

Perceived Barriers to the Use of Electronic Health Records for Infectious Disease Surveillance
in Canada

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List of Abbreviations

EHR	Electronic Health Record
EMR	Electronic Medical Record
LHIN	Local Health Integrated Network
PHAC	Public Health Association of Canada
WHO	World Health Organization

Abstract

This thesis examines the potential interface that exists between health information, specifically electronic health record (EHR) systems, and notifiable disease surveillance in Canada. It aims to highlight the benefits and barriers experienced by the current national notifiable disease surveillance strategy, as well as to highlight the successes and roadblocks to the successful implementation and adoption of EHR technologies in Canada. Qualitative methodologies, which include the 16 semi-structured interviews conducted with four key stakeholder groups, including public health experts, physicians, health administrators and academics that are concerned with EHR adoption and public health were used to obtain data. Data from interviews was analysed using grounded theory methodology and then verified using member checking and other data validation methods. Emergent themes from obtained data indicated that there is a large potential for the improvement of the current notifiable disease through the use of EHR technologies: however, the barriers currently faced by both the notifiable disease surveillance system and the state of implementation and adoption of EHR technologies prevent this from occurring. These barriers include political, financial, human, security/privacy, and technology barriers. Differences between stakeholder groups were explored, and potential solutions and insights into existing barriers were provided. The information gained from this study provides insight into the efficiency of the current infectious disease surveillance system and the progress of and need for the implementation of EHRs nationwide. In addition, the results of this study provide stakeholders with a deeper understanding of the barriers facing the use of EHR technologies for infectious disease surveillance and provide a starting place to address these issues. The results of this study can

help to inform policy regarding public health surveillance and EHR implementation and adoption.

Abstrait

Cette thèse examine l'interface potentielle qui existe entre l'information santé, spécifiquement au système de dossier de santé électronique (SDSE), et la surveillance des maladies à déclaration obligatoire au Canada. Le but est d'attirer l'attention aux avantages et aux obstacles qui se présentent à la surveillance des maladies à déclaration obligatoire courante, aussi bien pour la réussite et aux barrières envers la mise en œuvre des technologies du SDSE au Canada. Des méthodologies qualitatives qui se comprennent de l'emploi de seize entrevues semi-structurées conduites par quatre groupes d'intervenants clés, compris d'experts en santé publique, médecins, administrateurs santé et universitaires, impliqués à l'adoption du SDSE et la santé publique ont été utilisé pour obtenir les données. Les données des entrevues ont été analysées en utilisant une méthodologie de théorie pratique, suivie de vérification par les membres (sources clients) et autres méthodes de validation. Thèmes émergents obtenus des données indiquent un grand potentiel pour l'amélioration du courant SDSE envers la surveillance des maladies à déclaration obligatoire, cependant les obstacles envisagés à ce temps l'empêchent de se produire. Ces obstacles sont des obstacles politiques, économiques, humaines, sécuritaires/d'intimités et technologiques. Différences entre les groupes de parties prenantes ont été explorées, et solutions et perspicacités pour surmonter les obstacles sont incluses. L'information obtenue par cette étude fournie un aperçu à l'efficacité du courant système de surveillance des maladies à déclaration obligatoire et aux progrès et aux besoins de l'implémentation nationale du SDSE. En plus, les résultats de cette étude munies les groupes de parties prenantes avec une compréhension améliorée aux obstacles qui se présentent devant l'utilisation des technologies du SDSE pour la surveillance des maladies à déclaration

obligatoire et pour fournir un point de départ pour adresser ces questions. Les résultats de cette étude ce rendront pratique pour informer la politique au sujet de la surveillance de la santé publique et la mise en œuvre et l'adoption du SDSE.

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Chapter 1: Introduction

This chapter consists of three parts. The first section contains the rationale and motivation for conducting this study; the second outlines the main objectives of the thesis; and the third provides an outline of the organization of the thesis.

1.1 Background

The electronic health record (EHR) has been regarded as a key component in the advancement of the Canadian health care system (Canada Health Infoway, 2009). The EHR has the potential to reduce health care costs, reduce medical and drug errors, enhance the flow of information between health care providers, increase communication between patients and health care providers, and improve overall quality and efficiency of patient care (Gardner, 2010; Archer & Cocosila, 2011; Denomme, Terry, Brown, Thind, & Stewart, 2011; Lau, Kuziemy, Price, & Gardner, 2010; McGinn et al., 2011; Perera, Holbrook, Thabane, Foster, & Willison, 2011; Rozenblum et al., 2011). The EHR not only has clinical benefits, but also offers the potential for public health benefits. The richness of the data contained in an EHR provides a unique opportunity for health research and for the monitoring and surveillance of both chronic and infectious disease. However, despite the stated benefits from the implementation and adoption of EHR systems in Canada, their implementation has been slow and lags behind that of other developed nations. Technological, financial, human, and security barriers have all contributed to the slow implementation and adoption of an interoperable EHR. To understand the potential of these systems for non-clinical uses, such as notifiable disease surveillance, it is important to determine a deeper understanding of the issues faced by both the

implementation and adoption of EHR technologies and by the current notifiable disease surveillance system. In addition, it is also important to examine the viewpoints of the key stakeholders involved in EHR adoption and its use for notifiable disease surveillance. This thesis focuses on the potential interface between EHR technologies and infectious disease surveillance, specifically notifiable disease surveillance.

In Canada, notifiable disease surveillance is conducted by the federal agency known as the Public Health Agency of Canada (PHAC). The Public Health Agency of Canada relies on information from the provinces and territories regarding occurrences, outbreaks, and status of notifiable disease. For effective notifiable disease surveillance and monitoring, this information needs to be obtained in an accurate, complete, efficient, and timely manner. Current manual reporting methods and a lack of concrete legislation and policy concerning many aspects of the reporting of notifiable disease surveillance means that the current system is not working as efficiently and effectively as it should.

Current research focuses mainly on the benefits and barriers of EHR systems for clinical uses but does not thoroughly examine their potential in notifiable disease surveillance. As well, most qualitative research regarding EHR implementation and adoption nationally focuses on one group's viewpoint and does not examine the differences and similarities between key stakeholder groups. This thesis addresses these gaps in the literature.

1.2 Objectives

Through the use of qualitative semi-structured interviews, this study provides insight into the successes and needs of the current national notifiable disease surveillance system and

highlights the potential interface between EHR technologies and notifiable disease surveillance.

The main research questions to be answered by this study are as follows:

- i. What are the needs of comprehensive infectious disease surveillance systems and the barriers that prevent the achievement of them?
- ii. What opportunities exist for the use of health information technologies, specifically EHR, to support infectious disease surveillance in Canada?
- iii. What are the coordination and information needs that are needed to allow for disease surveillance using health information technologies, specifically EHRs?

1.3 Thesis Organization

The first chapter of this thesis discusses the current literature that exists regarding effective disease surveillance and the national notifiable disease surveillance strategy, the implementation and adoption of an interoperable EHR system in Canada, and the potential interface between EHRs and notifiable disease surveillance. As well, it highlights the importance of conducting this study. The next chapter outlines the methodology for data collection and analysis. The following section presents and discusses the results of the study. Finally, conclusions, contributions, limitations, and recommendations for future research are discussed.

Chapter 2: Literature Review

This chapter contains the literature review, which is presented in four main sections.

The first section provides a discussion on infectious disease surveillance; the second discusses electronic health records and their implementation and adoption in Canada; the third discusses the potential of EHRs and public health; and the fourth section provides a summary of what is known from the literature and the needs and gaps that still exist.

2.1 Infectious Disease Surveillance

Effective infectious disease surveillance is important to the protection of the health of the Canadian population. Effective surveillance, defined as "the ongoing systematic use of routinely collected health data to guide timely public health action", allows health care officials to monitor, detect, prevent, and react to disease outbreaks (Auditor General, 2008). An optimal and effective surveillance system requires accurate, complete infectious disease information that is readily available to health officials in a timely manner (Bellika et al., 2007). Such a system must analyze information and produce results on a near real-time basis requiring familiarity with systems and protocols at all user levels; demanding buy-in from private and public sector health care professionals; making constant monitoring and maintenance a requirement; and assuring consistent, high quality, real-time responses to infectious disease outbreaks (Bellika et al., 2007; Moghadas, Pizzi, Wu, Tamblyn, & Fisman, 2011). Real-time monitoring allows for early detection of outbreaks, understanding of disease patterns, and timely reactions to deal with outbreaks should they occur (Friedman, 2006).

2.1.1 Infectious Disease Surveillance in Canada

The Public Health Agency of Canada (PHAC) is the federal body that is responsible for the monitoring and tracking of infectious disease (AG, 2008). Through long standing agreements, the federal government, along with the provincial and territorial government have agreed to a list of “notifiable diseases” considered significant threats to public health (Carter, 1991). They maintain and periodically update the, “Notifiable Disease List”, tracking these disease trends and identifying new disease threats (Doherty, 2006). Information on a notifiable disease is reported to health authorities at regional, provincial and federal levels and may follow one of the many pathways in the Figure 1 from the 2008 Auditor General's report on

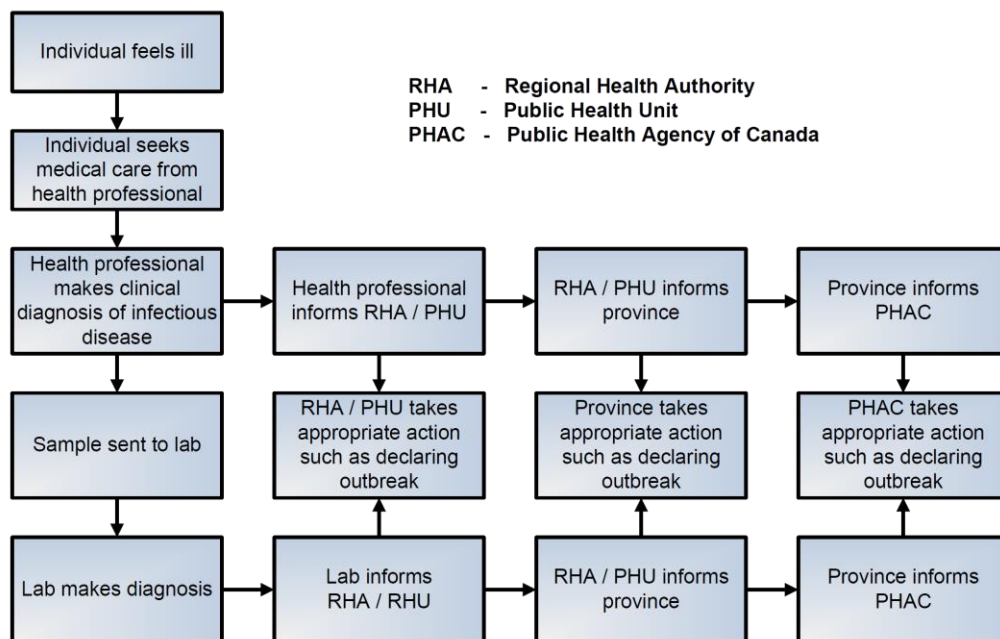


Figure 1: Infectious Disease Reporting Pathways (AG, 2008)

infectious disease surveillance. For the purposes of this thesis, the term, “infectious disease” will refer to these “notifiable diseases” identified by federal, provincial, and territorial governments as important to monitor and control.

Notifiable disease information can reach health care officials through a variety of information pathways. The most straightforward of these pathways starts when an individual feels ill and contacts their health care provider. The health care provider makes a tentative diagnosis of a notifiable disease and sends a sample to the lab for confirmation. If the lab confirms the diagnosis based on the sample, it forwards the information on to the regional health authorities or LHINs. A more streamlined pathway results in quicker notification of public health authorities, initially bypassing the lab, with the physician directly reporting a diagnosis of notifiable disease to the LHINs or regional health authorities. In either case, Regional health authorities then may decide to invoke appropriate responses. Region health authorities, in turn, pass information on to provincial/territorial health authorities and then on to PHAC (AG, 2008).

2.1.2 Shortcomings of the Canadian System

Although the Canadian infectious disease surveillance system seems comprehensive there are a few barriers that exist preventing accurate, effective timely reporting of notifiable disease to public health authorities (Moghadas et al., 2011). The most serious of these barriers the persistence of manual reporting methods, the lack of effective enabling legislation, and the lack of standards in reporting represent significant handicaps to the Canadian infectious disease surveillance system. These are significant barriers to infectious disease surveillance on a local, provincial, and national level (Friedman, 2006; AG, 2008). The shortcomings of the Canadian infectious disease surveillance system were highlighted during the 2003 SARS epidemic and again in the 2009 H1N1 pandemic (Moghadas et al., 2011).

2.1.2.1 Manual Reporting Methods

Current reporting of infectious disease in Canada is a manual process. Physicians diagnosing patients with an infection disease on the notifiable disease list relay the patient information to health authorities by mail, facsimile, or telephone. (AG, 2008). Obviously such a process results in significant reporting delays, perhaps delays critical to the control and management of infectious disease outbreaks (AG, 2008). Physicians and health care providers may resent the cumbersome reporting process, feeling that they should focus on patient care and leaving paperwork to the end of the busy day which further delays sending important disease information to public health authorities and, perhaps, delaying the initial response to an outbreak (Friedman, 2006).

2.1.2.2 Legislation

Lack of legislation governing the sharing and monitoring of infectious disease surveillance is a major barrier faced by the current Canadian surveillance system (Moghadas et al., 2011). A lack of a clear legislation mandating provinces and territories to share information concerning infectious disease outbreaks means that health authorities may be unaware of the status of similar outbreaks in other jurisdictions, hampering their ability to develop coordinated responses to effectively monitor and respond to outbreaks (AG, 2008). Provinces and territories are expected to voluntarily send infectious disease information to the Public Health Agency of Canada. Agreements made between provincial and federal bodies may vary from province to province concerning expected timelines of notifiable disease reporting (Moghadas et al., 2011). Lack of clear agreements between provinces/territories and federal health authorities concerning time lines for reporting creates confusion, delaying transmission of critical

information or, in extreme cases, resulting in the information not being sent at all (Freidman, 2001; AG, 2008,). Further, a lack of legislation concerning the roles and responsibilities of physicians, regional, provincial, and federal governments creates confusion amongst those involved in notifiable disease surveillance (AG, 2008). This can further delay and complicate the process.

2.1.2.3 Standards

A lack of regulation regarding the standards for the content of infectious disease reporting creates a further barrier to successful national infectious disease surveillance. Reporting standards for infectious disease may vary from province to province on such fundamental issues as level of detail concerning individuals presenting with an infectious disease, timeliness of information, and even what types of diseases are considered as notifiable (AG, 2008). Many physicians are unclear of which diseases are considered notifiable and reportable (Friedman, 2006). Further, many clinicians are unaware about what information should be reported to authorities and the precise reporting protocols and timelines (Friedman, 2006). This incomplete, inaccurate, and late reporting of Information exacerbates problems making it even more difficult for public health officials to effectively monitor and track disease patterns (AG, 2008). Effective monitoring of infectious disease is vital to the prediction, control, and prevention of disease outbreaks and the management of population health (Moghadas et al., 2011).

