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**Exploring mHealth Solutions: A Case Study on the Influence of mHealth Technologies on Communication and
Information Sharing at Hamilton Health Sciences**

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Running Head: EXPLORING MHEALTH SOLUTIONS: A CASE STUDY

**Exploring mHealth Solutions: A Case Study on the Influence of mHealth Technologies on
Communication and Information Sharing at Hamilton Health Sciences**

Master's Thesis Presented By:

Victoria Aceti

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Abstract

The recognition of the need to improve communication has led healthcare organizations to integrating health informatics technologies. This study investigated the extent to which mHealth applications influenced communication and information sharing patterns between interdisciplinary healthcare providers in the delivery of healthcare services. The study was conducted at a multi-campus health organization in Ontario. Sociotechnology theory examines the influence of sociological factors in the introduction and use of information and communication technologies. Through a sociotechnical approach, this research study focused on how the communicative and social aspects of an organization influence health informatics integration, as well as the extent to which information sharing and communication patterns were influenced. This study found that several factors contributed to the integration of mHealth technologies, including: significant end user contribution to system design, an organizational culture open to technological change, the use of creative internal communication practices, training, and evaluation procedures. Findings indicated that the limited use of mHealth technologies were a result of poor ergonomical design and a lack of employee consultation prior to integration. That being said, participants indicated that the accessibility of information and convenience of mHealth technologies ameliorated their work routines. Research shows that health informatics has the potential to improve healthcare service delivery, and consequently, future studies must look at the affect of these technologies on the fundamental elements of healthcare, including communication and information sharing patterns among healthcare providers.

Thesis Dedication

This thesis is dedicated to my parents who always encouraged me to pursue my dreams and championed my every aspiration.

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Chapter 1: Introduction

Four decades of research, in various fields and disciplines, has demonstrated the importance of effective communication in healthcare (Coiera, 2003; Edwards, Fitzpatrick, Augustine, Trzebucki, Cheng, Presseau, et al., 2009). Foucault (1973) investigated the affect of communication in healthcare settings and found that communication plays an integral role in the overall quality and efficiency of patient care. Researchers have tried to quantify this and found that, economically, poor communication whilst providing healthcare services, costs the American health system almost thirty billion dollars per year (Coiera & Tombs, 1998). In Canadian hospitals, Baker, Norton, Flitof, Blais, Brown, Cox, et al. (2004) found that up to 24,000 deaths from adverse medical events could have been prevented. Results from an Australian study showed that communication errors were twice as likely to cause preventable patient disability or death as inadequate medical skill (Zinn, 1995). More than half of the information exchanges in healthcare organizations occur between healthcare providers and that interruptions in these communication events may incur medical errors (Edwards et al.). Further, because of a growing specialization and professionalism of medical disciplines, more effective communication practices are required (Coiera). Thus, effective communication, and specifically interdisciplinary communication, is imperative to the delivery of quality healthcare services and the determent of medical error.

Information and communication technologies (ICTs) are seen as an effective tool in improving health communication and thus healthcare service delivery. ICTs in health are called, and generally researched under the umbrella of, health informatics. The term 'health informatics' began appearing in medical literature in 1973 (Coiera, 2003) and has become a legitimate field of research with fruitful research findings demonstrating that the use of informatics can affect the

delivery of healthcare services (Culler, Atherly, Walczack, Davis, Hawley, et al., 2006; Lenz & Reichert, 2006). As technology, health informatics is defined as a “systematic approach to the collection, organization, storage, use, and evaluation of health data, information and knowledge” (Layman & Watzlaf, 2009, p.6), while the research aim of health informatics is to “develop and improve the organization and management of information and thereby improve the overall quality of care for patients” (Bath, 2008, p.502). Further, health informatics researchers are interested not only in developing technology, but also in understanding the impacts that these technologies have on patients. Innovations in information science have created opportunities for improved health informatics technologies whilst creating further challenges for the organizations that integrate them.

The use of health informatics to improve communication between healthcare providers and between providers and receivers has been available for decades. The earliest, and most widely used form is known as *telemedicine*, which is the “...the use of transmitted images, voice and other data to permit consultation, education, and integration in medicine over a distance” (Merrell, 1995, p. 15). Using recognizable technologies such as the telephone, television, and in telemedicine’s earliest form, the radio. With the introduction of the Internet into healthcare organizations, telemedicine grew into eHealth which enables many more functions and communication tools to enhance health information sharing. *eHealth* is defined as, “an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies” (Eysenbach, 2001, n.p). As technological capabilities continue to evolve, wireless Internet has enhanced the use of eHealth and created a new subfield called *mHealth*.

Citing several health informatics evaluative surveys, Kaplan and Harris-Salamone (2009) state that over half of health informatics projects fail and claim that, “while recognizing that there still are technical issues related to functionality and interoperability, a consensus is emerging that problems with health IT projects, as in other sectors, are due to sociological, cultural, and financial issues, hence are more managerial in nature than technical” (p. 292). Further, many researchers have a bias towards technological determinism which skew the results of many studies to favour the use of technology while ignoring the issues regarding the social or contextual issues related to the use of health informatics (Kaplan, 2001a; 2001b). Thus, the extent to which health informatics influences interdisciplinary communication from the perspective users may illuminate deeper issues with and benefits of health informatics integration and use.

Understanding the affects of information technology on communicative patterns is important to healthcare organizations’ abilities to provide quality healthcare services. Looking outside the healthcare field for these understandings is one way to improve the rates of health informatics integration successes. Te’eni, Sagie, Schwartz, Zaidman, and Amichai-Hamburger (2001) state that computer-mediated communication (CMC) has become a major channel of communication in organizations where employees and processes are dispersed. The researchers contend that communication research has explored the extent to which CMC has impacted communication patterns and behaviour, however there is little research on “how to design information technology to better support the communication process” (p.6). By understanding how health informatics affects communication, the role of communication in information systems research can be heightened and expanded.

Emerging wireless communication technologies have begun to proliferate and research into the use of these are showing promise in the ability to improve communication in the delivery

of healthcare services (Istepanian, Laxminarayan, & Pattichis, 2006; Ortega, Taksali, Smart & Baumgaertner, 2009). As wireless Internet allows healthcare providers to securely access information online through virtual private networks (VPNs), healthcare organizations are capable of and confident in incorporating mobile technologies into healthcare providers' everyday work routines. With the introduction of wireless communication in healthcare, new types of health informatics technologies have been developed, including mobile eHealth (mHealth) which is defined as the "development, dissemination and application of mobile information and wireless telecommunication technologies in the area of healthcare" (Siau & Shen, p.90, 2006). Pagers were the first form of mHealth technology which are still widely used today, but as satellite and networking technology advances, smart phones and PDAs are pushing pagers into relative obscurity. Types of mHealth technologies include personal digital assistants (PDAs), laptops or mobile computers, smart phones (Blackberry, iPhone, Palm Pre), and cellular phones.

