost, the savings can be reinvested in other parts of the health care system. In the face of finite resources, there is an ethical imperative to manage those resources as efficiently as possible. The EHR is an invaluable tool in improving the efficiency of care. The EHR can promote cost savings through a variety of mechanisms, including the following:

At Chelsea and Westminster Hospital in the United Kingdom, installation of a clinical information system was found to reduce surgery cancellations by 63% by better ensuring that patients are medically cleared and adequately prepared prior to surgical procedures.³⁸

- Reduce administrative costs: chart pulls and filing, transcriptions, phone calls, photocopying of charts, faxing medical information
- Reduce duplicate testing that occurs when providers cannot find test results
- Reduce the treatment costs associated with effects of medical errors
- Reduce costs through more effective care management and disease management
- Reduce costs by increasing provider and staff efficiency
- Reduce costs of clinical trials and other forms of research

4.3.1 Reduce Administrative Costs: Chart Pulls and Filing, Transcriptions, Phone Calls, Photocopying of Charts, Faxing Medical Information

In the paper world, hospital medical records are stored in the medical records department and maintained by a dedicated medical records staff. Each time a lab or x-ray report is produced, the paper documents are sent to the medical records department, where the chart is pulled, slips of paper are manually placed in the medical chart, and the chart is then refiled by staff. Sometimes the results are placed in the wrong chart, placed in the wrong section of the paper chart, or are lost altogether. Each time a patient comes to the emergency department or is admitted into the hospital, medical records staff pull the chart and send it to the appropriate destination in the hospital. After clinicians are finished, the chart is sent back and refiled. Charts often are filed by a complicated color-coding system analogous to the Dewey decimal system used in libraries. The chart filing process is prone to human error and charts are often misplaced.

An entirely separate process may be followed for hospital outpatient charts. Frequently, patients have charts in multiple clinics, such as cardiology, oncology, and urology, that follow a parallel filing and retrieval process. Independent physicians' offices will have yet other systems to maintain their charts. Many clinicians will dictate certain kinds of notes, such as hospital discharge summaries or consultations. Costly transcription teams are required to listen to these dictations and type them. Medical records staff will then pull the charts, place these transcribed paper dictations into the charts, and then refile the charts. Sometimes an entire chart must be sent to a consulting physician or another hospital. Copying and faxing a paper medical chart can be an onerous and time-consuming task. The painstaking enterprise of maintaining and delivering paper medical records is a very labor intensive, inefficient, and expensive process. Despite the best efforts of dedicated personnel, test results and even entire charts are frequently misplaced and unavailable when urgently needed.

The EHR can electronically incorporate lab, x-rays, and other data elements, obviating the need to manually file each of these discrete data elements each time one is produced. EHRs are not kept in a physical place and do not need to "pulled" or "refiled" each time the chart is consulted. An interoperable EHR can be easily shared between different providers with no copying, faxing, or calling required. It is immediately apparent that one of the most concrete savings attributable to EHRs is the elimination of the expensive processes required to maintain and access paper charts.

The Franciscan Medical Group in Tacoma, WA, a six-clinic, 59-physician member organization, found that after implementing an e-transcription service, they saved \$55,000 USD (\$70,840 CAN) in their first year with only a 25% utilization rate of the service. They estimated that avoiding chart pulls saved them \$3.00 USD (\$3.86 CAN) per chart.⁴⁰ Partners HealthCare System in Boston, MA, estimated the average chart pull cost at \$5 USD (\$6.4 CAN) per chart and noted a 28% reduction in transcription costs by the decreased use of dictation services.⁴¹ At the Central Utah Multi-Specialty Clinic, a 59-physician group with practices in nine locations treating 200,000 active patients, the number of chart requests fell by 35% to 40% in the first year of use of their EHR.⁴²

Since Queens Health Network implemented a Computerized Patient Record (CPR) it has saved \$993,000 (\$1,278,984 CAN) per year at Elmhurst Hospital from film, supplies, and file room space reductions, in addition to gaining savings from decreased time for personnel services, such as scheduling, filing, making appointments, and relaying results. Additional benefits have included reductions in length of stay.³⁹

4.3.2 Reduce Duplicate Testing That Occurs When Providers Cannot Find Test Results

Having described above the convoluted and time-consuming process by which laboratory, radiology, and other results find their way to paper charts, it is not surprising that many results do not make it to the chart in time for the next provider-patient encounter. When a patient shows up in a doctor's office or the emergency room, a needed lab result or x-ray report may be sitting in a pile of unfiled slips in the medical records department, or it may be lost. The physician, pressed for time and data, may simply repeat the test.

