E-health: applying business process reengineering principles to healthcare in Canada

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Abstract: Healthcare in Canada is facing many problems. The most publicised symptoms are excessive waiting times for patients, lack of access, high cost of delivery and medical errors. e-health has been introduced as a potential solution for such problems. This research will explore the area of e-health and the technologies as well as the concepts that are included under its large umbrella. Bearing in mind that e-health is more than a set of technological applications, a business process reengineering (BPR) framework will be used to examine the application of particular BPR principles to address specific problems that are plaguing the Canadian healthcare system. The framework identifies the e-health technologies and processes that could best support the effective application of these BPR principles within a healthcare environment, as well as the key barriers impeding their implementation.

Keywords: healthcare; e-health; internet; business process reengineering; BPR; healthcare value network; patient waiting times; medical errors; healthcare costs; access to healthcare; health information.


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1 Introduction

Healthcare in Canada is facing many problems. The most publicised symptoms are excessive waiting times for patients, lack of access to providers and information, high costs of delivery and medical errors [1]. A recent study by Statistics Canada [2] revealed that 4.3 million Canadians had difficulties accessing first contact services in healthcare, and more than 20% of Canadians accessing specialist services reported that the waiting times for receiving care were unacceptable.

The Conference Board of Canada [3] indicates that

“public health expenditures are projected to rise from 31% in 2000 to 42% by 2020 as a share of total provincial and territorial government revenues.”

The report further estimates that

“adjusting for inflation, public per capita spending on healthcare is projected to increase by 58%, while public per capita spending on all other government services will increase by 17% over the forecast period.”

The extent of medical errors in Canada is largely unknown. Extrapolations from US figures, based on relative population sizes, lead to estimates of 10,000 annual deaths due to medical errors in Canada [4]. These unnecessary deaths are attributed to medication related errors, unneeded or ineptly performed surgeries, and untimely or mistaken diagnoses. These are the most severe errors in the healthcare system, but by no means the most common. The problem of medical errors appears to be now under investigation based on the recent request for research proposals in this area solicited by the Canadian Institutes for Health Research [5].

Part of the problem leading to medical errors is the heavy reliance on paper based patient records in medical institutions. These are often incomplete, out of date, or just plain illegible, which result in clinicians having to repeat parts of the data collection process, and often leaving physicians without crucial information when making decisions on treatment protocols and medications. It has been suggested that implementing the use of electronic patient records could reduce the frequency of medical errors. Tang et al. [6] found that doctors using computer based patient records kept better documentation about their patients, took more factors into account when making decisions and made more appropriate clinical decisions than doctors who used traditional paper records.

Recently, the Commission on the Future of Healthcare in Canada published its long anticipated report [1] on healthcare reform. This report makes 47 recommendations based on a multi-year study of Canadians’ perceptions of the future of healthcare. The essence of these recommendations is that Canada needs to spend more money on healthcare to provide more equitable access, measure performance, and implement electronic health records. Critics of the report [7] have been quick to point out that the recommendations are too conservative, and do not provide sufficient detail about how sustainability and radical improvements to Canada’s healthcare system can be achieved. While this issue is highly politicised, it is clear that some sort of reform or reengineering is necessary to improve or at least maintain the level of healthcare services that Canadians receive.
The term e-health describes the application of the internet and related technologies to the field of healthcare. The potential role of e-health in implementing healthcare reforms is enormous. The healthcare industry in Canada is one of the last industries to implement information technologies for administrative efficiency, knowledge management, and management of customer service. If one assumes that 30 million Canadians with a median age of 35 years each have two pages of medical records, then there are 2.1 billion pages of medical records archived throughout Canada’s healthcare system. This rough estimate is very conservative, but is useful as it illustrates the need for information systems to effectively manage this vast accumulation of information.

Despite the fact that the healthcare industry is one of the largest in the world, less than 2% of INFORMS [8] members belonging to the Health Application Sector according to Carter [9], who also theorised that political reasons have promoted the shortage of operations managers in the healthcare industry, despite the fact that many of the issues in this industry are largely the same as in other industries. It is increasingly becoming clear that modern information technologies are required to manage workflow and procurement of supplies in hospitals to achieve operational efficiency. These are just a few of the promising technologies that need to be implemented to contain costs. Other e-Health technologies address the issue of increased service for patients, such as decision support systems, consumer health information systems, and technologies associated with healthcare performance measurement.