Research investigating the benefits and challenges of integrating mHealth applications has been evolving since the end of the twentieth century. The main benefits of mHealth can extend from the health clinic, to the patient, to the Canadian national health system. In a comparative study of cellular phone and pager use among orthopedic surgeons and nurses, Ortega et al. (2009) found that miscommunication and medical errors decreased 22% when healthcare providers used cellular phones rather than pagers. Researchers have found three main benefits of mHealth applications, including: the mobility of health workers to provide more efficient healthcare services, the ability to monitor patient vitals from a distance, and a more efficient flow of communication between healthcare providers and receivers (Istepanian, Laxminarayan & Pattichis, 2006; Matusitz & Breen, 2007; Ortega et al.). These benefits highlight the promise of

mHealth technologies in ameliorating communicative inefficiencies between healthcare providers.

There is a plethora of research touting the benefits of mHealth technologies, however, there are several researchers who have explored the problem of workflow and communication interruptions caused by mobile technologies (Coiera, Jayasuriya, Hardy, Bannan, & Thorpe, 2002; Dykes, Hurley, Cashen, Bakken, & Duffy, 2007; Edwards et al., 2009; Schoop, 1999). Studies demonstrate that the result of interruptions within the healthcare setting negatively impact patient safety. The main drawbacks to mHealth technologies include: increased interruptions, technical problems, financial constraints, and user resistance (Coiera et al.; Dykes et al.; Edwards et al.; Schoop). Contradictions between researchers illustrate both the novelty of health informatics as a research field, and the need for more research in order to fully comprehend the benefits and challenges of mHealth technology. Several researchers claim that in order to take health informatics and mHealth research to the next level, research must focus on the sociotechnical aspects, as in the past, research has focused on the technical side of health informatics integrations (Berg, Aarts, & van der Lei, 2003; Kaplan, 2001a; Spitzer, 2009).

Communication research can help inform health informatics as 90% of information exchange in healthcare is through direct communication, whether it is through face-to-face or computer mediated channels. Coiera (2003) postulates that communication is the foundation of every healthcare organization and as a consequence is the cause of many issues and challenges within the organization. Thus, investigations should revolve around this phenomenon and take a direct focus on communication, especially when researching health informatics. However, Coiera (2003) emphasizes that as expert knowledge about the role that communication plays in health informatics lags behind, so does the integration of health informatics.

In addition to communication research lagging in health informatics, eHealth adoption in Canada is also sluggish according to Jha, Doolan, Grandt, Scott, and Bates (2008) who compared seven nations, (Canada, the United States, the United Kingdom, Germany, the Netherlands, Australia, and New Zealand), and concluded that Canada has the least proliferation of health informatics use. Moreover, the researchers further claim that the introduction of health informatics in Canadian hospitals is still in its infancy. Based on these results, it is clear to this researcher that initiative must be taken to understand the unique challenges faced in Canadian healthcare organizations.

The purpose of this research is to investigate the communicative impacts that mHealth technology has on interdisciplinary practitioners' ability to communicate and provide quality healthcare services. In addition, the aim of this research study is to investigate the necessary conditions for mHealth technologies to be effectively and successfully integrated. Focusing on the end user's experiences with mHealth in daily work communication scenarios, and the leaders who decide if and what technologies are implemented, the study explores the extent to which mHealth use impacts interdisciplinary communication.

The study is conducted at Hamilton Health Sciences¹, a multi-campus health organization serving Hamilton, Ontario, looking specifically at the use of mHealth in the Pediatric Critical Care Unit² at McMaster's Children's Hospital. A sociotechnology theoretical lens and case study research design is used to explore mHealth at Hamilton Health Sciences and the extent to which mHealth applications influence communication patterns between interdisciplinary healthcare providers in the delivery of healthcare services. Using semi-structured interviews and document

¹ Hamilton Health Sciences may be referred to as 'HHS' or 'The Organization'.

² Pediatric Critical Care Unit may also be referred to as 'the PCCU'.

analysis (internal communications and the strategic ICT plan), three research questions were asked:

RQ₁: In which ways do mHealth technologies influence interdisciplinary communication and information sharing within HHS?

RQ₂: In which ways are mHealth technological integrations communicated to employees within HHS?

RQ₃: What are the necessary conditions for mHealth technologies to be successful within HHS?

Scope

The scope of this study is narrowly defined for three main reasons. First, it is an exploratory study, second, little research has investigated mHealth at HHS, and third, few studies have used a sociotechnical lens to explore mHealth.

Healthcare in Canada is provincially defined, thus, the scope of the study will be limited to Ontario and segmented further to mHealth technologies at a single healthcare facility in Hamilton, Ontario. Further, the study will be limited to one unit, the PCCU, on a single campus in the Hamilton Health Sciences family of hospitals, McMaster Children's Hospital. Specific employees within the organization were contacted for participation in order to obtain a well-rounded perspective of mHealth technology at HHS. The sample was divided into two groups, one group comprised of employees who strategize about health informatics integration at HHS³, and the second group was healthcare providers who use mHealth technologies on a daily basis. The sample was confined to these two groups because of their daily use of or role in integrating mHealth technologies at HHS.

³ This participant group will be referred to as "HHS leaders" for the duration of this thesis.

Mobile technologies used in healthcare environments can sometimes be used for the management of chronic illnesses outside of the clinical environment and can be controlled by the patient. mHealth technologies researched in this study were used by healthcare providers to communicate or share information electronically only with other healthcare providers for the purposes of delivering healthcare services to in-patients only.

Finally, this study will take into account only the perspective of mHealth users or implementers, and only communication patterns among healthcare providers will be studied as the research is concerned with communicative benefits among interdisciplinary healthcare providers, and not receivers. The healthcare receivers of the case study are children, most of whom are unable to adequately characterize the communicative benefits or drawbacks of their healthcare providers' use of mHealth technologies.

Chapter 2: Research Context

Canadian Health Care System

Historical Perspectives

Kealey (2002) attributes many different factors to the emergence of publicly funded healthcare in Canada, also known as Medicare, including: urbanization, World War I, the Great Depression, the evolution of the socialist movement, and the growing professionalization of medicine. Key players who championed Medicare included prominent politicians, such as Prime Minister King and the Co-operative Conservative Federation (CCF) party leader Tommy Douglas. In his 1919 election campaign, Prime Minister King promised a publicly funded healthcare system; however, his dreams of a national system did not come to fruition until the Lester B. Pearson government of the late 1960s. In the absence of federal legislation, pockets of provincially run healthcare sprang up in Saskatchewan, British Columbia, Ontario, Alberta, and the not yet Canadian province of Newfoundland. Learning from the national health systems already functioning in Europe, including Germany, France, and Britain, Canada began to develop a unique Medicare system based on the unique challenges faced by the country.