2.1.2.4 Learning from SARS and H1N1

The shortcomings of the Canadian infectious disease system were highlighted in the 2003 SARS outbreak and the 2009 H1N1 pandemic (Moghadas et al., 2011). During the SARS

outbreak, public health officials did not get the information that they required because of widespread confusion about exactly what information they required (AG, 2008). Further lack of clarity about correct information sharing procedures and the responsibilities, requirements, and expectation of each actor in the system exacerbated this confusion. As a result, public health officials received inaccurate and incomplete information and were unable to successfully track reported cases and properly establish patterns of disease spread. The lack of clarity on the roles and functions of regional, provincial, and federal governments made public health collaboration difficult (Health Canada, 2003). No single, coordinated and maintained database existed to facilitate the effective sharing of information and so information was not received or analyzed in a timely manner (Health Canada, 2003). Lack of an effective surveillance system meant that there was a delay in reporting a potential outbreak to the World Health Organization (WHO) (Health Canada, 2003).

The 2003 SARS outbreak underscored the need for a comprehensive, strengthened infectious disease surveillance system. The system in place in 2003 demonstrated that it could not provide adequate response to an epidemic event and that significant changes must take place to implement a system capable of handling any large scale epidemic event in the future (Health Canada, 2003). As a result, in March of 2004, Canada Health Infoway was given \$100 million in funding by the government of Canada to develop of a pan-Canadian electronic health surveillance system that would be capable of “the collection, collation, analysis, interpretation and dissemination of routinely collected health surveillance data through the integration of business processes, standards, information and communications technologies to guide public health action generally and to manage infectious diseases specifically”(KPMG, 2009). This

surveillance system is called Panorama Unfortunately, local, provincial, and national systems have not demonstrated a significant coordinated improvement since 2003: this was demonstrated through the handling of the H1N1 pandemic, where many of the same issues existed (Moghadas et al., 2011). To date, the Panorama project has yet to be effectively developed, implemented, and adopted at a provincial/territorial level, and complete federal implementation seems unlikely in the near future. Promising developments in the use of health information technologies in infectious disease surveillance, specifically EHR technologies, represent the most promising potential solution to the shortcomings of the current system (Calderwood et al., 2010; Khiabani et al., 2010) .

2.2 Electronic Health Records

2.2.1 Definition

In order to properly contextualize this study, it is important to understand the difference between an electronic medical record (EMR) and an electronic health record (EHR). Although the terms are often used interchangeably, the two terms, in fact, describe two distinct things. Although separate items, it is important to note that an EMR is a form of EHR technology.

The term electronic medical record (EMR) describes an electronic records keeping system that exists within an isolated, individual health care setting, for example within a single physician's practice (Amatayakul, 2009). The EMR is a standalone system that exists at the patient-provider level (Kondro, 2011). EMRs contain information regarding an individual's health information and can be used to aid in diagnosis or treatment of a patient, booking

appointments and facilitating communication between patients and clinicians (Amatayakul, 2009; Kondro, 2011). The information contained in an EMR can only be accessed by authorized clinicians in the health care organization that owns and operates the EMR system (Lowes, 2004).

An electronic health record (EHR) is an electronic record keeping system that provides longitudinal patient information and is interoperable and accessible between multiple health care settings (Amatayakul, 2009). The term EHR is often used to describe the electronic infrastructure that allows for EHR data to be exchanged across many different health care settings. Where the EMR works to facilitate communication between patients and providers in an isolated setting, the EHR conversely allows for communication between multiple individuals across multiple different levels of care (Amatayakul, 2009). The information available in an EHR, as opposed to that in an EMR, can be available not simply to health care providers, but also researchers and policy makers (Kondro, 2011).

2.2.2 EHR Adoption and Implementation in Canada

The implementation and adoption of EHR systems has been identified as a necessary step in the advancement and amelioration of the Canadian health care system (McGinn et al., 2012). Although the benefits of EHR systems have been widely identified, their implementation and adoption has been quite slow.

The benefits of the using the internet and electronic resources to improve health care was first identified in 1994 by the Information Highway Advisory Council of the federal government. The Advisory Council on Health Infostructure was formed in 1995 to inform and

advise the Canadian government on the need for a national health information system (Morris, 2005). The government allocated \$50 million dollars over a period of three years, starting in 1997, to develop a National Health Infostructure (Morris,2005). In 2000, the Canadian government invested an additional \$500 million to develop Canada Health Infoway. In 2003 and 2004, further investments of \$600 million and \$100 million, respectively, were allocated to fund Infoway (Canada Health Infoway, 2009). Canada Health Infoway, a non-profit organization, is charged with accelerating the adoption and implementation of health information technologies nationwide. In addition, Canada Health Infoway is responsible for providing funding to the provinces and territories for the adoption of health information technologies (CHI, 2009). At the outset of the project, the main two elements of Infoway's mandate were as follows:

- i. Every province and territory will institute new health information systems by 2010.

These systems will benefit the populations of the provinces and territories and will aid in the transformation of the health care system on both a provincial and national scale; and

- ii. Fifty percent of all Canadians will have their own EHR available to their health care providers by 2010, and implementation [of these EHRs] will be completed by 2016 (Minister of Public Works and Services, 2010).

To achieve this mandate, Infoway provides funding to the provinces and territories on a first come first served basis. This funding is provided to the provinces and territories and can represent up to 75% of the costs of developing and implementing health information technology (MPWS, 2010).

As well as providing funding, Infoway assists by providing technical expertise in the planning phase and the implementation of health technologies. In 2003, Infoway released the EHR Solution Blueprint. This document, developed in partnership with the provinces and territories and subsequently revised in 2006, was produced to guide the implementation process nationwide (MPWS, 2010).

Unfortunately, despite funding and other initiatives by the government and Canada Health Infoway, the adoption and implementation of EHR technologies in Canada has proven to be a slow, complex process. In March 2009, Infoway stated that only 17% of Canadians live in an area that has access to a fully functioning interoperable EHR (MPWS, 2010). In fact, less than 40% of Canadian physicians reported using some form of EHR system in 2011 (Kondro, 2011).

On an international scale, Canada's progress in the adoption and implementation of EHR lags behind that of other developed nations (Archer & Cocosila, 2011; Rozenblum et al., 2011). According to a recent WHO report on e-health developments world-wide, Canada ranked 21st in health information technologies (Webster, 2011).

2.2.3 Barriers to the Implementation of Electronic Health Records

The implementation of a fully interoperable EHR system in Canada has yet to become a reality (Infoway, 2009). Key barriers to the implementation and adoption of EHRs include issues relating to technological, financial, political, human and security concerns (Deutsch, Duftschmid, & Dorda, 2010).

2.2.3.1 Technological Barriers

Technological barriers present a major roadblock to the implementation and adoption of EHR technologies (McGinn et al., 2011; Miller & Sim, 2004). At a base level, health care settings may lack the infrastructure to implement EHR technologies. Slow system speed and unexpected system outages are commonly experienced concerns by health care providers attempting to implement these systems (McGinn et al., 2011). This problem is further exacerbated in rural communities where access to high-speed internet capable of supporting EHR systems may still be limited or non-existent (Anderson, 2004).

In addition, many smaller operations lack the technological means of supporting EHR initiatives: they lack the technological ability and education to maintain and upgrade complex IT based solutions of this nature (McGinn et al., 2011). Many physicians have cited the ease of use of technologies and their reluctance to invest valuable time learning new electronic systems as a major barrier to the implementation of EHR systems at a clinical level (Anderson, 2007). End users of EHR systems may not be familiar with utilizing electronic systems in their practices (Griever, 2011). Software may be perceived as complex and somewhat daunting when first introduced, and concerns that, once the system has been learned, the technology will become rapidly outdated, negatively affect buy-in to EHR systems (Miller & Sim, 2004).

2.2.3.2 Financial Barriers

Financial issues are a commonly cited barrier to the adoption and implementation of a fully interoperable electronic health records systems (Pare et al., 2014). Much of the funding for the implementation and adoption of EHR is provided by the federal government through the non-profit organization Canada Health Infoway, which works with the provinces and territories

in investing in e-health technologies (AG, 2010). Funding is provided to the provinces and territories on a first come first served basis (Infoway, 2009). Because of this system, not all provinces and territories may receive equal amounts of financial support or may receive no support at all if they delay too long in applying. A lack of equal funding means that not all provinces and territories are at equal stages of implementation, which delays implementation and prevents coordinated development of a national EHR system (AG, 2010).

At a clinical level, large initial start up costs and lack of funding for EHR systems are frequently cited barriers to implementation (McGinn et al., 2011). Health care providers uncertain at the outset of the real benefits of EHR systems to them as individual practitioners and uncertain of the potential for acceptable returns on their investment are less likely to want to invest in an EHR system (Miller & Sim, 2004). Unexpected costs associated with implementation and adoption of EHR, such as system maintenance, additional software modules, training costs, and hiring of extra staff, represent further roadblocks to the clinical adoption of EHRs (Greiver, 2011). Problems with lack of funding are further exacerbated in rural settings or small to medium sized hospitals and clinics that may not have enough access to fund such endeavours (Ajami & Bagheri-Tadi, 2013).

A lack of financial support for physicians during the implementation phase is another common financial barrier to the implementation and adoption of EHR systems. Physicians, paid on a fee-for-service model, may be unwilling to take extra unpaid time to learn to use complex EHR systems when they could be investing their time seeing patients and earning a return for services (Miller & Sim, 2004).

2.2.3.3 Political Barriers

There exists widespread dissatisfaction with political support for and inaction in the development of e-health and EHR technologies. This political dissatisfaction and the perception of many health care professionals and e-health experts that Infoway has been unsuccessful in their endeavours to implement health information technologies has further hampered progress with EHR technologies (McGrail, 2010). Concerns regarding government spending and a lack of results leads individual practitioners to be apprehensive about buying into EHR systems (Kondro, 2011). The lack of a federal watchdog to monitor spending and implementation initiatives is a further source of concern for many stakeholders involved in EHR implementation (Webster, 2011).

The lack of local, provincial, and federal policy concerning allocation of funding for EHR initiatives makes it unclear who is accountable for appropriate spending and allocation of available funds. A lack of policy, outlining technical standards of system capability and interoperability of EHR programs, means that, although various EHR systems may be implemented in health care settings, they may not be capable of communicating or interfacing with one another, making information sharing across regions difficult and making the reality of a national integrated EHR system more difficult to achieve (Rozenblum et al., 2011).

This lack of clear policy and standards has allowed a multitude of EHR vendors to offer disparate systems that all purport to support the needs of individual practitioners, but that fail to meet reasonable standards of interoperability (Rozenblum et al., 2011; Valdes, Kibbe, Tolleson, Kunik, & Petersen, 2004). This problem is further exacerbated as many EHR vendors share very little system information about product on their websites, nor do they offer a free

trail of their programs, generating apprehension among users who cannot afford to waste valuable time and resources trying to resolve issues with system interoperability that could have been solved by sound policy decisions and the implementation of rigid standards (Yeung, Jadad, & Shachak, 2013). Sound policy that sets clear goals and expectations regarding the sharing of health information, and defines frameworks for data sharing is important for the development of data standards (Salzberg et al., 2012).

2.2.3.4 Human Barriers

Ultimately, humans must use any system and EHR is no different. Difficulties with use, overly steep or demanding learning curves, or any of a host of other negatively emotional experiences with the product will generate resistance on a human or personal level by health care professionals or anyone else tasked with using EHR systems (Archer & Cocosila, 2011). Such resistance will become a significant barrier to adoption of EHR systems. Many health care providers who already feel strapped for time in their daily activities may be unwilling to allocate time to learn to use EHR technologies (Anderson, 2007). Further, many health care providers may not have high levels of technological literacy and may find the use of electronic systems somewhat daunting (Ajami & Bagheri-Tadi, 2013). Faced with the prospect of developing basic computer literacy skills may overwhelm some users, reinforcing the suggestion that EHR systems are difficult to use (Griever, 2011).

A lack of leadership in EHR implementation and adoption presents another challenge. Without the presence of a champion, an individual who is familiar with the system and can help others learn the system, it is easier for those involved in implementation and adoption of systems to become discouraged and use the system less (Miller & Sim, 2004). Without the

presence of a strong leader, implementation may take longer and be more difficult (Greiver, 2011).

Resistance to change presents another human road block in the implementation and adoption of EHR systems. Many health care providers, especially those who have practiced for a long time, may feel that the system they have always used functions adequately (McGinn et al., 2011). They may be unwilling to try implement and adopt a new system in their practices for fear that it may disrupt the quality and efficacy of patient care (Miller & Sim, 2004).

2.2.3.5 Security Barriers

Security and privacy concerns are one of the most discussed barriers to the implementation and adoption of an interoperable EHR system. Many systems have been put in place to deal with security and privacy issues. One such system is the Personal Information Protection and Electronic Documents Act (PIPEDA). Introduced in 2000, the act was introduced to protect individuals from having their personal health information disclosed, collected, or used by private sector organizations (Canadian Department of Justice, 2000). The Pan-Canadian Health Information Privacy and Confidentiality framework was introduced in 2005 by the Canadian government to provide a framework to further govern the use, collection, and sharing of an individual's private health information by public and private health care organization (Health Canada, 2005). The framework contains many of the core components of PIPEDA as well as providing solutions to issues that exist in PIPEDA. Further, it ensures that a patient's health information is only used on a "need to know" basis and that the privacy and security of health care users is safely protected (Health Canada, 2005).

Despite these initiatives, privacy and security remain a key concern to many

stakeholders involved in the implementation and adoption of EHR systems. Concerns regarding safety and security of EHR systems is shared amongst health care providers and patients alike (McGinn et al., 2011). Many feel uncomfortable with multiple providers having access to their records as this may increase the frequency of inappropriate use of their information (Perera et al., 2011). The perception of diminished security inherent in electronic systems compared to traditional paper files may present a barrier to acceptance of EHR by health care providers and patients. The concern increases with the sharing of information on an internet platform accessible to multiple health care providers (Anderson, 2007). Patients have expressed concerns with access by secondary users to non-anonymous, identifying information that they have not explicitly consented to share (Perera et al., 2011).

2.2.4 Benefits of Electronic Health Records

The successful implementation and adoption of EHR presents the opportunity for advancement and improvement in many different areas of the health care realm. The potential far-reaching benefits of EHR include improvements in administrative, financial, clinical, research, public health coordination, and health policy (Archer & Cocosila, 2011; Binns, 2004; Denomme et al., 2011; McGinn et al., 2011; Miller & Sim, 2004; Perera et al., 2011; Rozenblum et al., 2011; Valdes et al., 2004).

2.2.4.1 Administrative

The implementation of interoperable EHR technologies presents many benefits in administrative areas of health care. EHRs can cut down on the amount of clerical time spent by physicians on administrative tasks (Miller & Sim, 2004). EHR technologies, operating on a standard technological basis, allow real-time sharing of patient information amongst health

care providers such as physicians, physiotherapists, imaging professionals and pharmacists (AG, 2010). EHR technologies can ensure that complete, accurate, legible requisitions or results are forwarded to those who need them quickly and automatically, creating greater efficiency and resulting in less time spent on administrative tasks (Miller & Sim, 2004).

Scheduling and messaging functions of EHRs can allow clinical administrators and physicians to easily and effectively set up appointments and communicate with patients regarding their care (Denomme et al., 2011). Billing functions of electronic health records assist health care providers in submitting documentation concerning billing and can greatly cut down on time spent on such functions (Miller & Sim, 2004). By reducing overhead and clerical costs, EHR systems present opportunities to reduce non-medical patient care costs (Desmartis, 2010).