Business process reengineering (BPR) has been defined as

“the fundamental rethinking and redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance such as cost, quality, service, and speed.” [10]

A Delphi study among health informatics experts, ranked BPR as one of the top research priorities for health informatics [11]. This study also identified electronic patient records and connected inter-operating systems as urgent research priorities. This comes as no surprise, as these two research issues are highly interrelated since BPR involves several organisational improvements that are enabled by electronic patient records, and inter-operating systems.

This paper will explore the area of e-health and the technologies as well as the concepts that are included under its large umbrella in Section 2. Section 3 will discuss BPR in healthcare using e-health technologies, and describe how BPR principles can be applied to the healthcare setting. Bearing in mind that e-health is more than a set of technological applications, a BPR framework will be used in Section 4 to examine the application of various BPR principles within the healthcare environment. This framework is used to selectively apply particular BPR principles to address specific problems plaguing the Canadian healthcare system. The framework also identifies the e-health technologies and processes that could best support the effective application of these BPR principles within a healthcare environment. A discussion of the key implementation issues that need to be addressed when applying these BPR principles is presented in Section 4.2. The paper ends with further discussion and conclusions in Section 5.
2 An overview of e-health

The term e-health describes the application of the internet and related technologies to the field of healthcare. Some of the applications covered by the term e-health include tele-medicine, access to online health information, provider convenience services, health products commerce, self care services, and medical record management systems [12]. In this section we examine some definitions of e-health, outline the scope of its various applications throughout the healthcare value network and explore various technologies and processes that are thought to facilitate its implementation.

2.1 Definition and scope of e-health

The scope of e-health is large and continuously changing, but can be defined as following:

“e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology.” [13]

More concise definitions of e-health are:

“a new term needed to describe the combined use of electronic communication and information technology in the health sector”, and “the use in the health sector of digital data – transmitted, stored and retrieved electronically – for clinical, educational, and administrative purposes, both at the local site and at a distance.” [14]

Another definition of the term e-Health is that it encompasses content, commerce, connectivity and care [15,16]; where content includes health information and assessment tools for consumers, and drug, health-plan, and medical research information for practitioners. Commerce includes a wide range of B2B, B2C and B2P (Business to Professional) interactions in the healthcare sector. Connectivity is seen as the exchange of health information through electronic means, such as prescriptions, claims, and e-mail. The care component of e-Health is vast, as it includes the use of the Internet and related technologies in patient care. An example of this would be a physician’s use of a drug-drug interaction checking program on her palm pilot.

Figure 1 illustrates the value network for the healthcare industry by depicting the parties involved in delivering healthcare and showing the interactions between them. The scope of e-health encompasses technologies employed to improve processes throughout this network. The parties illustrated in Figure 1 represent the actors in the healthcare process, where the insurance providers can be interpreted as both private and public providers. Physicians, hospitals, and other healthcare professionals are all represented by the icon Health Care Providers in this illustration. Note that this depiction of the healthcare system is simplified by only showing the major relationships and parties, as the illustration of every possible interaction would be too confusing.
2.2 Technologies and processes in support of e-health

There are several recent technological innovations that have facilitated the introduction of e-health, and which continue to evolve and further improve healthcare. First there was the development of the internet, which has facilitated the rapid transfer and sharing of information. The information distribution capability of the internet has been enhanced through wireless technology, which has allowed medical professionals to connect to information systems without being bound to stationary computers. This capability in conjunction with the increased processing and information storage capacity of today’s handheld devices (e.g. PDA’s) has made it possible for the implementation of workflow management systems and electronic medical records in hospitals.