The Great Depression intensified political pressure for Medicare, as the focus turned from international to domestic issues (Vayda & Deber, 1992) and Tommy Douglas was instrumental in keeping the Medicare conversation alive at the federal level. Years of discussion resulted in the Medical Care Act, passed in December of 1966, which covered medical services for all Canadians and supported a healthcare cost-sharing initiative between federal and provincial governments. A revised act, the Canada Health Act, passed in 1984, included five tenets of health care that govern the financial administration of healthcare service delivery to Canadians. This act differs from the one passed in 1966, as this act deals uniquely with fiscal health policies. The

Canada Health Act insured that for provinces to be eligible for federal funds, the province's health system had to ensure its residents, universal coverage, benefit portability, insurance for all medically necessary services, and that it was a publicly administered non-profit program (Kealey, 2002).

Thus, since July 1st, 1968, Canadians have enjoyed a Medicare system paid for through provincial and federal taxes. Although there are continuing financial struggles, the history of the creation of Medicare highlights the collaborative effort between federal and provincial parties to provide the best healthcare system for all Canadians. In the 20th century, this collaboration was purely financially and policy driven. Now in the 21st century it is focused on improving healthcare services through the use of health informatics (Esmail & Walker, 2005).

Canadian/Ontarian Issues

The Canadian geographic, political, and financial environments mingle and contribute to a unique context which both spurs and hinders information technology development within the country (Alvarez, 2002). As with many environments, geographic, financial, and political issues bleed into one another, creating much larger problems at the regional, provincial, and federal government levels. Bonneville and Pare (2006) postulate that understanding the various interrelated issues in health informatics development is a critical way to influence effective policy changes which can in turn ameliorate healthcare service delivery challenges. The following sections will highlight the aforementioned issues at the Canadian level, and more specifically at the Ontarian level.

Geographic Circumstances

In Balka, Rodje, and Bush's (2007) assessment of information and communication technologies (ICTs) in Canada, specifically in healthcare, the authors contend that the geographic

disparities in Canada have led to a more pervasive ICT environment where technology is a valued tool in connecting citizens who have been spatially distanced. In healthcare, telemedicine has allowed for healthcare providers to virtually attend to a patient, thus mitigating the need for patients to travel to receive medical attention (Alvarez, 2002). The use and expansion of telemedicine in Canada has afforded patients more convenient means of receiving healthcare services in both urban and rural areas. Further, investment in telemedicine has built the electronic infrastructure required for the creation and expansion of other health informatics technologies.

There are health informatics success stories in differing geographic locations within Ontario which serve as examples of technological best practices for other healthcare organizations. Protti (2008) names two health centres of excellence located within Ontario. The first is located in Toronto and includes a computerized physician order entry system within the University Health Network. Another centre of excellence is at the Group Health Centre in Sault Ste. Marie. This is a small health facility in a small city, whereas the University Health Network is a large multi-campus health facility in the largest city in Canada. These two examples provided by Protti highlight the essence of the vision of health informatics development in Canada, being that the size of the facility or its geographic location should not impact the success or failure of a health informatics integration. Although there may be other contextual factors which influence the success of these integrations, it demonstrates that geography is not necessarily the main reasons for determining the success or failure of a health informatics application. That being said, digital divides which still exist and create inequalities in access to and use of health informatics within certain regions of the country, namely smaller centres, Aboriginal reserves, and remote communities create health informatics disparities (Alvarez).

Political Matters

In dealing with a government-run, publically funded health care system, political issues commonly arise that affect the delivery of healthcare services. In Canada, some of these political issues revolve around the fact that, “decisions on access, coverage, spending, pricing, funding, and investment are influenced by political incentives and these can often conflict with rational economic considerations” (Skinner, 2009, p.105). This means that unpopular health policies can be disregarded by politicians even though they make economic sense, because the politicians want to be re-elected. Deber, Narine, Baranek, Sharpe, Duvalko, Zlotnik-Shaul, et al. (1998) contend that this fiscal management style has led to the politicization of Canadian healthcare, which can negatively affect the administration of healthcare services.

On October 8, 2009, the Auditor General of Ontario, then Jim McCarter, released his findings of an audit conducted at eHealth Ontario, the governmental agency set up to oversee and implement health informatics in Ontario. McCarter (2009) stated that there were five main areas in which eHealth failed: strategic planning, oversight, progress on Electronic Health Records (EHR) projects, the use and procurement of consultants, and expenditure management. First, eHealth Ontario (previously known as Smart Systems Health Agency) took nine years to create a strategic plan for the organization. Once developed, the plan failed to discuss or acknowledge the 2015 EHR deadline. A second concern McCarter (2009) highlights is that of oversight. There were two agencies in charge of delivering the EHR, eHealth Ontario and the Ministry’s eHealth Program Branch, each of which, according to McCarter, did not coordinate or have a productive working relationship. As a result, the development and deployment of EHR was delayed, leading to the failure of EHR projects, which was also a consequence of the lack of strategic planning prior to the initiation of EHR projects.

The main issue at eHealth Ontario, which ignited a media firestorm of controversy, was the

use of consultants, more specifically, the way in which favouritism was shown in the awarding of contracts. McCarter (2009) acknowledges the need for consultants, but points to the overuse of consultants and the vast amount of financial resources allocated to consulting instead of investment in EHR projects as a reason for the fundamental problems occurring at eHealth Ontario. Connected to the fourth issue of procurement, the fifth issue, the lack of expenditure management, negatively impacted the extent to which EHRs in Ontario progressed.

This scathing audit highlights many issues at eHealth Ontario and links them to lagging EHR adoption in Ontario. As can be seen from the audit and previous discussion on political issues in the Canadian healthcare system, financial investments are commonly the root of many of the lapses in the system. The following section focuses more directly on the financial issues in the Canadian healthcare system.

Financial Considerations

As Canada's healthcare system is funded publically, financial issues are also political issues. Recent political scandals, such as the one faced at eHealth Ontario, have brought to light the financial issues related to the development and implementation challenges of a health information system. Skinner (2009) contends that a major political concern in terms of informatics in the Canadian health system is the issue of financial control. Although the government hands down budgets to health facilities, if a facility or health agency goes over the annual budget the government subsidizes the facility in order to avoid bankruptcies. Korner, Oinonen, and Browne (2003) suggest that this fiscal policy has led to healthcare organizations avoiding the issue of innovation and efficiency as the government will subsidize any excess budget funds because it is political suicide to let a health facility go bankrupt or close.