Lastly, EHR technologies provide benefits in administrative areas of health care as the interoperable, electronic nature of EHR technologies means that a complete, accurate patient history is available to those involved in a patient's care instantly (McGinn et al., 2011). This means that less time can be spent on tasks such as finding charts and sending them to the individuals that need them.

2.2.4.2 Financial

Financial benefits are one of the major benefits of the successful implementation and adoption of electronic health records. Financial benefits of electronic health records can be realised at micro, meso, and macro levels of the health care system. EHR technologies offer the potential to increase efficiency and improve organization within clinics (Miller & Sim, 2004). An efficient interoperable EHR system allows for a complete electronic record of a patients history

to be stored in an internet based electronic infrastructure, no longer relying on individual machines or physical files in one location (Archer & Cocosila, 2011). The EHR contains all of the tests, procedures, and medications that a patient has been prescribed and can provide linkages to information about these procedures and medications in a 'one stop' fashion. The accessible nature of this record can cut health care costs by reducing incidences of needless duplicate or repeat tests and procedures currently conducted by health care professionals without access to prior patient records held by other practitioners (Valdes et al., 2004). In traditional paper based systems, results are often misplaced, lost, destroyed, or forgotten and end up being duplicated needlessly.

EHR technologies are also financially beneficial as they have been shown to decrease medical errors. Medical errors represent a major cost to the Canadian health care system and can often be easily avoided using EHR or health information technologies (Morgan, 2012). Medical errors are often caused by miscommunication between health care professionals, incomplete patient histories or information. The nature of EHR systems allows for automated forwarding of results to those who need them, which allows for increased and more accurate communication between health care providers and increased accuracy of patient care. The clinical decision support aspect of most EHR technologies can also provide alerts to physicians if they are prescribing a medication or treatment that conflict with something in the patient's history (Miller & Sim, 2004). This can also contribute to lower rates of medical errors and cut down on financial costs to the health care system. Reduction of medical errors results in more effective patient treatment and reduced liability costs (Thompson, Velasco, Classen, & Raddemann, 2010).

2.2.4.3 Clinical

Clinical areas of health care have a lot to gain from the implementation and adoption of a fully interoperable EHR system. EHR technologies assist in clinical settings enhancing communication amongst health care providers, as well as between providers and patients (Orchard, Dobrow, Paszat, Jiang, & Brown, 2009). The availability of patient health information, regardless of location, facilitates communication and coordination of information regarding a patient's care (McGinn et al., 2011). This enhances the ability for collaboration between all involved in a patient's care. Communication between patients and clinicians is also increased by EHR technologies (McGinn et al., 2011). The accessibility of information contained in an EHR means that providers can pull up information regarding a patient's care without having to search for results or missing pieces of information (Miller & Sim, 2004). In addition patients are able to feel more involved and informed regarding their care.

Enhanced communication allows for more efficient delivery of care. Enhanced communication and collaboration of health care providers provided by EHR technologies coupled with the order-entry systems and clinical decision support aspects of many EHRs help to reduce medical errors. Medical errors, such as prescription errors and contraindications, can be greatly reduced due to the accessibility of and the complete record contained in the EHR (Miller & Sim, 2004). Medical errors represent a large financial strain on the health care system and greatly affect the quality of care that an individual receives (Morgan, 2012). Should a medical error or adverse incident happen, the use of EHRs allows health care providers to react faster because of the availability of complete patient information. Fewer medical errors and a

faster response to adverse incidents means that patients spend less time in hospitals or care facilities and helps to reduce wait times.

Electronic health records systems can have significant benefits in management of chronic illnesses and follow-up patient care. More complete, accurate, and legible patient records afforded by the use of EHR technologies means that health care professionals are able to monitor chronic diseases and their trends effectively over a period of time (Miller & Sim, 2004). This allows medical practitioners to act proactively, developing treatment strategies to deal with anticipated future problems before they manifest themselves. In addition, individuals with chronic conditions who interact with and receive care from multiple health care professionals can benefit from a coordinated approach allowed when all providers interacting with the same patient can input information into one single repository instead of having information contained in separate silos (Morin et al., 2005). Coordination of information amongst providers allows for a faster and more effective quality of care. EHR technologies can also be used to involve individuals with chronic conditions in their own care, providing them with a sense of empowerment through education and a sense that they are a participant in their own care regime.

2.2.4.4 Research

Although frequently overlooked as a true benefit of EHR systems, they offer tremendous potential as a research tool (Marriott, 2012). An EHR system presents a unique opportunity to gather a rich longitudinal history of an individual's illnesses, medication histories, demographic information, and family health histories. The information found in an EHR provides a rich, diverse data set that is an invaluable source of information for health researchers (Guilbert et

al., 2012). Through data mining procedures, information from EHRs can be used to track and study disease co-morbidities, drug interactions, disease determinants, and treatment outcomes (Apte et al., 2011; Calman, Hauser, Lurio, Wu, & Pichardo, 2012). This information can be invaluable for developing new treatments and further understanding and evaluating clinical treatments. Research using EHR data could be used to inform public health policies and improve population health (Calman et al., 2012). The information contained in an EHR is also a valuable source of information for public health officials and disease surveillance.

2.3 Potential of Electronic Health Records and Public Health

An interoperable electronic health record presents a unique, promising opportunity for public health, specifically infectious disease surveillance. The detailed nature of the information contained in an EHR is invaluable to public health officials for the effective monitoring, prevention, and control of disease outbreaks. EHR technologies can be used to detect monitor, control and predict both chronic and infectious disease (Calman et al., 2012). In order for the successful interface between EHRs and public health to occur, public health uses of health information need to be considered when developing public policy (Zinszer, Tamblyn, Bates, & Buckeridge, 2013).

2.3.1 Chronic Health

EHR technologies can be used to improve public health through the monitoring, detection and prevention of chronic conditions. As previously mentioned, EHR technologies can be essential to improving the quality of care received for chronic conditions, improving overall

population health (Orchard et al., 2009). Data from EHR systems can be used to identify chronic diseases such as diabetes and cardiovascular risk (Green et al., 2012; Kennedy, Wiitala, Hayward, & Sussman, 2013; Klompas et al., 2013). In terms of cardiovascular health, studies have demonstrated that information contained in an EHR can be used to calculate risk of an adverse cardiovascular event (Green et al., 2012; Kennedy et al., 2013). Success has also been found in identifying diabetes indicators from EHR databases (Klompas et al., 2013). This information and the ability to identify individuals at risk of developing a chronic condition means that steps can be taken to treat individuals promptly and possibly preventing the development or lessening the ultimate impact of a chronic disease (Klompas et al., 2013). Early detection of individuals at risk for worsening states of chronic disease means that treatment can be adjusted. More effective treatment and understanding of chronic disease improves the health of the general population, can inform policies surrounding chronic disease and reduce the strain of chronic disease on the health care system (Green et al., 2012; Kennedy et al., 2013; Kennedy et al., 2013; Klompas et al., 2013).

2.3.2 EHR and Infectious Disease Surveillance

The effective surveillance of infectious disease is essential to the health of the population. Since the 2003 SARS outbreak, the improvement of the current surveillance system has been identified as an important priority. The importance of a surveillance system that is nationwide was highlighted by Birtwhistle and colleagues in 2009, who suggested the need for a nationwide electronic system for public health surveillance (Birtwhistle, 2009). The Canadian Integrated Public Health Surveillance system, developed to collect and collect national public

health information, echoes this opinion. CIPHSS highlights the importance and potential of health information systems in enhancing disease surveillance (PHAC, 2007). For infectious disease surveillance to be effective, complete and accurate infectious disease information needs to be available to all public health officials on a near real-time basis (Bellika et al., 2007). Properly designed and managed EHR technologies can be used as a tool to achieve this.

The potential for utilizing EHR systems for the detection of infectious disease has been demonstrated in a small number of studies (Friedman, Parrish, & Ross, 2013). Examination of information from EHR databases from the New York Presbyterian hospital during 2009 influenza epidemic showed that signs of the epidemic could be identified in the EHRs (Khiabani et al., 2010). The use of EHR technology to accurately detect an epidemic could be invaluable to health officials for predicting, managing, and treating potential outbreaks. The use of EHR technology has proven useful in an ambulatory care clinic in Eastern Massachusetts, where health care providers have developed an algorithm to provide live, prospective surveillance of tuberculosis (Calderwood et al., 2010). Further potential has been demonstrated through the development of the Electronic Medical Record Support for Public Health (ESP) by the CDC and Harvard University in the United States, which organizes and analyses raw extracted information from EMRs to identify and track public health concerns (Klompas et al., 2011).

Information such as demographics, laboratory tests and results, prescriptions, imaging, and diagnosis is contained within an electronic health record. The electronic nature of an EHR presents the opportunity for the sharing of complete, accurate information regarding notifiable

disease, on a real-time basis to public health officials(Friedman et al., 2013). For this to occur, information needs to be extracted on an ongoing basis in a standardized fashion and, if necessary, de-identified. A potential interface between EHR and infectious disease is demonstrated in Figure 2.

The efficacy and concerns arising from this potential interface will be explored in this thesis. In this model, information from physician input, other health care providers, lab results,

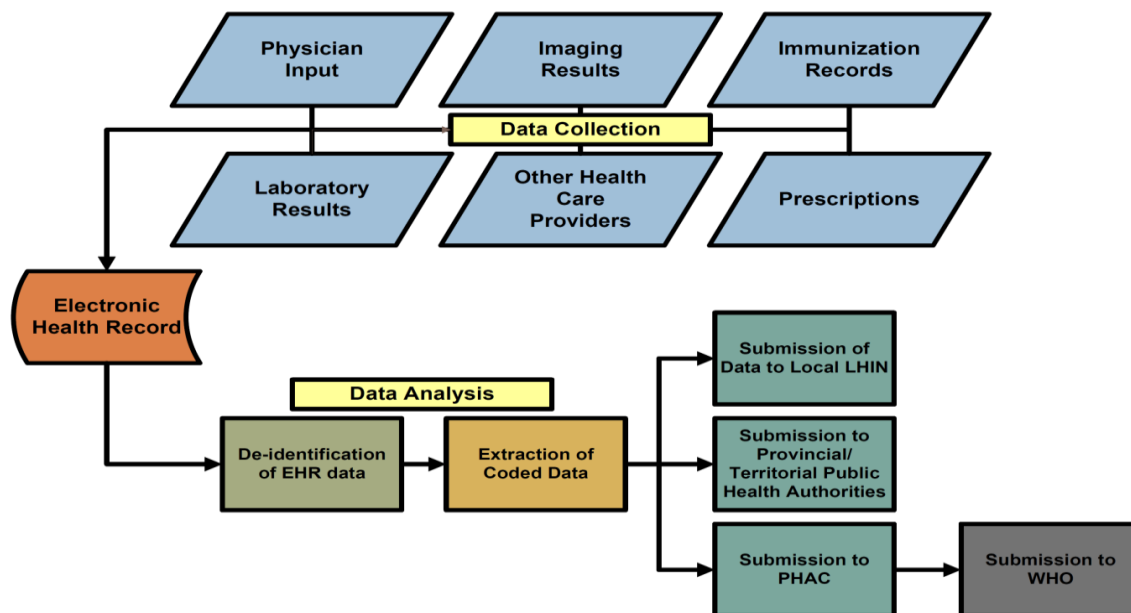


Figure 2: Potential Interface between EHR and Infectious Disease Reporting

imaging, immunizations, and prescriptions are all contained in an EHR. This information can then be extracted and de-identified on a frequent and as-needed basis and passed on automatically to regional, provincial, and federal public health agencies and then on to the WHO should it be required.

The potential of health information technologies, specifically EHR, to improve infectious disease surveillance has been identified in the literature. Although there are a few studies that

demonstrate the successful use of EHR systems for identifying signs of potential infectious disease outbreaks and surveillance of certain infectious diseases, these studies exist only in isolated settings (Friedman et al., 2013). As well, these studies do not explore the issues unique to utilizing EHR technologies in the Canadian health care system. There are also no studies that examine the barriers to implementing such a system in Canada.

2.4 Literature Summary

The existing literature concerning the interface between public health, specifically notifiable disease surveillance, and electronic health records can be summarized in three main parts. These parts are firstly surrounding existing literature regarding notifiable disease surveillance and the Canadian strategy, secondly EHR implementation and adoption in Canada, and thirdly literature concerning the interface between the two. Table 1, in Appendix 1 provides a summary of what we know and what gaps exist in the literature and need to be addressed.

Chapter 3: Methodology

This chapter explains the chosen methodology for this study. Sections will include the study design which outlines data sources, and data recruitment methods followed by an explanation of data analysis and data validation methods.

3.1 Study Design

To provide an answer to the above mentioned research questions, data was collected through a series of semi-structured interviews involving input from key stakeholders knowledgeable about implementation, adoption, and use of EHR technologies for infectious disease surveillance. This methodology is similar to one used by Rozenbloom and colleagues in 2011, to study Canada's experience with the implementation of EHR technologies (Rozenbloom et al., 2011).

3.1.1 Data Sources

To properly understand the benefits and barriers to implementation of EHRs for infectious disease surveillance in Canada, it was important to identify the main groups involved in this process. Participants were selected through theoretical sampling technique and represented individuals from five main sectors of EHR implementation and infectious disease surveillance. The five main groups of participants include:

1. end users (clinicians);
2. public health officials;
3. EHR vendors;
4. health administrators; and

5. academics who study health information technologies.

Participants were identified from government and vendor websites, government documents regarding EHR technologies, and from peer-reviewed, published academic papers. Participants were also identified from documents published by Canada Health Infoway.

To provide a national picture regarding the implementation and adoption of electronic health records and their use for infectious disease surveillance, and to highlight the differences that may exist on a provincial and federal level, participants were selected from Alberta and Ontario. These two provinces illustrate differences in the degree of implementation and adoption of EHR technologies. Alberta has realized considerable successes in advancing and implementing a province-wide EHR system, while Ontario, represents a province that is lagging behind in EHR implementation and adoption (Auditor General, 2010).

3.1.2 Recruitment

As previously mentioned, participants were identified through government and vendor websites, Canada Health Infoway and government documents, and peer reviewed, published papers regarding EHR adoption and implementation. Individuals who were identified as potential participants were first contacted via an introductory e-mail, fax, or letter explaining the purpose and methodology of the study (Appendix 2).

To ensure the response rate from participants was maximized, Dillman's method was used as a basis for the communications plan, with some modifications to reflect University of Ottawa policy and the practicalities of current communication preferences, as shown in Table 2 (Dillman, 2009).