Ammenwerth et al. [17] demonstrated how these technologies improved healthcare at the Heidelberg university hospital by enhancing physicians’ access to health information, patient records, and the ability to file requests for examinations. The bandwidth and processing capabilities of the handheld devices used in this early trial have since been surpassed, and a new industry as been created around mobile computing in healthcare. For example, the Dell Axiom X5 [18] handheld device has the capabilities of a Pentium desktop computer with a 400 MHz processor and 64 MB of SDRAM. The increased processing power combined with the speed of broadband new wireless access technology makes the use of mobile devices very powerful in healthcare settings. Applications such as prescription decision support tools, automatic billing tools, and health information lookup are just a few technologies that have been adopted by many physicians [19].

Supply chain management and enterprise resource planning systems have also matured. System developers such as SAP have started focusing on the healthcare sector,
promising significant improvements to the efficiency of hospital administration activities. Automatic workflow management [20], automatic billing systems, and electronic prescriptions offer further reductions in administrative inefficiencies by coupling such activities with electronic document management. All of these applications have been combined into the practice management packages offered by application service providers [21].

Other technologies that have matured to the point that they are starting to be useful within the healthcare setting are artificial intelligence, decision support, speech recognition, and character recognition.

3 e-health and business process reengineering

Hammer’s [22] idea of business process reengineering (BPR) revolved around achieving radical performance improvements through a clean slate approach for processes, instead of speeding up outdated inefficient processes with technology. His view entails breaking away from the outdated rules and fundamental assumptions that underlie existing operations. He suggests that:

“Information technology offers many options for reorganizing work. But our imaginations must guide our decisions about technology – not the other way around.” [22]

This idea is central to BPR and is an important caveat for understanding how promising new e-health technologies can be effectively implemented. In this section an overview of BPR in healthcare is presented and some motivations for reengineering in the healthcare system are explored. Specific BPR principles are then outlined and it is shown how these principles can be used to address specific healthcare problems within an e-health context.

3.1 Healthcare business process reengineering

To illustrate the importance of holistic approaches to technology implementation, it is useful to draw upon established ideas about the relationships between technology, people, structure, and tasks. Before the internet was conceived in the form of ARPANET, Leavitt [23] published his theory on organisational change that proposes a four variable conceptualisation for organisations. This was known as Leavitt’s Diamond, as seen in Figure 2, where the four variables are highly interdependent and change in one of the variables usually results in compensatory and sometimes retaliatory changes in the others. Leavitt’s view of organisational change still holds true, and must be kept in mind when examining the potential benefits of implementing e-health technologies.

Figure 2 Leavitt’s diamond [23]
It must be clarified at this point that we are speaking of a second generation BPR, which is not the same as the BPR projects of the early 1990s, which were widely seen as thinly veiled downsizing projects. A study of American and Canadian hospitals revealed that executives involved in BPR projects during the era of first generation BPR felt that lack of staff cooperation, buy-in, and skill were deterrents to success in both IT and restructuring projects [24]. This highlights the validity of Leavitt’s view of organisational change. In these cases the expected benefits from improvements in technology and structure were diminished by the other variables – the people and the processes.

More recently, studies on IT implementation in the UK healthcare system have shown that social, political, and organisational issues can impede the successful adoption of technological improvements [25,26]. For example, Wainwright and Waring [25] found that the people and structures in the UK healthcare system were not able to fulfil the goals of implementing electronic patient records within a timeframe set by policy makers because of underestimates in the effort it took for integration and the overestimates of the skills of the IT departments. Here the structure and people impeded the implementation of technology and tasks, as in Leavitt’s Diamond [23].

Administrative barriers preventing e-health technologies from being implemented were identified by Kerwin [27] as compatibility issues with existing information systems, constraints in available funds for IT investments, lack of consensus about what technologies should be adopted and how they should be implemented, and privacy and confidentiality concerns. These barriers are combinations of the structural, people, task, and technology variables in Leavitt’s Diamond [23].

Devaraj and Kholi [28] found that BPR projects involving IT investment in the US healthcare system not only led to increased profitability, but also resulted in reduced patient mortality and increased patient satisfaction. Their research showed that improvements from BPR did not manifest immediately, but after a period of several months after the IT investment project was completed. It is important to note that the BPR projects investigated by Devaraj and Kholi [28] were more than simply implementing new IT; they included changes to processes and structures as well, which is a core aspect of second wave BPR.