Financial contributions to the development of health informatics have been large, not only

at the provincial level, but federally as well. In the early 1990s, the Canadian Health Info-structure was developed with the creation of the Information Highway Advisory Council (IHAC) in 1995. This advisory council, along with the Canadian Network for Advancement of Research, Industry, and Education (CANARIE) “advocated the creation of [a] council to facilitate information and communication technology use in the health sector” (Balka, Rodie, & Bush, 2007, p. 478). This recommendation initiated the flow of billions of taxpayer dollars into developing, integrating, and expanding health informatics use in the healthcare system. In 2000, the federal government invested \$500 million in Canada Health Infoway which was “mandated to accelerate the development and adoption of information technology in health care. Canada Health Infoway received an additional \$600 million in 2003” (Balka, Rodie, & Bush, p.479) to achieve the goal of 50% of Canadians having an EHR by 2010 (Protti 2008). 2002 saw the creation of the Canada Health Infostructure Partnership Program, an \$80 million project aimed at developing health informatics for rural and remote residents.

Large financial investments by the government are based on the fact that research has shown that the use of health informatics can reduce costs and inefficiencies in healthcare (Alvarez, 2002). In spite of these investments, the introduction of health informatics is still largely a financial one as Bonneville’s (2005) analysis of Quebec’s Virage Ambulatoire, a response to the inadequacies in ambulatory care in Quebec’s health system, found that the overreaching need to meet economic standards overrode other critical issues, such as clinical and therapeutic efficiencies, thus decreasing the quality of healthcare. Although economic concerns are important, the crux of healthcare service delivery is quality and efficiency.

Nonetheless, these investments are doing little to expand the use of health informatics in Ontario, and thus Canada (McCarter 2009). For example, Ontario hospitals do not receive

funding for health informatics, “instead, hospitals must allocate funds from their operating budgets to implement, manage, and support their information and communications systems” (Information Technology Association of Canada (ITAC), 2004; Protti 2008). Thus, although large government investments have been made, the implementation of health informatics is still a financial responsibility at the healthcare organization level, and as a result, Canada lags behind the rest of the world. The following section discusses Canada’s international standing in health informatics deployments.

Status of Health Informatics in Canada and Internationally

Within Canada, health informatics integrations are continuously advancing with both federal and provincial governments making billion dollar financial investments in healthcare technology. The Canadian government is infusing billions of dollars of funding for the advancement of Canadian health informatics, however, compared to other similar nation, Canada still lags (Jha et al., 2008). Both Canadian and international researchers have compared similar countries’ health informatics landscape and provided a picture into the current international health informatics environment.

Jha et al. (2008) compared the use of health informatics in seven nations: Germany, the United States of America, the United Kingdom, the Netherlands, Australia, New Zealand, and Canada. Statistical results showed that only 23% of physicians were using the EHR in 2006, and in that same year only 11% of physicians prescribed medication through electronic means (Jha et al.; Skinner 2009). Comparatively, 89% of general practitioners in the United Kingdom were using an EHR, and nearly all prescriptions and laboratory tests were ordered electronically (Jha et al.). Germany had 60% of physicians using an EHR, and 98% of physicians in the Netherlands and Australia were an EHR, while 99% of New Zealand physicians employed an EHR (Jha et

al.). Although the EHR and ePrescribing are only two measures on which to compare nations, they are two of the largest eHealth initiatives internationally and the most publicized by each country's government. Jha et al. claim that the main reason health informatics, including an EHR, lag in Canada is the fact that physicians receive little external funding for integrating health informatics and at the same time receive little incentive for doing so. Further, the authors state the Canada's Infoway project is "limited both in scope and in investment: it focuses on several narrowly defined goals" (Jha et al., p. 852). This criticism is also emphasized in McCarter's (2009) audit in which the lack of strategic planning at eHealth Ontario has led to Ontario lagging behind other Canadian provinces and territories in health informatics deployment. This lack of strategic planning and leadership for health informatics at the federal level may have played a role in failures at the provincial level.

Nonetheless, there are pockets of successful health informatics integrations across Ontario and Canada. These healthcare organizations should be the focus of early investigation in order to understand how obstacles faced by other healthcare organizations are overcome. One of these successful organizations is Hamilton Health Sciences, and is the focus of this thesis. The following section will highlight the demographics and vision of HHS.

Hamilton Health Sciences

Hamilton Health Sciences (HHS) is a multi-campus health care organization located in Hamilton, Ontario, Canada. HHS serves over 2.3 million people in central west, and central southern Ontario with over 10,000 employees and 1,400 physicians, making it the largest employer in Hamilton (Hamilton Health Sciences, n.d.). In total, the organization has six campuses, five hospitals (Hamilton General Hospital, Henderson General, McMaster University Medical Centre, McMaster Children's Hospital, and Chedoke Hospital), and one cancer centre

(Juravinski Cancer Centre). Originally opened in 1848, Hamilton General Hospital was the original site of Hamilton Health Sciences, with the other four hospitals in Hamilton joining in 1996, and the Juravinski Cancer Centre, the newest addition, joining in 2003 (Hamilton Health Sciences). HHS specializes in several healthcare services, from cardiovascular and neurosciences care at Hamilton General, to orthopedics and rehabilitation at Henderson General, to complex rehabilitation services at Chedoke Hospital (Hamilton Health Sciences).

Hamilton Health Sciences is governed by a board of directors which consists of fifteen elected members, and an executive council which consists of: the CEO of HHS, two executive vice-presidents, seven vice-presidents, two assistant vice-presidents, and the Chiefs of Surgery, Medicine, and Information (See Appendix H). The board of directors and executive council are the top decision-makers on strategic and financial investments at The Organization (Hamilton Health Sciences, n.d.).

The mission of HHS is “to provide excellent health care for the people and communities we serve and to advance health care through education and research” (Hamilton Health Sciences, n.d.). This mission is exemplified through the close relationship between HHS and McMaster University, which not only educates future health care professionals, but also invests in several research areas. In fact, the research centre at McMaster University Medical Centre, in conjunction with HHS, “conducts more research into digestive diseases than any other program in the country” (Hamilton Health Sciences). Research initiatives undertaken at HHS have awarded The Organization millions of dollars in research from the Canadian government. Most recently, in March 2009, the Federal Minister of Health announced that a major nursing research project conducted at HHS will be funded an additional \$4.2 million (Hamilton Health Sciences).

Through the ongoing research being conducted at HHS, The Organization has been recognized for its advancement of healthcare both scientifically and in service delivery.

The Information Technology and Clinical Informatics departments are run out of an office space across from the Hamilton General Hospital. This 14,000 square foot site opened in September 2008 and is the central hub for all information and communication technology innovation, strategy, project management, and technical assistance at HHS. Over 80 employees are housed in this space which is designed to inspire collaboration and innovation, as well as promote teamwork (Hamilton Health Sciences, October 2008b). Closed offices line the left side of the space, with technical support cubicles running on the right side. Beside technical support desks are 'hotelling' locations where visiting vendors can log into HHS's secure site and complete work while on site. Low height cubicles are grouped in sets of four in the center of the floor. Each cubicle has a detachable desk on wheels, which when connected to the other three desks within the cubicle set, creates a communal desk in which to conduct group meetings or brainstorming sessions. Further, the site is equipped with facilities for conducting larger meetings.

