1-1-2010

Factors associated with the extent of information technology use in Ontario hospitals

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FACTORS ASSOCIATED WITH THE EXTENT OF INFORMATION TECHNOLOGY USE IN ONTARIO HOSPITALS

by

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A Thesis
presented to Ryerson University

in partial fulfillment of the
requirements for the degree of
Master of Management Science

in the Program of
Management of Technology and Innovation

Toronto, Ontario, Canada, 2010

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Acknowledgements

The completion of a thesis is a test of perseverance and dedication.
I am deeply indebted to those who took me through this part of my journey.

Jim Tiessen: my thesis supervisor who continues to be a pillar of strength and reason. Thank you for your direction, wisdom, patience, humour and kindness.

Catherine Middleton: my thesis advisor and one of Canada's leading IT researchers. Thank you for your critical thinking and attention to detail and your time.

Faculty, Administration and Staff at Ryerson: Thank you for recognizing my skills outside of the academic realm; I truly believe that diversity is a proven strength. Who would have ever known… thank you for the gift of curiosity. *You have changed my life.*

Health care in Ontario: to the professionals, support staff, administration, academics and the realists/idealists, thank you for embracing my questions and my work. My hope is to turn my operational (and now strategic) health care experience into academic questions for discussion and discovery. May this be a lifelong learning experience.

Faculty and Friends: thank you for the professional development and for piquing my curiosity in health care research/debate. The quest has already begun.

To my Friends: to the readers, technical support, practical advisors and the listeners. Thank you for supporting me. Friends are like seasons, they come and go. I hope that you stay (even if it is only for a season) and grace me with your presence.

To my Family: a million thanks for your support and encouragement. To my parents: I hope this may make you proud; to my brother: I hope you find what you seek; and to Bibi the dog: thank you for not tearing up my thesis or putting up too many physical obstacles.

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1 Abstract

Patients, providers and society are demanding more from health care systems worldwide. As health systems evolve, the use of health information technology is one method to deliver safer, more efficient, and more effective patient care. This paper presents analysis that explores whether location, hospital type, hospital size are factors in determining the extent that IT is used in Ontario hospitals.

The results show that urban hospitals use IT more extensively than non-urban hospitals. Hospital type does not have an effect on the relative extent that IT is used. Larger hospitals are likely to use IT more than smaller hospitals. Key implications for having location and size determine a hospital's use of IT are the increasing divide between urban and non-urban hospitals and the proliferation of smaller "have not" hospitals in Ontario.

2 Introduction

Due to social and demographic changes, as well as rapid technological advances, the use of information technology (IT) in hospitals has become more common in the twenty-first century. Consumers are demanding more from health care providers, and health information technology is one method to deliver safer, more efficient, and more effective patient care (Barnes et al., 2004; Bostrom et al., 2006; Geibert, 2006; Henriksen, et al., 2006; Jha et al., 2006). Hospitals are at the centre of health care delivery and advances in IT as part of a provider system will directly impact health care delivery. The Electronic Health Record (EHR) represents one method of how IT can be used in health care.

IT can be defined broadly. In this study, the use of clinical IT and use of data for decision-making are used to measure the extent that IT was used in hospitals (CIHI, 2007). Extent of use of clinical IT is defined as the availability of electronic clinical information to providers (CIHI, 2007). Providers are defined as hospitals (or hospital entities in the case of a multi-site hospital) that provide acute care to patients in Ontario (CIHI, 2007). Extent of use of data for decision-making is defined as how a hospital is using and disseminating clinical and administrative data (CIHI, 2007). This study is concerned with the extent that IT is used in Ontario hospitals and the factors (hospital location, type and size) that are associated with it.

This paper examines the research question: what impacts do hospital type, location and size have on the extent of IT used in Ontario hospitals? This study focuses on three factors: hospital type, location, and size. If factors associated with the extent of IT use are correctly identified, then more focused funding can be applied so that the extent of IT use can be optimized.

This paper is structured into five sections: background, literature review, methods, results, and discussion. The background provides relevant information about health IT and the Electronic Health Record (EHR), benefits and challenges of IT use in hospitals, institutional context of the Canadian and Ontario IT and health care systems and focuses on the research question at hand. The literature review contains information on key IT

theories, describes two measures of the use of IT in hospitals and the three organizational factors examined in this study (hospital location, type and size). The methods section describes the data sources, variables and data analysis and is followed by the results section. Finally, the discussion section highlights the implications of this study's findings, limitations, and suggestions for further work.

3 Background

Health care is complex and health information technology (IT) use in the form of the electronic health record (EHR) varies across jurisdictions in Canada and abroad. Technology is used in hospitals to support delivery of patient care. EHRs are beneficial to patients by promoting safety and positive outcomes while lowering administrative costs. Researchers have shown that environmental, organizational and individual factors influence IT use and adoption. This study focuses on the impact of hospital location, type and size on the extent of IT use (clinical and data for decision-making).

3.1 Health Care Information Technology and Government

3.1.1 The Electronic Health Record (EHR)

The main method of using IT in health care is the Electronic Health Record (EHR). According to Jha et al. (2006), there is no universally accepted definition of EHR. However, there is emerging consensus that it encompasses the electronic documentation of providers' notes, electronic viewing of laboratory results, physician order entry, and patient care pathways. Bostrom et al. (2006) found that EHRs can be used at many junctures throughout the full spectrum of care, from prevention through chronic care. In fact, at times, the terms electronic health record, electronic medical record and patient care record are used interchangeably.

Some authors do, however, offer a distinction between these related terms. For example, "an EHR can refer to the full patient record that is compiled by one organization; which is typically accessed only by clinical staff. Personal Health Records (PHR), on the other hand, are tailored for, and even sometimes designed and populated by, the individual patient" (Leonard et al., 2008). Leonard et al. (2008) argue that, from the patient's perspective, there are only two wants from the health care system: care and information. Care can only be delivered in person, but information can be delivered in person or by electronic means (Leonard et al., 2008). As there are limited human resources available,

more and more facilities are turning to electronic means to deliver patient care. As a result of this, there has been a proliferation of EHR adoption and use in hospital environments.

Many studies suggest that the use of health information technology (IT) and specifically, the EHR has the potential to improve the quality of care, control costs, increase the continuity of care (Geibert, 2006; Prince, 2001), and contribute to more streamlined and patient-centered health care (Barnes et al., 2004; Bostrom et al., 2006; Geibert, 2006; Henriksen, et al., 2006; Jha et al., 2006). For example, allowing less time to be spent by the health care provider on medication orders, test results, accurate diagnoses and medical interventions (Wolf et al., 2006) allows more time to be spent on actual patient care.

The EHR is typically a template document that is created by the hospital and populated by clinicians serving the patient. It may include personal information (e.g. address, gender, employer, etc), medical history (e.g. past conditions, prior hospital visits, etc), clinical information (e.g. reason for current visit, signs and symptoms, diagnostic tests, etc) and other documentation (e.g. consent forms, laboratory results, etc). Sometimes, the EHR is linked to non-clinical care (e.g. registration or billing) in some countries (Eysenbach, 2001). Data on the EHR is usually available to different health care providers within a hospital entity who have access to patient records. Different jurisdictions have laws governing the protection and privacy of health records.

In summary, the EHR is the electronic documentation of health information used in a clinical setting (usually in hospitals and clinics). At this point, very few patients have their own EHR that they can control or help populate. Thus, if a patient does have an EHR, then it is one that is obtained, stored, used, and essentially, controlled by the clinician or hospital. IT in health care exists in many forms and for the purpose of this study, it refers to electronic systems that are clinical in nature and related to patient care (i.e. clinical information technology; e.g. patient chart), and other non-clinical systems that are not directly related to patient care (i.e. data for decision-making; e.g. quality measurement tools and billing). Internationally, it is estimated that EHRs are used

anywhere from under 20% to 90% in some Scandinavian countries (eClinical Forum and PhRMA EDC/eSource Taskforce, 2006). To date, a universal health record of a patient does not exist in any city or country but the Netherlands is very close to 100% EHR use.

3.1.2 Benefits and Challenges of Technology Use in Hospitals

Health IT has many potential benefits for patients, providers and the health care system-at-large (Maffei, 2006). Some of these benefits include: increased patient safety, prevention of adverse effects, accurate outcomes management, and lower administrative costs (Barnes et al., 2004; Bostrom et al., 2006; Geibert, 2006; Henriksen, et al., 2006; Jha et al., 2006). Most of the current research is found in the USA and some in other jurisdictions.

Health IT can promote patient safety (Brooke, 2007; Geibert, 2006; Henriksen, et al., 2006; Jha et al., 2006; Stewart et al., 2007) by reducing medical errors (Barnes et al., 2004; Brooke, 2007; Hampton, 2008; Prince, 2001; Wolf et al., 2006), and saving lives (Prince, 2001). However, there is conflicting evidence that some nurses found that EHR enabled safer care but decreased the quality of care (Kossman & Scheidenhelm, 2008). With the use of EHR, there were fewer preventable incidents reported, however, the quality of care given by nurses to patients suffered as more time was allocated to EHR data entry than direct patient care (Kossman & Scheidenhelm, 2008). There are different operational definitions of quality of care, but despite these differences, there is overall support for increased patient safety as measured by fewer medical errors and preventable patient deaths.

From a patient perspective, effective health IT may help in preventing adverse effects from conflicting courses of treatment (Wolf et al., 2006), possibly eliminating unnecessary visits (Wolf et al., 2006) and reducing redundant tests and procedures (Hampton, 2008; Wolf et al., 2006). When health IT is used effectively, patients can have detailed information and, in some cases, test results so as to engage him/her in care

plans (Leonard et al., 2008). On the other hand, EHR can be seen as an attempt by clinicians and health care organizations to offload administrative work to the patient (Leonard et al., 2008), as the patient would potentially be performing many tasks now completed by staff (e.g. filling in address and non-clinical information). This is similar to what occurred in the financial sector with the advent of automatic teller machines (ATMs) and Internet banking where consumers now do most of their own banking transactions (Hannan & McDowell, 1984). Currently, this is not an issue in health care because most EHRs belong and are administered by hospitals rather than patients. Accordingly, there is concern that even if supporting IT structures via the EHRs can be programmed to identify conflicting courses of treatment, patients and their families will ultimately bear the administrative burden of a health IT system.

Outcomes measurement has been used on some occasions to defend the need and the use of EHRs (Werner & Asch, 2007). For example, studying the number of patient infections post-surgery can be an outcomes measure of how effectively a surgeon closed the wound or the effectiveness of nursing care if an infection was preventable. McAdams (2005) suggested that, "quality measurement and outcomes management is the sine qua non of excellence in patient care" (McAdams, 2005; Schraeder et al., 2000). Further, McAdams (2005) puts forward that until now, outcomes measurement was determined manually from medical records, discharge data, and administrative claims review. Health IT systems may increase the capacity to analyze outcomes, thereby addressing both patient concerns for the need to implement health IT, and clinicians' behavioural resistance to implementing the EHR.

From an organization or system perspective, IT systems may help lower administrative costs (Barnes et al., 2004; Hampton, 2008) because there is a possibility of simplifying documentation (Bostrom et al., 2006) and reducing paperwork (Wolf et al., 2006; Kossman and Scheidenhelm, 2008). Beyond the data-entry level, by coordinating the storage and retrieval of records, efficiencies can be obtained and standardization can be promoted (Hampton, 2008). Further, disparities from geographic areas, such as access to care, or access to specialist human resources, can be reduced (Bostrom et al., 2006), thereby decreasing overall human resource costs and administrative expenses. However,

these costs do not disappear, as IT resources to support EHR implementation are significant and training costs are rarely accurately accounted for in the calculation of implementing EHRs. Health IT is important as it can help provide patients with more efficient, effective and focused care, potentially addressing important issues such as wait times for care and the overall patient experience. For clinicians and health care administrators, health IT may lead to more effective measurement and evaluation of effectiveness and funding, as well as pave the way for improvements.

Health IT is never without the human element. Organizations have found that managing technological change is difficult and will often be met with resistance (Maffei, 2006). Nonetheless, researchers have found that clinicians preferred EHR-only systems versus combined systems[1] (Lium et al., 2008; Woodend, 1992). However, the authors did note that old routines remained unchanged, and thus the potential of EHRs were unrealized (Lium et al., 2008). Some clinicians declared that the lack of time and inappropriate and unreliable information sources were barriers to adopting the EHR (Geibert, 2006). Thus, it seems that the technology is not the root of the problem of implementing the EHR, but rather, the disruption of pre-existing IT and difficulties in managing change is the larger organizational issue.

Despite its numerous benefits, the process of transitioning a paper-based records and processes to the EHR can be met with significant challenges (Nembhard et al., 2008). Paper-based system users tended to prioritize the availability of sufficient workstations and printers, physician champions, workflow education, and existing high comfort level of clinicians and support staff with IT (Zandieh et al., 2008). In contrast, EHR-leaders tended to prioritize improved technical training and ongoing technical support, protection for patient privacy, and open recognition of physician resistance (Zandieh et al., 2008). Different priorities in how EHRs should be implemented have created tension and resistance within stakeholder groups and at the organization-level.

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[1] i.e. a fully implemented and integrated health information system versus partial implementation and partial integration, thus meaning that the clinician would need to learn and use both paper-based systems and electronic-based systems.

There are additional individual-level barriers affecting EHR implementation, these include varying degrees computer literacy of users, the reluctance of clinical staff (a large component of clinicians are not employees but instead are outside consultants to the organization), the focus on gaining clinician's compliance, and the need to convince users of the need for technological change (Wolf et al., 2006). Adoption theory suggests that the person's attitude toward technology is a major factor in IT use and adoption rates (Rogers, 2003; Wolf et al., 2006; Yang & Yoo, 2004). As well, rapidly changing technology can cause newly-implemented systems to become outdated in a very short time frame (Wolf et al., 2006). Yet, this is the reality of the health care industry today. Together, these individual challenges lead to difficulty in implementing IT-related change in fast-paced environments (Bostrom et al., 2006; Maffei, 2006).

Sachs (2005) suggests that in order to increase the effectiveness of health IT implementation, there needs to be individual-level incentives for IT adoption. These incentives include using pay-for-performance metrics that require physicians and hospitals to work together, increasing real-time reporting elements for providers, and creating a marketplace for cooperation and competition. This would be relevant in a competitive marketplace, such as that of the health care system in the USA, but not in Canada. Sachs (2005) believes that by providing [monetary] incentives to clinicians that help them do their work more effectively, that some of the barriers of health IT implementation could be addressed. In Canada, monetary incentives for clinicians are difficult to implement as health care is a public good, and does not exist in the same competitive marketplace as that in the USA. Nonetheless, researchers have found that providing non-financial incentives for clinicians to perform more effectively is one way to increase successful health IT implementation.

In summary, the potential benefits of health IT (increased patient safety, more favourable outcomes, and reduced medical errors) far outweigh their barriers (increasing human resource costs, duplication in documentation, and organizational changes to workflow). Organizations implementing health IT have faced resistance due to individual-level challenges. However, some research has suggested that the use of incentives may foster greater adoption of health IT in organizational settings.

3.1.3 **EHR and Health Care in Canada**

Canada has a population of 33 million people in both urban and non-urban areas. Yet, most health care facilities tend to be in located in large urban areas where most human resources, such as specialists, and technological equipment are found. There is a growing trend of under-serviced non-urban communities (Picard, 2009) where citizens often need to travel to urban centers for specialized care. Governments have attempted to encourage non-urban delivery of services by providing incentives to practitioners, as well as other technological initiatives (such as tele-health) but this has been met with limited success. As there are many non-urban communities, the focus has been on using IT to address this inequality in service delivery (Abdolrasulnia et al., 2008).

The Canadian health care system is publicly-funded and governed by the *Canada Health Act,* R.S.C. 1985, c. C-6, and administered by individual provinces and territories[2]. In 2007, health care spending in Canada was $160 billion Canadian dollars (The Canadian Press, 2007), roughly 70% public sector funding and 30% private funding (Marchildon, 2005: 2). The leading areas of health care spending are on physician remuneration and pharmaceutical drugs. The *Canada Health Act* (1985) has five pillars: publicly-administered, universality, portability, comprehensiveness, and accessibility for "medically necessary" services for "insured persons" (Canada Health Act, 1984). Medically necessary services are those required to sustain health and mobility, and insured persons are those that live in and pay into a publicly-administered health system in Canada. Citizens carry their "health cards" which identify the patient as a member of a provincial or territorial health program. In addition, the Canadian health care system has service and pay agreements with other countries to provide care for its citizens.