El Sawy [29] describes second wave BPR as being much richer than the first wave BPR of the early 1990s, because

“it is more closely linked to strategic dimensions; it is more focused on cross-enterprise e-business, it takes much greater advantage of capturing and creating new knowledge around processes; and it takes greater advantage of the internet.”

According to El Sawy, second wave BPR incorporates time-based competition, web-enabled e-business, and knowledge management. Where time based competition is seen as redesigning processes to be fast, focused and flexible; web enabled e-business is the collaborative transformation of processes across departments, suppliers, and partners; and the application of knowledge management expands the knowledge creation capacity of processes. Second wave BPR projects look for longer term benefits than TQM based first wave BPR projects, as they are geared towards value creation, organisational learning and administrative savings.

Second wave BPR is related to the idea that one can only effectively manage what can be measured. Quite often it is difficult to determine the causal relationships between the inputs and outputs of processes unless one considers the intermediate variables.
This idea is developed in Kaplan and Norton’s [30] paper on the Balanced Scorecard. The use of the balanced scorecard to measure performance is already being applied in some hospitals today. Bridgeport Hospital and Healthcare Systems in the US, for example, has adopted a balanced scorecard and is measuring metrics on five critical success factors; organisational health, process improvement, quality improvement, volume and market share growth, and financial health [31]. While implementing the scorecard, the hospital management took care to involve different departments in developing metrics, allowing staff to set their own goals and refine measures to reflect their impact on the five critical success factors.

In other research, Pringle et al. [32] examined measures to assess the quality of healthcare provided by physicians and healthcare systems. They cautioned that not only are the measures themselves important for improving the quality of service, but equally important are the consequences of achieving different levels of performance. In other words, it must be recognised that measures should be used to promote and reward good healthcare, not to point blame and shift responsibility from the administration to individuals. It is clear that one cannot manage what cannot be measured, thus Pringle et al. [32] write that

“One cornerstone of healthcare improvement is continual measurement as a tool for understanding systems and determining whether changes are effective.”

3.2 BPR principles within an e-health context

The principles and tactics for process redesign for e-business as suggested by El Sawy [29] can be applied within an e-health context. Below, we examine how each of these ten principles can be used to improve healthcare systems.

*Lose wait*. This principle addresses not only waiting times for patients, but also waiting times in processes in the healthcare system. One example is the reduction of waiting times between when lab results are requested and when they are delivered through the utilisation of faster communication technologies such as email to shorten administrative delays. Another way of applying this principle is to reconfigure laboratories so that they can perform the most frequently requested tests faster, or by having facilities closer to where they are requested. Tactics associated with this principle in the e-health context include designing for continuous flow, and reconfiguring support activities to avoid bottlenecks.

*Orchestrate*. This principle can be applied in healthcare by coordinating between healthcare providers to balance workloads. For example, when one hospital has more beds for heart patients than another, the two can share heart patients between them so that both facilities have similar capacity levels. This is more efficient than taking on patients until capacity is reached in one hospital and then redirecting new patients to other hospitals with available beds. When hospitals have less than 100% utilisation of capacity, medical staff have more time to tend to patients and to improve service possibly leading to a shorter length of stay for patients. Similarly it makes sense to orchestrate workloads between labs to minimise overall turnaround time between the moment samples are received and when results are delivered.
Mass customise. The idea behind this principle is to provide flexibility of interaction options and service offerings to different kinds of patients. This principle is difficult to apply in a standardised setting such as healthcare. However, the principle can be applied when communicating with patients that have different levels of health literacy, and who also have varying levels of interest in managing their own health by researching health information online. For example, patients could be offered multiple ways to access healthcare professionals when seeking advice – through telephone, email, or personal appointments. Another example of mass customising care is through online support systems, for example by providing diabetic patients with online tools to record and graph their blood sugar levels, and then giving them customised advice and feedback based on their progress.

Synchronise. Here the principle is to synchronise the physical and virtual parts of processes. This can be done by ensuring that the online content accessed by consumers already serviced by a healthcare system also reflects the treatment options available under that healthcare system. Another method of applying this principle is to track the movements of medical supplies, laboratory results, and patients electronically in order to ensure that everything is where it is needed when it is needed.