Sometimes it is not sufficient to simply read a typed x-ray report; a physician may need to actually view a chest x-ray, abdominal CT, or MRI of the brain to detect nuances not revealed in a typed summary. In the nondigital world, such images are recorded on film and kept in a file room. These films are frequently misplaced. Providers may take them up to the patient's hospital unit and forget to bring them back, or sometimes the films are simply misfiled in the diagnostic imaging file room. If these images are needed and cannot be readily found, they are often repeated. In other circumstances, the CT scan or MRI performed at another institution is not available for viewing when needed. In such cases, these tests are often repeated.

After EHR implementation at Maimonides Medical Center in New York, there was a 30% reduction in hospital length of stay (7.25 to 5.05 days) that was attributed to more timely and accessible clinical data. There was also a reduction in testing attributed to decreased redundancy. Chemistry tests declined approximately 50%, while urinalysis and microbiology tests both declined by about 40%.

In the electronic world, test results can be captured in real-time in the lab and automatically entered in the EHR. When the test is done, it is available to all providers and the need to repeat the test is obviated. Radiographic images can be captured digitally and stored in picture archiving systems (PACS). These digital images cannot be lost or misplaced. These images can be viewed by multiple providers at multiple locations and can be shared between institutions thousands of miles away. Not surprisingly, the evidence shows that EHRs can have a significant impact on cost savings by reducing the incidence of redundant testing.

4.3.3 Reduce the Treatment Costs Associated With Effects of Medical Errors

Medical errors can be expensive. A single dose of Amoxicillin mistakenly given to a patient with a severe penicillin allergy might induce anaphylactic shock, causing obstruction of the airway and a drop in blood pressure in a life-threatening allergic reaction. An ambulance would be dispatched, emergency care would be provided in the emergency department, the patient may be put on a ventilator, admitted to the intensive care unit, and might die. In such cases, the costs would be measured in many thousands of dollars.

Considerable research has documented the impact that errors have on lengthening hospital stays or forcing new admissions to treat complications. Studies of the direct costs of medication-related errors fall into three categories: (1) population-based studies of patients in a community or health plan; (2) studies of medication-related errors that occur in hospitals; and (3) studies of medication-related errors that occur in nursing homes. Bates et al. found that preventable ADEs led to an increase in length of stay (LOS) by 4.6 days.⁴⁴ In Canada, CAES estimates that 1.1 million days are added each year to hospitalizations as a result of medical error.⁴⁵ The financial impact of medication errors alone in the United States has been estimated to be as high as \$2.00B USD (\$2.58B CAN) per year.⁴⁶ In the UK, NHS hospitals estimate that adverse events occur in 850,000 admissions per year at a cost of 2 billion pounds a year in additional hospital stays.⁴⁷

A retrospective review of charts in the UK in 2001 showed—

- 10.8% of patients with an adverse event
- 33% of those led to increased morbidity or death
- Each event led to 8.5 average additional days in the hospital
- 12% were medication related
- Costs extrapolated to the UK estimated to be 1.1 billion pounds/year

*Vincent et al.*⁴³

The cost of medical errors can be analyzed by the location of where the error occurred, be it inpatient or outpatient. The IOM estimates that the total national cost of inpatient adverse events in the United States is \$37.6B USD billion (\$48.4B CAN) per year.⁴⁸ It has been estimated that for every dollar spent on ambulatory medications, another dollar is spent to treat new health problems caused by the medication.⁴⁹ One estimate has placed the annual national health care cost of drug-related morbidity and mortality in the ambulatory setting as high as \$76.6B USD (\$98.7B CAN) in 1994.⁵⁰ Not all drug-related morbidity and mortality outcomes are preventable, but numerous studies document errors in prescribing,^{51,52} dispensing by pharmacists,⁵³ and unintentional nonadherence on the part of the patient.⁵⁴

As we discussed earlier, EHRs are highly effective tools to reduce medical errors and so contribute significantly to cost control by reducing the treatment costs associated with adverse drug events.