The Clinical Informatics department is a recent development, only eighteen months old, and was borne out of the need for better communication between clinical staff using the technology and the IT staff developing the applications (Hamilton Health Sciences, October 2008b). It encompasses various healthcare professionals, including a physician, registered nurse, physiotherapist, and other professionals who used to practice but now act as ambassadors between IT and their respective healthcare professional colleagues. Clinical Informatics specialists' main roles are to educate, explain, and train employees on the health informatics technologies which will be integrated. Also, the specialist from Clinical Informatics

communicates the needs and issues of the unit to the IT department. For example, if there is a new nursing mobile device being integrated, the registered nurse in Clinical Informatics educates, explains, and trains super-users on the new technology. Also, when issues arise and improvements are suggested, the RN in clinical informatics forwards these issues to the IT department.

Located at McMaster's Children's Hospital, the Pediatric Critical Care Unit (PCCU) is a small unit looking after critically ill children. The unit is small compared to other units, not only in size, but also in employees. It employs only fifty nurses, thirty respiratory therapists, six physicians, a nutritionist, a pharmacist, a pharmacist technician, a service coordinator, and eight administrative staff members. Demographically speaking, the majority of the staff are young females, many being recent university graduates (Hamilton Health Sciences, n.d.). Although exact numbers could not be released, the employee trend illustrates that employees are young, female healthcare providers. A main difference between the PCCU and other units is that PCCU nurses work one-on-one with patients during a shift, as opposed to other units where a nurse could be looking after up to twenty patients during a shift. The PCCU is made up of very specialized health care providers working in a fast paced environment and are frequently the pilot site for many new health informatics technologies. Currently, the first mHealth technology is being pilot tested in the PCCU. This three-year project began in May 2009 and incorporates all healthcare providers within the unit. It is the mHealth project at the PCCU which is the basis of this research study.

Chapter 3: Key Definitions and Theoretical Foundations

The following chapter will define common terms, which will be used throughout this paper, including: communication, health informatics (clinical informatics), mHealth, healthcare provider/receiver, point-of-care, mobility, and success.

In its rawest form, communication is information exchange and is a “complex process with many components” (Adler, Rosenfeld, Proctor, & Winder, 2006, p.6). Communication is the basis for every interaction, including in healthcare where studies have proven that effective communication is a necessary condition for the successful treatment of a patient. Through information and communication technologies, health informatics aims to “improve the organization and management of information and thereby improve the overall quality of care for patients” (Bath, 2008, p. 502). Health informatics is “the systematic approach to the collection, organization, storage, use, and evaluation of health data, information, and knowledge” (Layman & Watzlaf, 2009, p.6). Further, “the impact of ICT applications on health and information professionals, on the interaction between healthcare professionals, and on the interaction between professionals and patients requires consideration” (Bath, p. 502). This definition distinguishes health informatics from medical informatics which focuses on technology use in medical procedures. It also differentiates health informatics from health information management which focuses solely on information organization within healthcare. At Hamilton Health Sciences, health informatics is managed under the Clinical Informatics and Information Technology departments.

A healthcare provider refers to a medically trained professional who is licensed to administer health services. A healthcare receiver is a person who receives health services from a medically trained professional. Point-of-care refers to the specific place where healthcare services

are administered (<http://medical.webends.com/kw/Point-of-Care%20Systems>, n.d.), the point where healthcare providers and receivers meet to deliver or receive health services.

The direct definition of mobile or mobility is being “able to move or be moved freely or easily” (Soanes, 2001, p. 578). mHealth refers to mobile information and communication technology which is used to aid in the delivery of health services. These technologies have multiple functions which include not only communication but also an ability to provide information pertinent to the delivery of healthcare services. Examples of such technology include: computers on wheels, laptops, personal digital assistants (PDAs), cellular telephones, and smart phones (Blackberry, Palm Pre, iPhone). Istepanian, Pattichis, and Laxminarayan (2006) define mHealth as “emerging mobile communications and network technologies for healthcare...[it] represents the evolution of e-health systems from traditional desktop ‘telemedicine’ platforms to wireless and mobile configurations” (p.3). This definition places mHealth technology as the newest health informatics technology and in the same family as telemedicine and cHealth.

In the fall of 2006, at the American Medical Informatics Association’s annual symposium, health informatics leaders from the United States, Europe, and Canada attempted to synthesize a definition of a successful health informatics integration. The discussions of this working group were recently published and determined that the intricacies of each healthcare organization and health informatics system made it difficult to define success because:

Success may be defined as simply getting the application or system turned on, getting people to use it, and getting at least grudging acceptance, with the caveat that grudging acceptance can turn to non-acceptance. It might entail only offering even “small successes” to users. Problems are compounded in that what works for one group, such as pharmacists, may not work for another group, such as nurses, and those who gain may not be those who actually do the work. (Kaplan & Harris-Salamone, 2009, p.294)

In other words, success must be defined by the organization or even as small as the professional group using the technology. Success is thus not easily measured en masse or at one time. As Berg (2001) suggests it is a dynamic concept. Consequently, the working group recommended more longitudinal and qualitative studies researching organizational issues related to the failure or success of a project. These studies should incorporate theories such as diffusion of innovation and sociotechnical theory, which may inform organizations better about the contextual issues influencing the successes or failures of health informatics integrations.

Theoretical Foundations

Sociotechnology Theory

Healthcare environments are complex communication systems, which require the coordination of several people and tools to function efficiently and effectively. As such, researching an information system in this environment requires a holistic view of at least two major environments, the social and technological components of the system. “Sociotechnical theory tells us we must importantly consider people, task, process, and environment (both internal and external) when considering how best to implement technology into our organizations” (Coakes, 2006, p.591). Through further investigation of this concept, it is now understood that social subsystems can include, but are not limited to: organizational culture, politics, work-life issues, and other non-technical factors (Kaplan, 1997; Pirnejad & Berg, 2007). For Herrmann, Loser, and Jahnke (2007) the sociotechnical paradigm includes a, “focus on the web of communications which keeps the relevant components together, and attempts to improve their relationships.” (p.452), and that the user within the organization is central to the integration of technology. Further, that the “degree of integration between organisational and technical structures is closely interrelated with the degree of communication about the technical system and

the ways of using it... and the degree of communication which is mediated by the technical system” (Herrmann, Loser, & Jahnke, p.451). The authors suggest that sociotechnical paradigms are rooted in communication, and that without understanding and exploring communication in technological integrations, an adequate understanding of the impacts of the system on the organization cannot be uncovered.

