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

Pan-Canadian Electronic Health Record

Executive Summary

March 2005

Report Highlights

Booz Allen was engaged by Canada Health Inforoute to provide a strategic approach to implementing an interoperable Pan-Canadian Electronic Health Record (EHR), and to project the costs and benefits of such an implementation. This report provides a detailed account of Booz Allen's analysis of costs and benefits for a multiyear EHR implementation plan, as outlined below:

- ***The 10-year cost of acquisition*** for a Pan-Canadian EHR is estimated to be \$9.99B CAN: \$1.4B for Physician Practice Systems, \$3.9B for Inpatient Systems, \$1.8B for a Long-Term Care System, \$0.05B for the Home Health extension, and \$2.9B for Infostructure costs.
- ***The 10-year total cost of ownership*** for a Pan-Canadian EHR, which includes both acquisition and recurring costs, is estimated to be \$22.7B CAN: \$2.5B for Physician Practice Systems, \$7.4B for Inpatient Systems, \$2.6B for a Long-Term Care System, \$0.08 B for the Home Health extension, and \$10.0B for Infostructure costs. Based on Inforoute's mandate, Booz Allen estimates Inforoute's projected cost to be \$4.1B.
- ***Reduction in Adverse Drug Events*** is estimated at 29 million events over 20 years, which will yield a cost savings of \$48.3B CAN.
- ***Reduction of duplicate and unnecessary radiologic tests*** is estimated to yield a cost savings of \$3.6B CAN over 20 years
- ***Reduction of duplicate and unnecessary laboratory tests*** is estimated to yield a cost savings of \$10.4B CAN over 20 years.
- ***The return on investment*** from a Pan-Canadian EHR is estimated to have gross benefits exceeding investment dollars by an 8:1 margin, and a net savings of \$39.8B CAN over a 20-year period.
- ***Canada's cash flow*** on this investment at a society level is estimated to turn positive during the implementation period, with the investment paid off shortly after completion of the deployment.

In addition to these quantifiable financial benefits, significant qualitative benefits will likely be realized. Evidence suggests that quality and processes of health care will be greatly improved, leading to a more patient-centric care environment and improved patient and staff satisfaction. Chronic diseases may be managed in a more coordinated and efficient manner because information will be more readily shared. Access to care may be improved and waiting times reduced by improving appointment and scheduling functions, and by increasing the clinical productivity of providers. Automating key administrative functions and freeing clinical providers from onerous clerical tasks may redirect labor towards more productive clinical activity, which is particularly relevant given the current projected shortages in the health care workforce. Perhaps the most compelling benefits, however, are the anticipated improvements in patient safety. Although the financial benefits are strong, one could argue that the qualitative benefits, particularly the lives saved, create a moral imperative for implementing an interoperable Pan-Canadian EHR.

Background

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 the health care industry. Such anachronistic means of managing health care 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.”

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 7–8% each year and now command a historic high of 10% of the country’s GDP. Canada spends more of its GDP on health care than many European countries, including the United Kingdom. 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.” Furthermore, the Commission on the Future of Health Care in Canada states that the risk to sustainability is likely to rise in the future.

An emerging body of evidence reveals that Canada, like other countries with advanced health care systems, has an inordinately high rate of medical errors. The landmark Canadian Adverse Event Study (CAES) showed that the overall incidence of hospital-based adverse events in Canada was 7.5%. This suggests that there are about 185,000 adverse events each year, and that about 70,000 of these are potentially preventable. Extrapolation of these figures suggests that between 9,250 and 23,750 Canadians die every year due to medical errors in the hospital setting. This does not include the errors that occur in the ambulatory and long-term care environment. The average of these estimates would make medical errors the third leading cause of death in Canada, just shy of lung cancer. Stated another way, more people die as a result of medical errors in Canada than from HIV, breast cancer, and motor vehicle and transport accidents combined. These findings have been corroborated by other studies, and there is a growing consensus that the Canadian experience with regard to patient safety is similar to that published in an established international body of literature.