4.3.4 Reduce Costs Through More Effective Care Management and Disease Management

It is well established that a small percent of patients account for a very large percent of health care costs. Some have estimated that 3–5% of the most ill patients account for approximately 60–70% of health care costs.⁵⁵ Disease management, and the broader term, care management, which includes the notion of case management and population management, is based on the premise that well-coordinated proactive care of the most at-risk populations will result in significant savings and better patient outcomes. Applying evidence-based clinical best practices across an at-risk population can reduce the incidence of acute exacerbations and complications of these chronic states. Acute inpatient admissions, emergency department and urgent care use decline, while the patient’s functional status and mental health improve. In addition, it has been shown that disease management improves compliance on the side of the patients. Noncompliance in care has significant impact on costs. For instance, in the United States, it has been estimated that noncompliance with medications costs \$100B USD (\$128.8B CAN) annually.⁵⁶

As in other countries, chronic diseases in Canada represent the largest demand on the health care system. It is estimated that chronic disease costs \$83.9B per year in direct costs, i.e., total cost of illness, disability, and death.⁵⁷ There is an additional \$75.5B in indirect costs attributable to chronic disease. Fifty percent of these overall costs are due to just four diagnostic categories: cardiovascular disease accounts for \$6.8B in direct costs (\$11.7B indirect); musculoskeletal diseases \$2.6B (\$13.7B indirect); cancer \$2.5B (\$11.8B indirect); injuries \$3.2B (\$9.5B indirect). Chronic disease management has the potential to reap large cost savings, as studies are beginning to document. These savings range from \$800–\$1,500 per patient a year, beginning 3 to 15 months into starting such a program.⁵⁸ In a 6-month randomized trial of chronic disease self-management, Lorig et al. noted an improvement in patients’ symptoms, a reduction in hospitalizations, and a reduction in length of stay.⁵⁹ They estimated a cost savings of \$750 US (\$966 CAN) per individual, 10 times greater than the cost of the program itself. Rossiter et al. in the United States estimated \$3–\$4 (\$3.9–\$5.2 CAN) direct savings to Medicaid for every dollar spent giving physicians disease management support in their care for asthma in low-income young patients.⁶⁰ The “Women Take PRIDE” study showed a savings in inpatient charges of \$3,200 (\$4,122 CAN) per individual per year, five times the cost of the program. This study involved older women with heart disease and randomized them to a heart disease management program.

To be successful at managing chronic diseases, health care specialists must have access to clinical data on individuals and data on populations. Thus it is nearly impossible to provide effective chronic illness care without information systems.⁶¹ As noted above, EHRs provide multiple providers access to the complete patient record so that informed decisions are made and redundant testing is minimized in these complex patients. A commonly accessible record promotes the coordination of care, which is an essential part of managing both the medical and social dimensions of complex chronic conditions. These records allow the identification of high-risk patients who need to be targeted for proactive care. Alerts and reminders prompt providers to take appropriate clinical actions. The display of cost and effectiveness data to the clinician at the point of care can eliminate unneeded tests and induce greater use of generic medications, resulting in cost savings. Many believe that the greatest potential lies in the ability of the EHR to be an “intelligent” partner that provides physicians with clinical practice guidelines customized to the needs of an individual patient. It is premature to estimate the savings an EHR could achieve through these mechanisms—these capabilities are not fully mature, and it is not yet clear how these measures will influence physician behavior. The potential savings, however, appear to be quite large. For instance, in the United States, it is estimated that approximately \$30B USD (\$38.6B CAN) of unnecessary care is rendered through Medicare, most of it for an aging population with multiple chronic conditions.⁶²

By improving care management of hospitalized patients and by improving timeliness of the administration of medication, further reductions in costs can be realized. Tierney et al. noted a reduction in length of stay by 0.9 days when CPOE was implemented. They also noted a 13% reduction in hospital charges.⁶³

4.3.5 Reduce Costs By Increasing Provider and Staff Efficiency

In modern medicine, much time is wasted looking for information that should be readily available. EHRs hold the promise of making health care workers and providers more efficient in almost every aspect of their work by putting essential information at their fingertips. Kaiser Permanente found that 44% of the benefit it realized from implementation of an outpatient EHR was attributable to increased staff efficiencies.