Table 2: Modified Dillman's Method Used in Survey

Dillman	Modified Method
Provide respondent friendly questionnaire	Attach questionnaire to form letter / e-mail but state preference for in-person or telephone interview
4 contacts by first class mail with additional 'special' contact by phone or certified mail	Doctors – 2 contacts by fax (most physicians still prefer fax as primary method of communication). Others – contact by e-mail. Follow up with telephone calls
Use of return envelopes with real first class stamps	Provide online based fax return services; reply e-mail and telephone contacts
Personalized correspondence	Personalized e-mail and fax letter forms (see Appendix 2)
Token financial incentive sent with survey request	Not provided – conflicts with University of Ottawa policy Alternative – provided professional information on LinkedIn for reference

Where possible, participants were first contacted, as mentioned, through an introductory email. If participants did not reply to emails within a week, a follow up email was sent addressing the first email and providing further background to the study. If there was still no response after another week, they were contacted through a final follow up telephone call to address the email and discuss potential participation in the project. Most physicians do not have public e-mail. In these cases, participants were contacted by mail or by fax (see example in Appendix 2). Follow up was also by e-mail and finally by telephone, as described above.

Interviews

Participants who agreed to take part in interviews were able to choose how they would like to be interviewed. These methods included in person, via telephone, Skype / GoToMeeting

or electronic correspondence such as email or fax. Semi-structured interviews were conducted with participants and followed the interview guide shown in Appendix 3. Interviews were thirty minutes in length and were comprised of ten main questions, followed up if necessary with deeper probing questions to gain a more in depth insight into responses. A total of 16 interviews were conducted. In total, interviews were conducted with 4 physicians, 4 academics, 4 public health experts, and 4 administrators. No participants from the vendor group agreed to participate in the study. All interviews, with the exception of those conducted via electronic correspondence, were audio recorded with the permission of participants to ensure that all information discussed in the interviews was accurately captured. All of the audio recordings were transcribed to facilitate data analysis and coding.

3.2 Data Analysis

3.2.1 Methods

Data gathered from interviews was analysed using grounded theory methodology. This methodology, first introduced by Glaser and Strauss in 1967, aims to explain a social situation or phenomenon through the identification of the main processes that occur to drive and influence it (Bryne, 2001). Grounded theory has demonstrated its effectiveness in social science research, and more recently, in health informatics research. In these instances, grounded theory has been used to understand the issues affecting a process and not simply the processes itself. This use of grounded theory was used effectively by Rozenblum et al, who utilized

grounded theory to understand physician perceptions to EHR adoption and implementation (Rozenblum et al., 2011).

Interview transcripts were analysed according to grounded theory methodology using NVIVO 10. Analysis was first on a micro level, meaning that interviews were coded and analysed on an individual basis and then on a macro level. Through the process of constant comparison, interviews were analysed to identify key themes, processes, and categories that emerged (Julien, 2008). These themes, categories, and processes from individual interviews were used to form overall categories on a macro level emerging from the body of interviews. Themes and categories formed include variables that are frequently occurring, explanatory, or that provide insight into key processes (Bryne, 2001 and Chiovitti & Piran, 2003). Constant comparative analysis was used to identify similarities that exist between interviews to provide a deeper understanding of emergent themes and to provide a well-informed answer to the research questions (Mills, 2008). The framework outlined in figure 1 (page 5) was used as a sensitizing concept for the data analysis process.

3.2.2 Data Validation

To provide rigour to this thesis and ensure no bias exists, data was validated using two main methods:

1. Member checking; and
2. Inter-coder reliability analysis

Member checking ensures data reliability through validation of coded themes by checking them with "members" or participants involved in the study (Bryne, 2001 and Chiovitti & Piran, 2003). After the coding of individual transcripts was completed, the main themes and categories that

emerged were shared with at least one interview participant from each category. Participants were asked to provide feedback regarding whether they agree with and can validate coded themes from their interviews. Not only does this allow participants to confirm validity of information gained from their interviews, it also allows for them to contribute any information that they feel was missed during the coding procedure. While there were no instances of participants disagreement with the coded themes, it is important to note that member check was done via email, as participants who had already participated in initial interviews, were unable to give more time for another interview.

The second method that was used to ensure rigour and validity of analysed data was inter-coder reliability (van den Hoonaard, 2008). Interview transcripts were coded independently by both myself and Dr. Deonandan and Dr. Kuziemy. Categories and themes that were coded from the initial round of coding were compared to ensure reliability and more relevant themes were discussed and refined for further coding. In this process the development of main categories was discussed, and codes that were similar but coded differently were collapsed into main codes and themes. Coding was then compared a final time to ensure agreement between coders.

Chapter 4: Results

This chapter summarizes the main results of the thesis. The results are divided into three main sections. The first examines results related to notifiable disease surveillance in Canada, the second to electronic health records, the third to the potential interface between EHR systems and notifiable disease surveillance, and the fourth provides a brief summary of all the results.

The results and findings from the interviews conducted with physicians, administrators, public health officials, and academics are discussed in this chapter. There are no results or findings involving vendors because we were unable to schedule any interviews with them. This issue will be discussed later. To enhance the discussion, I have included verbatim quotes from selected interviews. To preserve interviewee confidence, these quotes are not attributed to the source.

4.1 Notifiable Disease Surveillance in Canada

While citing numerous examples of the strength of the current notifiable disease reporting system, respondents also highlighted some significant weaknesses and needs for improvement that could be addressed by an efficient EHR system, including addressing issues with delays in reporting, timeliness of reporting, and continued use of outdated surveillance systems. These observations were made by all participant groups, with the exception of physicians.

4.1.1 Strengths/ Successes

4.1.1.1 Successful Monitoring Systems

Two administrators, one academic, and one public health official, discussed current successful surveillance systems that have been implemented on smaller scales. On the regional level, one respondent explained the development of an Emergency Department Surveillance System that automatically flagged public health officials when certain disease criteria were met. Another example was the use of EHR technology in Appletree clinics, a system that automatically sends notifiable disease information to and from regional public health officials. On a provincial level, an Alberta respondent discussed the ADSS (Alberta Diabetes Surveillance System), and the Alberta Diabetes Atlas, which represents an example of a surveillance system that successfully, uses electronic data from clinical interactions to construct its disease prevalence models. Despite these successes, interoperability on a more universal scale was identified as an area of concern. The ISIS system in Ontario was also mentioned as a successful database for disease surveillance, however, like the other examples; its inability to effectively transfer data was mentioned as a barrier. Only one physician expressed confidence in the current manual method of disease reporting.

4.1.1.2 Strengths of Current Notifiable System

Two public health officials discussed the strengths of the current notifiable disease system. These officials expressed that the current notifiable disease surveillance systems works fairly well between the local and provincial jurisdictional levels.

“I think infectious disease surveillance, as it is now, in terms of things being reported from a local level to the [provincial] jurisdiction, and then a portion of that being reported federally actually works quite well.”

These respondents expressed the belief that individuals who are required to report information usually understand that they need to and do so.

4.1.2 Weaknesses

4.1.2.1 Delays in Reporting

Delays in reporting of notifiable disease to appropriate public health agencies was discussed by nine participants including four public health, three academics, and two administrators. In their opinion, current manual methods of reporting notifiable disease to public health officials delayed or even prevented the flow of important information.

“... the province gathers records and so on, and somebody keeps track of those records, and sometimes things are reported. Many times they’re not.”

As well, the current length of time taken between a disease being identified as a notifiable disease and its reporting to public health officials was identified as a significant barrier to the efficient reporting of notifiable disease.

“The length of time between the recognition of something reportable and our notification is often dependent on a lot of things that are happening over there. So you get a person into the hospital, for example, with meningitis and they do blood cultures, and, at some point, they’re going to tell the infection control provider. The infection

control provider is going to find out more information, call us, and then we're going to call the hospital back and find out more information about that person to decide how close does this look to meningitis? What do we need to be doing in the community?"

4.1.2.2 Content of Reporting

Three public health, one academic, and one administrator respondents mentioned issues with the content of reporting of notifiable disease to the Public Health Agency of Canada. Participants mentioned that a lack of agreement amongst the provinces on which diseases are considered notifiable creates problems with surveillance, as if each province is reporting different information and some are not reporting certain diseases, effective national surveillance is impossible as information is incomplete. As well, several mentioned that a lack of agreement about what information should be included when reporting notifiable disease, in addition to issues with reporting format, created further barriers to effective surveillance.

"there is no standard for the infrastructure that any given jurisdiction, or any given physician for that matter, uses to collect information and then have to submit the information. And I'm not arguing there should be. I'm not sure what the answer is. The way things are now is everybody uses the infrastructure that they are going to use and then the recipients of the information that need to use it have to deal with the hodgepodge that they get and make it work for them."

4.1.2.3 Outdated Surveillance Systems

One physician and one public health official mentioned frustration with current outdated surveillance systems that they felt were incapable of effectively tracking and

monitoring infectious disease. Difficulties accessing information in current systems was also discussed.

“Our current system is antiquated, and difficult for researchers or ID [infectious disease] personnel to access across sites. Data storage techniques are currently incompatible with each other.”

The public health respondent expressed frustration with the failure of initiatives such as electronic health records in general and Panorama specifically to achieve their promised outcomes.

4.2 Electronic Health Records

4.2.1 Implementation of EHRs in Canada

4.2.1.1 Familiarity with EHR implementation

Familiarity with EHR implementation was discussed by 13 participants including four academics, four administrators, three physicians, and two public health officials. Of the 13 participants who discussed familiarity with EHR implementation, all, except the physicians, were quite familiar with the implementation of EHRs on a national level. The three physicians were familiar with implementation at a more local, clinical level, but unfamiliar with the concepts of systems operating at provincial or federal levels. Many participants expressed that, in terms of implementation of EHR technologies in Canada, we were significantly behind other countries in our roll out of systems. Many expressed disappointment with the lack of a

comprehensive federal implementation strategy and the disjointed approach to comprehensive, wide scale implementation on a national and provincial level.

“... as far as I can gather, the implementation of EHR in Canada is probably the worst of any industrialised western country ... I believe that, frankly, Canada has been the significant laggard in, not only the EHR implementation, but almost anything to do with the implementation of electronic technology to advance care delivery...

Our ability [technological] in the country is fairly low. There are some phenomenal advancements that have been made with specific applications in medical imaging, with digital archiving, and with pathology systems, for example ... recording or pharmacy ordering, etc., but we have a real challenge seemingly organising things between organisations within regions and then across the provincial, certainly across the country. It’s absolutely dismal.”

Participants also cited a few positive examples of implementation of EHR technologies at regional and provincial levels, such as the near complete adoption and implementation of EHR technologies in Barrie, Ontario and the interoperability and connectivity of EHRs in Appletree clinics across the province, showing some promise of success. They noted that some implementation incentives have had positive effects on the implementation of EHR technologies.

4.2.1.2 Experience using EHR

Personal experience using EHR technologies was discussed by all four physicians interviewed in this project. Of those interviewed, three suggested that EHR technologies have

positively affected their practice and have added efficiency to their workflow. In addition, many mentioned that they would not go back to paper charts if they had the choice.

“All I see from using electronic medical records [is that] I couldn’t see myself going back to paper. I think that would be just be ... I mean looking at it now, I think it would be do-able, it would just be a headache. ... I could see things getting ... the follow up getting misplaced, not even getting done. Probably [I] would just forget about something, I mean its so possible ... especially [as] my patient population and practice builds up. ... it would be so easy to just forget about someone or something not getting done. So I think EHR is definitely the way to go. Everyone should probably transfer over to it – specifically a practice [that plans to continue to operate] for a significant number of more years.”

Physicians noted that some EHR technologies are more difficult and less user friendly to use and in those situations believe that lack of experience with the system may present a significant barrier to adoption. Of the physician respondents, one mentioned that EHR technologies and the investment in learning time, technology acquisition, and other financial barriers were too great and that EHR technologies had negatively affected their practice.

4.2.2 Benefits of EHRs

4.2.2.1 Access to Information

The accessibility of information contained within an EHR was the most discussed topic by participants in the study. Accessibility of information was discussed by 14 individuals

including four physicians, four administrators, three academics, and three public health officials. Almost without exception, participants agreed that access to information contained in an electronic health record represented one of the major benefits of an EHR system. Interviewees believed that access to information would positively impact patient care, with the EHR providing a central repository of information concerning a patient's medical history and treatment.

“[with an EHR] you don't miss things because it comes right back into our ... [personal workspace] Every day when I opened up my electronic medical record under my name things pop up – as in labs I ordered for a patient. So it's very hard to miss things. And it's, like, if you're in a paper practice a fax can be misplaced here and there, mail can get misplaced here and there. And it's much quicker that I just see it right away. It's not like I'm waiting for someone to hand me something or fax me something. So much better in terms of not missing things.”

Respondents commented that easy access to patient information allowed faster intervention, more coordination, and better communication between health providers. One academic reported that access to the amount of information contained in an EHR is too vast to be useful and viewed access to vast amounts of electronic health information to be overwhelming and too time consuming to sift through.

4.2.2.2 Workflow

Workflow, the systemic pattern of business activity and processes required to achieve positive results relating to notifiable disease surveillance, and the facilitation of this workflow

offered by effective EHRs was the focus of many interview participants' comments. Impact on workflow was a theme discussed by nine participants interviewed: three academics, three administrators, two public health, and two physicians. They felt that EHR technology enhanced workflow by increasing communication between health care professionals, patients, and public health officials, by creating a more efficient mode of coordinating, sharing, transferability, and through continuity of information. One physician respondent, a member of a large family health team, noted:

“all of the eighty physicians, and all of the members of the Family Health Team and all the practitioners within that have, literally, the same view of the patient. We're all in the same EMR and that creates a lot of value in that ... not only [do we have a] more efficient system, in that it enhances workflow having an electronic system versus paper-based system, but it also effects continuity of care [and] ease of making appointments between different physicians.”

This physician participant commented that the accessibility of information and automated nature of EHR technology would positively affect workflow.

4.2.2.3 Efficiency

Perceptions of efficiency was discussed by three administrators, one public health, one academic, and one physician. In general, respondents thought that EHR technologies increased efficiency at a clinical level.

“... the immediate value is that, you know, instead of paper based it's electronic based. And so an EMR is ... is a more effective tool in doing your ... a physician practice”

As well, respondents thought that the use of EHR technologies for public health purposes increased the efficiency of information sharing between physicians and public health officials. The improper implementation of EHR systems was thought to decrease efficiency.

4.2.2.4 Improvements in Quality of Care

The potential for improvements to quality of care for patients afforded by EHR technologies was discussed by two administrators and one physician. They felt that EHR technologies could significantly reduce errors in patient care. They also pointed out that the ability for systems to alert physicians to potential adverse interactions or to prompt physicians concerning potential health issues would positively affect patient care.

4.2.2.5 Environmental Benefits

One physician noted that the implementation of EHR technologies and their use for notifiable disease surveillance had positive affects for the environment, as electronic technologies provided a greener alternative to traditional paper systems and cut down on waste from such methods.

“having multiple health care provider (HCP) using the same system cuts down on error, duplication, and is a greener alternative to paper charts.”

4.2.2.6 Ability to Monitor Health Care System

The ability to use EHR technologies to monitor trends and issues in the health care system was discussed by one academic and one administrator.

“Another strength would be the ability to be able to monitor the performance of the health system based on the interventions, and being able to do comparisons across the country. In those areas that have got good results and best practices, we would want to try to encourage it in those areas where it might be appropriate to be able to pursue that.”

4.2.3 Barriers to the Implementation of Electronic Health Records

4.2.3.1 Political Barriers

Lack of a Clear Vision

Lack of a clear vision and consistent implementation strategy was identified as a concern by four academics, three administrators, two public health officials, and one physician. Lack of a comprehensive understanding of who is responsible for funding and implementing EHRs at a clinical, regional, provincial, and federal level was also a commonly discussed topic.