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[2] The Canadian health care sector is comprised of paediatric facilities, hospitals, clinics, rehabilitation centers, psychiatric facilities, and long-term care facilities. Health practitioners include: physicians, nurses, allied health professionals (occupational therapy, radiation therapist, chiropractors, etc), and diagnostic imaging. All facilities also have administrative and operational personnel. Health care is delivered through acute care facilities, such as hospitals, medical clinics, community health centers, etc.
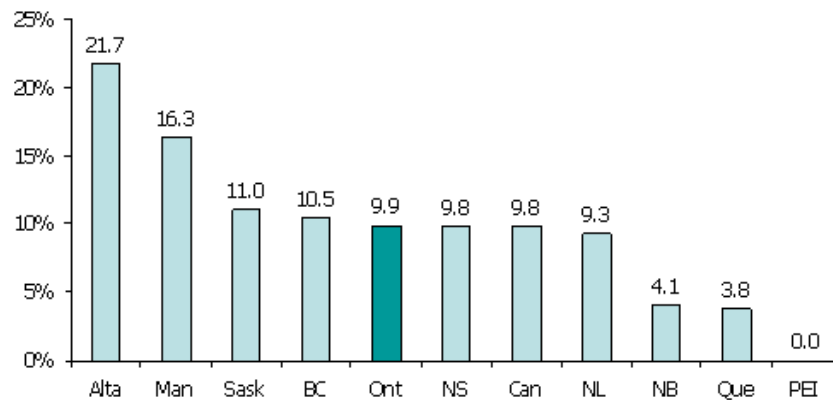
Primary health care (i.e. a general practitioner or family doctor) is the first access point for the patient. Primary care providers are usually general practitioners who make specialist referrals. However, in the case of emergencies, a hospital emergency rescue department may be the first point of contact for a patient seeking care. Secondary care generally refers to specialized care provided from referrals from primary care physicians; these are often specialists who operate or are connected to hospitals or other facilities. Tertiary and quaternary care is even more specialized care offered by specialists with advanced and specific training in a narrow area of expertise.

In a recent national survey of Canadian health care centers, 54% of hospitals had some sort of EHR, but of that percentage, 98% reported that it was not the sole method of recording patient information (Urowitz et al., 2008). Current practice is that there is more than one method of recording patient information, i.e. clinicians record information in paper form and in electronic form, thus causing much duplication.

At the federal level, Canada Health Infoway is the organization charged with advancing the Electronic Health Record (EHR) with a target of 50% of Canadians having an EHR by 2010 (Canada Health Infoway, 2008). As per the public website, "the EHR is a secure, digital record of [a patient's] medical history stored and shared via a network of EHR systems." (Canada Health Infoway, 2008). It appears as though Infoway is on track to deliver on its mandate.

According to Canada Health Infoway, the "creation of a network of electronic health record (EHR) systems, enables health care providers to share, access, manage and safeguard the essential health care information" of Canadians. In fact, "in Canada there are 2,000 health care transactions every minute" (Canada Health Infoway, 2009). As of March 2009, Canada Health Infoway has spent $1.59 billion dollars on 283 projects (Canada Health Infoway, 2009). Furthermore, "through its investment programs, Infoway and its partners have put in place EHR for 17% of the Canadian population." (Canada Health Infoway, 2009: 11) However, there is evidence from a national physician survey that suggests that the use of EHR is much lower (closer to 10%). See Figure 1.

Figure 1: Percent of Physicians Using Electronic Records in Main Patient Care Setting by Province (2007)

Based on Infoway`s six domains[3], provinces do not adopt the EHR at the same rate, and groups of provinces emerge in their use of EHR. According to the national physician survey, Alberta, Prince Edward Island and British Columbia have made significant progress, while Saskatchewan, Newfoundland and Labrador, Manitoba and Nova Scotia have made some progress. Ontario followed and then Quebec, New Brunswick, Northwest Territories, and Yukon round up the remainder of the provinces and territories (Canada Health Infoway, 2009). Finally, Nunavut trails in its use of the EHR. See Figure 1.

The province of Alberta is the leader in the EHR adoption effort. Yet, two-thirds of provinces/territories had less than 50% of their reporting systems electronic (Urowitz et al., 2008). Alberta's Netcare system is a large-scale EHR that connects physicians, pharmacists and diagnostic technicians. Only 21.7% of physicians in Alberta were using

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[3] Domains: client registry, provider registry, diagnostic imaging, drug info systems, lab info systems, and clinical or immunization reports.

electronic records in 2007. Not all provinces and territories have a similar EHR system in place and many still use paper and pencil legacy systems. See Figure 1.

The use of EHR varies by health professional, health profession, health care setting and organization. In Canada, EHR implementation at the Intensive Care Unit (ICU) level in hospitals is more advanced than at the hospital level; with 92% being able to access laboratory data and imaging reports and 76% using a picture archiving and communication system (PACS). Other functions were less prevalent, such as medication records [46%], clinical notes [26%], medication order entry [22%] (Lapinsky et al., 2008). However, there are different adoption rates across departments within the same hospital. Lapinsky et al. (2008) found that there was no association between EHR adoption and ICU size or university affiliation (Lapinsky et al., 2008). Also, the authors noted that there were a variety of vendors used; there were 15 vendors of clinical information systems represented in the survey sample (Lapinsky et al., 2008). As most vendors are from the USA, this creates a competitive marketplace for standards and norms with different vendors, processes and systems. Implications for the Canadian health care system are the choice of vendors as well as their associated costs, processes, standards, and systems. In summary, there are varying degrees of IT usage (and EHR adoption) across provinces/territories in Canada, even where the *Canada Health Act,* R.S.C. 1985, c. C-6, in principle, calls for standards across all provinces and territories.

Hospitals are social systems with many groups and subcultures of individuals. In health care, peer groups are formed based on the roles that individuals play within the hospital. There are usually groups of physicians (who are actually consultants to the hospital), nurses (who are strongly represented by unions), other allied health professions (who are employees of the hospital), administrative and maintenance staff (who are employees usually represented by unions), and management (who are employees but not part of unions). With many peer groups and differing views, innovation within hospitals is often met with resistance. Hospitals typically use authority-innovation decisions to implement change (Rogers, 2005). In theory, champions are usually medical directors or physicians in positions of power who influence change amongst peer groups and the organization.

However, there has been limited success with implementation efforts by champions in hospitals.

Another organization involved with measuring health IT is the Canadian Institute of Health Information (CIHI). CIHI is a non-partisan health information collector for the country (including data reporting for all jurisdictions which consist of ten provinces and three territories). Through multiple registries and reporting mechanisms CIHI provides reports to the government and the public about health care and its delivery in Canada. It is the chief administrator of the *2006 Acute Care System Integration and Change Survey (SIC),* which is a major data source for this study. The 2006 report is published in 2007 as registries and reporting mechanisms are not real-time. Therefore, reports and aggregate data are submitted by hospitals to CIHI, then processed and analyzed prior to their release, usually in the following calendar year. As a result, most health industry reports are released one to two years after the reporting year.
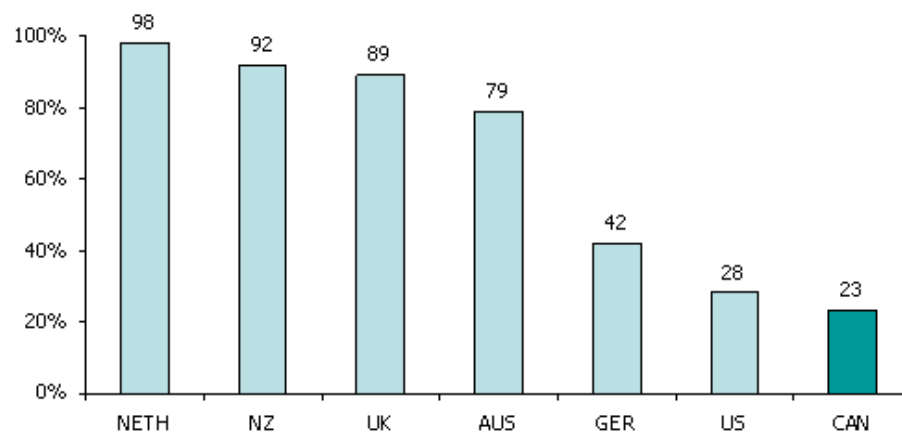
At the federal level, there have been many committees and commissions charged with the task of making recommendations to improve health care and its delivery. However, many of their recommendations have yet to be implemented. Non-governmental agencies and associations also exist for purposes such as voluntary accreditation and membership (Marchildon, 2005: 35), as well as independent Colleges for health care professionals (e.g. Royal College of Dental Surgeons of Ontario).

In summary, Canada has a publicly-funded health care system for a relatively small population over a vast land. It would be expected that the use of EHR would be advanced; however, the reality is that EHRs are not widely used in Canada. The most technologically-advanced province, Alberta (estimated 20% use of EHR), is making inroads to implementing EHRs but the country is far from 100% EHR use. EHR use varies by profession, where the diagnostic imaging profession is by far the leading adopter of health IT.

3.1.4 Health Care IT Use in other Jurisdictions

In order to place Canada's health system within context, it is useful to take a brief look at two similar, yet very different systems, such as those of the United States of America ("USA") and the United Kingdom ("UK"). The health IT use experiences in the USA and UK show that EHR adoption is not a unique challenge to the Canadian health care system. In fact, health IT usage is similar amongst different health care systems around the world, despite different politics, regulations, policies and health care marketplaces. See Figure 2.

Figure 2: Percent of Primary Care Physicians Using Electronic Patient Medical Records by Country (2006)

Source: 2006 Commonwealth Fund International Health Policy Survey of Primary Care Physicians

In the USA, a 2006 survey found evidence that 24% of physicians used EHRs in an ambulatory setting while 5% of hospitals used computerized order entry (Jha et al., 2006). Zandieh et al. (2008) had similar usage findings. Yet, EHR adoption is fragmented in its mandate and operations; many companies and associations are involved in moving hospitals towards patient-centered care by adopting EHRs.

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There is a range of EHR capacity within all health care systems today. For example, the difference in physician adoption of EHR varies across the USA, with roughly 70-80% adoption in Massachusetts, yet single digit adoption in Mississippi (Hampton, 2008). Shields et al. (2007) found that 26% of community health centers reported some sort of EHR capacity. Over 85% have electronic clinical notes, 71% have computerized orders for tests and 71% have computerized lab results (Shields et al., 2007; Murray, 2008). Lapinsky et al. (2008) also found that IT use varies widely by organization and jurisdiction. Thus, EHR adoption varies across jurisdictions in the USA.

Similar to Canada, the National Health Service ("NHS") in the UK set public performance targets for implementing the EHR as early as 1998 (Burke, 2002; Marshall et al., 2000). Its goal was to have electronic patient records cover four areas: prescribing details, tests and procedures ordered, test results, and an integrated care pathway (Burke, 2002). As of 2002, the UK was behind in its implementation; however with significant injections of funds and national priority, it currently enjoys a high rate of adoption and use amongst physicians and hospitals today[4].

Both the USA and the UK have experienced challenges in implementing EHRs at the individual-level and at the organizational-level. Canada is not unique in the challenges it faces with regards to limitations in system structure and funding, resistance from clinicians and administration, difficulties in IT implementation and change management, and the understanding, potential and capacity of EHRs in general.

3.1.5 EHR and Health Care in Ontario

Ontario, the largest province by population in Canada, has a population of 12 million and the provincial government has strong governance and control of the healthcare sector

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[4] National Health System, latest deployment statistics and information for March 3, 2010 at http://www.connectingforhealth.nhs.uk/newsroom/statistics/deployment accessed on April 7, 2010

(Marchildon, 2005: 5). The Ontario Government is the largest funder of health care, estimated at 70%, with insurance companies, foundations and private donators representing the remaining 30%. Much of the policy-development is done by the Ministry of Health and Long-Term Care (MoHLTC). Increasingly, policymakers (i.e. MoHLTC policy analysts) are taking on more of a stewardship role in changing health care delivery in Ontario. There are approximately 150 hospital entities delivering health care services in Ontario (OHA, 2008).

The population in Ontario is aging in large numbers, technology is advancing rapidly, and consumers are becoming more demanding (Bessen, 2009). As a response, Ontario hospitals are required to become more efficient and effective in their operations. Wang et al. (2005) state, "the health care sector is aligning its IT strategies with organizational goals in response to environmental pressures." Increasingly, hospitals are looking to IT to deliver superior patient care because of cost-cutting measures from the government and demand from patients.
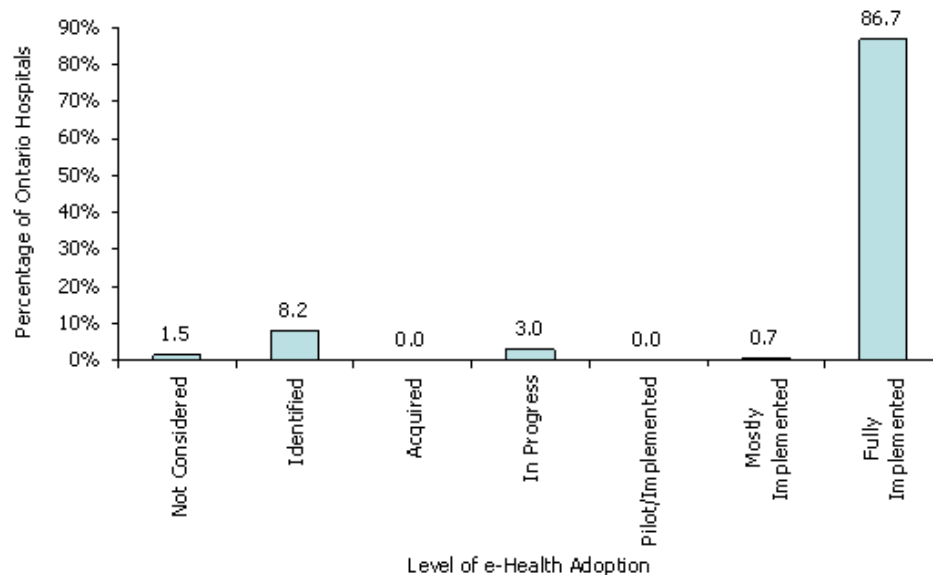
In Ontario, the patient record is protected by privacy legislation. The ownership of the patient record resides with the patient, and clinicians are only health record custodians (Personal Health Information Protection Act, 2004). Patients may always ask to view their own records.

In Ontario, there were 30 Canada Health Infoway projects[5] funded in 2009-2010 (Canada Health Infoway, 2009). Most of these projects were in the domains of diagnostic imaging (8 projects), and tele-health (8 projects). The focus was on delivery of information to both clinicians and to patients (Canada Health Infoway, 2009). Ontario is still in the early stages of fully adopting an EHR (Canada Health Infoway, 2009).