However, it must be acknowledged that EHRs also disrupt paper processes, which, however imperfect, have been used and honed over years. The transition from the paper world to the electronic world can be difficult for providers, and the immediate post-transition period may be a time of cumbersome inefficiency. This prospect has led to resistance from some physicians who are already working at their limit and do not want to prolong their day adapting to a new system. It should also be noted that not all EHRs are equal in their user interfaces and usability. It seems clear that well-designed EHRs can, over the midterm to long-term, substantially increase physician and nurse efficiency and contribute to their productivity.

Wirral Hospital NHS Trust

In January 2001, a robotic dispensing system was installed in Wirral Hospital NHS Trust. As a direct result, there was noted:

- A reduction in the time from ordering to dispensing medications
- An increase in staff efficiency that led to 3 FTEs pharmacy technicians being released to support patient care
- A reduction in dispensing errors from 19/100,000 to 7/100,000

*A Spoonful of Sugar
The Audit Commission, London 2001*

Studies have found that residents spend 5.2 hours daily procuring clinical information.⁶⁴ An EHR that made this data immediately available would free this time for more productive clinical or

educational activity.⁶⁵ In the outpatient environment, enhanced productivity does not necessarily mean seeing more patients per day, but may mean providing a richer clinical interaction each time the patient is seen. When a physician is provided all the information that is needed, reminded to perform appropriate preventive interventions and provided robust decision support, the quality of care delivered in a given time period is likely to be enhanced. This may lead to less frequent visits and more cost-effective care, which may be translated into enhanced physician productivity per unit of time.

On the inpatient side, the improvements seen in nurse efficiency allow nurses to spend more time in direct patient care. These efficiencies come about via improved communication with the care team, availability of documentation tools, availability of electronic patient education tools, availability of decision support tools, the reduction in medical errors, and improvements in scheduling and workforce management.⁶⁶ It is no secret that medical documentation consumes a large portion of each clinician's day. Documentation tools within an EHR directly improve the efficiency in which a nurse is able to work. This has been documented in the literature:

- It has been estimated that in a given 8-hour shift, an installed EHR and POE system saves 2 hours of nursing time.⁶⁷
- At Yale New Haven Hospital in the United States, it was found that such tools allowed for the documentation of assessments to be done in half the time it had taken in the paper chart. A documentation system installed at a hospital in Oregon reduced the time spent on nursing documentation from 24.6% of the nursing staff's day to 18.4%.
- At a hospital in Mississippi, nurses documenting electronically spent 3 fewer minutes on their admission assessments. Shift assessments were reduced by 5 minutes per shift. The outcome was that 1 to 1.5 hours in overtime were saved for each shift.⁶⁸

Biomedical interfaces to medical equipment allow for the automatic population of information such as vital signs and ventilator settings directly into the EHR, obviating the need to record these by hand. Forms documentation allows duplicate information to be "pulled forward" so that this information need not be repetitively recorded. The ability to carry information forward means that unchanged assessments may be documented more quickly. The Feldman Group found in its survey of nurses in the United States that 50% of nurses were unable to find time to provide patient training and education at least once a week.⁶⁹ With the availability of electronic patient education materials, this training and education become far easier for nurses to provide in a timely fashion. Customization for each patient and for clinicians is simplified in an electronic format. In addition, documentation of which materials have been given to which patients occurs automatically, lessening the documentation burden of the nurse.

Electronic scheduling systems lead to improved efficiencies via more efficient workforce utilization. A process that is difficult to coordinate on paper becomes much easier and faster when electronic. Some groups have made scheduling systems accessible via the Internet so that nurses are able to view their schedules no matter where they are physically located. In addition, some have allowed for the electronic submission of preferences for shifts. This allows greater flexibility in work schedules, meshing better with an individual's lifestyle, which in turn increases staff satisfaction. Some hospitals have even introduced an online bidding process for

uncovered shifts, allowing those who are looking to work additional hours to bid for them. This decreases the amount of mandatory overtime and again leads to improved job satisfaction.