Berg, Aarts, and van der Lei (2003) suggest that, “as information systems require interaction with people and thereby inevitably affect them, understanding information systems requires a focus on the interrelation between technology and its social environment” (p.297). This means that the extent to which health informatics is effectively integrated in an organization is not entirely a technical issue but a socially negotiated one; between users, middle management, and strategic leaders, “ and it is the outcome of all these interactions that in the end settles the system’s fate” (Berg, 2001, p.144). As a result, investigating health informatics integrations requires that all these factors must be taken into consideration in order to formulate a clear picture of the entire technological integration process.

Although there is no one sociotechnical approach (Berg, Aarts, & van der Lei, 2003), sociotechnical theory is based on the hypothesis that there are “two subsystems in every organization or corporate; they are the technical sub-system and the social sub-system” (Cartelli, 2007, p.1; Susman, 1976), and these two systems must be balanced. These two sub-systems impart obstacles and challenges on each other, ultimately resulting in the success or failure of an implementation (Berg, 2001). Sociotechnical paradigms map well onto health informatics research, as the healthcare environment is complex and dependent on communication between various partners in order to function effectively. Thus the exploration of information systems in

this environment must reflect that complexity and also focus on both the social (communication, interaction) influences, and technical (mHealth technologies) aspects of integration.

Social Interaction

Social interaction is an expansion of Parsons' (1964) action theory and is defined as "a situation where the behaviors of one actor are consciously reorganized by, and influence the behaviors of, another actor, and vice versa" (Turner, J.H., 1988, p.13-14). In health informatics, "the communication space is apparently the largest part of the health system's interaction space. It contains a substantial proportion of the health system information 'pathology'" (Coiera, 2003, p.233). In other words, intra-organizational communication is the root of many problems inherent in the entire system and thus should be the focus of research and exploration. It is not refuted that effective communication in health is important to the successful delivery of healthcare services, then so too the conversations surrounding health informatics integrations are just as important in assessing the technology's success or failure.

As health informatics continues to evolve, so do the approaches taken to explore integrations. "newer evaluation approaches take what is known as a social interactionist perspective by considering relationships between system characteristics, individual characteristics, organizational characteristics, and effects among them" (Kaplan, 1997, p.94-95). In other words, communication and relationships within the organization, its employees, and the technology itself all affect the extent to which health informatics integrations will be successful. A social interactionist approach involves "studying social, political, organizational, and related processes as they unfold over time" (Kaplan, 2001a, p.48). Just as disease and illness are no longer viewed as phenomena that occur in isolation, it is now understood that knowledge, information sharing, and communication do not occur in closed systems but open and connected

milieus of interaction (Coiera, 2003). These conversations about the technology create perceptions about the use of mHealth technologies, which, according to Kaplan (1997), have the potential to affect the effective integration of health informatics.

In the context of this current study, these theories are used in two main capacities, first in developing interview questions which focus on uncovering sociotechnical aspects of health informatics integration and mHealth use. Second, these theories assist in development of a model, in conjunction with study findings, to illustrate sociotechnical aspects of health informatics integration. The inherent focus on this study is on communication, a sociotechnical aspect, thus these theories assist the researcher in understanding study findings.

Chapter 4: Literature Review

Communication and health informatics are both relatively new research disciplines, and as such researchers are continuously unraveling the intricacies of each. Communication and health informatics are both relatively new research disciplines, and as such researchers are continuously unraveling the intricacies of each. It has been 17 years since Sharf (1993) called for a secular body of research focusing on the challenges of communication in health. Seventeen years later, health communication research has advanced rapidly, but compared to other research fields, is still quite young. Foucault (1973) began studying communication in health almost four decades ago, and this early research concluded that ineffective or miscommunication can be detrimental to a patient's health. More recent investigations into this phenomenon have demonstrated that communication between healthcare professionals throughout treatment is essential to the successful management of the patient's overall health (Coiera 2000, 2003; Coiera & Tombs, 1998; Edwards et al., 2009; Herrman, Trauer, & Warnock, 2002). Coiera (2003) claims that communication channels and procedures in healthcare have not kept up to the pace of the changing health environment; for example, healthcare professionals and patients no longer have to be connected geographically to deliver or receive healthcare services. Although there are many rich information and communication technologies (ICTs), the comprehension of the role these particular technologies play in healthcare still lags.

Coiera (2003) contends that the incomprehension of the affect of health informatics has led to "an apparent delay in the widespread adoption of the new communication options within healthcare" (p.232; Rigby, Forsström, Roberts, & Wyatt, 2001). Adversely, Fischer, Reichlin, Gutzwiller, Dyson, and Belinger (2006) note that it is in fact "the rapid technological progress in the last decade... [which] has led to a surge of interest in telemedicine" (p.203). Although these

statements seem to contradict each other, both can be interpreted as an urgent call to better understand how various ICTs affect communication within healthcare service delivery. Health informatics have been viewed as a way to meld several problems in health communication, however, the research on health informatics and health communication has not kept up to the pace of the technology (Simmons, 2001; Suggs, 2006). Further, the increase of technological applications in health has led to health informatics research, including advantages to non-clinical areas, such as health administration, education, and communication (Riva, 2000). Other authors, such as Coiera (2003), claim that although information exchange is of utmost importance in a clinical setting, communication and information exchange has been largely ignored in informatics thinking. Several scholars agree that research into health informatics has been lacking, and as such the integration of ICTs in health are in peril without proper investigation into the phenomenon.

The following literature review will be split into two major sections. First, literature focusing on communication in healthcare settings will be reviewed, followed by a review of pertinent literature on health informatics, including telemedicine, eHealth, and mHealth technologies. The health informatics section will outline the development of information and communication technological innovation in the health field starting with telemedicine, continuing to eHealth, and concluding with mHealth technologies. The field of health informatics has been built on the research of prior health ICTs and, as such, research conducted on previous technologies is applicable to newer health applications. Thus, a chronological approach will be taken in understanding the field of health informatics and, more importantly, the evolution of the field up until and including mHealth applications.

Given that the proposed research is specific to mHealth in the Canadian context, a concerted effort was made to incorporate several applicable Canadian studies. However, as the field of health informatics is still quite novel in Canada, and little research has focused on the topic, international studies were used. Further, health informatics is an increasingly globalized field; research conducted internationally was included as it is important to understand how other environments encounter similar problems in the integration of health informatics.