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[5] In 2009-2010 fiscal year, Ontario's projects included: 1 registry, 8 diagnostic imaging, 3 drug information systems, 1 lab information system, 2 interoperable systems (clinicians viewing an integrated record), 8 telehealth (deliver information to patients), 1 public health surveillance, 5 innovation and adoption (focusing on quick uptake and deployment), and 1 patient access to quality care (PAQC); for a total of 30 projects.
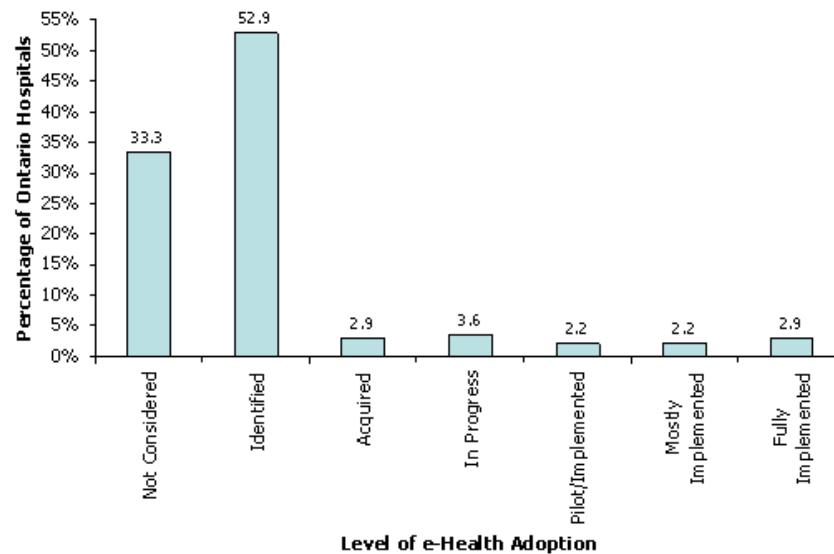
The Ministry of Health and Long-Term Care has integrated its formerly fragmented approach to EHRs for patients under one agency; eHealth Ontario was announced in 2007 with a mandate of delivering a diabetes registry, a web-based centralized health information service and the availability of e-prescribing (Ministry of Health and Long-Term Care news release, 2007). Two organizations in Ontario have helped Ontarians with EHR. These are Smart Systems for Health (www.thinksmart.ca) and E-health Ontario (www.ehealthontario.on.ca). By 2015, eHealth Ontario is hoping that all Ontario citizens will have an EHR (Ministry of Health and Long-Term Care news release, 2007). Figure 3 and Figure 4 show support for Ontario hospitals adoption of e-Health in 2008.

Figure 3: Ontario Hospitals' Level of e-Health Adoption: Presenting Diagnostic Imaging Reports Electronically in Inpatient Setting (2008)

Source: 2008 Ontario Hospital e-Health Adoption Survey: Clinical Capabilities Key F1indings, Ontario Hospital Association.

Figure 4: Ontario Hospitals' Level of e-Health Adoption: Presenting Clinical Results and Reports via a Patient Portal (2008)

More sophisticated hospitals are aligning quality to delivery of care and are "using performance management as a strategic management tool [that] is not restricted to inpatient care" (Brown, et al., 2006; Duffy, 1992). Using effective and efficient IT administrative and patient care systems are ways to deliver care at a lower cost. Administrative systems mean that clinical staff (e.g. nursing wards) can access patient records that are acquired at the administrative level (e.g. registration). An integrated EHR has the potential to allow clinicians to dedicate more time to patient care, versus onerous non-patient care activities, such as record-keeping and filing, thus making the case for the adoption of health IT and EHRs. However, since there are partial implementations of health IT within departments (and very little communication between departments) the advantages of a fully integrated EHR have not been realized.

Ontario has moved forward with a regionalization model for health care. Regionalization means that Local Health Integrated Networks (LHINs) are mandated to control funding in their respective regions (MoHLTC, 2005). Increasingly, health providers are negotiating with private companies and suppliers as larger units, with the goal of reducing per unit

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costs for purchases. Similarly, IT systems are being thought of as regional systems, and multiple hospitals may choose to negotiate together for more power and resources from the government. As capital expenditures are few and far between, there is increased incentive for hospitals to work together, under the auspices of their LHIN in order to create efficiencies in operations through the implementation of EHRs. See Appendix 1 (LHIN map) and Appendix 2 (LHIN summary).

The political environment for Ontario favours larger-scale IT implementation efforts. LHINs have the responsibility for hospitals, divested psychiatric hospitals, Community Care Access Centers (CCAC, 2001), community support service organizations, community mental health and addictions agencies, community health centers, and long-term care homes (Ontario, 2008). This includes the authority to fund these service providers. Further, LHINs have the statutory responsibility to enter into accountability and service agreements with the MoHLTC. The LHIN Act (2006) provides authority for the MoHLTC to allow LHINs to reinvest a portion of savings back into patient care (Local Health Integrated Network, 2006).
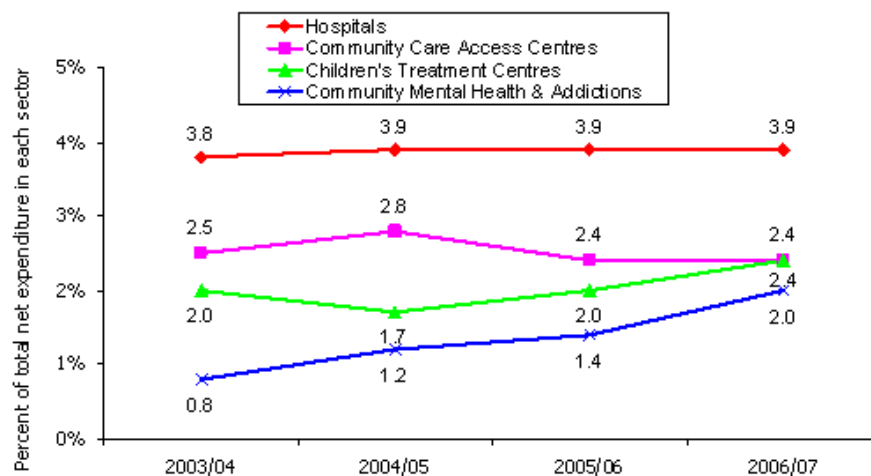
However, the Ministry of Health and Long-Term Care retains responsibility for funding physicians, ambulance services (emergency and non-emergency), laboratories, public health and provincial networks and programs (Ontario, 2008). Further to that, the legislation requires the province to publish a provincial strategic plan to help guide the health care system and the LHIN to develop an integrated health service plan (IHSP) with input from the community, and requires each LHIN to establish a Health Professionals Advisory Committee (comprised of health care professionals, including doctors and nurses) as part of its community engagement process (Local Health Integrated Network, 2006). So while much of the health care services will be funded by LHINs, the Ministry still retains control of some health service delivery elements.

With regionalization of healthcare and its funding, there is an opportunity to implement clinical and decision-making programs that have regional reach. For example, instead of hospitals opting to adopt an individual IT system, synergies between hospitals can be realized by implementing IT systems at the regional level. Clinicians with privileges at

several hospitals may realize time savings because they could use the same interface at different sites, thus dedicating more time to delivering patient care. Patients may realize time savings as their records would be accessible to the clinicians within the same region. However, implementation of an IT system that spans a region has different, and potentially more issues than implementing a single-use system within one hospital.

Currently, cost outlays for IT and communications represents only a small fraction of net spending for hospitals (Ontario Health System Scorecard, 2007). Costs typically include computer hardware, computer software, computer services, communication services and wired and wireless equipment. If the cost of individual IT systems are significant and is a barrier to implementing IT systems, then the cost of a national system can be insurmountable. Kaushal et al. (2005) stated that costs of a national information network are significant because necessary infrastructure must be already in place for its success. Hence, both the provinces and the country have relied on investing billions of government funding in the EHR infrastructure development. See Figure 5.

Figure 5: Ontario Information Systems and Communications Net Expenditure as a Percentage of Total Net Expenditure (2003-2007)

Source: Ontario Health System Scorecard 2007/08, Ministry of Health and Long-Term Care.

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As one of the largest provinces in Canada, Ontario has one of the strongest governance models in the country. Ontario has long considered the benefits of health IT to deliver superior care and is now dependant on several national and provincial organizations to implement EHRs for patients. The regionalization model allows Local Health Integration Networks to control funding, however, a recent survey of IT and communications systems showed that spending is only 4% of net expenditures. As seen in Figure 5.

3.2 Summary

In sum, empirical researchers have established that IT benefits (patient safety, outcomes management, and cost savings) outweigh its challenges in hospitals worldwide. Yet, the extent that IT is used in hospitals varies between departments and functions. The organizational-level factors affecting the use of IT in hospitals are numerous, however, this study examines the research question: do hospital location, hospital type and hospital size matter in determining the extent that IT is used in Ontario hospitals?

4 Literature Review

As organizations, hospitals have the key competency of delivering patient care. Individuals provide patient care, but IT use is measured at the organizational level. IT use in hospitals can be measured in two ways: by use of clinical IT (those systems directly related to patient care) and by data for decision-making (those systems related to everything outside of direct patient care). The literature showed three main organizational factors associated with the use of IT: this study assessed hospital location, type and size for the use of IT in Ontario hospitals.

4.1 Use of Information Technology in Hospitals

There are both individual and organizational factors affecting the use of IT in hospitals. Although individual barriers are not the focus of this study, they do exist. Some of these include competency, age, ease of use of system, perception of duplication, attitude towards technology, individual resistance to change and ease of access to technology (Abdolrasulnia et al., 2008; Geibert, 2006; Lium et al., 2008; Murray, 2008; Wolf et al., 2006). This study examines the organizational factors rather than the individual determinants. Individual factors are more widely used in measures of effectiveness. This study focuses on the extent of use of IT by the organization, rather than the effectiveness of IT.

The extent of use of IT is a measure of how much an organization uses IT (Wang et al., 2005; Simon et al., 2006; Tourangeau et al., 2005; Kossman and Scheidenhelm, 2008). This study examines two types of IT: use of clinical IT (which is directly linked to providing patient care, e.g. electronic health records, tele-health and real-time monitoring data) and use of data for decision-making (which is not directly related to patient care but rather, the administrative functions of a hospital, e.g. benchmarking, quality and safety measures, utilization and registry reporting). These are not measures of effectiveness, but

rather, of the extent of IT use as noted. Together, these two measures provide an indication of how much a hospital uses IT at the organization level.

4.1.1 Use of Clinical Information Technology

The role of hospitals is to provide patient care. In Ontario, Wang et al. (2005:46), note that "clinical information systems support diagnosis, treatment planning, and the evaluation of medical outcomes" providing further support that clinical IT is an important component of patient care today. Given that hospitals provide patient care, clinical IT is therefore, one measure of the extent of IT use in Ontario hospitals.

As mentioned previously, there is a substantive and growing area of literature that highlights the importance of increased clinical decision support in the future of healthcare (Glaser and Foley, 2008; Wolf et al., 2006; Gagnon et al., 2008; Richards, 2000; Urowitz et al., 2008). Glaser and Foley posit that, "clinical decision support will center on patient care and be expressed through EHR and connected care applications" (Glaser and Foley, 2008:84). Specific technologies are cited, including EHR and tele-health, which can be used within hospitals. Outside of the hospital, tele-health can be used to effectively monitor patients; where patients from non-urban areas can be monitored remotely by clinical staff (Lehmann et al., 2006; Price and Kricka, 2007; Richards, 2000). Clinical IT systems are important in the future of health care delivery.

However, there are many barriers to the use of clinical IT in hospitals, many of which relate to the environment, organization, and individuals. From an organizational perspective, researchers found two major factors affected the success of clinical information systems in Quebec: the presence of a project champion and the support from senior management (Pare et al., 2008). These organizational findings may be relevant to Ontario hospitals as well, and can aid in the development of IT implementation plans, however, this is not the focus of this study. Rather, what can be taken from the Quebec

work is that the experience regarding the use of clinical IT may have little to do with the clinical IT itself, but rather the implementation of clinical IT in hospitals.

4.1.2 **Data for Decision-Making**

Many organizational functions need to occur to enable patient care provision. Some examples of an administrative system not directly involved in clinical care is where managerial-strategic decision support systems provide information to analyze finances, assist with strategic planning, allocate resources, and oversee quality improvement operations" (Wang et al., 2005:46). While this is not a patient or clinical care system, such administrative systems do exist in hospitals as with other institutions (e.g. a banking institution has many administrative systems unrelated to lending to clients). In a hospital setting, these administrative systems can help ensure the structure and support needed so that clinicians may spend more time on clinical care. As Schraeder et al. (2000: 40) state, "the goal is to provide data that can be used for clinical decision making that is population-based, yet individualized for specific patient care situations … it can be used to identify persons who could benefit from early detection, intervention, or treatment.." Thus, effective data for decision-making may eventually lead to clinical IT use for clinicians.

There are numerous benefits of data for decision-making including the ability to measure improvements in productivity, cost control, and the ability to focus patient care by implementing clinical practice guidelines (CPG) (Carter, 2002; Gagnon et al., 2008; Sharman, 2007). CPGs are as standards of care, for example, for a 60-year-old patient in good health with hip replacement surgery, a CPG may require that the patient stay in the hospital for "x" number of days for post-surgery monitoring. Thus, while some IT systems are not directly used for patient care, they may shed some light on aggregate data, and help inform CPGs or provide data to support clinical decisions. Effective data for decision-making eventually leads to effective patient care.

There are success stories in Canada too. In Comox Valley, a community near Victoria, British Columbia, the successful implementation of HealthLink (CliniCare) showed that the transmission of laboratory data information was highly beneficial for both clinicians and patients (Moehr and McDaniel, 1998). Customized decision support helped provide information for complex management decision-making (Gordon et al., 1998). However, computerized decision support is not widely used as yet (Amarasingham et al., 2008).

Use of data for decision-making can also be transformed into learning and teaching practices (Schraeder et al., 2000). Some ways this can be done are through activities like continuing medical education, evidence-based guidelines, social network learning and performance rewards (Schraeder et al., 2000: 41; Cooper & Zmud, 1990). Currently, systems of integrated reporting and feedback are used and there is the potential for information sharing, screening, and management, which can also lead to the production and dissemination of patient reports to aid clinicians in care planning (Schraeder et al., 2000). There is significant work to be done on transformation of data into clinical practice.

Given the discussion above, the two indicators are used (1) the clinical use of IT and (2) the data used for decision-making. As IT is an important part of any organization, these data were collected as scorecard indicators for measuring internal processes. The Use of IT measures internal processes by looking at patient care systems (clinical systems) and also at administration systems not related to patient care (data for decision-making). Both these measures are standard measures collected by CIHI for Ontario hospitals. These measures were assessed against organizational factors of hospital location, type and size.

4.2 Factors Associated with the Use of IT in Hospitals

There are environmental, organizational and individual factors affecting health IT adoption in hospitals.

The environmental factors relate to health care system influences such as macro-level, political or government-level policies that users must operate within. Examples of this factor include health information and privacy laws, provincial-level drug formularies and health IT systems available for public consumption. In the USA, government regulations such as reimbursement, payer restrictions, and volume of service continue to be barriers to fully implementing IT systems (Chan, 1993). In Canada, the political environment, the Minister of Health and Long-Term Care, the Ministry of Health and Long-Term Care, and LHINs are regional organizations are examples of this category. This factor is not the focus of this study.

The organizational factors are of interest in this study. As previously mentioned in the background section, Ontario uses the "Ontario Health System Scorecard," a derivative of the Balanced Scorecard from Kaplan and Norton (1992), as a framework for strategic planning and performance measurement. The Balanced Scorecard (BSC) has four components: business process (or internal perspective), learning and growth, customer perspective, and the financial perspective (Kaplan and Norton, 1992). Ontario hospitals are at the early stages of implementing the perspectives of the Balanced Scorecard; most hospitals have elements of the BSC in their reporting or accountability documents, but this is not common across all hospitals. CIHI uses an adopted-BSC in its hospital reports like the *Hospital Report for Acute Care 2006*. Following the BSC framework, Ontario hospitals are assessed by their financial and customer perspectives, but the level of learning and growth, and internal business processes are not commonly measured. IT practices can be seen as an internal business process because they relate to how data is handled and used both within the organization and for benchmarking and registries. If specific and relevant information is available to health care providers, the level of care may improve, because less time would be spent on administrative tasks (e.g. looking for the information in a physical paper chart).

Santerre & Thomas (1993) found that there were three main factors that influenced the extent of the use of IT in hospitals: the location of the hospital (urban or non-urban), the type of hospital (teaching or non-teaching), and the size of the hospital (total staff or number of beds). This can be stated as follows:

Extent of Use of Clinical IT = F (location, hospital type, hospital size), AND

Extent of Use of Data for Decision-Making = F (location, hospital type, hospital size)

In this study of Ontario hospitals, IT is defined as the availability of electronic clinical information to providers (as measured by the extent of use of clinical IT) and whether a hospital is using and disseminating administrative data (as measured by the extent of use of data for decision-making). Wang et al. (2005:45). noted that, "from an organizational adoption perspective, diffusion of innovation theory can be used to form important components of a predictive model of health IT adoption, comprising three predictor categories: the individual, organizational, and environmental factors." The study focuses on the organizational factors. See Table 1.