Electronic task lists not only allow nurses to track their work, but also allow the nursing supervisors to track completion of tasks and late tasks, so that if one nurse falls behind, staffing can be shifted to support the over-burdened nurse. This kind of workforce management means that nurses are supported before becoming dangerously behind in their activities. In addition to being able to monitor task lists, the use of acuity monitors also helps to ensure proper staffing for those patients who need more intense care.

4.3.6 Reduce Costs of Clinical Trials and Other Forms of Research

Clinical trials assign individuals, sometimes thousands, to two or more different groups that then receive different interventions. Those interventions may be a placebo for one group versus a medication for the other; medication versus surgery; medication versus psychotherapy; or several different medications across several different groups. The results are then analyzed by sophisticated statistical techniques to determine which treatments were the most effective. This procedure has become the gold standard by which to determine how specific diseases and conditions should be treated, and which drugs are effective and which are not. Unfortunately, clinical trials are extremely expensive. It is difficult to recruit the numbers of patients needed to achieve statistical significance, and the enrollment process is very paper intensive. It is also very expensive to follow research subjects for months at a time, observing them closely and combing their paper charts for specific laboratory and clinical indicators of improvement or complications related to their treatment. In 2002, it was estimated that the total capitalized cost to develop a new drug to market was \$802M USD (\$1,033M CAN).⁷⁰ Investigators attributed this high cost in part to difficulties in patient recruitment and the need to run larger trials. More recent estimates have placed this cost at \$1.7B USD (\$2.2B CAN), in part due to declining research and development productivity.⁷¹

EHRs have the potential to significantly reduce the cost of recruitment by linking together networks of physicians who can, after obtaining patient consent, enroll patients in a clinical trial that holds promise for their specific condition. Rather than having teams of reviewers scrutinizing the patient-participants' charts, key clinical data can be automatically abstracted and analyzed to determine the impact of that drug on a given individual. Data can then be automatically rolled up and aggregated. Although this may seem remote to the everyday needs of patients and providers, clinical trials are the means by which science and quality of care progress. More cost-efficient approaches are likely to lead to more rapid advances and potentially cheaper therapies.

4.4 Community and Public Health

To maximize the health of communities, it is important to have ready access to information about public health vulnerabilities and efforts to address those vulnerabilities. This applies to threats, such as childhood illness that may be prevented with vaccines, as well as efforts to promote pap smears among women. Electronic access to clinical information can help us understand how successful our public health interventions have been.

International mobility has significantly diminished the geographic barriers that inhibited the spread of infectious diseases in the past. The recent SARS outbreak is a graphic example of vulnerability to such outbreaks and of some of the deficiencies in our ability to efficiently detect and respond to such threats. The economic impact alone of such an outbreak is staggering: Toronto saw a decrease in its retail sales in April 2003 of 3.8%; it has been estimated that the cost of the public health response totaled more than a billion dollars.⁷² Some of these deficiencies are directly related to a reporting system that is mired in paper. Deficiencies that have been cited include the difficulties with timely access to laboratory testing and results, absence of protocols for data sharing among levels of government, uncertainties about data ownership, inadequacies regarding infectious disease surveillance, and weak links between public health and personal health services systems.⁷³ The Toronto Board of Trade estimates that the economic loss due to the SARS outbreak in Toronto alone was nearly \$1B.⁷⁴

Disease surveillance can be divided into communicable disease and chronic disease surveillance. Communicable disease surveillance programs have been in place for quite some time and have been run in conjunction with intervention and reporting systems. They frequently have been set up as a result of legislation or regulatory mandates. Data collection and reporting are generally the result of a series of labor-intensive manual inputs at various stages of the process. This may include a manual report by a physician who has diagnosed a reportable case, such as tuberculosis. This data is then aggregated at the local health department and then may be aggregated at a regional or provincial level. An automated reporting system driven by an EHR would increase reporting compliance and accuracy while constraining the costs currently associated with this labor-intensive process.