Digitise and propagate. This principle is key to moving into the 21st century of healthcare. The benefits of digitising health records, workflows and health information are enormous because the information can be shared faster, and more controls can be put into place to ensure their accuracy and completeness. Tactics for applying this principle include eliminating paper in processes, and shifting much of the data entry to the healthcare consumer. An example of how this is done is having patients enter their own medical histories and complaints as part of their medical records through a series of structured questions prior to the consultation with a physician. This not only improves the communication between patients and their physicians, but also reduces the amount of clerical work performed by professionals. Workflow information can also be digitised and propagated to enable the orchestration between hospitals and care providers in a more efficient manner, using capacity balancing algorithms [33].

Vitrify. This principle means making processes transparent, and it extends the benefits of the Digitise and Propagate principle. When information about patients and workloads is shared – not only throughout individual hospitals but throughout the healthcare system as a whole – management, researchers and policy makers can get a clearer picture of problems and opportunities within the system. Understanding the healthcare system is easier when this principle is applied, allowing on-the-fly analysis of trends and faster problem identification. It needs to be clear at this point that personal information is not to be shared indiscriminately instead we are talking of aggregated statistics and anonymised information about what kinds of patients are being treated, and what resources – in terms of medical equipment and staff – are being utilised. On an individual patient level, information is shared between healthcare providers on a need-to-know basis, following privacy policies.

Sensitise. This principle is the crux of continuous improvement and preventing medical errors. Sensors can be utilised to detect abnormalities within the system, such as when a patient has been waiting longer than normal. Once abnormal situations in processes have been detected, software agents can prompt action by notifying the care provider responsible for the patient. This principle also works well in the healthcare context as
sensors monitoring patients’ conditions are already employed with the ability to alert staff when a patient’s medical condition changes. Another example of the application of this principle is the use of software agents to detect prescription errors, such as incorrect dosages and adverse drug-drug interactions.

Analyse and synthesise. Healthcare processes can be monitored using some of the previously mentioned principles to enable timely reactions to sudden changes in environment. For example, outbreaks of influenza can be detected when the number of patients reporting symptoms rises suddenly. When this information is shared and aggregated, it can allow administrators to prepare for increased emergency visitations by adjusting their staffing schedules. In an ideal situation, where information is shared throughout the healthcare system, predictions can even be made of how fast outbreaks spread and what geographic regions will be hit next. This principle promotes data analysis capabilities at executive levels and research levels. The data-mining potential of health records is enormous, and can contribute greatly to the field of evidence based medicine. To make full use of this principle, data must be aggregated from multiple information sources including patient records, workflow data and laboratory results. The analysis of such data can lead to the identification and simulation of further improvements to the healthcare system in terms of quality of care and cost reductions.

Connect, collect, and create. The application of this principle is the basis of knowledge management. By codifying and sharing the knowledge about processes by their participants, new insights can be gained and best practices can be shared. Tactics for implementing this principle include the creation of communities of practice, knowledge repositories, and expertise maps. In order to effectively apply knowledge management in a healthcare setting, mechanisms need to be in place to capture knowledge from the participants in processes within the healthcare system. These can include reporting by healthcare professionals, medical and pharmaceutical suppliers, as well as exit interviews with patients.

Personalise. This principle can be seen as making relationships between healthcare providers and patients more intimate. This is already being done by family physicians, who become familiar with the needs and concerns of their patients through conversations about their lifestyle and professions. This principle can be extended to other medical professionals as well. For example, different patients have different opinions about the use of antibiotics or homeopathic treatments. With the consent of the patient, these preferences could be included in the patient’s medical record along with information about allergies so that when patients see other care givers, they will receive more personalised treatment according to their preferences.

4 A framework for addressing healthcare problems through BPR principles and e-health solutions

The application of the BPR principles, as outlined in the previous section in conjunction with enabling e-health technologies and processes can help reduce several problems in the healthcare system. Table 1 presents a framework for addressing the most important problems in the healthcare system through specific BPR principles. Cooperation of several parties is required to achieve more than incremental improvements from such
reengineering efforts. The table lists only the main participants who will be most affected by the potential improvements. It should be noted that when executing reengineering projects it is recommended to enlist the aid of BPR consultants, process owners and participants, the project sponsors, and IT specialists. Table 1 also outlines the e-Health supporting technologies and processes that are needed to address each healthcare problem area. Following the discussion of the application of BPR principles to problems in healthcare in Section 4.1, the key implementation issues are discussed in Section 4.2.