There are many organizational factors that can be used to measure IT use for hospitals. Technology research tends to use financial data (which is one element of the BSC) however, other factors do exist. This study uses hospital location, type and size as factors for measuring the extent of IT use. See Table 1.

Individual factors are personal characteristics of the clinician or user. Some examples are professional affiliation, professional needs and training, competency, age, ease of use of IT system, perception of duplication, attitude towards technology, individual resistance to change, and ease of access to technology. These factors are important in determining each individual's use of IT, however, this study is interested in examining the organizational-level factors. See Table 1.

Table 1: Environmental, Organizational, and Individual Factors Affecting Health IT Adoption

Factor	Examples
Environmental	Policy and regulation (e.g. Privacy laws, Canada Health Act) Drug formularies Reimbursement Payer restrictions Volume of service Political powers Ministry of Health and Long-Term Care Regional organizations (e.g. LHIN)
Organizational	Hospital vision, mission and goals Business processes (e.g. use of IT) Learning and growth Customer perspective Financial perspective Implementation champions Hospital location Hospital type Hospital size
Individual	Professional affiliation (e.g. doctor, nurse) Professional needs and training Competency User age Ease of use of IT system Perception of duplication Attitude towards technology Individual resistance to change Ease of access to technology

4.2.1 **Hospital Location: Urban or Non-Urban**

Empirical researchers have confirmed that urban hospitals are more likely to have a higher extent of IT use than non-urban hospitals (Duffy, 1992, Shields et al., 2007). Particularly, Shields et al. (2007) found that urban hospitals were almost twice as likely to use IT as non-urban hospitals. As urban hospitals are more likely to focus on delivering specialized care, have access to more funding and are likely to be closer to

teaching facilities (research funding and fellows), urban hospitals tend to have more IT use than non-urban hospitals.

Non-urban hospitals are vulnerable to falling behind because of the lack of competition and likeliness to adopt new technologies (Abdolrasulnia et al., 2008; Trinh & O'Conner, 2000). However, the authors caution that when defining the non-urban hospital, that there are subclasses of non-urban hospitals, or in other words, "different degrees of non-urbanity" (Trinh & O'Conner, 2000; Santerre & Thomas, 1993). In Canada, urban and non-urban hospitals exist, yet the extent of IT use has not been a primary area of study and there are few articles on this topic.

Urban hospitals differ from non-urban hospitals (Santerre & Thomas, 1993). In the USA, urban hospitals tend to cover large populations of over one million patients, and increasingly, there are more large, urban hospitals than ten years ago (Olden et al., 2002; Harrison & Sexton, 2004; Kimberly and Evanisko, 1981). Other characteristics are available, but the literature uses size as the main determinant.

The ability to have remote access to patient information was seen as an advantage of newer EHR systems (Drain, et al., 2001; MacPhee and Scott, 2000; Zandieh et al., 2008) and applies to both urban and non-urban hospital locations.

Given the preceding discussion about urban hospitals using IT to a higher extent because of their likeliness to adopt new technologies, leads to the first hypothesis:

H1a: *The extent of use of clinical IT is higher in urban hospitals than in non-urban hospitals.*

H1b: *The extent of use of data for decision-making is higher in urban hospitals than in non-urban hospitals.*

4.2.2 **Hospital Type: Teaching or Non-Teaching**

Hospitals are typically distinguished by hospital type, either teaching or non-teaching[6].
Amarasingham et al. (2008) found that teaching hospitals in Texas, USA, adopt clinical
IT systems more readily than non-teaching hospitals. The authors used a clinical
information technology assessment tool (CITAT) which measured the degree that clinical
IT systems were fully computerized in four areas: test results, notes and records, order
entry and decision support (Amarasingham et al., 2008; Simon et al., 2006).
Amarasingham et al. (2008) observe that teaching hospitals seem to adopt advances in IT
due to their history of innovation and experimentation. Given that teaching hospitals
serve similar functions in both the USA and in Canada (i.e. education and training of new
surgeons, testing of new techniques and technology, etc) it can be anticipated that
teaching hospitals in Ontario would be similar to those in Texas, USA.

The distinction between teaching hospitals and non-teaching hospitals has been well
researched (Amarasingham et al., 2008; Simon et al., 2006; Tsai, 2008; Duffy, 1992)
however; the distinction between community and small hospitals is ongoing (Wang et al.,
2005 and Lapinsky et al., 2008). In Ontario, a similar distinction can be made as to
whether a hospital is teaching or non-teaching. Duffy (1992) found evidence that non-
teaching hospitals, which were defined as hospitals with less than one residency program,
were less likely to use technology than teaching hospitals. However, in contrast, Wang et
al., (2005) and Lapinsky et al., (2008) found that teaching status was not associated with
the use of IT.

In other jurisdictions, Tsai et al. (2008) found evidence that teaching hospitals in Taiwan
were more likely to adopt IT than area [non-teaching] hospitals and medical centers
without a teaching component, thus having higher technological innovation scores than
non-teaching hospitals and medical centers. In the Taiwan study, technological
innovation was defined as: products, services, processes and others related to basic
management (Tsai, 2008). Given that there are differences in the Taiwan health care

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[6] The Canadian health care sector is comprised of paediatric facilities, hospitals (teaching, community and
small), clinics, rehabilitation centers, psychiatric facilities, and long-term care facilities.

system and Canada's health care system, the only distinction that can be made here is whether the hospital is a teaching or non-teaching hospital.

As teaching hospitals are generally at the forefront of using new techniques and innovations, and because typically, research funding and research fellows are more readily available, it is likely that teaching hospitals have a higher extent of IT use than non-teaching hospitals.

The preceding discussion leads to the second hypothesis:

H2a: *The extent of use of clinical IT is higher in teaching hospitals than in non-teaching hospitals.*

H2b: *The extent of use of data for decision-making is higher in teaching hospitals than in non-teaching hospitals.*

4.2.3 **Hospital Size: Total Staff and Number of Beds**

Generally, hospitals with more beds have more funding associated with them, thereby making the purchase of large-scale IT systems more affordable and increasing their ability to take advantage of economies of scale. According to Kimberly and Evanisko (1981), the most common measure of hospital size is the number of employees, or the workforce, where larger organizations tend to have higher use of IT. Thus, total staff is a proxy for hospital size. Further support for size and IT use was found by Amarasingham et al. (2008), where hospitals with higher IT operating expenses and those with larger IT staff had higher automation scores in Texas, USA (Jha et al., 2006). Proportionately, it is expected that the more hospital staff in an organization, the more IT staff would be in the same organization. The number of IT-specific staff was not available for this study; so total staff information was collected as a proxy for hospital size.

The number of beds is another measure of the size of the hospital, where larger hospitals are more likely to use IT (Drain, et al., 2001; Kimberly and Evanisko, 1981; Trinh & O'Conner, 2000). Amarasingham et al., (2008) found evidence that larger hospitals may benefit from economies of scale in relation to the high fixed costs of implementing new IT systems, and that smaller hospitals may have more challenges with respect to resource availability (Wang et al., 2005; McCue & Kim, 2005) .

Overall, Hampton (2008) found that there were significant barriers to the implementation of EHR, anticipated difficulties in changing from paper to electronic records, and the availability of a system at an affordable cost (Freking, 2005; Chaudhry, 2006; Harswood et al., 2003; Shields et al., 2007). Financial resources are necessary for IT purchase and implementation and represent one of the most important barriers that hospitals face within the organizational context (Barney, 1991; Bostrom et al., 2006; Murray, 2008; Simon et al., 2006; Hampton, 2008; Wolf et al., 2006). Thus, the size of the hospital entity matters as generally, larger hospitals receive more funding than smaller hospitals. Without financial resources, there is no IT system. However, without clinicians, there are no users of the said IT system.

Technology adoption research has shown that the size of the organization as measured by profits is an important factor in assessing IT adoption (Wallace & Kay, 2009). However, Ontario hospitals rarely record a profit (unlike private organizations) and health literature uses hospital type and location for proxies of measuring the size of an organization. Technology adoption researchers use revenues as a measure for size of organization. With limited data for the revenue variable, proxies for hospital size used are total staff and number of beds in this study.

The size of the hospital entity could potentially have an impact on the extent that it uses IT. From an aggregate funding perspective, generally hospitals with more beds have greater funding, thus making large-scale IT systems more affordable. Also, hospitals with more staff are generally larger in size. However, one limitation is that total staff and total beds are reported and for hospitals with multiple sites, this may mean many small sites instead of one large hospital. For example, Niagara Health System is Ontario's

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largest multi-site provider and is comprised of six hospital sites, an ambulatory care centre, and five emergency care centers, however, in this study, it is represented by one hospital entity, the Niagara Health System, which is a non-urban, non-teaching hospital. For some hospitals, a large hospital may actually be comprised of many small hospitals connected through a corporate hospital entity.

Given the preceding discussion on measuring hospital size, this study uses total staff and number of beds. Generally, the larger the hospital, the more resources are spent on IT. For further analysis, categorizations of staff and beds were also attempted in order to reveal differences between groups.

The preceding discussion leads to the third hypothesis:

H3a: *The extent of use of clinical IT is higher in larger hospitals than in smaller hospitals as measured by the hospital staff.*

H3b: *The extent of use of data for decision-making is higher in larger hospitals than in smaller hospitals as measured by the number of beds.*

Taken together, these three hypotheses are considered in relation to the use of clinical information technology and the use of data for decision-making.

5   Methods

This study uses data from three sources: CIHI, individual hospitals, and Statistics Canada. The main source of data is from the Canadian Institute for Health Information (CIHI) report: *Hospital Report 2006: Acute Care* in the form of two (out of a possible ten) indicators: use of clinical information technology and use of data for decision-making (Wagg et al., 2007). The Canadian Institute for Health Information is a respected source for Ontario hospital information. This report compiles data from a province-wide survey of health care facilities. The data collected was in the form of a survey completed by individual hospitals, and thus the accuracy and reliability of the data is unknown, except that it is received directly from hospitals. The survey had a high response rate of 87% representing 122 hospital entities (Wagg et al., 2007). This report was used because it was the most comprehensive measure of IT use at the provincial-level and it was publicly-available. Analysis was performed on this data. See Table 2 and Appendix 3 for the full list of questions.

Despite its accuracy at the time of reporting in 2007, it must be noted that hospital entities change from time to time (e.g. prior to 2006, Sunnybrook Hospital and Women's College Hospital was one hospital entity, after 2006, it operated as two separate hospital entities with independent Boards and budgets), and by limiting the measures to one fiscal year, this study captures the IT use of Ontario hospitals at that point in time. The hospital reporting year ends in March of the calendar year (i.e. year ending March 31, 2007) and includes approximately 120 hospital entities in Ontario. CIHI uses the same fiscal year as the hospital reports.

In order to determine whether this sample was representative, it was compared to the Ontario Hospital Association membership, representing 155 hospitals. In this study, 149 hospitals are assessed. Yet the Hospital Report (CIHI, 2007) contains data from only 122 Ontario hospitals. However, for one corresponding hospital, University Health Network (UHN), data from 2006-2007 was used, as the previous year was unavailable, thus, this study uses data from 2006-2007 for UHN. In this study, sixty-three hospitals had

complete data. See Appendix 4 for a complete listing of hospitals used in this study and Appendix 5 for hospitals not included in this study.

Further, individual hospitals reported independent variables such as bed size and staff, which may not be accurate at all times. The most reliable data is the financial data which is prepared and audited by accounting firms, on behalf of the hospital, and based on *Generally Accepted Accounting Principles*; however the interpretation of each individual accountant or accounting firm may vary and may have an effect on data quality. Some financial data was summarized in this study. The number of beds and total staff were drawn from hospital websites, annual reports and direct communication with the hospital departments (administration, communications, finance, and/or human resources). See Appendix 5.

Urban hospitals in this study are defined, using the Statistics Canada Census Agglomeration (CA) concept, as those located in cities with over 100,000 population. Cities, counties, and towns that do not meet this definition are considered non-urban areas in this study. Population data in the form of CA was drawn from the Statistics Canada 2006 Census (the most recent data available). There were other population classifications for cities and towns available at Statistics Canada that were not used for this study. Other possible classifications were census metropolitan areas (over 500,000 populations) and census divisions (provincially legislated areas). The 2006 Census is regarded as a reliable source of data for measuring the Canadian population. As discussed previously, since Canada has approximately one-tenth the population of the USA, it would be unreasonable to use the same one-million population cut-off for both countries in representing an urban location. Thus, after examining the availability of data from the 2006 Census and estimating comparable sizes for cities in Ontario, it was determined that a cut-off of 100,000 would be a reasonable estimate of an urban location.

5.1 Variables

The use of IT is measured by two dependent variables in this study: use of clinical information technology and use of data for decision-making. Together, these variables measure the extent of IT use in Ontario hospitals. They are index scales, thus are relative to other hospitals, rather than a percentage of IT use. These are described in detail below.

5.1.1 **Dependent Variables**

These two indicators are the dependent variables in this study. They represent the extent of use of IT in Ontario hospitals and will be assessed against independent variables hospital location, type and size.

> *"The use of clinical information technology indicator was constructed to reflect the degree to which clinical information is available electronically to care providers inside and outside of the organization… it is based on six questions from the 2006 Acute Care System Integration and Change (SIC) survey."* (Wagg et al., 2007: 10)

The use of clinical IT indicator index scale consists of two major components: use of IT and access to IT. The use of IT component comprised three questions. The access to IT component comprised three questions. Each component had a different number of points allocated to each question, e.g. the question about the existence of the tele-health or video-coordinator role was out of two points: 1 point if the role was under development and 2 points for a permanent role. See Table 2 and Appendix 3 for full list of questions.

> *"The use of data for decision-making is the degree to which organizations are disseminating and utilizing both clinical and administrative data"* (Wagg et al., 2007: 21)

The use of data for decision-making indicator index scale consisted of eleven questions in five areas: clinical data dissemination and benchmarking, safety and utilization management, staff information-based roles, dissemination of information, and

benchmarking of information. The clinical data dissemination and benchmarking component had only one question. The safety and utilization management component was comprised of 7 questions. The staff information-based roles component was comprised of 2 questions. The dissemination of information component was comprised of 2 questions. The benchmarking of information component was comprised of only 1 question. Each component had a different number of points allocated to each question. Altogether, these questions made up the two components of the dependent variables used in this study. See Table 2 and Appendix 3, for a list of the items, and Wagg et al (2007) for a detailed description of how the indices were composed.

Table 2: Canadian Institute for Health Information's 2006 Hospital Report Definitions

Indicator / Component	Component Details
Use of Clinical Information Technology Use of Information Technology	 ■ Existence of role of telehealth/ video-care coordinator. ■ Use of electronic records and data as a primary source of information in the organization. ■ Performance of functions online and in real-time.
Access to Information Technology	■ Access of clinical workstations to different applications. ■ Access for regulated health professionals to email address, intranet, online access to real-time monitoring data, online access to medical images. ■ Total number of desktop computers or workstations divided by the total number of full-time employees.
Use of Data for Decision-Making Clinical Data Dissemination and Benchmarking	 ■ Current collection of fifteen clinical measures: sharing data with quality group), comparing internally across specialties or past performance, comparing externally with others.
Safety and Utilization Management	■ Form of data reporting for actual and potential adverse events (paper or electronic form submission). ■ Existence of registry for sentinel events ■ Conducting a safety-related prospective analysis and implemented improvements or changes. ■ Existence of adverse event / patient safety committee. ■ Form of data reporting for routine incident reporting system (paper or electronic form submission). ■ Utilization management strategies used in the hospital.
Staff Information-Based Roles	■ Existence of four staff roles (utilization, quality, decision support and infection control practitioner). ■ Participation of continuing education activities for staff groups (physicians, nurses in administrative roles).
Dissemination of Information	■ Dissemination of employee satisfaction results. ■ Use of hospital website, bulletin board, newsletters, etc… ■ Dissemination of patient satisfaction surveys to different groups in the organization.
Benchmarking of Information	■ Engagement in external benchmarking practices with two or more organizations comparing physician and employee satisfaction for different groups of staff.