Syndromic surveillance tools do not rely on final diagnoses, but rather identify and categorize symptoms associated with unusual and concerning infectious diseases. The objective is to help public health officials recognize outbreaks more rapidly, ideally in the earliest stages of an outbreak, and then track that outbreak in real time. However, these tools are not yet integrated with other health care IT systems, and thus the information is not automatically collected by the system. Instead, this information must be hand-recorded and submitted by clinicians working in busy emergency departments and primary care sites. The key to making such information promptly available on a large scale is to enable care sites to collect and record clinical information in an electronic format. Once this is done, data elements can be automatically extracted, fed to the appropriate public health destinations, and analyzed to identify worrisome trends in the community or region. In this way, trending could be done passively and alerts raised automatically by the system. If such systems were to be integrated on a national level, previously unrecognized trends could be detected, making these surveillance systems significantly more robust, useful, and cost effective.

On the other hand, chronic disease surveillance has few data collection systems in place today. This data is usually organized by a type of event, such as the number of hospitalizations for a particular diagnosis. Data is typically collected from systems that have been developed for some other reason, for example, discharge databases. Interventions are generally aimed at a particular population, such as smokers, diabetics, or children with asthma. Outside of cancer surveillance, there are no legislative or regulation mandates to have these systems. Unlike communicable diseases that are more closely associated with a single causal factor, such as a virus or bacterium, chronic diseases are “caused” by a confluence of multiple factors. These factors include genetics, nutrition, personal habits, environmental exposures, and socio-economic conditions. In addition

the time frame for disease development is measured in years to decades. This makes surveillance of chronic diseases more complex than communicable diseases. A fully interoperable EHR would allow for the automated extraction of key de-identified chronic disease data that can be used to track and manage chronic disease trends and the efficacy of a variety of interventions. As the population ages, it will be increasingly important to assess the efficacy of chronic disease interventions in a cost-effective manner. The EHR is an invaluable tool in this endeavor.

5.0 International Trends and Benchmarks

As Canada charts its EHR adoption course over the next decade, it is important to consider trends in the international community. In particular, it is useful to benchmark against other “peer nations” in the community of affluent industrialized countries. Canada, which has been a leader in organized health care delivery, should at the very least seek to maintain parity with its peers. This has implications both for the health and satisfaction of its citizens but is also relevant to economic competitiveness. Failure to keep pace with other nations’ health care cost control efforts may result in a competitive disadvantage in international labor markets. Below we briefly discuss the current EHR status and future plans of three “peer countries”: the United Kingdom, Australia, and the United States. Each has ambitious objectives for the next decade, with a goal of having an EHR for each citizen at the end of that period. Each country has had its own triggers that have driven it towards this goal; and given these triggers, the approach being taken is quite varied.

5.1 The United Kingdom

With increased resources and a robust implementation plan, the UK is pursuing the implementation of a national EHR system for England with vigor. Beginning in 1998, the UK National Health Service (NHS) recognized the importance of IT in health care in its report, *Information for Health*. In this report, NHS identified and documented the benefits of a national EHR with the main driver of improved patient safety. The UK has since developed the National Programme for Information Technology (NPfIT). This program is designed to develop, procure, and implement an integrated IT infrastructure and systems that will enable EHRs for all National Health Service organizations and provide 50 million NHS patients with EHRs by 2010.⁷⁵ The NPfIT includes the following components: an electronic care records service (CRS), an electronic booking service, a system for the electronic transmission of prescriptions, an IT infrastructure through the procurement of a New National Network (N3), IT to support the new General Medical Services contract, and picture archiving and communication systems (PACS). The aim of the NPfIT is to ensure health professionals, patients, and caregivers have “the right information, in the right place and at the right time.”⁷⁶

“NPfIT is not just the biggest IT project in the world, it is also, and more importantly, an opportunity to transform how healthcare professionals engage with their patients. The real aim of the programme is not new computers sitting on desks, in wards and surgeries but improved patient care by exploiting state-of-the-art technology.”