“There’s one of two things going on. There’s too many chiefs in the kitchen, or too many chefs in the kitchen and nobody knows who’s in charge, or there’s not enough.”

Fragmented implementation, differing political ideologies and lack of a common agreement surrounding standards across provinces was thought to be a major barrier to the implementation and adoption of EHR systems at a national level. Lack of a clear vision concerning the uses of EHR systems was also discussed by participants. Differing interests by stakeholders into uses of EHR data, means that implemented systems may not all be capable of

the same applications and as a result may not link up or be capable of use for secondary purposes.

Leadership

Leadership was a topic discussed by two public health officials, two academics, one administrator, and one public health official. A lack of leadership on the part of the federal and provincial governments on implementing and leading the adoption of EHR technologies was thought to be a major barrier to the implementation of an interoperable EHR system at a national level. A failure on the part of the government to lead standards development was discussed as well.

“the barrier is the inability, politically, of the country to come together, in other words, all of the provinces to co-operate, and to work towards a common standard and strategy for implementation that might provide for interoperability and exchange of information that can be trusted.”

Lack of leadership by governments to prioritize EHR adoption and implementation, and raise awareness regarding the importance of secondary use of EHR information was a barrier discussed by participants.

Failure of Top Down Approach

One academic mentioned that the top-down approach to the implementation of EHR technologies created barriers to their successful implementation. The top-down approach was thought to prevent adoption of systems by excluding lower level staff from gaining familiarity with systems and promoting its acceptance from within the clinic or other health care setting in

a more 'grass-roots' type of approach, which has seen success in promoting the growth of other technological solutions.

Lack of Trust

Lack of trust in technologies, EHR processes, and government agencies was a concern expressed by a minority of respondents, including one physician, one administrator, and one public health official. They cited lack of trust in government agencies arising from past e-health scandals and a general failure to meet deadlines which they thought presented a significant barrier to the universal 'buy-in' of EHR systems.

"... you hear the same song and dance from them every time they get up to speak and you wonder, "don't they ever catch on?" They're never hitting their deadlines. There's a reason for that ..."

Lack of trust in EHR systems to reliably perform required tasks successfully was mentioned by one physician respondent as a barrier to the adoption and use of EHRs at a clinical level:

"Right now I don't trust any of it, so if I need you to know something, I print it out, go through my [own] paper, my [own] toner [and], my [own] equipment ... and I give it to you [on paper]."

4.2.3.2 Technological Barriers

Accessibility of Information

Although accessibility of information was thought to be a major benefit to the EHR technologies, contributing to their effective use for infectious disease surveillance, participants also mentioned a few barriers associated with accessibility of information. The sheer volume of

information contained in an electronic health record, although accessible, could, in some cases, make it difficult for end users to find the exact information they need. Respondents noted some 'housekeeping' type issues including limitations on who should have access to the information contained in an individual's electronic health record and restricting the content to information that contributed in a useful way to development of viable and complete in-depth patient care information profiles.

"...if there was an emergency, would having all those records really be that helpful?

Probably not, because usually the management of patients in [an] emergency is not about planning the next level of care. I don't need the full record to stabilize a patient. I do need a full record for planning. So I think if it's delayed by a week or two it doesn't make that much of a difference. It's 'par for the course' in Canada anyway."

Usability

Usability was a topic discussed by two public health officials, one administrator, and one physician. Issues such as having to view data and records on a screen, multiple pop up windows, the lack of ability to "spread things out in front of the patient", and the ability of individuals to use EHR systems for secondary functions, not simply as records keeping systems, were thought to provide barriers to the use of EHR systems. The idea that systems are more complicated than needed was also expressed by one respondent as:

"I think the other thing is the systems themselves; they make it harder than it should be.

I think a lot of our systems are still very clunky. They're not really next generation, they're not intuitive. It's certainly not like using your iPhone, let's face it."

Vendor Issues

Issues dealing with EHR vendors were discussed by five participants in the study, with one member of each group, except administrators, discussing the issue. In the administrator group, two participants highlighted the issue. Academics focused on issues of compatibility between existing EMR and health information technologies as significant factors preventing the use of these systems for surveillance or secondary purposes. Other groups identified a lack of trust in vendors and their products. Many individuals felt hesitant about committing to a vendor or system that may not suit their needs, may go bankrupt, or may become obsolete.

“Health Screen went belly-up, bankrupt so Accuro took over some of those clients. Well, those programs don’t speak to each other. So the people that do information migration have had no end of trouble getting it to work smoothly. So I said never [again]. Like actually, if Accuro goes belly-up, I will quit. I will retire.”

Data Volume and Storage

The volume of information from EHR technologies and the storage of information was discussed by five participants in the study, two administrators, one physician, one public health official and one academic. Respondents noted that the sheer volume of information contained in an electronic health record created difficulties searching for information and getting an accurate picture of the data.

“... the other thing of course is the sheer volume of information... too much information almost at once.....So much information, and it’s going to be highly fragmented because it’s not like a sheet of paper... different tables and different databases or different

repositories And so you could have this kind of portal, which allows you to see multiple repositories, but it's not a chronologically integrated view.”

Large volumes of information also presented challenges finding reliable and sufficiently large venues for the storage and housing of the data, providing sufficient redundancy to avoid data loss. Compatibility of data from differing storage methods was also a concern.

Technological Infrastructure

One physician, one administrator and one public health expert cited issues with technological infrastructure as negatively affecting implementation of EHR technologies. Although increasingly reliable, electronic systems depend upon the reliability of critical infrastructure such as high speed internet systems or electrical power supplies. Fear of data loss or corruption in the event of failure of these systems continues to delay the successful use of EMR and EHR technologies.

4.2.3.3 Human Barriers

Workflow

Some participants felt that the implementation of EHR systems at a clinical level could have a negative effect on workflow and was a perceived barrier to the implementation and adoption of EHR technologies. They suggested that, at least in the initial stages, implementation of systems would impair workflow and decrease productivity in clinical settings due to the amount of time required to learn systems, detracting from the clinic's core focus of patient interaction and care. Perceptions of extra work created by new processes was, in their mind, a barrier to the successful implementation and adoption of EHR technologies and not an

improvement in workflow. Additional workload added onto administrative staff and physicians was another barrier discussed by participants. Additional system maintenance time, for example, the requirement to change and clean up data to make it useable for secondary purposes, presented extra work demands that they felt did not justify the perceived improvements in workflow.

Learning

Education and learning demands associated with EHR systems was a common theme discussed as a barrier to the implementation of EHRs and their use for notifiable disease surveillance. Two academics, two administrators, one public health official, and one physician cited learning requirements as a significant concern. The initial time commitment required to gain familiarity with the specific EHR systems was perceived as a barrier preventing implementation and adoption in clinical settings. Many of the physician respondents objected to the extra time taken away from direct patient interaction that would be required to learn how to use EHR systems. Learning and education had more of an impact on older physicians who had learned to practice medicine using traditional paper methods and for whom learning to use an EHR means changing the way they practice. One respondent offered this anecdote:

“... someone shared with me a little story about a guy running along the street with a bicycle under his arm and someone said, you know, “Where are you running to?” and he says, “Well, I’ve got to get to ... I’m late for appointment. I have to run ... it’s about a mile down the road. I have to ... to get there real quick.” He says, “Well, why don’t you use ... your bicycle?” He says, “Well, I don’t have time ... to learn how to use a bicycle.” ... you know, it’s kind of like that’s like EMR. So many physicians, they’re so used to

doing things and they're [so] busy the old way, ... they don't want to invest the time in doing it the new way."

Some respondents also commented that, even if they were already using or partially using EHRs, the need to learn new functions, such as using EHRs for notifiable disease surveillance, presented ongoing barriers and time demands.

Age

Two administrators, one¹ public health official and one physician respondent identified age as a factor adversely affecting the individual willingness to accept EHR technology. Many older physicians, lacking significant basic computer literacy skills, find it difficult to adapt to a computer based system and resist change. Respondents expressed the opinion that in order for EHR implementation and adoption to be fully successful and for such systems to be used for notifiable disease surveillance purposes, older physicians who are used to traditional paper methods of recording may need to retire out of the system.

"As older physicians retire and new physicians that are trained on EMR's start to practice, you know, over time more and more utilization of EMR's will be prevalent."

Lack of Support

A lack of ongoing support for clinicians and administrators after EHR systems are implemented was a significant issue that was discussed by one physician, one academic, and one administrator. Respondents noted that without proper technical and IT support after system implementation EHR systems would actually increase the workload on physicians and present a barrier to the implementation and adoption of EHR technologies.

Willingness to Use

Willingness to use EHR systems both at clinical levels and for notifiable disease surveillance was discussed by two administrators.

“Change management in health care is really, really, really important. Because people are afraid that people are going to die, so it doesn’t matter if the change is this big or the change is this big, the resistance will be the same. That’s what’s so tough in healthcare when you’re writing projects, you don’t exactly know how much change management to make because the resistance to change is so high.”

The administrative respondents noted that physicians’ general resistance to change presented a common obstacle to implementation of EHR systems. Successful implementation plans needed to incorporate change management strategies to overcome this resistance.

Lack of Technological Understanding

Lack of technological understanding was discussed by two administrators, one physician, and one public health official. At a base level, ‘technophobia’, a lack of technological understanding and computer literacy, creates a large hurdle for physicians attempting to implement and use EHR systems in their clinics. Many physicians, especially those from older generations, do not possess even basic computer literacy skills, such as typing , and as a result may find the time required to learn these skills is too large of an investment, detracting from their most important priority, patient care. This gap in technological knowledge creates further issues when it comes to selecting an EMR system to install for use in their clinics.

“the biggest problem with all this is we’re so innocent and we don’t even know what we don’t know, which is more dangerous, and then everybody’s into our business. So Bell or Rogers, then, you know, the college wants one thing, Ontario MD wants another thing, the IT people want another thing, our vendor wants another thing. So it goes on and on and on and on and on, and we’re stuck. And then we’re supposed to sort all this out and run a full practice, full business, and our business runs on numbers. So if we’re not seeing the numbers we’re not making a dime.”

Physicians who may not have a strong technological background may feel overwhelmed by the process of implementing an EHR system in their clinics and the amount of time required to learn the new system and may as a result be hesitant to install and utilize the system in their clinics. As well these physicians may feel hesitant about championing the implementation of EHR technologies to other colleagues and patients.

4.2.3.4 Privacy and Security

Privacy and security issues were a topic discussed by the majority of participants in the study: four physicians, two academics, two administrators, and two public health experts. Many participants expressed the concern that information contained in an EHR had the potential to fall in to the wrong hands and have negative impacts on patient. The potential for a larger volume of patient information to be lost or stolen in electronic form compared to paper form was another theme discussed.

“It was difficult to lose a chart (or a log book) during the paper days; today we can lose charts on 1 million patients with one USB key. This poses particular problems in ID

surveillance; how do we protect the data on AIDS patients, or prevalence rates when the data can so easily fall into the wrong hands?”

Privacy concerns were perceived to be exacerbated when moving from a more localized system at a clinical or regional level, to an externally networked system at a provincial or federal level. As well, the use of information contained in an EHR by secondary users such as public health officials or researchers was an area of potential concern for patient privacy and security. The potential for a larger volume of patient information to be lost or stolen in electronic form compared to paper form was another theme discussed.

Although privacy and security concerns were mentioned as a potential barrier and an area that requires appropriate attention, almost all of the participants who discussed privacy and security issues did not perceive it to be a major issue, nor one that is insurmountable and deserving of as much attention as it gets.

“People are overreacting. It is easy to deal with privacy. We’ve been doing it for years. We’ve been doing it for years on paper, and I’ll admit the paper process is cumbersome and there’s probably an efficiency to be had by doing it electronically... The law is very good, and the law is very clear, about how you do it. A very good mechanism is in place to protect patient privacy.”

Participants stated that concerns surrounding privacy and security issues can be easily and effectively addressed. Further, the belief that patient information was no more secure in electronic form than in paper form was mentioned.

4.2.3.5 Financial Barriers

Financial barriers were a common theme discussed by study participants. 11 out of 16 participants mentioned financial issues as a barrier to the implementation of EHRs and their use for notifiable disease surveillance: four administrators, three physicians, three academics, and one public health official. Upfront technical, program, and installation costs were a commonly perceived barrier to the implementation of electronic health records. Ongoing maintenance costs such as training, IT personnel and technical support were also thought to be significant enough to serve as an impediment to the implementation and adoption of EHR technologies, a fact that was thought to be further exacerbated in rural areas.

“...some of the smaller-, and that’s where Nova Scotia and Newfoundland are still accepting it, because their issue is: “can they afford the operating costs of the system after it’s implemented?” They have no problems implementing it because we’re providing a lot of the funding for implementing it initially, but the annual operating costs for them is what they’re looking at now and saying, can they afford it long-term in light of all the other systems they’ve got and the money they’ve got to spend?”

Respondents considered these barriers to be even more significant in smaller provinces and rural areas.

4.3 Potential of Electronic Health Records and Public Health

4.3.1 Benefits of EHRs and Notifiable Disease Surveillance

4.3.1.1 Access to Information

Respondents commented that easy access to patient information allowed faster intervention, and more coordination and better communication between health providers and public health agencies. They noted that capturing a vast amount of data capable by EHR technologies was valuable in public health and disease surveillance as authorities gain access to a vast amount of health information on a regular basis.

“...I think a lot of the benefit of the EHR is actually how it then interacts with what you do at the point of care. So for that, it’s sort of making sure that my information continuity is better, ... it helps me make management decisions [knowing] that the right evidence is there and it’s as complete as possible. And then it helps with other types of continuity...”

The ability to query the EHR system to find pertinent information, as well as the potential for eventual access to larger data sets were cited by many respondents as additional benefits beyond basic accessibility of information.

4.3.1.2 Quicker Detection of Outbreaks

Two academics and one administrator and one public health expert mentioned the potential for the use of EHR technologies to aid in the quicker detection of infectious disease outbreaks. The availability of information contained in an interoperable EHR was thought to help in the detection of disease outbreaks and identification of spread patterns. Quicker

detection, they felt, would protect healthy individuals and aid government organizations in the development of effective responses, minimizing the scale and extent of disease outbreaks.

“the opportunity to protect the public interest in circumstances in which there are trends or patterns beginning to develop in the clinical indications for disease, be it for surveillance purposes or for purposes of trying to get ahead of the curve on issues such as social behaviour leading to morbid obesity, etc.”

The use of health information technologies for surveillance was thought to be beneficial because of the ability to develop algorithms to identify and model early stages of outbreaks or issues.

4.3.1.3 Identification of Vulnerable or Affected Populations

Potential for the identification of vulnerable or affected populations was discussed by two administrators, one academic, and one public health official. They reasoned that the electronic and longitudinal nature of EHR technologies made it easier to identify individuals who may be behind on preventative screening procedures or vaccines and to provide early intervention before an issue arises. Further, the nature of EHR technologies would allow for the existence of prompts, reminding physicians to check certain patient indicators, such as smoking status, and to take appropriate preventative measures.

4.3.1.4 Population Coverage

Population coverage was discussed by one academic and one administrator. The coordination and interoperability of EHR technologies at a regional level represents a large step in the right direction achieving adequate coverage of patient information for the majority of

patients, presuming that it is only the minority of patients that seek health care services in another region.