4.1 Applying BPR principles to problems in healthcare

**Patient waiting times.** The problem of lengthy waiting times of patients can be mitigated by applying the BPR principles of Lose Wait, Orchestrate, Mass-Customise, and Digitise and Propagate. The processes and technologies that enable the reduction of patient waiting times include workflow management programs, capacity planning tools, scheduling, and connectivity across providers. Over 20% of Canadians reported unacceptably long waiting times for surgery and specialist services [2]. Through the use of these technologies and processes the detrimental impact on the quality of life that waiting for healthcare has on patients can be reduced.

**Medical errors** can be reduced through the utilisation of electronic medical records and physician order entry systems [6,34]. Electronic medical records are a core component of e-health and are clearly necessary to tackle the problem of medical errors both by identifying and monitoring the frequency of errors and by reducing them as Tang et al. [6] found in their research. Clinical Decision Support systems (CDS) including expert systems and software agents can also yield a reduction in the incidence of medical errors [35]. The BPR principles most applicable to addressing the problem of medical errors are Digitise and Propagate, Vitrify, and Sensitise. The application of these principles involves implementing electronic health records, order entry systems, and error checking applications that alert healthcare providers when there are suspicious entries detected in their records.

**High healthcare costs** have been attributed mainly to the costs of administration by Picot and Cradduck [36], who found that $0.25–0.40 of every dollar spent in the US and Canada on healthcare is spent on administration costs. BPR principles that can be applied in healthcare to reduce costs are to Orchestrate activities, by removing duplication of administrative tasks, and enabling those who perform tasks most efficiently to carry out those tasks. Furthermore, by Analysing and Synthesising information about processes in healthcare, it becomes possible to better understand best practices and workload distribution throughout the healthcare system. This goes hand-in-hand with Collect, Connect and Create; the BPR principle that advocates a knowledge management aspect to enable communities of excellence who are the best suited to manage continuous improvement efforts in terms of quality and costs. Almost everyone is a participant when it comes to applying BPR principles and enabling technologies to reduce the costs of healthcare. The most relevant processes and technologies that enable cost reductions are supply chain management, automatic workflow management, and claim management applications. When these are used in conjunction with electronic medical records, they can lead to significant savings by eliminating vast amounts of paper documentation, and automating many routine tasks. It is estimated that a more efficient supply chain could save $120 million annually in Ontario hospitals alone [37].
Access to healthcare was identified as a problem in the report by Romanow [1] and Statistics Canada [2]. Canada’s vast geography makes it difficult for many citizens living in remote areas to receive adequate healthcare services, and close to impossible to access specialist services. Additionally, Canada’s multicultural population sometimes has difficulty accessing healthcare because of language issues. Telehealth initiatives have been introduced in Canada [36] to provide virtual healthcare services to Canadians. This kind of solution to healthcare access problems draws upon the BPR principles of Orchestrate, Mass-Customise, and Personalise. Connectivity technologies are a central part of telehealth, not only for connecting patients with remote physicians, but also to support effective communication among different physicians and specialists so that patients can receive virtual healthcare for any kind of issue. Automated translation is also an important enabling technology for improving access to healthcare, in both the virtual environment and also in the traditional healthcare setting.

The problems with access to health information include information overload for consumers and physicians, as there is more health information available to be accessed with the ease of publication offered by the internet. It is clear that the internet is becoming the channel of choice for health information publishing and distribution for all. The issue of which information is accurate and reliable has been raised frequently by both consumers and medical professionals [38]. In an extensive literature review of this issue, Eysenbach et al. [39] illustrate the problem by stating that online health information is often regarded as suspicious because the purpose of the information is unclear. For example, a pharmaceutical company posting online information on its website has the clear purpose of promoting its products. But when medication related information appears on a health information website, it is unclear whether the information is objective or biased by the presence of corporate sponsors. Also, consumers have reported difficulty in accessing information from their healthcare providers [2]. The BPR principles that should be applied to address the information overload problem are: Collect, Connect Create, Personalise and Synchronise. Only by synchronising online information with practices and knowledge applied in local healthcare systems, will the full benefit of online health information be realised. This means that Canadians should be able to access content that is in line with the medical services that are being offered in Canada. The e-Health technologies that are useful here are national health information portals and digital triage programmes. The availability of trusted third party seals for validating the quality of information on health websites could also be helpful in winning the trust of online health information seekers [40].