Communication in Healthcare

Communicating in healthcare is paramount to the successful treatment of a patient as these events are where major information sharing between various healthcare providers occurs (Parker & Coiera, 2000). In *The Birth of the Clinic*, Foucault (1973) observed that communication in healthcare played an integral role in delivering quality patient care. The medical field is constantly fragmenting into several disciplines, and, as a result the effectiveness of interdisciplinary communication is important (Leonard, Graham, & Bonacum, 2004; Pirnejad, Bal, Stoop, & Berg, 2007), as “inter-clinician communication accounts for more than half of the information exchanges within the health care system” (Edwards et al., 2009, p. 629). Further, multiple interruptions in interdisciplinary information exchange have the potential to increase the risk of medical error. A study of operating room communication by Lingard, Espin, Whyte, Regehr, Baker, Reznick, et al. (2004) found that communication errors occurred 30% of the time, and that a third of these errors led to an increased risk to patient safety. In fact, Fortescue, Kaushal, Landrigan, McKenna, Clapp, Federico, et al. (2003) concluded that 17.4% of errors could have been prevented through improved communication between disciplines, and Marshall, Harrison, and Flanagan (2008) found that 60-70% of communication errors led to serious incidents. Although there is little consensus on the amount of medical incidents that are related to

poor communication, several researchers agree that effective communication, and specifically interdisciplinary communication, is imperative to the delivery of quality healthcare services and the determent of medical error (Fortescue et al., 2003; Leonard, Graham, & Bonacum, 2004; Lingard et al., 2004; Pirnejad, Bal, & Berg, 2008; Stebbing, Wong, Kaushal, & Jaffe, 2006).

As the health environment is becoming increasingly fragmented, Leonard, Graham, and Bonacum (2004) argue that there is a greater need for improved team and interdisciplinary communication in healthcare. Modern healthcare is a complex communication system, and due to “the highly technological nature of the work, coordination of activities often involves a complex social network of individuals” (Marshall, Harrison, & Flanagan, 2009, p. 137). Leonard, Graham, and Bonacum outline problems with communication in healthcare environments, claiming that the majority of failures result from the differing ways in which disciplines are trained to communicate, power distance inherent in healthcare settings, and cultural barriers. First, communication skills training differ between disciplines; for example, nurses are trained to be broad and general, often talking in narratives, whereas physicians are more concise in their communication with other clinicians. This common difference can lead to miscommunication between disciplines. Second, power distance in healthcare environments “...frequently inhibits people from speaking up” (Leonard, Graham, & Bonacum, p.i86). Concomitant, the lack of standardized communication creates a gap between disciplines, leading to miscommunication. Finally, cultural barriers inherent in the medical system ascribe medical mistakes to personal errors, thus decreasing the chances of inevitable mishaps being openly discussed. These various communication challenges in the healthcare environment can lead to mistakes which many scholars claim can be ameliorated through a variety of health informatics integrations (Ash, Berg & Coiera, 2004; Bates, Cohen, Leape, Overhage, Shabot, & Sheridan, 2001; Bath, 2008;

Edwards et al., 2009; Norris, 2002; Coiera, 2003; Rigby, Forsström, Roberts, & Wyatt, 2001; Stebbing et al., 2007).

Coiera and Tombs' (1998) evaluation of communication in a British general hospital concluded that "the healthcare system seems to suffer enormous inefficiencies because of poor communication infrastructure and practices" (p. 673). This bold statement clearly points to the many problems that are inherent in many healthcare organizations today: first, the inadequacy of communication due to mediocre channels of communication, and second, the ignorance of effective communication strategies. Coiera and Tombs observed the communication patterns between physicians and nurses in the general medicine ward of a Bristol hospital. Ninety-six call events in which a participant attempted to communicate through a pager or telephone were observed. The researchers found that communication within this particular ward suffered several inefficiencies. Communication usually involved many intermediaries to obtain information or order a particular test. There were a number of instances in which messages had to be reiterated because by the time the message was given to the intended receiver it was distorted. These types of inadequacies result in a highly interruptive work environment, an overload of information, and miscommunication, all of which ultimately affect patient care.

Coiera and Tombs (1998) call for a deeper understanding of current communication patterns of healthcare professionals and ways in which they can be ameliorated through health informatics. Second, the researchers emphasize the need for staff to be educated on various communication tools at their disposal. Ultimately, there is a need for more research to understand how mHealth technologies can assist in ameliorating communication as healthcare professionals are rarely stationary.

A limitation of the study was the inability of the researchers to document the occurrences of face-to-face communication events. Although this study was not generalizable due to the small sample size and scope of the project, it is interesting to reflect on the ways in which communication can be inefficient in a hospital setting. This study spurs inquiry into a clinician's preference for synchronous modes of communication (face-to-face) as opposed to new health information technologies.

The inherent preference for simple modes (usually synchronous) of communication has led to an increasingly interruptive workflow environment (Edwards et al., 2009). Over a five-day period, Edwards et al. observed seven attending physicians and two nurses for two to four hour periods of time. Of the 2014.67 minutes of observation, researchers noted that forty-two percent of the communication events involved a disruption. Researchers defined disruptions as, but not limited to, a telephone call, questions from colleagues, patient requests, or waiting for colleagues. Also, multitasking events, which were noted when clinicians were conducting a task whilst communicating to a colleague, were recorded fifteen percent of the time. This research illustrates the preference for synchronous communication in the clinical environment which has the potential to lead to inefficiencies in communication and lapses in patient care. To fix this, the researchers call for:

The development of information communication technologies that streamline clinical workflow through the use of asynchronous communication systems (e.g. instant text, e-mail, and voice messaging) could provide a solution by aggregating these interruptions or diverting interruptions to more opportune times. (Edwards et al., p.630)

A limitation of the study is the fact that only quantitative data was collected, and the exclusion of qualitative data leaves a gap in the understanding of the participants' preferences for synchronous communication. Further, the context in which the physicians were interrupted is not explained, leaving many questions as to whether these interruptions were in fact disruptive. As acknowledged by the authors, the short interval of observation of only five days leaves out many contextual factors in the number of interruptions. Notwithstanding these limitations, the implications of this study illustrate the importance of integrating and improving health informatics to ameliorate interdisciplinary communication.

In a study of pediatric drug safety, Stebbing et al. (2007) researched the extent to which effective communication had the potential to prevent medication errors. Specifically, the researchers focused on the role of communication and concluded that there are three domains in which medication errors could be prevented: doctor-patient communication, interprofessional communication, and dialogue between researchers and professionals. Stebbing et al. stated that "error reduction is also greatly enhanced by technology; again, this is partly through improved communication" (p. 443; Ash, Berg, & Coiera, 2004; Bates et al., 2001; Edwards et al., 2009), claiming that "research has repeatedly shown clinical benefits of such [computerized] systems... although computerization is not without errors" (Stebbing et al., p.443). Outside of the technology, Stebbing et al. pointed to communication as the essential tool for successful technological integration in health, and emphasized that "failed adoptions of technology have been caused partly by poor interactions between those pushing for automation and those using the

new technology” (p.443). The authors insinuate that a lapse in effective internal organizational communication, more so than the problem of flawed technology, results in the failure of technology. It is this fact that Bates et al. claimed a resistance of health facilities to implement technology resulted, citing that only a small amount of organizations have successfully integrated technologies to improve healthcare service delivery. Thus, these researchers stress that communication plays a vital role in healthcare service delivery and that health informatics has the potential to ameliorate inefficiencies in healthcare communication. That being said, the failure of this research to address the role of the organization and users as determinants of success has resulted in an incomprehension of failures and thus a lag in health informatics integrations.