*Dr. Aiden Halligan
Joint Director General of NHS IT*

The NpFIT implementation plan includes a national user database provided by the national government, while each of the five regions will establish specific standards that will allow connection to the national level. The NpFIT will be implemented in two phases. The National Service Providers (NASP) will implement common services to all users nationally, and Local Service Providers (LSP) will provide services at the local levels. NHS has divided the UK into five clusters, each with an identified LSP. Legacy systems within clusters will be updated to ensure interoperability with N3. Where this is impossible, the legacy system will be replaced. The data “spine” will be used as the national database of key information regarding a patient’s health and care. The local level of each cluster will maintain more detailed information about the patient. The combination of information on both the local and national levels will constitute the complete CRS. Examples of key data points include NHS number, date of birth, name and address, allergies, and adverse drug reactions.⁷⁷

It was originally estimated that the implementation of NpFIT would cost the government £10B (including training, software, and hardware); and it is the largest IT investment known to date.⁷⁸ The government has already allocated £2.5B over a 7-year period, with additional funding to be determined by annual spending reviews.⁷⁹ The UK recently finalized its contracts with eight companies to implement this program, with the total value of the contracts over £6B, including the value of the contracts for electronic booking, NHS Care Records Service, and five local service providers (see Table 6).⁸⁰ More recent reports in the UK have estimated significantly higher costs. In October 2004, it was reported that officials at the Department of Health were projecting total implementation costs of between £18.6B and £31B,⁸¹ with the larger estimate being attributed to local implementation costs.

Table 6. NHS EHR Contractors and Contract Value

Contract	Area	Value	Duration
NHS Care Records Service - NASP	National	£620M	10 years
NHS Care Records Service – LSP	North East	£1,099M	10 years
NHS Care Records Service – LSP	Eastern	£934M	10 years
NHS Care Records Service – LSP	London	£996M	10 years
NHS Care Records Service – LSP	North West & West Midlands	£973M	10 years
NHS Care Records Service – LSP	Southern	£896M	10 years
N3	National	£530M	7 years
Electronic Booking	National	£64.5M	5 years
TOTAL		£6112.5M	

Source: *Delivering 21st Century IT Support for the NHS: National Strategic Programme*

5.2 Australia

In Australia, like other countries, there has been an increasing awareness of medical errors. In 1995, a retrospective review of 14,000 records in 28 hospitals found a rate of adverse events of 16.6%, 51% of which were considered to be preventable.⁸² Extrapolating, it was estimated that hospital errors caused 18,000 deaths a year. Studies such as these spurred the discussion of the use of EHRs to reduce medical errors.

In 2002, the National Electronic Health Records Taskforce Australia initiated an EHR system known as HealthConnect, currently in its fourth year of a planned 10-year rollout. It began in 2002 as a series of pilots in Tasmania and the Northern Territory. In 2004, these pilots were expanded to include Queensland, New South Wales, and South Australia. The entire nation is scheduled to be fully connected by the year 2014. The federal government has allocated \$128.3M AUS (\$117.74M CAN) that it will spend over the next 4 years on this initiative. The six Australian states are planning to spend between \$470 and \$590M AUS (\$430–\$540M CAN) outside of the federal initiative.⁸³

It is difficult to compare Australia's EHR initiative with initiatives in other countries because their approach to connectivity is quite different. HealthConnect is envisioned as a national health information network that will enable the "collection, safe storage and exchange" of clinical data between end-user systems. As such, HealthConnect does not provide end-user systems such as clinical decision support, health management, research functions, patient administration, or finance and administration. MediConnect, the current national electronic medication record system, will be connected to HealthConnect to make the EHR more robust than HealthConnect would be on its own.

The HealthConnect network will consist of three layers:

- **HealthConnect records systems layer:** regional storage repositories that will store summary consumer health information to form consumers' "HealthConnect records."
- **User or source system layer:** the software that will interface with HealthConnect to allow providers and consumers to either view or review HealthConnect records or add new event summaries to records.
- **National coordination layer:** linking all regional storage repositories and linking these repositories and user/source systems to allow consumers to access their record throughout the nation.

Connecting HealthConnect to MediConnect will add functionality to HealthConnect. Current and planned capabilities of MediConnect include:

- The storage of patients' personal medication history information
- The ability of patients to grant or withhold consent for information release
- The generation of medication history reports
- The availability of a "read-only" Internet browser in hospital accident and emergency and admission departments
- Consumers' nomination of agents
- Nonprescription items included in the records
- Inclusion of rationales for treatment in the records.