“certainly from a local/regional point of view ... people that get clinical services, health services, don’t normally travel very far. So for example somebody living in Hamilton, it’s unlikely they’ll go to Toronto unless there’s some very, very special service they get. So those records get into the hospitals in the Hamilton area and plus their family physician, plus maybe some specialists in Hamilton. So when within a region, those records are interoperable, we’ll be 99% of the way there.”

Respondents suggested that the implementation of Panorama or a surveillance system in five of the provinces of Canada, excluding the Maritimes and territories would provide coverage for the majority of the population of Canada.

4.3.1.5 Potential for Faster Coordination of Information

The potential for faster coordination in the face of an infectious disease outbreak using EHR technologies was discussed by 1 academic and 1 public health official. They suggested that use of electronic data involved in EHRs and the interoperability afforded by them would mean that information can be coordinated and shared faster between health authorities, leading to faster notification and response to notifiable disease outbreaks.

4.3.2 Barriers to Using Electronic Health Records Systems for Notifiable Disease Surveillance

4.3.2.1 Political Barriers

Public Buy-In

Public buy-in into the importance of the use of EHR technologies for notifiable disease surveillance was highlighted as a concern by one administrator. They suggested that lack of awareness and public buy-in to developing surveillance systems using EHR technologies presented a barrier to the use of EHR technologies for notifiable disease surveillance.

“I think the challenges would involve raising the knowledge and awareness of Canadians generally on the importance and necessity of that kind of surveillance and reporting”

Lack of a Clear Vision

Lack of a clear vision and consistent implementation strategy was identified as a concern by four academics, three administrators, two public health officials and one physician. Lack of a comprehensive understanding of who is responsible for funding and implementing EHRs at a clinical, regional, provincial, and federal level was also a commonly discussed topic.

“There’s one of two things going on. There’s too many chiefs in the kitchen, or too many chefs in the kitchen and nobody knows who’s in charge, or there’s not enough.”

Fragmented implementation, differing political ideologies and lack of a common agreement surrounding standards across provinces was thought to be a major barrier to the implementation and adoption of EHR systems at a national level. Lack of a clear vision concerning the uses of EHR systems was also discussed by participants. Differing interests by stakeholders into uses of EHR data means that implemented systems may not all be capable of

the same applications and, as a result, may not link up or be capable of use for secondary purposes.

Foundation

The lack of a solid foundation for the implementation of EHR technologies and concrete strategies for their use for notifiable disease surveillance was discussed by three academics, three public health officials, one physician, and one administrator. The lack of a solid EHR blueprint and implementation at provincial and federal levels was thought to be a barrier for the use of EHRs for notifiable disease surveillance.

“one of the things I remember learning in an IT class a long time ago was that an investment in information technology doesn’t make you a strong player in the game. It only strengthens your position if you’re already strong. So an EMR, EHR is not going to make up for other deficiencies in your system. If you don’t have the right partnerships, if you don’t have the right processes – it doesn’t make up for those things. It can just strengthen an already strong system. But it’s not going to strengthen a weak system.”

In addition, the lack of a solid cohesive strategy for notifiable disease surveillance was thought to further impede the use of EHR technologies for surveillance. At a clinical level, the lack of a solid business and operating plan providing a good foundation for the practice and the lack of good standard processes was thought to be further exacerbated by the introduction of EHR technologies.

Standards

The need for national standards was a theme discussed by nine participants interviewed: four academics, three public health officials and two administrators. Lack of comprehensive standards for the terminology or standard data formats for EHR systems was thought to present barriers to the implementation of an interoperable EHR system. Lack of standards concerning the information reported by the provinces concerning notifiable disease surveillance was also thought to be an important barrier to the use of EHR systems for notifiable disease surveillance. Participants did note that work was being done by provincial and federal levels of government, however, it is not enough and more should be done.

Accountability

Accountability was a theme discussed by three administrators and two public health officials. Administrative respondents were especially concerned with the general lack of accountability and the lack of clarity around who is responsible for the implementation of EHR technologies and the development of standards concerning EHR technologies. Concerns regarding who is responsible for possible security and privacy breaches of EHR systems and their secondary use of information for notifiable disease surveillance and other secondary purposes was also a concern with public health officials.

“What are the issues around privacy of personal information, and what happens if the central database of everybody’s health information gets hacked? Like who’s going to take responsibility for that?”

Legislation

Legislation was discussed by two of the academics included in this study and one public health official. Lack of clear legislation regarding which diseases are notifiable and must be reported was identified as a significant concern at both a provincial and federal level. Respondents also discussed the need for legislation regarding who has access to EHR information, and problems that this creates in workflow of health officials.

“some of the legislation and policies stuff that’s out there that’s actually impacting interoperability. I’d like to highlight a great example. In BC here we’ve had PharmaNet, which is effectively a sort of one of the first electronic health records. It’s provincial; it’s interoperable; it’s only focused on medications – specifically dispensing records. But legislation doesn’t allow a nurse to look at it. And yet the nurses, in their scope of practice, are told to do medication reconciliation, which according to some other documents from the government – they encourage you to use PharmaNet to do that. And yet they can’t look at it. They’re not allowed to.”

Lack of formal reporting agreements compelling provinces to report infectious disease to the public health agency of Canada was thought to be a barrier to the flow of information to public health officials.

4.3.2.2 Technical Barriers

Data Quality

Concerns about the quality of data contained in an electronic health record was one of the most frequently expressed barriers to the use of EHRs for notifiable disease surveillance.

Data quality barriers were discussed by over half of all participants interviewed, including all four academics, three public health officials, two administrators and one physician. Concerns regarding the quality of data entered into electronic records were a notable concern. Errors in data entry, differences in data entry methods, and the potential for errors to be compounded were identified as aspects of concern relating to data quality.

“... the next level up from there is around adoption. So how I use my EMR, how we use my hospital information system. What I end up doing with it in terms of interoperability I’m shooting myself in the foot there too. So I’m putting in bad data. I found in my own electronic record I think it was 34 misspellings of ‘hepatitis’ – and not just me. When we look at it nationally, we’ve seen literally hundreds of ways of documenting diabetes in a large data set across hundreds of practices... this scales out in common conditions where the vendors have said, “Well, you know, make your own data types. Go ahead. Make your own. You asked for it. Here it is.” And now we’ve got all those legacy data [sets] that’s not very useful.”

Concerns with data quality and the potential for compatibility issues arising as systems evolve undermine user confidence in the viability of EHR systems for purposes such as research and disease surveillance.

Data Compatibility

The compatibility of data from differing EMRs and health information technologies was discussed by half of the participants in the study including three academics, two administrators, two physicians, and one public health expert. Difficulties linking up existing EMR systems on a

regional, provincial, and national level were the most frequently discussed issue concerning data compatibility.

“... is it the same system that somebody else has across the hallway or across to another organization? And a lot of the times ... at the moment those systems aren’t connecting. So I have some great examples from research that I’ve done where a cancer clinic, a cancer agency – a large building, lots of equipment, dealing with all the cancer care for a region – which is just across the street from the “regular hospital. They don’t talk to each other.”

The inability to link these systems, because of differing formats and data entry methods, was perceived by most to be a major barrier to utilizing EHRs for notifiable disease surveillance.

Data Loss

Concerns regarding the loss of data was thought to be a barrier to the use EHRs for notifiable disease surveillance by one physician and one academic. Respondents identified that loss of data can be due to technological infrastructure failure, physical damage, trans-generational data loss from upgrading of technologies or conflicting technologies, inadvertent data deletion, computer viruses, and malware or erroneous entries.

4.3.3 Other

4.3.3.1 Panorama

The Panorama system, proposed by Canada Health Infoway as an electronic solution to disease surveillance was discussed by two administrators and one public health official. They noted that the implementation of Panorama, initially started in response to shortfalls to the

notifiable disease surveillance system highlighted by the outbreak of SARS, was behind on implementation. Although Infoway claims that the system will be implemented soon, respondents noted that it has yet to exist as anything but a pilot project, and they expressed some doubt about whether it will actually be implemented.

4.3.3.2 Chronic Care Monitoring

The potential for the EHR technologies to be used for the monitoring of chronic care issues was mentioned by one administrator, who felt that the electronic nature of EHR technologies could permit individual patients with chronic care conditions, such as diabetes, to upload their information and be monitored from home.

“a trend now is that there’s also more chronic disease management systems that are out there now, so for example, in Ontario, people with diabetes are taking their own vital signs on various things, which then get communicated to a central nursing station. And they monitor those things, and if some things are going off whack, maybe they call the patient. .. the person with diabetes can stay at home, hook up some of these devices to them, and the reading goes directly to a central nursing area who then provide advice ... change in medicines and all that kind of stuff.”

4.3.3.3 Hopes for the Future

One public health official, one administrator, and one physician expressed an optimistic outlook for evolution of existing EHR systems, envisioning development of a comprehensive federal and provincial surveillance system that could interface with different EHR systems, creating a viable and efficient public health surveillance network.

“I hope, in the future, we will have a system that works on a provincial and/or federal level and will be able to use the different EMR systems, because I think it’s critical. I think that to be able to have surveillance where, if you want to collect this data, you ... want to provide the results and take action in a timely manner. ... the best way to do that is using electronic health records via the electronic medical records. So I think I’m actually really disappointed that we haven’t [done that already]”

4.4 Summary of Results

The needs of a comprehensive notifiable disease surveillance system in Canada was discussed by participants mainly from the administrative, public health and academic categories. Respondents mentioned the strengths that exist within the current notifiable disease system, as well as reporting many barriers to the successful functioning of the system. These barriers included delays in reporting of notifiable disease information, confusion regarding the content of reporting and the need to update current outdated manual reporting systems.

The potential for EHR systems to support the need for infectious disease surveillance nationwide was discussed by all groups, however the least frequently by physicians. Access to information available in EHRs, the potential for quicker detection of outbreaks, identification of vulnerable or affected populations and the potential for faster coordination of information amongst health care providers and public health officials should an outbreak occur, were all considered to be benefits resulting from the interface between EHRs and infectious disease surveillance.

The political, technological, human, privacy/security, and financial barriers faced by the implementation and adoption of EHR technologies in Canada were commonly discussed themes affecting the use of EHR systems for notifiable disease surveillance.

The results of the study are shown in Table 3 in Appendix 4. The codes from the data analysis process are outlined in the table as well as a count of how many respondents out of each group discussed the codes, out of a possible n=4 for each group. Figure 3 below highlights the key subjects (those discussed 75% of participants in a given group), that were of importance to the different respondent groups.

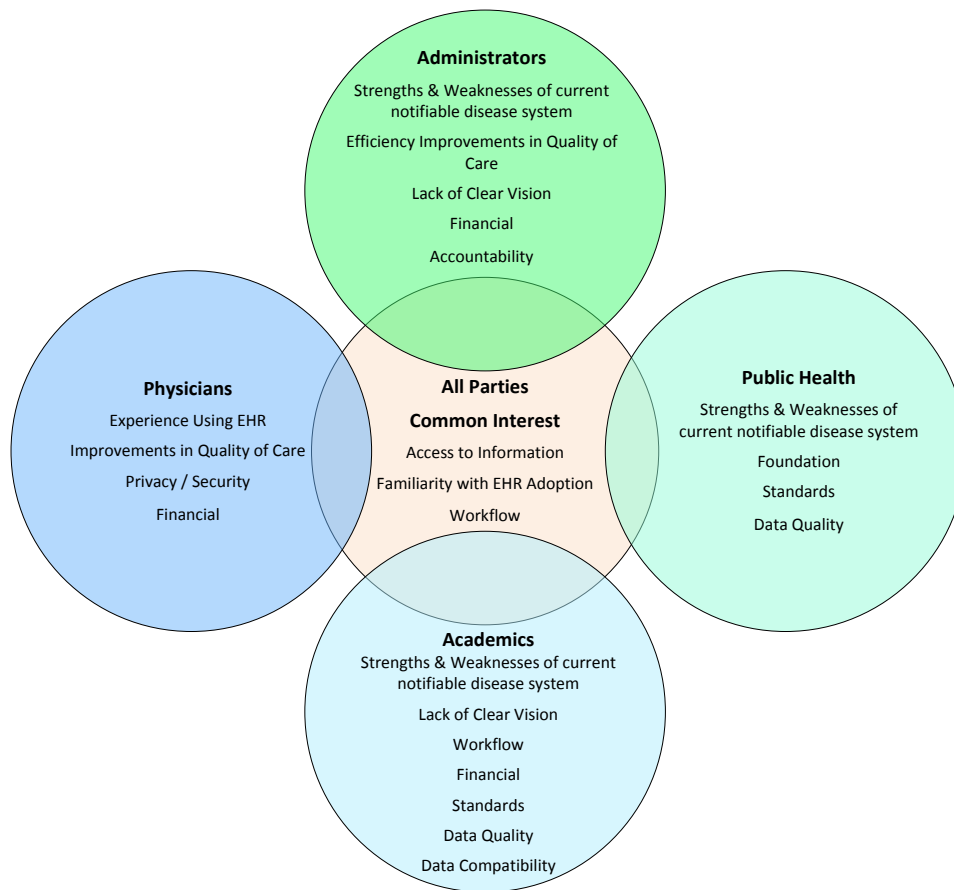


Figure 3: Spheres of Interest in EHR Systems

Chapter 5: Discussion

This section consists of five sections. It starts with a discussion of the findings, followed by a comparison between responses from different participant groups, insights into EHRs and public health, limitations of the study, and finishes with recommendations for future research.

5.1 Findings

This study aimed to conduct interviews with health care professionals to identify some of the high-level needs and gaps that exist within the current notifiable disease surveillance system; to explore the potential interface between health information technologies -- specifically electronic health records-- and public health; and to identify perceived information and coordination gaps that need to be addressed in order to allow a path forward for an efficient EHR system, accepted and used by all levels of health care professionals. Interview participants' comments typically fell into one of the nine categories listed below;

1. Accessibility of Information
2. Current Notifiable Disease Surveillance
3. Workflow
4. Attitudes/Experiences
5. Privacy/Security
6. Financial
7. Technological
8. Governance
9. EHR and Public Health

5.1.1 Access to Information

Not surprisingly, the majority of respondents expressed concerns about the accessibility of information afforded by electronic health records. This study found that respondents generally agreed that the ability of EHR technologies to provide health care officials with a rich, longitudinal, complete view of a patient's history was a benefit. This finding has also been documented in other studies (Miller, 2004). Specific findings in this study, including the perception that the accessibility of information provided by an electronic health record can enhance communication amongst providers at a patient level, increase efficiency and increase sharing of information amongst health care providers was discussed by participants and consistent with the literature (Miller, 2004 ; Orchard, 2009; McGinn, 2011;). Similarly, suggestions from respondents in this study that the potential for easier sharing of a rich data set amongst health care providers, researchers, and public health officials was a potential future benefit of implementation and adoption of EHR technologies was also documented by Calman in 2012 as well. Many interview participants stressed that accessibility and coordination of information was vital to successful surveillance, a theme noted in the existing research (Calman, 2012). An understanding of the importance of the benefits of access to information was of fairly equal importance to all respondent groups. Additionally, some interview participants expressed concerns with the potential for EHR systems to deliver too much information, resulting in them becoming inundated beyond that which is required or useful in patient care in emergency settings. This outcome had not been anticipated at the beginning of this study.