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.” The Fyke Commission Report stated that 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.”

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

Interoperable EHRs have the potential to deliver a broad spectrum of benefits. Below we briefly discuss some of the more commonly cited benefits of this technology.

Quality Improvement

EHRs improve quality of care by helping to reduce medical errors via the use of alerts, reminders, and decision support. With the explosive growth in medical knowledge, new discoveries, and new clinical trials outcomes, a clinician's ability to stay current with his or her medical knowledge has become a daunting task. EHRs help to make this sometimes overwhelming task manageable by bringing standardized, evidence-based protocols, ordersets, and care pathways to the physician at the point of care. By providing support to clinicians at the point of care, EHRs can promote best medical practices to improve quality, reduce variance of care, and reduce medical errors.

EHRs also improve quality by promoting a patient-centric process. In a patient-centric environment, the information follows the patient as the patient moves through the system. Complete information is therefore available to all providers as needed. This procedure promotes better care for the patient and is also respectful of the patient's time. The patient does not have to repeat the same history to multiple providers. Patients do not have to lug bags of pills from provider to provider to show what medicines they take, and they do not have to endure repeated needle sticks and x-rays because a clinician can't access needed information that is in an unavailable paper chart. In each case, this information would 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 or personal view 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 PHR may 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 that patients experience health care. In the emerging world of more targeted, individualized medicine, the EHR will facilitate the customization of prevention and care. Patients will be engaged in a manner that may lead to more accurate collection of health information and more informed patients may be more adherent to treatment regimens. This greater involvement will empower patients and may be a significant source of improvement in patient satisfaction.

Improved Access

A digitized medical information system has been recognized as a means to improve access for remote populations. This can be achieved through a variety of complementary electronic approaches. Telehealth is a critical piece of this strategy. If a telemedicine link is placed 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. The advanced EHR can help guide the provider in the decision-making process, and physicians may receive 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.

Appointment and scheduling programs may improve access by improving workflow and utilization. Jurisdictional appointment and scheduling programs, as opposed to institutional systems, can provide data on the geographic distribution of patients and available resources. This information facilitates planning and the more efficient use of limited resources. For instance, such data can help plan the appropriate specialty mix and facility requirements for a given geographic 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 those openings.

EHRs may help address health care workforce issues, particularly regarding the shortage of physicians, nurses, and pharmacists, by increasing efficiency and job satisfaction. For instance, evidence exists that EHRs increase nurses' efficiency in clinical documentation. This not only enables nurses to devote more time to patients but also contributes to job satisfaction. Increased satisfaction may result in improved recruitment and retention rates.

Contributions to Community and Public Health

To maximize the health of communities, it is important to have ready access to information regarding public health vulnerabilities and efforts to address those vulnerabilities. This need for ready access to information applies to childhood illnesses that may be prevented with vaccines, as well as to 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 illustrates some of the deficiencies in our ability to efficiently detect and respond to such threats. The economic impact of such outbreaks may be significant. Toronto experienced a 3.8% decrease in its retail sales in April 2003, and the estimated cost of the public health response exceeded one billion dollars.¹ EHRs can provide the data required for effective surveillance and management of the public health.

Cost Control

A certain tension exists between cost and quality, but cost-efficiency can be an important vehicle to promote the quality of care. Providing high-quality care at lower cost yields savings that can be reinvested in other parts of the health care system. In the face of finite resources, there is an ethical responsibility to manage resources as efficiently as possible. The EHR may promote cost savings through a variety of mechanisms, including the following:

- Reduce administrative costs: chart pulls and filing, transcriptions, phone calls, photocopying of charts, faxing medical information

¹ The Toronto Board of Trade. SARS Frequently asked questions: Important information for Business leaders. At http://www.bot.com/ContentIslands/PublicPages/FloatingPages/SARSFAQS_06_17_03.asp. Accessed September 2004.