Source: Ontario Hospital Report 2006: Acute Care, Technical Summary document. Canadian Institute of Health Information, 2007.

5.1.2 **Independent Variables**

As stated previously, hospital location is divided into two categories: urban and non-urban. Hospitals in urban locations have a CA of over 100,000 residents as per Statistics Canada Census (Statistics Canada, 2008). Examples of these urban locations include: Barrie, Guelph, Kingston, Kitchener, London, Ottawa, Sudbury, Thunder Bay, Toronto, and Windsor. Examples of non-urban locations include: Oakville, Oshawa and Timmins. Other cut-off populations attempted were cities with 500,000 and 2,000,000 populations.

For hospitals with multiple sites, the location of the main site is considered as its hospital location in this study. For example, Lakeridge Health Corporation had three sites in total, Oshawa, Bowmanville and Port Perry; however, since the main site is in Oshawa, the hospital entity is considered to be located in Oshawa (e.g. Bridgepoint Hospital is located in the city of Toronto and therefore is classified as an urban location). Some smaller hospitals are part of larger hospital entities/corporations.

Hospital size information, as measured by number of staff and beds, came directly from each hospital, as an aggregate measure of Ontario hospital human resources was neither available to nor accessible by the author of this study.

The hospital types included in this study are: teaching and non-teaching hospitals, as defined by both the Canadian Institute of Health Information and the Ministry of Health and Long-Term Care. These hospitals deliver acute care and serve the mainstream population. The hospital types not included in this study are: pediatric facilities, rehabilitation centers, psychiatric hospitals, and long-term care facilities. There are fewer of these other types of hospitals which typically offer more specialized care and do not typically serve the general population.

In this study, teaching hospitals are defined as hospitals who are members of the Council of Academic Hospitals in Ontario (Council of Academic Hospitals of Ontario, 2008). According to the CIHI, these hospitals "provide highly complex patient care, are affiliated with a medical or health sciences school and have significant research activity

and post-graduate training" (Ontario Hospital Report: Acute Care, 2007:7). The Joint Policy and Planning Committee definition of hospitals types[7] follows fairly closely to that of CIHI's definition. Further to this, the CIHI defines small hospitals as "single community providers" (Ontario Hospital Report: Acute Care, 2007:7). Small hospitals are the only health care provider for a community, and often have limited facilities, e.g. few specialists and equipment. Community hospitals are defined as not small and not teaching hospitals (Ontario Hospital Report: Acute Care, 2007: 7). Small hospitals and community hospitals were grouped together to form the non-teaching hospitals category. It is noted that not all hospital types in Ontario are included, but only hospital entities serving the average Ontario citizen, i.e. they are not long-term care facilities or specialty care units and are accessible to patients with immediate or short-term health care needs, e.g. emergency care or elective surgery.

For hospital size, the number of hospital beds and the total staff were collected from individual hospital entities and recorded by the author. Information for 2006-2007 was collected by the author in the summer of 2008. Most financial data were drawn from publicly-available, audited financial statements from individual hospital entities. Some revenue, expense, and MoHLTC funding information was collected but not used in this study's analysis.

Health researchers (Menachemi et al., 2007) typically use two different factors in determining the hospital size: number of beds and hospital type. Although technology researchers often use revenues as an indicator of size, this study follows the conventions of the health literature, using hospital size and hospital type instead of revenues to measure size.

Two variables (number of beds and total staff) had a high correlation with each other. The categories used in the analysis were later tested for robustness. This is discussed in the Results section of this paper.

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[7] According to the Joint Policy and Planning Commission (JPPC) a small hospital is defined as a hospital with a referral population of less than 20,000 and less than 50 in-patient beds (Ontario Ministry of Health and Long-Term Care, 1999).

5.2 Data Analysis

There were four steps for data analysis used: collecting and entering the data from multiple sources, cleaning up the data by verifying information, performing statistical analysis on the data and, finally, interpreting the results.

Cleaning up the data or verifying information was a systematic process with random testing, i.e. sample hospital entities were examined in detail to ensure that their information was entered correctly, e.g. the number of beds and total staff were accurate. There were few significant changes in this process, but for data integrity, the author found it necessary to perform this step.

The original database was constructed in Microsoft Excel 2007 (spreadsheet program) and then exported into SPSS software (SPSS Version 16.0) to conduct further analysis.

Performing statistical analysis was the next step, and began with the descriptive statistics of measures used in the analysis, comparing means for the different variables and then Fisher's ANOVA. Further, regression analysis was performed on the location, type and size variables and results are noted in a later section. First, the three variables are considered separately (i.e. hospital location, type and size) then the variables are combined in the regression analysis.

The data analysis tested whether location, hospital type, and size of hospital had an impact on the extent that a hospital uses IT. Firstly, hospital location (urban area or non-urban) and its use of IT was compared. By comparing the means and the variance of the two independent variables (use of clinical information technology and use of data for decision-making), differences between hospitals were identified.

Secondly, the hospital type (teaching or non-teaching) and its extent of use of IT were examined. By comparing the means and the variance of the two independent variables (use of clinical information technology and use of data for decision-making), differences between hospital types were identified.

Thirdly, whether the size of the hospital was associated with its extent of use of IT was examined by looking at proxies for measuring the size of the hospital, the number of beds and the total staff. By comparing the means and the variance of the two independent variables (use of clinical information technology and use of data for decision-making), differences between hospital sizes were identified.

5.2.1 Summary of Data Used in this Study

The data descriptions and their sources are summarized in Table 3.

Table 3: Summary of Data Sources for this Study

Data Name	Data Description	Data Source
Hospital type	Teaching hospital Non-Teaching hospital	CIHI Joint Policy and Planning Committee (MoHLTC)
Hospital location	Urban areas 100,000+ population Less than 100,000 population for non-urban areas	Statistics Canada Census, Census Agglomerations
Number of Beds	Number of beds in the hospital Less than 150 beds 151-300 beds 301+ beds	Websites Individual hospital reports and communication
Total Staff	Number of staff employed at the hospital Less than 1000 staff 1001-2000 staff 2001+ staff	Websites Individual hospital communication
Use of Clinical information technology	Index Scale of extent of IT use	CIHI
Use of Data for decision-making	Index Scale of extent of IT use	CIHI

This study focused on hospital type, hospital location, and hospital size and measured them against the extent of IT use for clinical information technology and use of data for decision-making. LHIN, total revenues, total expenses, MoHLTC funding was collected but was not used in the analysis for this study.

6 Results

6.1 *Sample Description*

In this study, the average sample hospital was non-teaching hospital, in a non-urban location, and large in size. It had $188.72M in total revenues, 276 beds, and 2,055 staff (see Appendix 6 and Appendix 7).

There were 149 hospital entities in Ontario but only 63 were used in this analysis. Eighty-six hospital entities had missing or incomplete information. For hospital type, 15.9% (n=10) were teaching hospitals and 84.1% (n=53) were non-teaching hospitals (74.6% were community hospitals and 9.5% were small hospitals). For the location of the hospitals, 57.1% were non-urban (n=36) and 42.9% were urban (n=27). For the size of the hospital, 38.1% (n=24) hospitals had less than 1000 staff, and 40.0% (n=25) with over 300 beds. Outside of the hospital type, there were overlaps in the other areas, i.e. a hospital can be both large and non-urban or large and urban. Refer to Table 4, Appendix 4, and Appendix 6. For complete information, a list of hospitals that were not included in this study is found in Appendix 5.

The literature notes that there are different levels of urbanity. This study used a cut-off of 100,000 population to define an urban location. Other cut-offs were attempted and their significance reviewed, however the analysis is not presented in this paper. In this sample, teaching hospitals had an average of $493.4M in revenues, whereas non-teaching hospitals had an average of $131.1M. Teaching hospitals are, on average, 3.5 times larger than non-teaching hospitals. See Table 4.

Table 4: Key Independent Variables

Variable	Number	Percentage
Hospital Location		
Urban	27	42.9%
Non-Urban	36	57.1%
Total	63	100%
Hospital Type		
Teaching	10	15.9%
Non-Teaching (Community and small hospital)	57	84.1%
Total	63	100%
Hospital Size by Staff		
Less than 1000 staff	24	38.1%
1001-2000 staff	19	30.2%
2001+ staff	20	31.7%
Total	63	100%
Hospital Size by Beds		
Less than 150 beds	18	28.6%
151-300 beds	20	31.7%
301+ beds	25	40.0%
Total	63	100%

There was a range of 14 to 1,066 beds with a mean of 276 and a standard deviation of 253 for the number of beds. There were 28.6% hospitals with less than 150 beds (n=18), 31.7% with 151-300 beds (n=20), and 40.0% had 301+ beds (n=25). As will be discussed later, various categorizations were attempted.

Table 5 shows the variable description of use of clinical IT and use of data for decision-making. Data was available for sixty-three hospitals. For use of clinical IT, there was an index range of 14.2 to 98.3, with an average of 58.5 and a standard deviation of 14.4. For the use of data for decision-making, there was a range of 20.2 to 89.5, with an average of 63.7 and a standard deviation of 14.7.

This sample of sixty-three is representative of Ontario hospitals because there are more non-urban hospitals than urban hospitals. In Ontario, there are more small hospitals than large hospitals. This sample is within the range of the Ontario Hospital Association's membership which is an organization representing hospitals in Ontario. See Appendix 4 and Appendix 5 for lists of hospitals.

6.2 Use of Information Technology and Hospital Factors

Using ANOVA analysis, significant results were found for hospital location and hospital size. Note that the Mean Index Scale is used for each independent variable and represents its relative IT use when compared to other hospitals. The differences in the use of IT are classified by the three factors hospital location, type and size and their means are found in Table 5.

Table 5: ANOVA Table for Use of IT by Hospital Factors

	Use of Clinical IT Mean Index Scale (n=63)	Use of Data for Decision-Making Mean Index Scale (n=63)
Hospital Location – Average All	**58.5**	**63.7**
Urban (n=27)	63.4**	70.1**
Non-Urban (n=36)	54.8**	58.9**
Hospital Type – Average All	**58.5**	**63.7**
Teaching (n=10)	65.6	70.4
Non-Teaching (n=57)	57.1	62.4
Hospital Size by Staff – Average All	**58.5**	**63.7**
Less than 1000 staff (n=24)	52.7**	60.6
1001-2000 staff (n=19)	58.1**	60.9
2001+ staff (n=20)	65.7**	70.0
Hospital Size by Beds – Average All	**58.5**	**63.7**
Less than 150 beds (n=18)	53.4*	58.9*
151-300 beds (n=20)	56.4*	61.1*
301+ beds (n=25)	63.7*	69.2*

Note: * denotes significance of difference of means at $p = 0.05$, and
              ** denotes significance of difference of means at $p = 0.01$

6.2.1 Hospital Location: Urban or Non-Urban

The significant results were found for the location factor for use of clinical IT. As seen in Table 5 urban hospitals (63.4 index scale) were more likely to have higher levels of clinical IT use than non-urban hospitals (54.8 index scale) at ($p=0.05$).

Urban hospitals (70.1 index scale) were more likely to use data for decision-making than non-urban hospitals (58.9 index scale). The results also were significant for the location factor for use of data for decision-making (p=0.05).

In this study, therefore there was support found for H1, that urban hospitals tend to use IT more for both clinical IT and data for decision-making in Ontario hospitals.

6.2.2 Hospital Type: Teaching or Non-Teaching

For use of clinical IT, ANOVA analysis comparing mean index scores for use of clinical IT showed the significance at 0.09, which is not significant between groups See Table 5. Similarly, for the use of data for decision-making, ANOVA analysis showed the significance at 0.11, which is not significant between groups.

In this study, support was not found for H2, teaching hospitals tend to use IT more than non-teaching hospitals. The extent of IT use was not significantly different for teaching hospitals compared to those of non-teaching hospitals.

6.2.3 Hospital Size: Number of Beds and Total Staff

A simple correlation showed a very high correlation (0.9) between the two hospital size indicators, number of beds and total staff. The ANOVA results showed both size factors, however, the regression analysis will use only one factor (number of beds) to represent hospital size as the results for this size variable were significant.

For the use of clinical IT, hospitals with 2001+ staff (65.7 index scale) were more likely to use clinical IT than hospitals with 1001-2000 staff (58.1 index scale) and hospitals

with less than 1000 staff (52.7 index scale).   ANOVA analysis showed a statistical significance of 0.01, (p=0.05). This was a significant result across the three categories.

For the use of clinical information technology, a larger hospital is more likely to use clinical IT than a smaller hospital. For the use of data for decision-making, its ANOVA analysis, this factor had a significance of 0.06, so at p=0.05, this is not a significant result across the three categories. For the use of data for decision-making, there is not a significant difference in the hospital size. See Table 5 and Appendix 6.

For H3a (total staff), partial support was found for hospital size association for use of clinical IT.

For the use of clinical information, ANOVA analysis showed that the class of beds factor had a significance of 0.05, (p=0.05). The larger hospitals (>300 beds) were more likely to use clinical IT more (63.7 index scale) compared to the medium hospitals (151-300 beds, 56.4 index scale) and small hospitals (150 or less beds, 53.4 index scale). For the use of data for decision-making, there is a difference in the extent of IT use for the hospital size by the number of beds. The larger hospitals (>300 beds) were more likely to use clinical IT more (69.2 index scale) compared to the medium hospitals (151-300 beds, 61.1 index scale) and small hospitals (150 or less beds, 58.9 index scale).   Therefore, this difference is significant. See Table 5 and Appendix 6.

Other size categorizations were used to test robustness and sensitivity of the findings to different size categorizations. Analyses were performed for (1) less than 100, 101-500, 501+, and (2) less than 200, 200-500, 501+ beds. A similar pattern emerged: smaller hospitals had lower index scores than larger hospitals, however none of the results were significant (p=0.05, the significance was 0.19 for the categorization of less than 100,101-500,501+ beds), though the differences were not significant, the pattern was the same.

For H3b (number of beds), this study showed that clinical IT and data for decision-making were used more in larger hospitals than in smaller hospitals. Thus, number of beds was the variable used in the regression analysis.

As mentioned before, revenues matter for technology adoption. In this sample, large hospitals (300+beds) had an average of $371.3M in revenues, whereas small hospitals (less than 150 beds) had an average of $27.1M. Large hospitals are, on average, thirteen times larger than small hospitals. This is consistent with the use of hospital beds as a proxy for hospital size.

6.3 Hospital Location, Type and Size: Multiple Regression

Given the above findings that hospital location and hospital size were associated with the extent of IT use in Ontario hospitals, regression was performed to consider the variable effects together. Again, there were dependent variables (1) use of clinical IT and (2) use of data for decision-making and thus two separate regressions were formulated. The correlations between the regression variables are presented first.

6.3.1 Correlation

Correlation analysis of the variables, not surprisingly, showed that the highest correlation was found between the two hospital size variables: number of hospital beds and total staff had a Pearson correlation of 0.90 (significant at $p=0.01$). This was expected as the higher number of beds would presumably be served by a greater number of staff. See Table 6 and Appendix 6.

There was a significant correlation (0.31) between the two dependent variables, use of clinical IT and use of data for decision-making ($p<0.05$). For the location factor, there was significant correlation (0.30) between use of clinical IT and the urban location at $p<0.05$. There was also a significant correlation (0.38) with use of data for decision-making at $p<0.01$. For the hospital type, the only significant correlation (0.30) was between the urban location and the teaching hospital ($p<0.05$).

Beyond a simple regression analysis, a preliminary visual examination of the data suggested a curve linear relationship between hospital size (number of beds) and extent of IT use. Thus, transforming the data (i.e. using a log function) would improve the relationship between independent and dependent variables and adjust for violations in the assumptions[8] of the regression (Hair et al., 1992). This was done in anticipation that the change in dependent variables would not be constant, and thus, would more accurately reflect the relationship between variables. Therefore, a log transformation was performed on the number of beds variable as it represented the hospital size factor.

There were significant correlations for the log of beds and use of clinical IT (0.37) and use of data for decision-making (0.34) and urban location (0.66) at p<0.01. See Table 6.

As mentioned, there was also a high correlation found between the number of beds and total revenues (0.9) significant at p=0.01. Since this study uses number of beds as a means for size, the larger hospitals have higher numbers of bed, and relationally, higher revenues. See Appendix 7.