4.2 Key implementation issues

Several key implementation issues need to be addressed when applying the above BPR principles and implementing e-health technologies, as described in Table 1. In order for cross healthcare provider communications to occur, there needs to be collaboration and standardisation of systems between hospitals, labs and other healthcare providers. As well, there are requirements for security, privacy and training of healthcare professionals before e-Health technologies can be used effectively.

The security of electronic records and communications is an issue that can be resolved through access control, authentication, and encryption technologies [41]. Security policies and auditing information access is crucial to be certain that information systems and patients’ personal information is not being abused [42].
Patients’ privacy must be protected with guarantees that need to be in place to ensure the confidentiality of patients’ health information through privacy legislation and the application of security technologies and policies [41]. In Canada, there is the problem of competing standards and legislations at provincial, federal and institutional levels when it comes to protecting privacy [43]. The legal complexity of the different legislations in Canada pertaining to health information is summarised in a CIHR report [44].

In addition to the security and privacy issues discussed above, another key implementation issue is the phenomena of the digital divide, as many people living in remote areas not only have limited access to the internet, but are also computer illiterate [45]. General practitioners can act as liaisons to telehealth for many of these people by offering basic healthcare services, and collaborating with remote specialists via telehealth technology. Public access centres such as those in libraries and patient training can help alleviate the problems of the digital divide.

The main issues arising from the use of Clinical Decision Support systems (CDS) are liability and reliability. Decision support tools must be carefully designed so that they are reliable and accurate [46], and their users must be trained to properly use the tools to avoid cases when the recommendation of a software system leads to patient harm. It is important to bear in mind that these tools should be used to assist the decision maker as opposed to replacing the physician altogether.

Collaboration between the many parties identified in Figure 1, and the standardisation of the software and languages used in the interactions between these different parties represent another two key implementation issues in this field. Standardisation of data formats is crucial for the interoperability of electronic medical records and healthcare information systems [47]. A related issue is creating universal patient identifiers [48] for these systems to function.

As significant cost reductions and system wide improvements require cooperation from many parties with different agendas, there are many political issues that need resolution for such efforts to succeed [49]. Additionally, there are typically internal politics that need to be addressed when moving towards paperless administration systems, orchestrating workloads, and implementing the automation of routine tasks. These political issues can make the reengineering of healthcare systems one of the most daunting tasks for the healthcare system designers. It is crucial for end users of the systems to be involved in the design process of the information systems for successful implementation [50]. This kind of effort requires strong leadership with sufficient foresight to anticipate and resolve conflicts between all the parties and individuals involved in such projects. It also requires the resources to not only implement information technology, but to also create incentives for healthcare providers by reimbursing them for achieving desired outcomes, and managing the health of their patients, instead of operating on a fee for service basis [41].

Another issue is training care providers to utilise implemented systems and processes effectively [29,51]. This issue is significant, as healthcare professionals are already overworked and may find it difficult to find the time to take courses on using the e-health technology designed to address problems in the healthcare system.

The key implementation issues involved around the access to health information are accountability and accuracy of online health information. Many physicians have expressed concerns regarding the quality of information on the internet [39]. Several websites are relieving themselves of all accountability for the information they publish through broad disclaimers and cautions that their content does not equal medical advice.
There is a need for quality control for the information found on the internet, because much of the information is not scientifically sound, as it is anecdotal, or based on other patients’ personal experiences [52]. Finding the right amount of content is also an issue that will need further examination, as both too much or too little can be counterproductive.