5.1.2 Current Notifiable Disease System

Discussions with respondents, surrounding current notifiable disease surveillance systems, centered on topics such as delayed reporting of notifiable diseases to appropriate authorities, successes of existing monitoring systems, outdated surveillance systems, and the strengths of the current notifiable disease systems. The discussion of delayed reporting of infectious disease to appropriate regional, provincial, and federal public health authorities due to current manual methods reporting methods, mentioned in the Auditor Generals report on infectious disease in 2008, had been an expected outcome, and this study found similar concerns being expressed by respondents in most categories.

It is interesting to note that physicians were the only group of respondents who did not discuss delays in reporting as an issue facing the current notifiable disease surveillance system. This reflects a difference in focus apparent between the physician respondents and the other respondent groups. Physicians are not unfamiliar with issues with the current surveillance systems. In fact, one physician respondent specifically noted that current systems were antiquated and outdated. Physician respondents typically expressed concerns with primary health care at a patient level and perceived benefits and issues with EHR systems in that light. They regarded other capabilities of EHR systems as being of secondary importance and typically responded within their sphere of concern, the primary health care aspects of EHR systems.

Concerns with linkage of smaller scale electronic monitoring systems to EHR technologies was an important outcome of the interview process. One participant mentioned that the clinical organization that they were a part of had an EHR system that has all of its clinics linked up. The system shared information from these clinics and automatically sent

designated information to regional public health officials, providing an example of successful interfacing between EHRs and notifiable disease surveillance. The potential for successful use of EHR technologies for notifiable disease surveillance was consistent with the literature (Calman, 2012; Khiabani, 2010; Calderwood, 2010).

5.1.3 Workflow

The impact of EHR technologies, both positive and negative, on workflow is a commonly mentioned theme in the literature. Many respondents discussed the positive benefits of the implementation of EHR technologies and their contribution to enhanced workflow, increased ease of communication, improved sharing of information, coordination of information, and increased efficiency within their practices. McGinn and colleagues (2011) also documented these benefits in the literature. Lack of time to learn to use electronic systems, training required to learn systems, and resistance to change were all themes mentioned by participants as negatively affecting workflow with EHR implementation and adoption, a finding complementary to the research (Anderson, 2007; Archer, 2011; Griever, 2011).

Although age is a factor discussed both by the literature (Miller, 2004) and respondents, it is interesting to note that some respondents perceived that the successful implementation and adoption of a full EHR nationwide ultimately depended on the retirement of older physicians and the phasing in of new physicians trained on electronic systems. It is important to note as well that young physicians interviewed and those who had successfully implemented and adopted the use of EHRs into their practice expressed that they would not consider going back to paper charts if given the option.

Concerns regarding additional increases to workloads and increased administrative burdens that would be created when using EHR systems for notifiable disease surveillance was expressed by many respondents, particularly physicians. Many physicians, feeling overwhelmed time demands related to the adoption and implementation of EHR technologies, expressed a hesitancy to consider secondary uses and capabilities of EHR systems because of the potential increases to their non-patient interaction workloads. Some respondents noted that system designers need to take this into consideration, focusing on producing systems that are intuitive, quick to learn and demonstrate near immediate benefits to users while fulfilling these secondary requirements vital to the efficient functioning of EHR systems for disease surveillance. In a world of iPhone apps, users expect a seamless interface even with complex systems.

5.1.4 Attitudes/Experiences

The discussion of individual attitudes, knowledge, and perception of EHR systems and notifiable disease surveillance systems, as well as experiences using EHR technologies amongst participants, provides insight into the differences between the groups of respondents. It is not surprising to note that both amongst and within respondent groups, individuals had both positive and negative attitudes, perceptions and experiences concerning both the implementation and adoption of EHR technologies and their potential use for notifiable disease surveillance in Canada.

Physicians, understandably, were the only group of respondents who cited experience using EHR technologies on a daily basis. Nevertheless, they represented the group of respondents who were the least familiar with current strategies implementation and adoption

of EHR systems. This represents an important opportunity for targeted educational interventions.

Negative opinions regarding slow and fragmented implementation and adoption of EHR technologies nationwide, and a lack of trust in governments and vendors by respondents was an understandable and consistent finding of this study. These issues are consistent with the data on EHR implementation nationwide (Webster, 2011). Although many respondents expressed frustration with slow adoption and limited implementation levels, the majority also expressed the belief that an interoperable EHR system will eventually become a reality, although the process may take some time. This is an encouraging finding as it suggests that, despite slow progress to date, numerous negative experiences, and failed initiatives, the implementation of such systems is understood as a necessary driving factor to the advancement of the Canadian health care systems. Generally, respondents understood the value of the secondary use of these systems, suggesting that the benefits of these systems for notifiable disease surveillance is appreciated by all respondent groups.

5.1.5 Privacy / Security

Consistent with the literature privacy and security issues were noted as one of the main barriers to the implementation and adoption of EHR technologies and as a source of concern around the secondary uses of health information contained in these systems (McGinn, 2011; Perera, 2011). Concerns regarding the potential for EHR information and notifiable disease information to fall in to the wrong hands was a common theme of comments from study respondents and existing research (McGinn, 2011). Respondents noted that privacy issues become more complicated when patient information is moved from a clinical level for use by a

public health authority for use in notifiable disease surveillance data and information. This concern was understood but considered to be a manageable aspect of EHR systems used for research or surveillance. This concern has also been discussed by Perera and colleagues (2011).

Issues of privacy were of more concern to physicians compared to any other group. Physicians, more than any other respondent group, interact with patients at a personal level and feel more accountability for their patients' individual privacy. It was somewhat surprising to note that although all groups were aware of and viewed privacy and security concerns to be a barrier to the implementation and adoption of EHR technologies and their use for notifiable disease surveillance, the majority of respondents felt that these issues were not as insurmountable as previously suggested by the literature and other health agencies. Privacy issues may not be the most important barrier to adoption and implementation of EHR technologies. Some respondents suggested that perceptions of "fear mongering" and an overreaction to privacy and security issues have negatively affected public perception of the safety of these technologies and public buy in to them. This has had negative impacts on implementation, adoption, and secondary uses of EHR technologies.

5.1.6 Financial

Financial barriers represented a frequent area of discussion amongst respondents in the study. Current literature dedicates a lot of space to the impact of financial constraints as a barrier to adoption and implementation of EHR technology. Concerns with funding systems at clinical levels, ongoing maintenance costs of maintaining systems, and training costs were all commonly discussed by both participants and the literature (Miller, 2004; McGinn, 2011; Greiver, 2011). The idea that cost impacts are exacerbated in rural areas is consistent with

findings by Anderson and colleagues (2007) and are demonstrated by patterns of implementation on provincial and federal levels. It is important to note that, although financial incentives were mentioned as important in aiding in the implementation of EHR technologies, respondents noted that existing incentives are not adequate to support the ongoing costs of system implementation. Concerns with costs associated with cleaning of data and linking of systems required in an effective systems for notifiable disease surveillance was an important finding and not one commonly found in the literature. Financial costs associated with cleaning or de-personalizing data represents an important barrier to the use of EHR technologies for notifiable disease surveillance.

Not surprisingly, this issue was less of a concern to public health respondents than to other groups more directly concerned with the impact of costs on their combined functioning as health care providers and businesspeople. Public health respondents typically had less personal financial investment in EHR systems and were more concerned with analysis and reaction to data reported by primary health care providers.

5.1.7 Technology

Respondents commonly mentioned themes associated with technology during the interview process. Technological barriers are one of the most commonly discussed barriers to implementation and adoption of EHR technologies in current research (Miller, 2004; McGinn, 2011). Lack of infrastructure to support EHR systems, lack of technological knowledge, rapid advancement of technology leading to rapid obsolescence and outdated systems, and lack of data compatibility are all issues that are frequently discussed in EHR literature (Miller, 2004; Anderson, 2007; McGinn, 2011). It was not surprising that these issues were echoed by

respondents in this study. Issues with vendors such as lack of support, vendors going bankrupt, and lack of information from vendors concerning their products and compatibility were mentioned by respondents as well as by Miller and colleagues (2004). In fact, in the original scope of this study, vendors were to be included; however, after repeated attempts to schedule interviews with member of this group, through repeated phone calls, emails, and cancellations of scheduled meetings, it became apparent that receiving comments from this group was unlikely. A number of respondents echoed similar experiences in attempting to communicate with this group. In a highly technological enterprise like EHR systems, vendor support is critical to success.

Technological issues, whether hardware related, software related, or related to training and support can present barriers to successful implementation and adoption of EHR technologies for notifiable disease surveillance, and left many respondents with strongly negative impressions of the system. Issues with data quality and data compatibility were discussed mostly by public health and academic respondents, the respondents who would stand to gain the most from the use of secondary data extracted from EHRs and understandably more concerned with the usability of this data and the extra time and resources required to clean it, making it useful for research, monitoring and surveillance purposes.

5.1.8 Governance

Perhaps one of the most important themes discussed by respondents in this study was issues with governance concerning both the current national notifiable disease surveillance system and the implementation and adoption of an interoperable EHR system. This concern is echoed in the literature (Rozenblum, 2011; Kondro, 2011; Webster, 2011). Lack of leadership

from provincial governments concerning legislation and policies surrounding infectious disease surveillance and EHR were common in both interviews and with current research (Friedman, 2001; Moghadas, 2011; Webster, 2011; Rozenblum, 2011). Some respondents suggested that the lack consistent leadership, and governance surrounding EHR technologies and notifiable disease surveillance prevented development of a solid foundation on which to construct a successful interoperable EHR system. Respondents noted that government leadership was also needed to avoid continued fragmentation of implementation and adoption methods allowing vendors to monopolize the development of EHR systems, setting their own standards. It is important to note that some individuals did mention that total control by governments is, equally, not a workable solution for the implementation of EHR technologies. A government monopolized system will also be met with resistance from physicians and the public.

Lack of standards on the quality of data contained in EHR systems and reported to public health agencies, lack of legislation concerning data formats and system standards, and lack of legislation compelling health care workers to report infectious disease to the government has created a situation where implementation of EHR technologies has been stalled, leading to incomplete and ineffective notifiable disease surveillance.

5.1.9 EHR and Public Health

Real evidence of the use of EHR technologies as an effective tool for notifiable disease surveillance was very limited in the literature. Respondents in this study commented on the potential interface between EHR technologies and public health but had no anecdotal evidence of its successful use, probably because, as an emerging technology, fully integrated EHR systems have not been tested in real infectious disease outbreaks. The potential for quicker

identification of outbreak detection and monitoring was mentioned by respondents as well as by Calman et al. (2012). Not surprisingly, and consistent with current research, respondents perceived the identification of vulnerable populations and the potential for the monitoring of chronic disease to represent one of the most significant benefits of the potential interface between EHR technologies and public health. While it is encouraging to note that respondents among all categories saw the potential for this beneficial use of EHR in public health sphere, many perceived this as something that would take time and considerable resources to become a reality.

It is interesting to note that perceptions of the Panorama system introduced by Canada Health Infoway varied greatly between respondents from Infoway and respondents in other sectors. This suggests a disconnect between perceptions of those responsible for implementing systems and stakeholders of the systems and further highlights issues of governance and accountability.

5.2 Comparison between Respondent Groups

The most commonly discussed themes (those discussed by three or more respondents) discussed by physicians were accessibility of information, privacy/ security issues, experience using EHR technologies, familiarity with EHR adoption, and financial barriers. Administrators most frequently discussed accessibility of information, lack of a clear vision, familiarity of EHR adoption, workflow, efficiency, financial barriers, and accountability. For academics, the most frequently discussed themes were familiarity with EHR adoption, data quality issues, standards, lack of a clear vision, lack of foundation, data compatibility, financial barriers, workflow, and

accessibility of information. Finally, for public health respondents most commonly discussed themes were delays in reporting, content of reporting, lack of a foundation, standards, data quality, and accessibility of information. These similarities and differences between respondent groups are shown in Figure 4.

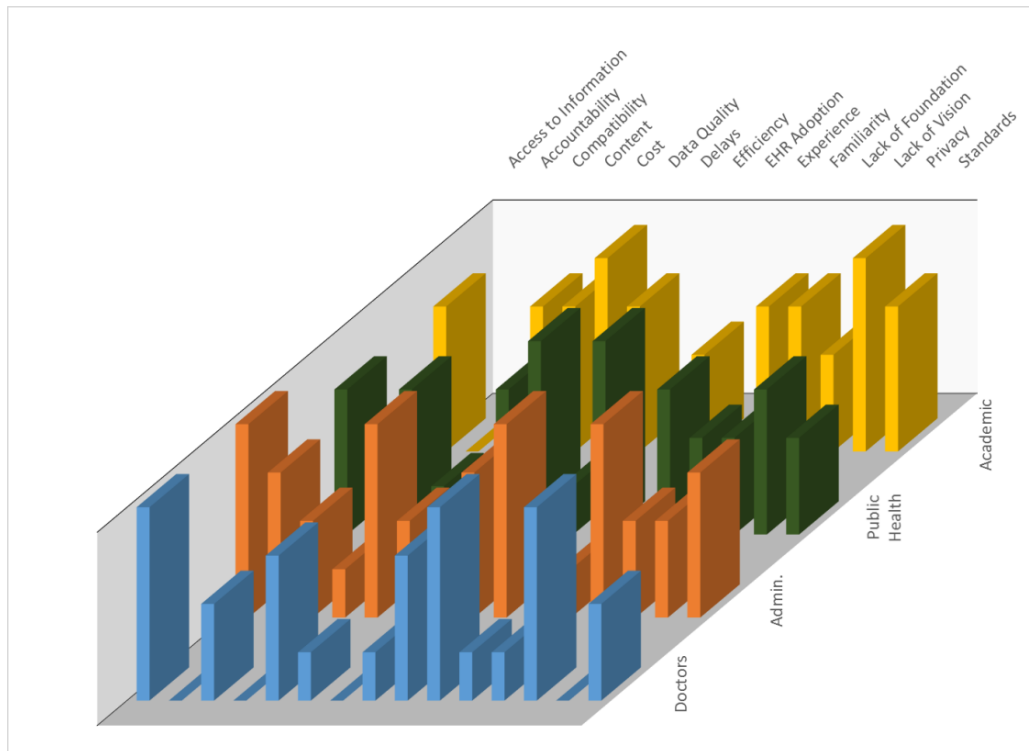


Figure 4: Levels of Interest by Respondent Groups

As previously mentioned, it is not surprising that accessibility of information was a theme discussed by all participants as an important benefit of EHR technologies. Privacy and security concerns were of much higher concern to physicians compared with other respondent groups. Physicians, due to the nature of their jobs, have a vested interest in privacy of patient information and may feel themselves to be representative of patient's interests, unlike other respondent groups. Also unsurprisingly, physicians discussed actual experiences using EHR

technologies more than other groups, which is not unexpected as they are the ones who are currently using these technologies the most, albeit in a more clinic centre approach.

Although, physicians and respondents in academic and administrative categories discussed familiarity with implementation of EHR technologies, none of these groups seemed familiar with implementation on both provincial and national levels. The lack of familiarity of EHR implementation and adoption on provincial and federal levels by physicians and public health respondents is understandable, as both of these groups are not typically involved in provincial and federal initiatives for EHR implementation, unlike the other investigated groups.