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[8] Statistical assumptions are that measurement errors are normally distributed and that residuals have a follow a normal distribution and have uniform variance.

Table 6: Descriptive Statistics, Scale Reliabilities and Correlations among Study Variables (n=63)

	M	SD	1	2	3	4
1 Use of clinical IT	58.46	14.37				
2 Use of data for decision making	63.68	14.66	0.31* (0.02)			
3 Urban location (0=non-urban, 1=urban)	0.18	0.39	0.30* (0.02)	0.38** (0.00)		
4 Teaching hospital (0=non-teaching, 1=teaching)	0.19	0.39	0.22 (0.86)	0.20 (0.11)	0.30* (0.01)	
5 Log of beds (1=0-150, 2=151-500, 3=501+ beds)	2.23	0.47	0.37** (0.00)	0.34** (0.01)	0.66** (0.00)	0.21 (0.09)

Note: **. Correlation is significant at $p<0.01$, two-tailed test.
         *. Correlation is significant at $p<0.05$, two-tailed test.

6.3.2 **Multiple Regression Results**

For the multiple regression, functional relations between the independent and dependent variables were sought (Marques, 2007: 271). In order to make inferences with the regression model, errors were assumed to be independent and normally distributed (Marques, 2007: 279). It was useful to use the log function for the hospital size factor so that effects of the dependent variables were set to the natural log and thus more comparable between variables. The simple regressions for each independent variable were performed separately[9]. See Table 7.

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[9] Regressions for both independent variables, use of clinical IT and use of data for decision-making, were completed with populations of 500,000 and 2 million in Ontario; however, they were reviewed but not reported here as the classification for urban hospital location in this study is 100,000.

Table 7: Results of Regression Tests for the Use of Information Technology

Variable	Beta	s.e.	P-value
Clinical Use of IT			
Hospital Location (0=non-urban, 1=urban)	0.063	4.854	0.711
Hospital Type (0=non-teaching, 1=teaching)	0.089	5.179	0.503
Hospital Size (Log of beds)	0.296	5.862	0.075
Overall R^2 –value	0.147		
Model F *(df)*	3.401 (3)		
Significance of model	0.023		
Use of Data for Decision-Making			
Hospital Location (0=non-urban, 1=urban)	0.275	4.916	0.106
Hospital Type (0=non-teaching, 1=teaching)	0.041	5.245	0.756
Hospital Size (Log of beds)	0.136	5.937	0.406
Overall R^2 –value	0.159		
Model F *(df)*	3.716 (3)		
Significance of model	0.016		

First, the multiple regression for the use of clinical IT was performed. The variables considered in this model were hospital location (urban or non-urban), type of hospital (teaching or non-teaching), and the log of beds. One of the purposes of the regression analysis was to determine whether there was a relationship between the factors studied (hospital location, hospital type, and hospital size). For the use of clinical IT, the regression model was statistically significant (p= 0.02). Neither the location factor (p=0.71) nor the type factor (p=0.50) were statistically significant. See Table 7.

The coefficients in the model have the following beta: hospital location (urban) = 0.063 (significance=0.711), hospital type (teaching) = 0.089 (significance=0.503), and hospital size (by number of beds) = 0.296 (significance=0.075). However, the individual coefficients were not statistically significant.

Second, the multiple regression for the use of data for decision-making was performed. The variables considered in this model were hospital location (urban or non-urban), type

of hospital (teaching or non-teaching), and the log of beds. One of the purposes of the regression analysis was to determine whether there was a relationship between the factors studied (hospital location, hospital type, and hospital size). For the use of data for decision-making, the regression model was statistically significant (p=0.02) even though neither the location factor (p=0.10) nor size factors (p=0.76) were statistically significant. In short, the model was statistically significant; however the individual coefficients were not. Therefore, the regression results does not allow for stronger claims. See Table 7 and Table 8.

Therefore, for both regressions, the results found no significance of coefficients even though the models were statistically significant. The influence was in the direction as predicted but the sample was insufficient to make stronger claims.

6.3.3 **Summary of Hypotheses and Findings**

Hypotheses and independent variables are presented below in Table 8:

Table 8: Summary of Study Hypotheses and Results: Use of IT

Hypothesis	Result	Strength of Support
H1: location – clinical IT	Urban > Non-urban	Significant
H1: location – decision-making	Urban > Non-urban	Significant
H2: type – clinical IT	Teaching hospitals > Non-teaching	Not significant
H2: type – decision-making	Teaching hospitals > Non-teaching	Not significant
H3a: size (staff) – clinical IT	Large > Medium and Small hospitals	Significant
H3a: size (staff) – decision-making	Large > Medium and Small hospitals	Not significant
H3b: size (beds) – clinical IT	Large > Medium and Small hospitals	Significant
H3b: size (beds) – decision-making	Large > Medium and Small hospitals	Significant

6.4 Discussion of Results

For hypothesis 1, there was a difference between urban and non-urban hospitals using IT at a cut-off of 100,000 population. This shows that the physical location of a hospital impacted its use of clinical IT and its likeliness to adopt new technologies. For the use of data for decision-making, it seemed that urban hospitals are more sophisticated in their use of administrative systems (use of data for decision-making). Thus, H1 was accepted for both clinical IT and data for decision-making.

Although a key competency of any hospital is to provide patient care, there was support found that urban hospitals can also be both clinical and administrative IT system leaders. However, it is noted that the definition of urban may have an impact on the results, i.e. the cut-off of 100,000 residents was used to classify cities as urban. A 100,000 resident cut-off means that urban cities included Barrie, Guelph, Hamilton, Kingston, Kitchener, London, Oshawa, St. Catharines-Niagara, Sudbury, and Thunder Bay, Toronto and Windsor. If a 200,000 resident cut-off was used then the urban cities would include only Ottawa, Toronto and Windsor. If a 300,000 resident cut-off was used, then the urban cities would include Kitchener, London, and St. Catharines-Niagara and Toronto. If a 2 million resident cut-off was used, then the only urban city in Ontario would be Toronto. Results may change because of this study's definition. Refer to Table 8 and Appendix 5.

As discussed previously, urban hospitals may have access to other resources that are important in the use of IT such as project champions and senior management support. This study found support that there is a risk that non-urban hospitals may be falling behind in the use of IT. Currently, non-urban hospitals are less likely to use IT compared to urban hospitals. However, the impacts of using less IT need to be studied further.

Hypothesis 2 could not be supported. For use of IT, even though teaching hospitals scored higher than non-teaching hospitals, the results were not significant. This was an unexpected result as some of the literature states that teaching hospitals are more likely to have higher IT use scores. There was opposing literature. This study found support in Ontario hospitals for the opposing literature; that teaching status was not associated with

IT use (Lapinsky et al., 2008). Teaching hospitals are typically users of new techniques and innovations, research funding and research fellows are more readily available, and it was surprising to find that teaching hospitals did not have a significantly higher extent of IT use than non-teaching hospitals. However, there were very few teaching hospitals in this study (n=10), which may have impacted on the results. Most hospitals in this study (84%) were non-teaching hospitals (n=53).

For hypothesis 3a, larger hospitals (as measured by total staff) were more likely to use IT, which was an expected result as larger hospitals typically have more aggregate funding for IT projects which typically require large initial upfront costs. In fact, "the diffusion of innovation theory argues that organizations with excess resources are more likely to adopt innovations" (Wang et al., 2005: 45) which was supported in this study's findings. Thus, there was support for H3a. This study found further support that the number of beds and total staff are relevant measures for hospital size. See Appendix 5: .

For hypothesis 3b, larger hospitals (as measured by number of beds) were more likely to use IT, which was an expected result. There was a significant difference in the likeliness of a larger hospital to use IT than a smaller hospital. These results were significant and as such, there was support found for H3b. For smaller hospitals, it is advantageous and desirable to join larger hospital entities to increase the use of IT. Small hospitals existing on their own may have issues using IT within the organization, but also in connecting with other hospital entities.

Further, a cross-tabulation showed 86% congruence between the categorization between beds and staff. That is, the classifications of hospitals as small, medium and large were the same 86% of the time when using staff number and total beds under these categories. Thus, this provided further support that either size proxies are appropriate for this sample of Ontario hospitals.

7 Discussion: Ontario Hospitals' Use of IT

The key findings of this study show that there are differences in use of IT for Ontario hospitals. Two factors associated with higher extent of IT use are: (1) an urban hospital location, and (2) a larger hospital size. The type of hospital (whether it was teaching or non-teaching) did not impact on its IT use. Some implications for having location and size determine a hospital's use of IT are the increasing divide between urban and non-urban hospitals and the proliferation of smaller "have not" hospitals in Ontario. Study limitations include the sample size, population cut-offs, generalizability of results and variable definitions. There are many areas for further research including successful implementation strategies, private sector collaboration, public patient care records, and social and individual aspects IT adoption factors. This study makes two contributions to the area of knowledge of IT use in Ontario hospitals.

First, the location of the hospital is important to the extent of IT use. Urban hospitals tend to use IT more than non-urban hospitals. Urban hospitals have populations of over 100,000, receive more referrals than do non-urban as specialists and equipment are available (Bostrom et al., 2006); tend to be larger and service a higher population due to their location in metropolitan areas, and is likely to adopt new technologies. Thus the sheer volume of records necessitates the use of IT systems.

There are several LHINs with more urban hospitals compared to other LHINs. LHIN 7 (Toronto Central) and LHIN 8 (Central) house most of the province`s urban hospitals and are high users of IT (relative to other LHINs). This is an ideal environment to implement large-scale IT projects because of the existing use of IT. These two LHINs are special they have many urban hospitals and may have quick uptake of new technology. It is likely that there are also more IT professionals within the hospital currently to support the IT systems creating an atmosphere where IT use is supported, valued and successfully implemented. Urban hospitals need to continue to reach out to non-urban hospitals that may send in their referrals. By catering to their needs, urban hospitals may have a broader reach without jeopardizing quality of care. There are many opportunities for both urban and non-urban hospitals.

Second, larger hospitals (as measured by the number of beds), were more likely to use IT than smaller hospitals. This may be due to the geographical reach of larger hospitals as many of them have multiple sites and more funds to implement large-scale IT projects. Managing the IT function for multiple sites may have its benefits. For example, standardization of data, policies, procedures and care may be helpful for clinicians. Managing IT for multiple sites may have its challenges too. For example, some potential issues may be the training associated with new programs, availability of human resources for problem solving, and the continual update and maintenance of IT systems. In the USA, larger organizations are likely to have larger networks and connectivity; this was also the case for Ontario hospitals.

Larger hospitals are ideal locations to implement IT systems. Such systems could include EHR, diagnostic imaging, and tele-health systems, quality programs, benchmarking, or registries/reporting programs. By funding IT projects in larger hospitals, policy-makers may direct funds and realize benefits most effectively. When different hospital sites see patients with similar needs, standardized care pathways can be developed and used across the province. These pathways can be communicated to other facilities to create even broader reach. Geographically, patients may also benefit by receiving care closer to home, as larger hospitals have broader reach. Large hospitals may have internal networks that could be used to connect to other health facilities. Public health researchers may also be attracted to larger sites to study the effects of large-scale treatment or implementation studies.

Hospital size had an impact on the extent that IT is used in Ontario hospitals in both clinical IT and data for decision-making. Innovation in hospital systems can be copied and distributed to other hospitals. Clinical care pathways may be standardized assuming that all hospitals have the right mix of resources (human, financial, physical, etc). Health IT can also be used for simplifying documentation (Wolf et al., 2006). The number of beds is a good indicator of the extent of IT use; the higher the number of beds, the higher the extent of IT use.

Finally, even though teaching hospitals were more likely to use IT than non-teaching hospitals, these results were not significant. Teaching hospitals are different from other hospital types in their use of IT (Shields et al., 2007; Murray, 2008; Lapinsky et al., 2008). They are usually tasked with making new discoveries, adopting new innovation, and contributing to education of clinical resources. However, teaching hospitals may also have existing systems so that implementing new IT systems may cause conflict with old clinical systems. This needs to be studied further as there was conflicting literature in this area.

There are some key implications to these findings, e.g. Ontario hospitals are different in terms of urban location. For Ontario policy makers, this means that given that implementation success is constant, it would be more effective to implement IT systems in larger hospitals first, where the extent of IT use is higher, rather than in smaller hospitals. It would be useful to know how much of the IT use is due to hospital policy and how much of it is due to IT being helpful, but this cannot be determined given the data collected for this study. Further, the number of IT staff and training staff would be helpful in determining training needs at the organizational-level.

Even though there are hospitals that use IT more extensively than others, IT is essential in all hospitals. As the government continues to improve on benchmarking hospitals and comparing performance, factors that are associated with the use of IT will become more important to funding allocation where accountability is measured. Policy makers may find that certain types of hospital are well-suited to IT use, while others need more training or structural changes to succeed. In Ontario, significant funding has been attached to IT implementation and adoption without assessing usage. All in all, the funding formula for IT investment is complex and political in nature, whereas this study only identifies organizational factors associated with IT use in hospitals. More information, time and funding would be necessary to develop a more comprehensive model of IT usage in Ontario hospitals.

This study identified two factors that are associated with the extent that health IT is used in Ontario hospitals. Previously, much of the research in this topic area was conducted in

the USA. This study helps to develop an understanding of these factors in a publicly-funded Ontario health system. This study contributes to the area of interest by confirming two factors relevant for the health care system in Ontario, Canada. Urban location and hospital size are associated with the extent of IT use in Ontario. Policy makers may use these findings to implement health IT funding at the regional, provincial, or national level. Clinicians and administrators may use this to support larger scale funding projects for health IT use. Patients have the most to gain when health IT is used effectively and eventually leading to safer, more efficient and more effective care with better outcomes.

7.1 Study Limitations

Sufficient ample size is necessary to draw statistically significant conclusions. This sample only represented 63 (out of a possible 150) Ontario hospital entities. Should additional information be available and collected for the remaining Ontario hospitals, the results may also be different. With only 63 hospitals represented, there was insufficient data for the statistical analysis (ANOVA and regression analysis) to draw conclusive and statistically significant conclusions of the variables of interest.

As other authors have observed, "technology implementations are often ongoing processes with no distinct end point" (Amarasingham et al., 2008: 43). This study attempts to look at a snapshot of the IT environment in Ontario hospitals, and therefore, accounts for only fully-implemented IT projects, at the time of the study. It may not capture IT projects newly-implemented and not reported, projects being implemented, nor plans for future IT implementations.

The Canadian health care system is unique, and the province of Ontario operates in a separate political and structural environment with specific demographics. Thus, what is supported in this study may not be generalizable to other jurisdictions (e.g. to the province of Nova Scotia). Other authors found this as well, and as Abdolrasulnia et al.

(2008) state, it is difficult to control for policy variations between states [thus leading to variations of IT use]. Hospital location may be non-urban or urban, which would exist in other jurisdictions. Hospital types may also be common but not exhaustive in nature (some provinces may have a higher complement of rehabilitation facilities than Ontario).

7.2 Suggestions for Further Research

One of the main reasons that EHR systems fail is due to their implementation strategy (Nembhard, et al., 2008; Middleton, et al., 2005). Thus, research on successful implementation strategies deserves more focus. Nembhard et al. (2008) offer six strategies for implementation success: create opportunities for staff experimentation and innovation adoption, frame innovation implantation as a learning challenge, promote organizational identification, use transformational leadership processes, involve workforce in performance measurement and control system development, and measure and reward implementation efforts.

Wolf et al. (2006) reported on the successful implementation of a computerized physician order entry system with 98% acceptance and utilization in the USA and made the following recommendations for others: using the improved quality of care as a foundation for conversation, involving stakeholders early in the process (they conducted a survey to identify user needs and readiness), using clinicians and physician champions in training and implementation, pairing the information technology staff with clinicians, making the innovation visible (kiosks were set up in offices and public areas) and communicating often with stakeholders. The authors also noted the importance that it was neither an IT effort, nor an administrative system (Wolf et al., 2006). The study that was reported on used a grassroots approach, starting with "super users," with communication strategies such as asking medical staff to sign up their peers for training sessions, including physician-to-physician training (Wolf et al., 2006). More research on successful implementation strategies would aid in developing not only more user-friendly IT, but also for quicker adoption rates.