- Reduce duplicate testing that occurs when providers cannot find test results
- Reduce the treatment costs associated with effects of reduced medical errors
- Reduce costs through more effective care management and disease management
- Reduce costs by increasing provider efficiency and productivity.
- Reduce costs of clinical trials and other forms of research

The EHR can electronically incorporate lab, x-rays, and other data, obviating the need to manually file each discrete data element; and EHRs do not need to be “pulled” or “re-filed” each time the chart is consulted. An interoperable EHR can be shared between providers with no copying, faxing, or calling required. Test results can be electronically captured in the lab and made available to all providers. Radiographic images can be captured digitally and stored in picture archiving systems (PACS). 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 duplicate testing.

Booz Allen has estimated that as a result of implementing a Pan-Canadian EHR, a cost savings of \$3.6B CAN will accrue over 20 years due to the reduction of duplicate and unnecessary radiologic tests. The cost savings from the reduction of duplicate and unnecessary laboratory tests is estimated to be \$10.4B CAN.

Medical errors may occur in hospitals, ambulatory settings, or in long-term care environments, though the most commonly cited error data in the United States and Canada pertain to hospital-based errors. Medical errors are potentially costly because they may lead to additional care to treat error-related complications. Bates et al. found that preventable adverse drug events (ADE) led to an increase in length of stay (LOS) of 4.6 days.² In Canada, CAES estimates that 1.1 million days are added each year to hospitalizations as a result of medical errors.³ The financial impact of medication errors alone in the United States has been estimated to be as high as US\$2 billion per year.⁴ In the United Kingdom, National Health Service hospitals estimate that adverse events occur in 850,000 admissions/year at a cost of £2B a year in addition to hospital stays.

Booz Allen has estimated that use of a Pan-Canadian EHR would reduce ambulatory, hospital and long-term care ADEs by 29 million over 20 years and generate cost savings of \$48.3B CAN.

Implementation

The implementation strategy is based on an incremental rollout of EHR functionality. The goal is to have an integrated, interoperable EHR that incorporates the entire continuum of care: hospitals, physician offices, public health offices, mental health facilities, long-term care facilities, and home health care.

² Bates DW, Spell N, Cullen DJ, et al. The costs of adverse drug events in hospitalized patients. *JAMA*. 1997; 277: 307-311.

³ Baker GR, Norton PG, Flintoft V, et al. The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. *CMAJ*. 2004; 170 (11); 1678-1686.

⁴ Bates DW, Leape LL, Cullen DJ, Laird N, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA*. 1998; 280:1311-6.

Given the range of current EHR components and functionality, many possible permutations could be incorporated into a rollout plan. Infoway has embraced a conceptual framework of EHR functionality expressed in several generations.⁵ The first generation system consolidates patient data for viewing; the second generation facilitates the documentation of care and provides basic decision support; and the third generation provides robust ordering capability and decision support. Infoway asked Booz Allen to develop a conceptual framework that could be used to plan for a third generation EHR by the end of 10 years.

We present a three-phase approach consistent with achieving this objective. Figure 1 depicts these three phases and the sequencing within them. In the first phase, the emphasis is on setting the foundation or “Infostructure” that will support the EHR. This lays the groundwork for the connection of pharmacies, laboratories, physician offices, mental health facilities, long-term care facilities, hospitals, and public health offices and clinics to the EHR. The second phase provides the capability to capture clinical data, execute e-prescribing and outpatient order entry, provide centralized patient education materials, and integrate pharmacies. The third phase introduces full outpatient and inpatient care documentation, order entry, and case management. The sequencing within the phases has been structured to gradually introduce clinicians to escalating EHR functionality in an effort to facilitate their transition, and enhance acceptance of these new tools.

The 10-year implementation schedule is conservative enough to be achievable, but aggressive enough to realize financial benefits within a reasonable time frame. The Institute of Medicine has published guidelines for what it believes can be reasonably implemented in a 7-year time frame.⁶ All elements in these guidelines have been incorporated in this roll-out plan.