Lack of a clear vision and foundation for both the implementation of EHRs and for notifiable disease surveillance systems was discussed commonly amongst respondents in every group except for physicians, suggesting that physicians are more concerned with the implementation of EHR technologies as a tool to enhance their practices at a clinical level, and are less interested and invested in interoperable EHR systems in a nationwide setting, when compared to other respondent groups.

Issues surrounding quality of data and data compatibility were discussed most frequently by academics and public health respondents, suggesting that these issues are of the most important to these two respondent groups than the others. Both groups perceive high quality data as the cornerstone of any effective response to infectious disease outbreak monitoring and consider public health officials as key players in the development of disease spreading models. In their view, without effective, high quality data, responses to outbreaks may be delayed.

5.3 Surveillance and Public Health

The findings of this study provide insight into the barriers and needs that exist within the current infectious disease surveillance system. Lack of governance concerning content of reporting, timeliness of reporting, and the quality of data reported were all mentioned by respondents and highlighted in the research. The current practice, using manual methods of reporting on these barriers, continues to represent a major stumbling block to the successful monitoring of notifiable disease surveillance. The presence of an awkward hybrid of older manual reporting and incompatible EHR technology platforms may, in fact, make this worse. Unwillingness of governmental bodies to enforce standards of reporting, further prevents the successful reporting of disease. Lack of knowledge on the part of physicians about the needs and operation of a notifiable disease surveillance system represents a gap in the successful monitoring process. Understanding of notifiable disease management systems and the importance of taking correct and timely actions to support their optimal functioning is paramount to the operation of a successful system. More effective outreach and education for physicians, as well as development and enforcement of legislation, reporting protocols, and standards would help to bridge existing gaps in notifiable disease reporting.

The original Canada Health Infoway plan (Canada Health Infoway, 2009) presented the potential interface between local EHR technologies and public health notifiable disease surveillance systems as an evolutionary step towards more rapid and effective notifiable disease surveillance.

They suggested that real time, or near real time, access to complete health information would dramatically increase efficiency in coordination of information and communication amongst health care providers, leading to earlier identification and intervention in cases of disease outbreaks. Differences of opinions between respondent groups on the importance of systems for this use suggests that current academics and public health respondents have differing interests than physicians and administrators. This difference of outlook is likely due to physicians' and administrators' perceptions of EHRs as tools to improve clinical practices, and do not realise, or have not had the time to consider, the full potential of these technologies on a larger scale. Although respondents acknowledged the potential benefits of using EHR systems for notifiable surveillance, they expressed a pessimistic outlook about this concept becoming a reality given the current state of EHR implementation and adoption in Canada. More effective governance, educational outreach, standards and leadership are required to create a firm foundation for effective interoperability of systems and the development of a common standard for data usable for secondary purposes.

Coordination at the provincial, territorial and federal government levels to develop a federal standard for EHR implementation, and the use of these technologies for notifiable disease surveillance would contribute significantly to the successful implementation and adoption of EHRs and the potential for notifiable disease surveillance. Increasing awareness of the importance of data quality, interoperability, and the importance of EHR information for secondary purposes such as notifiable disease surveillance amongst physicians and administrators, while ensuring the process does not create excessive workload demands, would

help to increase buy-in from these groups, eventually changing them from detractors to supporters.

5.4 Limitations

One of the main limitations of this study was its sample size. Originally, the study was designed to interview 25 respondents from five differing groups, the four included in this study and vendors of relevant EHR technologies. As a result of the vendor sectors' representatives' unwillingness to participate in this study, their views could not be included in these data. Their unwillingness underscores some of the communication and technological frustrations mentioned by physician respondents describing their experiences trying to implement EHR systems. As a result of vendors not being included in this study, the sample size was initially dropped to 20 participants, or 5 respondents per remaining group. Additionally, extremely low response rates to recruitment processes meant that the sample size had to be dropped to 16 respondents to obtain data in a reasonable time period. Low response rates meant that differences between respondents from different provinces could not be examined.

Since the sample size of this study was small, findings may not represent the general opinions of the groups interviewed. Although possibly a shortcoming, the insight provided through the interview is valuable, providing understanding of some of the issues faced by stakeholders in the implementation and adoption of EHR technologies and their use for notifiable disease surveillance. It should be noted, however, that the purpose of this type of key informant qualitative research is not to allow us to make inferences about a grander reference population, but instead to explore concepts and issues arising from the interviews.

A further potential limitation is the potential for bias in the interpretation of results. However, this was accounted for by intercoder reliability and member checking processes that occurred during the analysis phase of the study.

5.5 Recommendations for Future Research

Future research seeking solutions and insights to governance issues preventing and delaying the adoption and implementation of electronic health records would, of course, be valuable. On a more pragmatic technical level, research seeking solutions and exploring development of effective standards for information and data reporting would suggest solutions to current interfacing issues between EHR and notifiable disease reporting systems. Expanding sample size and mixed methods analysis would help to address these issues.

From an education and communications perspective, valuable research could be conducted exploring methods for engaging older physicians, transitioning them from paper based records to electronic health records and providing them with better understanding of the secondary uses of EHR systems.

System developers and governmental proponents need to consider research into the development of user friendly EHR systems that can achieve the core tasks of data collection in an automatic, standardised fashion while providing the busy physician user with a system that can be easily understood, learned, and maintained.

Chapter 6: Conclusion

For notifiable disease surveillance to be successful, accurate complete disease information must be provided on a real-time basis to the appropriate health officials. The current notifiable disease system that exists nationally does not function optimally. Delays in reporting, data compatibility, and data quality issues represent major roadblocks to the successful functioning of the system. Further lack of governance concerning content, format, notifiable disease status, and timeliness of reporting negatively affect successful notifiable disease surveillance in Canada. EHR systems are perceived as beneficial to notifiable disease surveillance as it is a potential source for rich, real time data concerning notifiable disease that is easily accessible to health care officials. For EHR technologies to be useful in notifiable disease surveillance, the barriers preventing their successful implementation and adoption must be addressed. Without a strong infrastructure, vision, and governance guiding the implementation and adoption of EHRs they cannot be utilised to their full potential for notifiable disease surveillance and other useful secondary functions.T

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Appendix 1 : Literature Review Summary

Table 1: Literature Results Summary

Infectious Disease Surveillance		
	Existing Knowledge	Knowledge Gaps
	Effective surveillance of infectious disease requires information that is: • Complete • Accurate • Timely PHAC is the federal body responsible for infectious disease monitoring and surveillance in Canada Agreements exist between provinces and territories to relay information regarding notifiable diseases outbreaks to appropriate regional/provincial/federal authorities Shortcomings of the notifiable disease surveillance system were highlighted in 2003 by the SARS outbreak, since then little has been done to improve the situation Shortcomings of the current system include • Manual reporting methods • Lack of legislation • Lack of standards	What are the barriers faced by the current infectious disease surveillance system in Canada, specifically of those considered notifiable? What are the successes and strengths that exist within the current notifiable disease surveillance system?

Electronic Health Records		
	Existing Knowledge	Knowledge Gaps
	An EHR is an electronic records keeping system, providing longitudinal patient information and is accessible across multiple health care settings Implementation and adoption of an interoperable national EHR system has been a national vision since 2000, however implementation remains slow, fragmented and lags behind that of most other industrialised nations	What are the barriers that exist to the successful implementation and adoption of an interoperable EHR system in Canada? How are these barriers perceived differently by key stakeholders involved in implementation and adoption? What are the perceived benefits to the implementation of such a system to key stakeholders?

	EHR systems provide benefits in the following areas of health care: • Administrative • Financial • Clinical • Research • Public health coordination • Health Policy Barriers to the implementation of an interoperable EHR system include: • Technological • Financial • Political • Human • Privacy/Security	
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Potential of EHRs and Public Health		
	Existing Knowledge	Knowledge Gaps
	The nature of the information contained in an EHR provides a unique opportunity for the monitoring and surveillance of public health EHR technologies have demonstrated use in the chronic health sector for : • Identification of risk factors • Identification of adverse events • Early detection of chronic disease • Long-term monitoring of treatment • Possible improvements in chronic conditions The need for a national electronic surveillance system for infectious disease is well documented Some demonstrated effectivity in post identification of infectious disease in EHR data Some efforts have been made in micro settings to interface EHR technologies and infectious disease surveillance, larger scale national efforts such as Panorama have yet to become a reality	Can EHR technologies be effectively interfaced with notifiable disease surveillance? What are the perceived barriers to such an interface to key stakeholders? What are the perceived benefits of the interface between EHRs and notifiable disease surveillance in Canada, according to key stakeholders?

Appendix 2 : Recruitment Email and Mailing

Recruitment E-Mail Text:

From: Jessica Scott <email >
Sent: <<date>>
To: Jessica Scott
Subject: Interview Request - Use of Electronic Health Records for Infectious Disease Surveillance in Canada

Jessica F. Scott B.H.S, B.S.S

Dear <<Contact>>,

My name is Jessica Scott, and I am working on an Masters of Science in Health Systems at the University of Ottawa, on the topic of “Perceived Barriers to the Use of Electronic Health Records for Infectious Disease Surveillance in Canada”, under the supervision of Dr. Craig Kuziemyk and Dr. Raywat Deonandan.

The thesis involves interviewing individuals involved in the implementation of Electronic Health Records in Canada including: Clinicians; Public Health Officials; EHR Vendors and Hospital Administrators.

I understand that your office uses electronic health records extensively. I would greatly appreciate it if you would consent to an interview with me, either in person or on the telephone. I have attached the interview, consisting of 8 questions that have been approved by the University of Ottawa Ethics Board. The interview takes about 20 minutes.

I am also looking for additional contacts with vendors, hospital administrators and clinicians for interviews in February or early March. Any assistance would be greatly appreciated.

I would be pleased to make any arrangements that suit your needs and schedule. I can arrange for an in-person interview, an interview using GoToMeeting, an interview by telephone, or if you wish, you could simply respond to the questions in writing. My strong preference would be for some sort of interview. If you wish more information, please contact me by telephone or by e-mail.

Thank you,



Jessica Scott, M.Sc. Candidate

Recruitment Mailing Text:

Dr. XXX

<<date>>

<<Address Block>>

Fax Number: XXX.XXX.XXXX

Dear Dr. XXX,

My name is Jessica Scott, and I am a Master of Science in Health Systems candidate at the University of Ottawa doing a thesis on integrated electronic health records (EHR) for infectious disease surveillance in Canada under the supervision of Dr. Raywat Deonandan and Dr. Craig Kuziemy. You are receiving this email as you have been identified as a key stakeholder in the adoption and implementation of electronic health records in Canada.

I plan to interview a series of key stakeholders, such as yourself, who are recognized as leaders influencing the adoption and implementation of electronic health records in Canada. Individuals from provincial health agencies, electronic health records vendors, public health agencies and health professionals will be included in this study. My hope is that through these interviews I can provide insight into barriers to the implementation of an integrated electronic health records system, that is critical to the development of effective real-time disease surveillance in Canada. Interviews will be approximately 30 minutes in length. This study will attempt to provide answers to the following questions:

- i. What barriers and needs exist within the current infectious disease surveillance system in Canada and how do they prevent optimal functioning of the system?
- ii. What opportunities exist for the use of health information technologies, specifically EHR, in infectious disease surveillance in Canada?
- iii. What are the coordination and information requirements specific to the implementation of disease surveillance using health information technologies, specifically EHRs?

I would be pleased to make any arrangements that suit your needs and schedule. I can arrange for an in-person interview, an interview using GoToMeeting, an interview by telephone, or if you wish, you could simply respond to the questions in writing. My strong preference would be for some sort of interview. If you wish more information, please contact me by telephone, by return fax, or by e-mail). In addition, I would greatly appreciate your referral to any other individuals that you believe could contribute to this study.

Thank you,

Jessica Scott

Appendix 3: Interview Guide

1. Are you familiar with the current state of electronic health records adoption and implementation in Canada? Please describe.
2. What is your function, with respect to the implementation and adoption of EHR in Canada?
3. What do you perceive are the main benefits to the implementation of an interoperable HER system?
4. What potential challenges can you identify to the successful implementation and adoption of an integrated EHR system in Canada?
5. Given what you know about the current infectious disease surveillance system in Canada, do you perceive any issues or problems with the current system?
6. Do you think that EHR systems can help with infectious disease surveillance and help to address these problems?
7. What barriers can you identify for the use of such a system for disease surveillance?
8. What role do privacy and privacy issues play in the successful adoption of EHR for such a purpose?
9. Do you believe a fully integrated EHR, that is capable of being used for disease surveillance and public health purposes would be beneficial? Why or Why not?
10. Is there anything you would like to add?

Appendix 4: Results Summary

Table 3: Notifiable Disease Surveillance in Canada

	Physicians	Administrators	Public Health	Academics
Strengths				
Successful Monitoring Systems	0	2	1	1
Strengths of the Current Notifiable Disease System	0	0	2	0
Weaknesses				
Delays in Reporting	0	2	4	3
Content of Reporting	0	1	3	1
Outdated Surveillance Systems	1	0	1	0

Electronic Health Records

	Physicians	Administrators	Public Health	Academics
Implementation of EHRs in Canada				
Familiarity with EHR implementation	3	4	2	4
Experience Using EHR	4	0	0	0
Benefits				
Access to Information	4	4	3	3
Workflow	2	3	2	3
Efficiency	1	3	1	1
Improvements in Quality of Care	1	2	0	0
Environmental Benefits	1	0	0	0
Ability to Monitor Health Care System	0	1	0	1
Barriers				
Political				
Lack of a Clear Vision	1	3	2	4
Leadership	1	1	2	2
Failure of Top Down Approach	0	0	0	1
Lack of Trust	1	1	1	0
Technological				
Accessibility of Information	4	4	3	3
Usability	1	2	1	0
Vendor Issues	1	2	1	1
Data Volume and Storage	1	2	1	1
Technological Infrastructure	1	1	1	0
Human				

	Physicians	Administrators	Public Health	Academics
Workflow	2	2	2	3
Learning	1	2	1	2
Age	1	2	1	0
Lack of Support	1	1	0	1
Willingness to Use	0	2	0	0
Lack of Technological Understanding	1	2	1	0
Privacy/Security	4	2	2	2
Financial Barriers	3	4	1	3

Potential of EHRs and Public Health

	Physicians	Administrators	Public Health	Academics
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Benefits of EHR and Notifiable Disease Surveillance

Access to Information	4	4	3	3
Quicker Detection of Outbreaks	0	1	1	2
Identification of Vulnerable/ Affected Populations	0	2	1	1
Population Coverage	0	1	0	1
Potential for Faster Coordination of Information	0	1	0	1

Barriers to using EHRs for Notifiable Disease Surveillance

Political				
Public Buy-In	0	1	0	0
Lack of a Clear Vision	1	3	2	4
Foundation	1	1	3	3
Standards	0	2	3	4
Accountability	0	3	2	0
Legislation	0	0	1	2
Technical				
Data Quality	1	2	3	4
Data Compatibility	2	2	1	3
Data Loss	1	0	0	1

Other

Panorama	0	2	1	0
Chronic Care Monitoring	0	1	0	0
Hopes for the Future	1	1	1	0