Further, many hospitals are using IT as a risk management tool. For example, some pharmacy departments now have physicians order their patients' medications electronically, thus addressing the previous medical errors due to difficulty in reading prescriptions and lost, misplaced, or altered prescriptions. Patient safety is addressed leading to an effective method of decreasing preventable errors. More and more, outcomes measurement has been used to defend the use of EHRs (Werner & Asch, 2007). Quality improvements can be made with IT use and creativity and leadership would be useful.

From a systems perspective, despite all its advantages and benefits, national EHR systems are expensive. Kaushal et al. (2005) found that costs of a national information network are significant because necessary infrastructure must be in place for its success. Different levels of government have already spent billions of dollars and results are starting to be seen, however, there is a long way to go. In order for Ontario and Canada to fully implement EHR for all patients, additional and significant costs need to be incurred which would be in the billions of dollars. Governments, policy-makers, clinicians and patients need to make significant investments (and continual investments) before its benefits can be realized.

Despite the benefits known in implementing health IT systems, there is still a need to address concerns for security and confidentiality (Bostrom et al., 2006; Wolf et al., 2006). These issues are not addressed in this study.

Next, a significant area of new research is emerging: private sector collaboration. In fact, future research is happening today, where a partnership with Cisco, a communications technology company, allows virtual tours of hospital facilities before they are built (Bruck, 2008). Beyond this, Second Life allows for avatars to prepare for surgical procedures, train physicians and explore virtual software for educational purposes (Bruck, 2008). Both of these companies are working with health providers to integrate IT to help providers and health facilities.

Also, Microsoft's free (i.e. no fee) Health Vault (found at www.healthvault.com) is the beginning of a patient health record that has the capability to connect to hospital IT systems and represents another example where the private sector is driving public need. Google has made progress in this area as well. However, this is not new and in fact, health plans have been using the Internet to reach consumers and is well documented in a management consulting report: Achieving high performance in health care: how health plans are using the Internet to reach customers (Accenture, 2005). More and more information can be offered online in the future. It would be interesting to examine whether there is a relationship between obtaining online information to patient care in hospitals.

There are integration elements that would aid in advancing adoption and the electronic data capture at point of care is one area that needs additional focus. "The efficiency of data capture and data quality monitoring is likely to improve as EHRs and electronic data capture (EDC) tools become increasingly integrated, providing seamless transmission of data from the EHR to a digital case report form, billing record, or real-time adverse-event alert." (Stewart et al., 2007; w185) "EHR can facilitate and improve the likelihood that a patient is seen when appropriate" (Stewart et al., 2007:w187). Capabilities for outcomes monitoring and real-time adjustments for care pathways are only just the beginning.

Due to its implications on cost and quality, implementing EHR remains a high priority for hospital CEOs (Alexander et al., 2007). However, some CEOs are concerned about the fragmented nature of IT systems and would support the universal standardized record so that it could be transferred between providers more readily (Alexander et al., 2007; Jackson, 2004). Rogers' diffusion of innovation theory is helpful in explaining how technology can be spread through the hospital organizational environment. Hospitals have the ability to make the initial capital investment for large-scale IT projects such as the EHR. With several hospitals doing so, an installed based can therefore be created, leading to future network externalities in the future for the entire hospital sector.

IT adoption needs to address initial and ongoing costs of setting up the EHR; however, the technological and cultural changes necessary for successful EHR implementation

need more attention and investigation (Lium et al., 2008; Nowinski, et al., 2007; Simon et al., 2006; Simpson, 2002). "Large benefits from implementing an EHR can only be achieved if they are accompanied by organizational changes" (Lium et al., 2008). Organizations need to identify their current needs, future needs, compliance to regulation and ask details about how IT adoption is related to organizational change. Internal processes need to change. As with most change efforts, there is little focus on assessing the current state and the anticipated future state. Thus clinicians and staff end up aiming for an unidentified goal. Further, the skills necessary for IT adoption may not be found in-house and some hospitals are turning to external consultants to supply the necessary skill set for IT implementation.

Further, Simpson (2002) says that technology fundamentally changes the work flow and the culture of an organization and that it is about building a solution and using technology to support improved processes (Nowinski et al., 2006). Hospitals, as organizations, need to look at IT as an enabler for changes in work flow and culture, rather than a barrier to serving patients. Practical IT can be used to save time, rather than create more paperwork (Olsson et al., 2007). Clinicians need to have feedback as to how IT systems can be used to manage risk and contribute to clinical care (such as in the development of clinical care guidelines). Simply adding a new IT system will not encourage its use or its adoption. Understanding how it can help clinical or administrative tasks and relaying these results is the job of IT professionals, administrators and leadership.

However, it will likely be clinicians who use clinical IT and administrators who use data for decision-making. Engaging the user is necessary for successful IT projects. Henriksen, et al. (2006) showed that although most redesign [IT] efforts start with well-intentioned engagement feedback, communication efforts waned as the project progressed which was related to the lack of measurement and evaluation. The authors warned that to sustain major restructuring efforts, written and formal guidelines and management tools were necessary (Henriksen, et al., 2006). IT can be used to help drive priorities (e.g. patient safety can be examined as it relates to new policy implementation within the hospital). The key is to link IT efforts and measurement capabilities to health care delivery and quality care.

EHRs can be implemented widely. However, it will take time for both clinicians and patients to begin using and eventually, adopting this technology. In terms of gaining acceptance, EHRs can be used for specific populations, to gain a base of committed users (Callan et al., 2006). Leonard et al. (2008) estimate that there are between 12-14 million patients with "consumers with chronic care conditions" (3C; e.g. asthma, arthritis, cancer, diabetes, heart disease, inflammatory bowel disease, kidney disease, liver disease, lung disease, muscular disease, skin diseases) who use roughly 70% of the healthcare spending in Canada (Shine, 2002). This is a target population that could use EHRs because their conditions are chronic in nature and require repeat visits to the hospital, versus acute care patients who might be one-time or infrequent users of health care services (e.g. broken limbs are a result of accidents, versus asthmatic conditions). Significant cost savings could be realized even if EHR was only implemented for 3C patients first in Canada (Shine, 2002; Henriksen, et al., 2006). Hospitals that typically serve chronic care patients can be identified and used as a pilot for implementing the EHR. Analyzing service offerings for different hospital types could help to identify potential EHR early adoption sites.

From a patient's perspective, the idea that patients can take control of their own patient records and submit information to providers for monitoring disease or health status is empowering. This may lead to a more engaged patient. Currently, health care systems in place for Ontario are unidirectional; it is about clinicians giving information to patients (e.g. telehealth) rather than allowing the patient to drive their own care. One way to change this is to start with the expert patient. Chronic care patients have used treatments on numerous occasions. These patients may find refuge that with regular monitoring by a clinician (perhaps via their home computers); they may not have to travel for testing unless an abnormal result is detected. In the end, patient-centered care is the focus of providing health care in today's health care environment and patient ownership is important for accountability and outcomes. Clinicians may be experts in disease or treatment, but patients are experts in their own bodies and preferences. Communication can be a two-way encounter.

Finally, clinician influence on EHR adoption is paramount to its success. Hampton (2008) is careful to affirm that "personal health records will be valuable only if accurate medical information is provided by physicians and other clinicians through electronic health records generated at the point of care" (Hampton, 2008: 508). Having a well-organized approach to technology planning, assessment, committee membership, approval, evaluation, implementation and monitoring are key factors to successful IT implementation (Haselkorn et al., 2007).
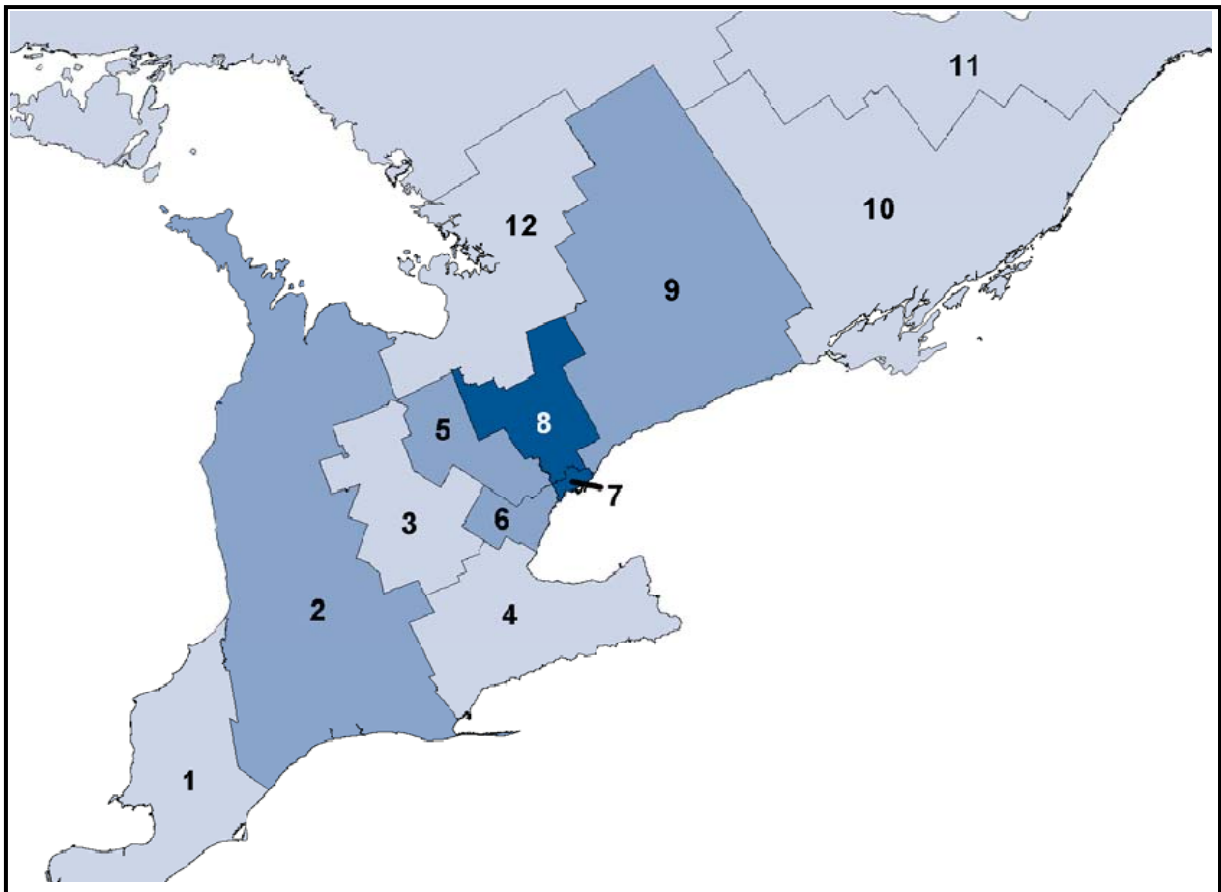
7.3 Conclusions

The results show that urban hospitals use more IT, teaching hospitals are not more likely to use IT; and larger hospitals are more likely to use IT than smaller hospitals.   Simple regression found support for the model but not for individual coefficients for these factors in relation to the extent of IT use in Ontario hospitals.

Location, hospital type and size are only several factors that can be used when comparing hospitals; other organizational factors can be used. Large and urban hospitals are ideal sites to begin large-scale IT (EHR) implementation efforts as these hospitals are already familiar with new innovations and have greater IT use than non-urban and smaller hospitals. Policy-makers may use step-wise implementation to build a base of patients with EHRs when implementing systems in Ontario.

Appendix 1: Ontario Hospitals by LHINs

1	Erie St. Clair
2	South West
3	Waterloo Wellington
4	Hamilton Niagara Haldimand Brant
5	Central West
6	Mississauga Halton
7	Toronto Central
8	Central
9	Central East
10	South East
11	Champlain
12	North Simcoe Muskoka
13	North East
14	North West

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Appendix 2: LHIN Hospital Information

Hospitals in each Local Health Integrated Network (n = 149)		
Local Health Integrated Network	Frequency	Percent (%)
LHIN1 Erie St. Clair	9	6%
LHIN 2 South West	14	9%
LHIN 3 Waterloo Wellington	7	5%
LHIN 4 Hamilton Niagara Halimand Brant	13	9%
LHIN 5 Central West	5	3%
LHIN 6 Mississauga Halton	3	2%
LHIN 7 Toronto Central	11	7%
LHIN 8 Central	6	4%
LHIN 9 Central East	8	5%
LHIN 10 South East	10	7%
LHIN 11 Champlain	21	14%
LHIN 12 North Simcoe Muskoka	5	3%
LHIN 13 North East	20	13%
LHIN 14 North West	11	7%
Subtotal Hospitals in LHINs	143	96%
Missing or Incomplete Information	6	4%
Total Hospitals	149	100%

In terms of volume of hospitals with LHIN representation, the middle level of LHIN representation was from LHIN 2 (South West) with n=14 (representing 9.4% of the sample), LHIN 4 (Hamilton Niagara Halimand Brant) with n=13 (representing 8.7% of the sample), LHIN 7 (Toronto Central) with n=11 (representing 7.4% of the sample), LHIN 14 (North West) with n=11 (representing 7.4% of the sample), and LHIN 10 (South East) with n=10 (representing 6.7% of the sample).

In terms of volume of hospitals with LHIN representation, the last level of LHIN representation was from LHIN 1 (Erie St. Clair) with n=9 (representing 6% of the sample), LHIN 9 (Central East) with n=8 (representing 5.4% of the sample), LHIN 3 (Waterloo Wellington) with n=7 (representing 4.7% of the sample), LHIN 8 (Central) with n=6 (representing 4.0% of the sample). LHIN 5 (Central West) with n=5 (representing 3.4% of the sample), LHIN 12 (North Simcoe Muskoka) with n=5 (representing 3.4% of the sample), and LHIN 6 (Mississauga Halton) with n=3 (representing 2.0% of the sample).

Appendix 3: CIHI Variable Definitions

Indicator / Component	Component Details
Use of Clinical Information Technology **Use of Information Technology** (section 1, question 7) (section 2, question 17) (section 2, question 18)	Existence of role of telehealth/ video-care coordinator. Use of electronic records and data as a primary source of information in the organization. Performance of functions online and in real-time.
Access to Information Technology (section 2, question 19) (section 2, question 20) (section 2, question 21)	Access of clinical workstations to different applications. Access for regulated health professionals to email address, intranet, online access to real-time monitoring data, online access to medical images. Total number of desktop computers or workstations divided by the total number of full-time employees.
Use of Data for Decision-Making **Clinical Data Dissemination and Benchmarking** (section 3, question 28)	Current collection of fifteen clinical measures: sharing data with quality group), comparing internally across specialties or past performance, comparing externally with others.
Safety and Utilization Management (section 6, question 49c) (section 6, question 49d) (section 6, question 49f) (section 6, question 51e) (section 6, question 51l) (section 6, question 52d) (section 3, question 33)	Form of data reporting for actual and potential adverse events (paper or electronic form submission). Existence of registry for sentinel events Conducting a safety-related prospective analysis and implemented improvements or changes. Existence of adverse event / patient safety committee. Form of data reporting for routine incident reporting system (paper or electronic form submission). Utilization management strategies used in the hospital.
Staff Information-Based Roles (section 1, question 7) (section 2, question 16b)	Existence of four staff roles (utilization, quality, decision support and infection control practitioner). Participation of continuing education activities for staff groups (physicians, nurses in administrative roles).
Dissemination of Information (section 3, question 23, 24) (section 3, question 27)	Dissemination of employee satisfaction results. Use of hospital website, bulletin board, newsletters, etc… Dissemination of patient satisfaction surveys to different groups in the organization.
Benchmarking of Information (section 3, question 25)	Engagement in external benchmarking practices with two or more organizations comparing physician and employee satisfaction for different groups of staff.