More aggressive schedules pose a number of challenges. The first is the need to carry out a procurement process that, in order to achieve desirable volume discounts, should occur at the national or provincial level. In addition to limitations regarding financial capital, there are also limitations regarding the availability of specialized IT human resources on the scale necessary to execute widespread simultaneous implementations. Nonetheless an accelerated implementation strategy is also presented in the body of the report, in which all components are rolled out simultaneously.

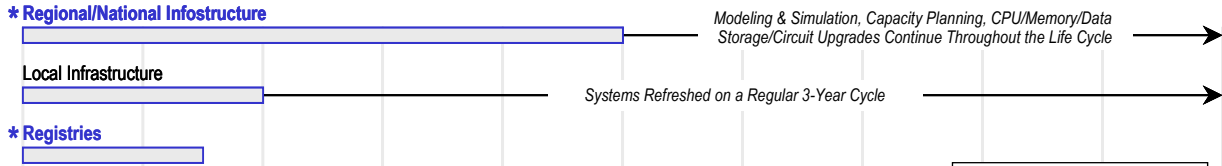
Booz Allen has estimated the 10-year cost of acquisition for a Pan-Canadian EHR to be \$9.99B CAN: \$1.4B for Physician Practice Systems, \$3.9B for Inpatient Systems, \$1.8B for a Long-Term Care System, \$0.05B for the Home Health extension, and \$2.9B for Infostructure costs.

⁵ Hieb B. CPR Generation Effectiveness in Reducing Medical Errors. Gartner Research Note. June 6, 2002.

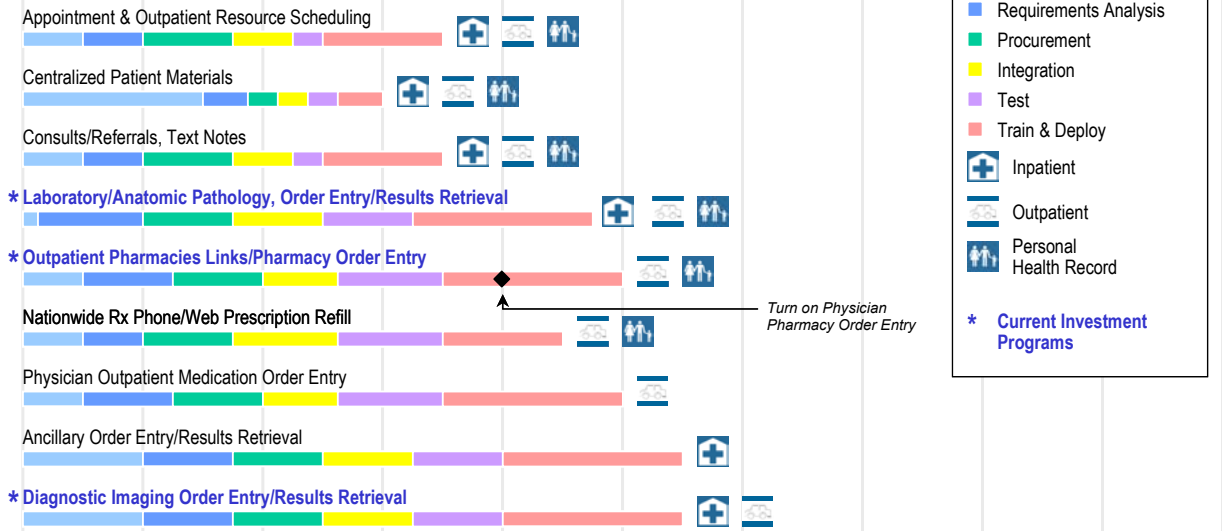
⁶ Institute of Medicine. Key Capabilities of an Electronic Health Record System. Letter Report. 2003. The National Academies Press. Washington, DC.