There are several implementation issues around patient–provider relationships that need to be explored as well. Many patients are now bringing health information originating from the internet to their doctors [53,54]. How this information contributes to the quality of patients healthcare experience is still unclear, as well as its impact on the patient–provider relationship. E-mail between patients and physicians could improve this relationship by increasing communications and helping patients cope with the uncertainty of information quality, yet many physicians are reluctant to adopt internet-based communications with their patients, because of liability, privacy and compensation concerns [55].

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<th>Problem</th>
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<th>Main participants</th>
<th>Enabling e-health technologies and processes</th>
<th>Key implementation issues</th>
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Table 1  A framework for the application of BPR principles and e-health solutions to address healthcare problems (continued)

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<th>Problem</th>
<th>BPR principles</th>
<th>Main participants</th>
<th>Enabling e-health technologies and processes</th>
<th>Key implementation issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to Health Information</td>
<td>Connect, Collect, and Create</td>
<td>Patients, Healthcare Providers</td>
<td>Health Information Portals</td>
<td>Accuracy, Content</td>
</tr>
<tr>
<td></td>
<td>Personalise</td>
<td>Pharmacetical Suppliers</td>
<td>Digital Triage Supported by (1,2,3,4,5,6,7)</td>
<td>Accountability, Patient-Provider Relationships</td>
</tr>
<tr>
<td></td>
<td>Synchronise</td>
<td>Labs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supporting technologies:
1. internet protocols
2. local area networks
3. wireless technology
4. hand-held devices
5. databases
6. email applications
7. encryption and authentication
8. imaging technology

5 Discussion and conclusions

The Canadian healthcare system faces major challenges in improving the quality of service and containing increasing costs. The many promising benefits offered through information technology and e-health can only be obtained if they are implemented systematically. We propose that a BPR perspective is beneficial when determining how to proceed with improvement projects in the healthcare sector, as many of these endeavours affect multiple parties and the processes managed between them. The BPR perspective of healthcare reform provides insights into the processes that are facilitated by technology, and examines what changes are required for processes within the healthcare system to exploit the full benefits of adopting 21st century information systems and management principles. We have identified several key obstacles that hinder the implementation of e-health using BPR principles, such as privacy, standardisation, collaboration and political issues. While there are many differences between the Canadian healthcare system and others, many of the problems, issues and solutions are similar – as such, the approach to healthcare reform using BPR principles and e-health technologies as described in this research can be utilised in other healthcare systems as well.

In Canada, there are now efforts underway to begin to tackle the barriers preventing the implementation of e-health systems. For example, the Ontario Hospital Association [56] has created an e-health council with multiple working groups to investigate various e-health applications. One of the greatest benefits of these working groups is that they contain multi-disciplinary participants that can contribute to learning from different perspectives and increase the knowledge about the objectives and challenges of different parties to enable better integration when implementing systems. On a national level, the Canadian Institutes for Health Research [57] and Canada Health Infoway [58] are also researching issues surrounding electronic medical records and other e-health technologies. These are but a few initiatives in this area developing technologies, investigating implementation issues, and laying the foundation for collaboration among all the actors in the healthcare system.
There is a definite need for leadership to provide a strong vision that will unite the many parties and individuals struggling to implement discontinuous improvements through changing processes and the implementation of new technologies. This leadership will need to foster collaborations between the many players in the healthcare sector, and exercise its authority in the standardisation of systems and processes. Leadership is also needed to gain the significant funding which can only be garnered through a unified political will for the purchase and deployment of new e-health technologies as well as for the training of users of these technologies. e-health promises to alleviate many problems in healthcare, but the vast scale of our healthcare system makes it a daunting challenge to coordinate and unify improvement efforts.

The framework presented in this research provides the basis upon which the various e-health technologies and processes can be integrated to provide radical improvements to healthcare systems. There are many issues within this area that will need to be addressed in future research, such as how to implement large scale reengineering projects, what data standards to adopt, and what the impact of e-health is on consumers in terms of usability and improvements to individuals’ health, just to name a few. Long term studies are required to examine the benefits and problems of applying BPR principles in healthcare. Healthcare is the largest industry, both nationally and worldwide, making reengineering efforts both extremely challenging and rewarding in terms of the benefits to society when improvements are achieved. We expect that the area of reengineering in healthcare will grow substantially, both practically and academically in years to come.

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References and Notes


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