Note: Questions were administered to Ontario hospitals in the annual Hospital Report 2006: Acute Care System Integration & Change survey by the Canadian Institute for Health Information

Appendix 4: List of Hospitals Used in this Study

Alexandra Marine & General Hospital	North York General Hospital
Bluewater Health	Northumberland Hills Hospital
Cambridge Memorial Hospital	Orillia Soldiers' Memorial Hospital
Chatham-Kent Health Alliance	Pembroke Regional Hospital
Children's Hosp. of Eastern Ont.	Perth & Smiths Falls District Hospital
Cornwall Community Hospital	Peterborough County City Health Unit
Deep River & District Hospital	Queensway Carleton Hospital
Dryden Regional Health Centre	Quinte Healthcare Corporation
Grand River Hospital	Rouge Valley Health System
Grey Bruce Health Services	South Bruce Grey Health Centre
Guelph General Hospital	Southlake Regional Health Centre
Halton Healthcare Services	St. Joseph's Health Centre, Toronto
Hamilton Health Sciences	St. Joseph's Healthcare, Hamilton
Headwaters Health Care Centre	St. Mary's General Hospital
Hôpital général de Hawkesbury & District General Hospital	St. Thomas Elgin General Hospital
Hôpital Montfort	Strathroy Middlesex General Hospital
Hotel-Dieu Grace Hospital	Temiskaming Hospital
Humber River Regional	The Credit Valley Hospital
Huron Perth Healthcare Alliance	The Ottawa Hospital
Joseph Brant Memorial Hospital	The Scarborough Hospital
Kingston General Hospital	Thunder Bay Regional Health Sciences Centre
Kirkland & District Hospital	Tillsonburg District Memorial
Lake of the Woods District Hosp.	Timmins & District Hospital
Lakeridge Health Corporation	University Health Network
Leamington District Memorial Hosp.	West Lincoln Memorial Hospital
Lennox & Addington County. Gen. Hosp.	West Parry Sound Health Centre
London Health Sciences Centre	William Osler Health Centre
Markham Stouffville Hospital	Winchester District Memorial Hospital
Mount Sinai Hospital	Windsor Regional Hospital
Muskoka-East Parry Sound Health Services	York Central Hospital
Niagara Health System	
Norfolk General Hospital	

Appendix 5: List of Hospitals Not Included in Analysis

	Hospital Name	Location	Type
2	Algoma Health Unit	CMA less than 100,000	nonteaching
3	Almonte General	CMA less than 100,000	nonteaching
4	Arnprior & District Memorial Hospital	CMA less than 100,000	nonteaching
5	Atikokan General Hospital	CMA less than 100,000	nonteaching
6	Baycrest Ctr. for Geriatric Care	CMA less than 100,000	nonteaching
7	Blind River District Health Centre	CMA less than 100,000	nonteaching
9	Brant Community Healthcare System	CMA less than 100,000	nonteaching
11	Brockville General Hospital	CMA less than 100,000	nonteaching
13	Campbellford Memorial Hospital	CMA less than 100,000	nonteaching
14	Centre for Addiction & Mental Health	CMA more than 100,000	teaching
17	Children's Rehabilitation Ctr. of Essex	CMA less than 100,000	nonteaching
18	Collingwood General & Marine Hospital	CMA less than 100,000	nonteaching
22	Elgin St. Thomas Health Unit	CMA less than 100,000	nonteaching
23	Erinoak (Kids Mississauga not a hosp)	CMA less than 100,000	nonteaching
24	Espanola General Hospital	CMA less than 100,000	nonteaching
25	Geraldton District Hospital	CMA less than 100,000	nonteaching
27	Grandview Children's Centre	CMA less than 100,000	nonteaching
30	Haldimand War Memorial Hospital	CMA less than 100,000	nonteaching
31	Haliburton Highlands Health Services	CMA less than 100,000	nonteaching
34	Hanover & District Hospital	CMA less than 100,000	nonteaching
37	Hôpital Glengarry Memorial Hospital	CMA less than 100,000	nonteaching
39	Hornepayne Community Hospital	CMA less than 100,000	nonteaching
40	Hotel Dieu Hospital, Kingston	CMA less than 100,000	nonteaching
41	Hotel Dieu Shaver Health & Rehab. Centre	CMA less than 100,000	nonteaching
45	Huronia District Hospital	CMA less than 100,000	nonteaching
46	James Bay General Hospital	CMA less than 100,000	nonteaching
48	KidsAbility Centre for Child Dev.	CMA less than 100,000	nonteaching
51	Lady Dunn Health Centre	CMA less than 100,000	nonteaching
55	Leeds, Grenville & Lanark District Health	CMA less than 100,000	nonteaching
57	Listowel Wingham Hospitals Alliance	CMA less than 100,000	nonteaching
59	Manitoulin Health Centre	CMA less than 100,000	nonteaching

	Hospital Name	Location	Type
60	Manitouwadge General Hospital	CMA less than 100,000	nonteaching
62	Mattawa General Hospital	CMA less than 100,000	nonteaching
63	MH Windsor Essex County Branch	CMA less than 100,000	nonteaching
64	MICs Group of Health Services	CMA less than 100,000	nonteaching
69	North Bay General Hospital	CMA less than 100,000	nonteaching
70	North Bay Parry Sound Dist. Health Unit	CMA less than 100,000	nonteaching
71	North Hamilton CHC	CMA less than 100,000	nonteaching
72	North Wellington Health Care	CMA less than 100,000	nonteaching
74	Northeast Mental Health Centre	CMA less than 100,000	nonteaching
76	Northwestern Health Unit	CMA less than 100,000	nonteaching
77	NorWest CHCs	CMA less than 100,000	nonteaching
80	Penetanguishene General Hospital	CMA less than 100,000	nonteaching
82	Perth District Health Unit	CMA less than 100,000	nonteaching
84	PHB	CMA less than 100,000	nonteaching
85	Porcupine Health Unit	CMA less than 100,000	nonteaching
86	Providence Continuing Care Centre	CMA less than 100,000	nonteaching
87	Providence Continuing Care Centre	CMA less than 100,000	nonteaching
88	Providence Healthcare	CMA less than 100,000	nonteaching
91	Rel. Hosp., St. Joseph, Cornwall, SJCCC	CMA less than 100,000	nonteaching
92	Renfrew County & District Health Unit	CMA less than 100,000	nonteaching
93	Renfrew Victoria Hospital	CMA less than 100,000	nonteaching
94	Renfrew Victoria Hospital	CMA less than 100,000	nonteaching
95	Riverside Health Care Facilities, Inc.	CMA less than 100,000	nonteaching
96	Ross Memorial Hospital	CMA less than 100,000	nonteaching
98	Royal Ottawa Health Care Group	CMA less than 100,000	nonteaching
99	Royal Victoria Hospital	CMA less than 100,000	nonteaching
100	Salvation Army Toronto Grace Hospital	CMA less than 100,000	nonteaching
101	SCO Health Service	CMA less than 100,000	nonteaching
102	Sensenbrenner Hospital	CMA less than 100,000	nonteaching
103	Simcoe Muskoka District Health Unit	CMA less than 100,000	nonteaching
104	Sioux Lookout Meno-Ya-Win Health Centre	CMA less than 100,000	nonteaching
105	Smooth Rock Falls Hospital	CMA less than 100,000	nonteaching
108	St. John's Rehabilitation	CMA more than 100,000	teaching

	Hospital Name	Location	Type
109	St. Joseph's Care Group, Thunder Bay	CMA less than 100,000	nonteaching
110	St. Joseph's General Hospital	CMA less than 100,000	nonteaching
111	St. Joseph's Health Care, London	CMA less than 100,000	nonteaching
115	St. Michael's Hospital	CMA more than 100,000	teaching
116	St. Peter's Hospital	CMA less than 100,000	nonteaching
118	Stevenson Memorial Hospital	CMA less than 100,000	nonteaching
120	Sudbury & District Health Unit	CMA less than 100,000	nonteaching
121	Sudbury Regional Hospital	CMA less than 100,000	nonteaching
122	Sunnybrook & Women's	CMA more than 100,000	teaching
124	Thames Valley Children's Centre	CMA less than 100,000	nonteaching
126	The Hospital for Sick Children	CMA less than 100,000	teaching
128	The Perley & Rideau Veterans' Health. Centre	CMA less than 100,000	nonteaching
130	Thunder Bay District Health Unit	CMA less than 100,000	nonteaching
134	Toronto Rehabilitation Institute	CMA less than 100,000	nonteaching
136	University of Ottawa Heart Institute	CMA less than 100,000	nonteaching
137	Wellington Dufferin Guelph Health Unit	CMA less than 100,000	nonteaching
138	West Haldimand General Hospital	CMA less than 100,000	nonteaching
140	West Nipissing General Hospital	CMA less than 100,000	nonteaching
141	West Park Healthcare Centre	CMA less than 100,000	nonteaching
144	Wilson Memorial General Hospital	CMA less than 100,000	nonteaching
147	Windsor-Essex County Health Unit	CMA less than 100,000	nonteaching
149	St. Joseph's Healthcare, Hamilton	CMA more than 100,001	teaching

Appendix 6: List of Hospitals and Factors in this Study

	Hospital Name	Location	Type	Staff	Beds
1	Alexandra Marine General Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
2	Bluewater Health	CMA less than 100,000	nonteaching	1001-2000	301+
3	Cambridge Memorial Hospital	CMA more than 100,001	nonteaching	1001-2000	151-300
4	Chatham-Kent Health Alliance	CMA less than 100,000	nonteaching	1001-2000	151-300
5	Children's Hosp. of Eastern Ont.	CMA more than 100,001	teaching	1001-2000	151-300
6	Cornwall Community Hospital	CMA less than 100,000	nonteaching	1001-2000	151-300
7	Deep River & District Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
8	Dryden Regional Health Centre	CMA less than 100,000	nonteaching	0-1000	0-150
9	Grand River Hospital	CMA more than 100,001	nonteaching	2001+	301+
10	Grey Bruce Health Services	CMA less than 100,000	nonteaching	1001-2000	151-300
11	Guelph General Hospital	CMA more than 100,001	nonteaching	1001-2000	151-300
12	Halton Healthcare Services	CMA less than 100,000	nonteaching	2001+	301+
13	Hamilton Health Sciences	CMA more than 100,001	teaching	2001+	301+
14	Headwaters Health Care Ctr	CMA less than 100,000	nonteaching	0-1000	0-150
15	Hôpital général de Hawkesbury & District General Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
16	Hôpital Montfort	CMA more than 100,001	nonteaching	1001-2000	151-300
17	Hotel-Dieu Grace Hospital	CMA more than 100,001	nonteaching	1001-2000	301+
18	Humber River Regional	CMA more than 100,001	nonteaching	2001+	301+
19	Huron Perth Healthcare Alliance	CMA less than 100,000	nonteaching	1001-2000	151-300
20	Joseph Brant Memorial Hospital	CMA less than 100,000	nonteaching	1001-2000	151-300
21	Kingston General Hospital	CMA more than 100,001	teaching	2001+	301+
22	Kirkland & District Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
23	Lake of the Woods District	CMA less than 100,000	nonteaching	0-1000	0-150
24	Lakeridge Health	CMA more than 100,001	nonteaching	2001+	301+
25	Leamington District Memorial	CMA less than 100,000	nonteaching	0-1000	0-150
26	Lennox & Addington City Gen.	CMA less than 100,000	nonteaching	0-1000	0-150
27	London Health Sciences Centre	CMA more than 100,001	teaching	2001+	301+
28	Markham Stouffville Hospital	CMA less than 100,000	nonteaching	1001-2000	151-300
29	Mount Sinai Hospital	CMA more than 100,001	teaching	2001+	301+

	Hospital Name	Location	Type	Staff	Beds
30	Muskoka-East Parry Sound Health Services	CMA less than 100,000	nonteaching	0-1000	151-300
31	Niagara Health System	CMA more than 100,001	nonteaching	2001+	301+
32	Norfolk General Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
33	North York General Hospital	CMA more than 100,001	nonteaching	2001+	301+
34	Northumberland Hills Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
35	Orillia Soldiers' Memorial Hosp	CMA less than 100,000	nonteaching	1001-2000	151-300
36	Pembroke Regional Hospital	CMA less than 100,000	nonteaching	0-1000	151-300
37	Perth & Smiths Falls District	CMA less than 100,000	nonteaching	0-1000	0-150
38	Peterborough County City HU	CMA more than 100,001	nonteaching	0-1000	301+
39	Queensway Carleton Hospital	CMA more than 100,001	nonteaching	1001-2000	151-300
40	Quinte Healthcare Corporation	CMA less than 100,000	nonteaching	1001-2000	151-300
41	Rouge Valley Health System	CMA less than 100,000	nonteaching	2001+	301+
42	South Bruce Grey Health Centre	CMA less than 100,000	nonteaching	0-1000	0-150
43	Southlake Regional Health Ctr	CMA less than 100,000	nonteaching	2001+	301+
44	St. Joseph's Health Centre, Toronto	CMA more than 100,001	teaching	2001+	301+
45	St. Mary's General Hospital	CMA more than 100,001	nonteaching	1001-2000	151-300
46	St. Thomas Elgin General Hosp	CMA less than 100,000	nonteaching	0-1000	151-300
47	St. Joseph's Healthcare, Hamilton	CMA more than 100,001	teaching	2001+	301+
48	Strathroy Middlesex General	CMA less than 100,000	nonteaching	0-1000	0-150
49	Temiskaming Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
50	The Credit Valley Hospital	CMA more than 100,001	nonteaching	1001-2000	301+
51	The Ottawa Hospital	CMA more than 100,001	teaching	2001+	301+
52	The Scarborough Hospital	CMA more than 100,001	nonteaching	2001+	301+
53	Thunder Bay Regional Health Sciences Centre	CMA more than 100,001	nonteaching	2001+	301+
54	Tillsonburg District Memorial	CMA less than 100,000	nonteaching	0-1000	0-150
55	Timmins & District Hospital	CMA less than 100,000	nonteaching	0-1000	151-300
56	University Health Network	CMA more than 100,001	teaching	2001+	301+
57	West Lincoln Memorial Hospital	CMA less than 100,000	nonteaching	0-1000	0-150
58	West Parry Sound Health Ctr	CMA less than 100,000	nonteaching	0-1000	151-300
59	William Osler Health Centre	CMA more than 100,001	nonteaching	2001+	301+

	Hospital Name	Location	Type	Staff	Beds
61	Winchester District Memorial	CMA less than 100,000	nonteaching	0-1000	0-150
62	Windsor Regional Hospital	CMA more than 100,001	nonteaching	2001+	301+
63	York Central Hospital	CMA more than 100,001	nonteaching	1001-2000	301+
Total	63	63	63	63	63

Appendix 7: Hospital Financial Information

Sample Description of Financial Data in Thousands (Canadian Dollars$)				
	N	**Range**	**Mean**	**Std. Deviation**
2006-2007 Total Revenue	61	$7,922 – $1,206,628	$188,721	$238,581
2006-2007 Total Expense	59	$8,183 – $1,201,373	$192,147	$239,557
2006-2007 MOHLTC revenue	60	$6,714 – $745,885	$146,999	$179,059
2005-2006 Total Revenue	54	$8,506 – $983,258	$166,302	$194,557
2005-2006 Total Expense	53	$10,909 – $981,933	$168,733	$195,330
2005-2006 MOHLTC revenue	53	$7,875 – $682,220	$129,798	$153,102

For 2006-2007, total revenue in Canadian dollars and had a range between $7.92M and $1206.63M with a mean of $188.72M and standard deviation of $238.58M; information was available for sixty-one hospital entities. Total expenses in Canadian dollars and had a range between $8.18M and $1201.37M with a mean of $192.18M and standard deviation of $239.56M; information was available for fifty-nine hospital entities. Ministry of Health and Long-Term Care revenue in Canadian dollars and had a range between $6.71M and $745.89M with a mean of $147M and standard deviation of $179.06M; information was available for sixty hospital entities.

For 2005-2006, total revenue was measured in Canadian dollars and had a range between $8.51M and $983.26M with a mean of $166.3M and standard deviation of $194.56M; information was available for fifty-four hospital entities. Total expenses were in Canadian dollars and had a range between $10.91M and $981.93M with a mean of $168.73M and standard deviation of $195.33M; information was available for fifty-three hospital entities. Ministry of Health and Long-Term Care revenue in Canadian dollars and had a range between $7.88M and $682.22M with a mean of $129.8M and standard deviation of $153.1M; information was available for fifty-three hospital entities.

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