Figure 1. The Three-Phase Approach

Phase I



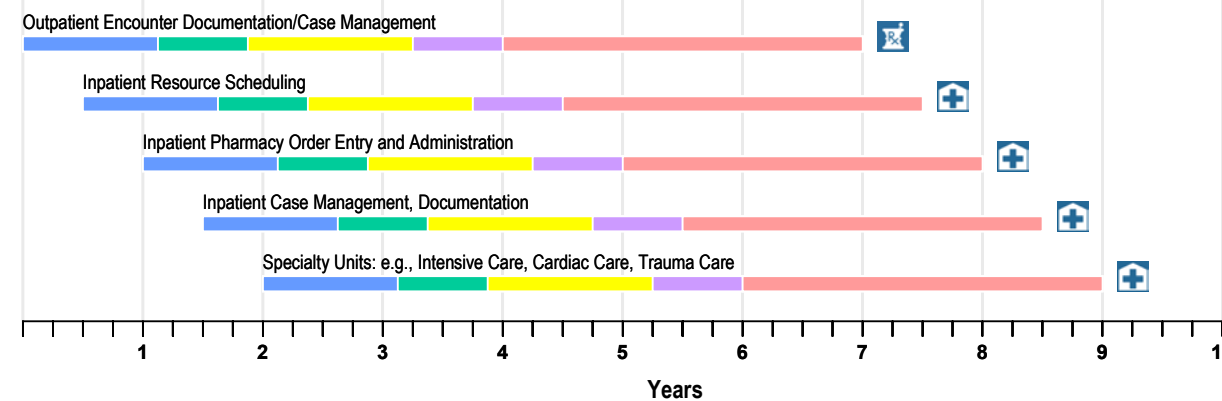
Phase II



LEGEND

- Requirements Gathering
- Requirements Analysis
- Procurement
- Integration
- Test
- Train & Deploy
- Inpatient
- Outpatient
- Personal Health Record
- * Current Investment Programs**

Phase III



Projected Costs and Benefits

Booz Allen Hamilton analyzed the costs and benefits of deploying a third generation system of interoperable electronic health record applications to cover 100% of the Canadian population and its health care providers and facilities. In performing this analysis, Booz Allen was not constrained by Infoway’s current investment areas; therefore, the estimated costs and benefits presented

transcend Inforoute's current mandate. Inforoute is currently not responsible for investing in comprehensive EHR systems for physicians, acute care, long-term care, or hardware for the home health sector. Inforoute is only responsible for establishing an Infostructure to cover 50% of the population.

This analysis was tailored to capture the unique characteristics of clinical IT systems and the Canadian health care environment. The analysis also involved new approaches to quantifying some of the more intangible organizational benefits. Factors considered for analysis included vendor selection, system effectiveness, procurement strategy and volume discounts, implementation strategy and sequencing, provider adoption and usage, and the presence of existing systems. Some of the clinical benefits analyzed included quality of care and outcomes related to adverse drug events, as well as the impact of decision support systems used in conjunction with creating computer orders for ancillary services, such as pharmacy, laboratory, and diagnostic imaging.

One of the challenges faced in trying to estimate system costs was the difficulty in obtaining detailed cost data. Software vendors were generally not very responsive to price inquiries, and when prices were presented, they were generally bundled so that component prices were inaccessible. Hospitals were willing to share high-level cost data; however, significant variation in the functional capability of the systems being priced made comparisons challenging. Booz Allen therefore leveraged its relationship with the Center for Information Technology Leadership (CITL) in Boston, Massachusetts. CITL had previously published work on a model that was used to estimate costs and benefits relevant to certain EHR functions in the United States. CITL provided valuable assistance in the costing exercise, especially with regard to physician practices.

Projected Costs

The costs cited in this report are predicated on the assumption that Canada will leverage its purchasing power on either a national or regional level to extract substantial discounts from vendors. Table 1 shows the estimated cost of ownership for a Pan-Canadian EHR. The top row represents acquisition and maintenance costs for the category columns. The second and third rows describe acquisition costs only. The point estimates provided are best estimates given the cost ranges provided. The total acquisition cost is estimated to be \$9.99B CAN with a range of \$7.9B–\$16.0B.