In a benefits study, it was estimated that such an Australian health EHR system could bring \$500M AUS (\$456M CAN)/year in benefits,⁸⁴ including \$231M AUS (\$210M CAN) in avoidance of ADEs, \$140M AUS (\$128M CAN) in savings due to improved diabetes

management, \$55M AUS (\$50M CAN) in medication management, and \$6.7M AUS (\$6.1M CAN) in avoided clinical visits.

5.3 The United States

Discussion centered on EHRs has gained significant political momentum in the last year. President Bush put the issue on the national agenda April of 2004, when he called for the widespread adoption of EHRs over the next decade. The President's vision is consistent with a groundswell of support that comes from both parties and both ends of the ideological spectrum.

The public-private mix of the U.S. health care system, superimposed on 50 separate states, makes "national planning" a challenge. The federal sector, however, has led the way in EHR adoption through the efforts of the Veterans Administration (VA). The VA system is the largest health care system in the United States with 172 hospitals, over 600 outpatient clinics, 200 nursing homes and other health care venues. In the 1980s, the VA began developing what has become VistA, the Veterans Health Information Systems and Technology Architecture and the backbone of the most widely deployed EHR system in the world. VistA is a robust clinical tool that has created a paperless environment in the VA and has dramatically improved the quality of care. Because the programming code for the VA is nonproprietary, it can be freely downloaded and used by anyone, and has been adopted even outside of the United States. The VA has not assessed return on investment because the development has been incremental and a baseline is not well defined. As Kenneth Kizer MD, the former Under Secretary for Health, U.S. Department of Veterans Affairs, has noted, the justification for VistA was not primarily financial—it was driven by the imperative to deliver the highest quality of care possible to the veteran.

Response by the private sector in the United States has been less robust. Although most physician offices are computerized on the practice management side, few are using EHRs. Currently it is estimated that only 13% of the United States' more than 6,000 hospitals have an EHR in place.⁸⁵ As noted earlier, such estimates are difficult to evaluate as the definition of EHR varies, and thus it is not certain to what level of capability these different EHR systems are functioning. Many systems tend to be rudimentary in their clinical functionality and lack sophisticated pharmacy order entry capability. Most outpatient implementations tend to be in large physician practices, and most hospital implementations tend to be in large facilities and networks. Small, rural, and cash strapped hospitals are far less likely to have implemented even a rudimentary EHR. In the United States, as in Canada, those facilities that currently have an EHR are faced with difficult choices around the migration of legacy systems to integrated, open systems.

Kaiser Permanente has been an early adopter of EHRs and has invested heavily in health care IT over the last decade. After a number of internal development experiments, Kaiser recently invested \$1.4B USD (\$1.8B CAN) to implement a proprietary EHR across the enterprise. This current project is planned as a co-development project in which the product is customized to Kaiser's specific needs. Although this does not represent all of Kaiser's past or future EHR investment, this contract alone translates into an expenditure of \$170 USD (\$219 CAN) per enrolled member. Despite the financial motivations for implementing an enterprisewide EHR and a projected positive return on investment, interviews with Kaiser executives indicate that quality of care is the principal motivation for implementing an enterprisewide EHR.

As with the UK and Australian efforts, Canada's approach to reaching its health care IT goals is different from that of the United States. Estimating the cost of implementing EHR in the United States is problematic because of the highly decentralized and privatized nature of the American health care system. Brewin reported a need for investment of between \$500B and \$700B.⁸⁶ This figure, however, was calculated based on a 3–4% investment in HIT of current industry revenues into health care IT and as such is a very rough estimate.

5.4 Summary

Like Canada, other industrialized nations have identified the need to implement EHRs in a comprehensive fashion. Cultural, political, financial, and technical factors have driven different approaches in different countries, making direct cost comparisons challenging. What is clear, however, is that affluent industrialized nations have embraced the need to move forward quickly with EHR initiatives. Although financial benefits will likely accrue with time, the primary driver for these initiatives is the ethical requirement to maximize the quality and safety of care for all citizens.

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