Table 1. Costs Summary

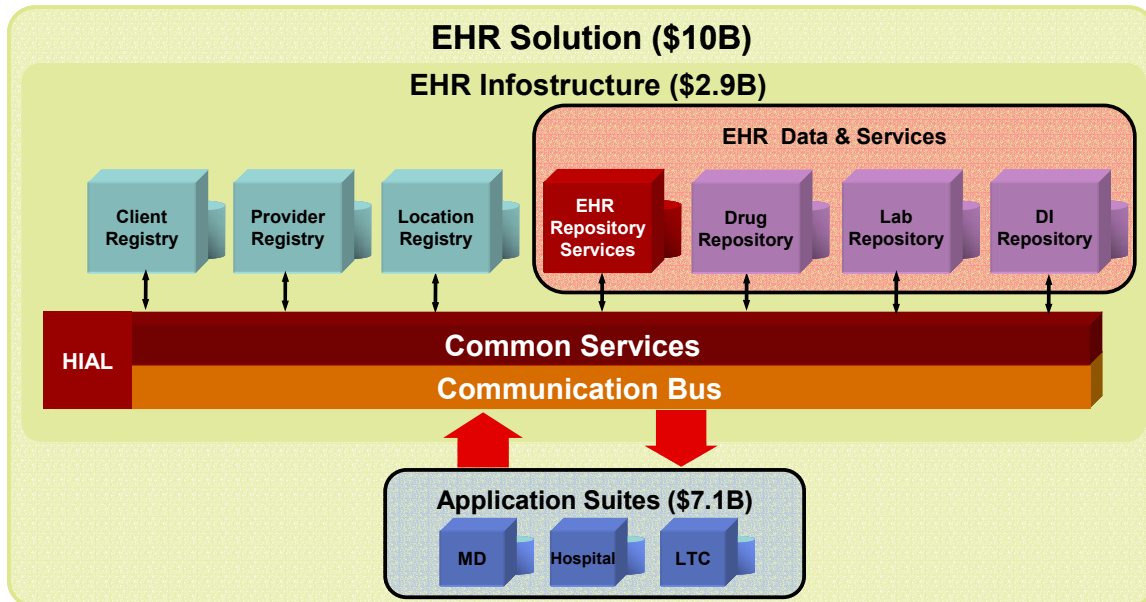
Statistic	Inpatient System	Info-structure	Subtotal	Physician System	Long-Term Care System	Home Health Extension	TOTAL
Booz Allen Acquisition Cost Range	\$3.0–\$5.5	\$2.6–\$3.7	\$5.6–\$9.2	\$1.0–\$1.8	\$1.3–\$4.9	\$0.03–\$0.06	\$7.9–\$16.0
Booz Allen Acquisition Cost Point Estimate*	\$3.9	\$2.9	\$6.8	\$1.4	\$1.8	\$0.05	\$9.99
Infoway's Acquisition Cost Component **	\$1.2	\$2.9	\$4.1	\$0.0	\$0.0	\$0.0	\$4.1
	Current Mandate			Extended Mandate			

In billions of Canadian dollars

* Assumes a fully funded deployment to all indicated facilities and 100% of population within 10 years

** Assumes deployment of EHR applications only to hospitals of 50+ beds in first 10 years; system (licensing, integration, hardware) and content (order sets, rules engine, knowledge base) costs are not funded; all other deployment costs are funded at 50%

Figure 2. EHR Cost Architecture



Projected Benefits

We estimated quantifiable financial benefits that can be grouped into two major categories: first, reductions in adverse drug events and the costs associated with those events; and second, the financial impact of clinical decision support systems. In two areas of decision support, we felt there was sufficient evidence on which to base projected savings—prescribing systems that suggest generic pharmaceutical alternatives, and systems that help reduce wasteful and duplicate testing (Table 2). In our assessment of the peer reviewed literature, these categories provided the strongest

evidence for cost savings. Other benefits, though highly plausible, have not yet been sufficiently quantified in the literature, thus it is premature to include these in a predictive model. Table 2 provides an overview of the benefits analyzed. The two bottom rows represent benefits realized on a yearly basis, while the two top rows depict the total sum of these annual savings over the entire 20-year period of 2005–2024. Total gross savings over the 20 years are projected to be \$82.4B CAN.

Table 2. Benefits Summary

Statistic	Amb ADE	Inpatient ADE	Post D/C ADE	Long-Term Care ADE	Pharm DSS	Lab DSS	Rad DSS	TOTAL
Benefit Range: 20-Year Total	\$15.0–\$26.2	\$15.6–\$22.6	\$3.2–\$8.0	\$1.9–\$2.6	\$16.7–\$23.4	\$7.5–\$11.2	\$2.6–\$5.0	\$62.5–\$98.9
Benefit Point Estimate: 20-Year Total	\$19.7	\$21.1	\$5.1	\$2.5	\$20.0	\$10.5	\$3.6	\$82.4
Benefit Range: Annual	\$1.05–\$1.83	\$1.17–\$1.70	\$0.24–\$0.60	\$0.17–\$0.22	\$1.26–\$1.76	\$0.56–\$0.84	\$0.20–\$0.38	\$4.7–\$7.3
Benefit Point Estimate: Annual	\$1.4	\$1.6	\$0.4	\$0.2	\$1.5	\$0.8	\$0.3	\$6.1

In billions of Canadian dollars

Amb = Ambulatory; ADE = Adverse Drug Event; D/C = discharge; DSS = Decision Support System

Pharm = pharmacy; Lab = laboratory; Rad = radiology

Projected Net Benefits

Quantitative net benefits are those that remain after accounting for the costs of system acquisition and annual operation. These are shown in Table 3, where Cumulative Net Cash Flow is the aggregate of the annual differences between cost savings benefits and money spent acquiring or operating the system.

Table 3. EHR Return on Investment (ROI) Metrics

Metric	Value – Year 10	Value – Year 20
Cumulative Net Cash Flow	(\$1.5) B	\$39.8 B
Positive Cash Flow by:	Year 7	
Investment Breakeven by:	Year 11	

Summary

Through analysis that captures the unique features of the Canadian health care environment, Booz Allen has projected the costs and benefits of a third generation, interoperable Pan-Canadian EHR. On the basis of what we believe to be reasonable assumptions, we concluded that deployment of an Infostructure and a third generation suite of EHR applications to the physician ambulatory, hospital, and long-term care environments would have an acquisition cost of almost \$10B CAN.

The current evidence also supports a strongly positive societal return on investment over a 20-year period. In the health care sector, total EHR savings per annum grow to more than \$6B CAN at peak levels of use and adoption. Further, these gross annual savings will outpace total annual EHR expenditures by Year 7 of the implementation (2011). This annual positive net cash flow will exceed a cumulative \$10B CAN in Year 11, effectively paying off the initial investment within a year of completing the staged deployment. By Year 20 (10 years after full deployment), cumulative

net cash flow will total \$40B CAN. This revenue can be reinvested in the Canadian health care system to help ensure its sustainability for the next generation.

As noted elsewhere in this report, medical errors are a leading cause of death in the most medically sophisticated nations—Canada is no exception. Many of these deaths are related to inadequate paper-based information systems. Existing evidence strongly suggests that an interoperable, third generation EHR will significantly reduce the number of deaths; and for many more patients, the quality of care and the level of satisfaction with that care will be improved.

This impact on safety and quality suggests that even in the absence of a positive financial return on investment, a strong argument can be made that there is an ethical imperative to implement a Pan-Canadian system of interoperable EHRs. Given the cost and benefit estimates Booz Allen has provided, it appears that this ethical imperative can be achieved at a net savings.