McAlearney, Chisolm, Schweikhart, Medow, and Kelleher (2007) studied physicians’ perceptions of technology in healthcare, what they call clinical information technology (CIT) claiming that “new physician-directed CIT including, ... handheld computers, can help improve legibility and provide information to help with clinical decision making at the point of care” (p.837; Ash, Berg, & Coiera, 2004). Over a three-year period, seventy-one physicians were involved in ten different focus groups which asked about the opportunities and issues surrounding CIT integration in their work environment. From the analysis, two major themes emerged: skepticism about the ability of CIT to reduce medical errors, and the impacts of these technologies on physician workload and their lives.

Physicians seemed to be concerned with the new technologies creating new problems, namely in information credibility and reliability, concerns surrounding the technological appropriateness in certain medical arenas, and the capability of the technology to suit the physicians’ needs (McAlearney et al., 2006). With regard to the impact of technologies on the physician workload and the altering of their work routine and lives, physicians were concerned

with their changing role within the medical environment. As one example, “physicians using these new technologies found themselves doing direct data entry... the experienced shift in workload was not well-appreciated by the majority of our physician participants” (McAlearney et al., p.839; Ash, Berg, & Coiera, 2004). This particular work shift as a creator and disseminator of information signals the need for a new skill set in physicians, one which many practicing physicians may not have been prepared for before the integration of ICTs.

McAlearney et al.’s study, although thorough, does not discriminate between various technologies, and as such, the various nuances of differing technologies is not taken into account. In addition, technology is evolving rapidly and the study, taken over a three-year period, does not account for environmental differences in the change of physicians’ perceptions of technology between 2003 and 2006. That being said, this study is significant to the advancement of health informatics research as it focuses on the sociotechnical side of technological integration into the healthcare field.

Balka, Doyle-Waters, Lecznarowicz, and FitzGerald (2007) conducted a review of literature on the topic of adverse effects stemming from the use of technological integrations which affect patient safety. Through the review, the authors conclude that “contrary to the traditional approach of blaming users, it is increasingly suggested that many such errors are caused partly by poor device design, which fails to account adequately for the needs of users” (Balka et al., p.S44). Thus, the authors suggest that not only does human error contribute to adverse medical events, but that the technology, which is not properly adapted to the user’s needs, is also a contributing factor. This implies a need for user involvement in designing the health informatics system that will be incorporated into the users’ work routines. Like McAlearney et al. (2006), Balka et al. calls for more research into health informatics through a

sociotechnical lens.

This first section of the literature review has illustrated the importance of communication in health, communication issues inherent in healthcare, the extent to which health informatics integration has attempted to ameliorate the issues, and finally the emerging recognition of the need for health informatics research to be approached through a socio-technical lens. The following section will highlight the advances in health informatics and health informatics research over the past 40 years, looking at the technologies integrated to improve communication in health.

Health Informatics

Norris (2002) claims that healthcare organizations around the world are facing the same challenges, some of which include: aging populations, the rising cost of medical technology, and patient demand for quality care, all of which increase the cost of healthcare for governments and decrease the equitable accessibility to healthcare services for patients. As a way to proactively address these issues health informatics technologies are seen as “vital elements in this drive for efficiency and effectiveness and the key challenge and opportunity for policy makers and healthcare professionals is to harness information to balance demands and costs” (p. 205). As a research area, health informatics aims to “develop and improve the organization and management of information and thereby improve the overall quality of care for patients... their families and carers, and the general public” (Bath, 2008, p.502). Generally, health informatics research gives prominence to human, social, and communication issues, whereas medical informatics focuses on technological issues (Bath, 2008).

A review of ten years of new technologies in health communication was conducted by Suggs (2006) and argued that “using technologies such as the computer, the Web, telephone, PDAs, and tailoring technology, the previous decade of health communication research has demonstrated incredible innovation and positive health outcomes” (p.69). Although not without challenges, Suggs maintained that the introduction of the Internet in the mid-1990s has irrevocably changed the way in which patients, physicians, and other healthcare service providers communicate and deliver healthcare services. In consequence, in the next ten years, health informatics technologies will become “...smaller, faster, more dynamic and tailored” (Suggs, p.70), as the goal of integrating health informatics is to reinforce physician-patient communication, which invariably will lead to improved health outcomes for patients.

Although Suggs’ utter optimism for health informatics is inspiring, the review only glanced over the inherent problems in implementing technologies such as organizational factors, and focused on potential outcomes instead of looking to the historical record of health informatics adoption in healthcare, which would lead to a different conclusion and a recognition of how little research has answered fundamental health informatics questions.

As technology continues to evolve, so has the breadth and depth of health informatics integrations. Beginning with the use of telephones or voice-only asynchronous ICTs, called telemedicine, to web-based multimedia ICTs encompassing video conferencing, email, and computer networks, called mobile eHealth, or mHealth, where mobility of the technology is possible, health informatics have become more pervasive. In the following sections, telemedicine, eHealth, and mHealth research will be reviewed with a focus on both evaluative explorations of the technologies as well as the evolution of research on these health informatics integrations.

Telemedicine

Telemedicine is a specific group of health information and communication technologies under the umbrella of a larger research area, health informatics. Telemedicine can be defined as “... the use of transmitted images, voice and other data to permit consultation, education, and integration in medicine over a distance” (Merrell, 1995; Bashshur, 1997; DeBakey, 1995; Turner, 2003). Kaplan and Litweka (2008) add to this by emphasizing that in order for a technology to be considered telemedicine, one of the participants must be a healthcare provider.

The earliest documentation of telemedicine was in the 1920s when physicians were linked telephonically with patients onboard military ships requiring immediate medical attention (Dwivedi, Bali, Raouf, Naguib, & Nasaar, 2006). However, the development and mainstream application of telemedicine was not introduced until the 1960s (Collen, 1986; Merrell, 1995; Whan, Brown, & Wootton, 2006). Concomitant with the increasing integration of telemedicine into healthcare in the 1970s, researchers began exploring this phenomenon by evaluating these processes as they pertain to the betterment of healthcare service delivery. Outside of Canada, telemedicine advanced more quickly in countries like the United Kingdom and Australia, a trend that continues today with mHealth technology (Gagnon, Shaw, Sicotte, Mathieu, Leduc, Duplantie, et al., 2009; Whan, Brown, & Wootton;). Nonetheless, Canada ranks third of all countries who have contributed to telemedicine research, following closely behind the United Kingdom and far behind the United States (Whan, Brown, & Wootton).

Through four decades of research, potential benefits of telemedicine include: “greater availability of services and access to healthcare providers ...reduced disparities in healthcare accessibility, less travel time for both patient and clinician, lower costs, ... and improved information flow” (Kaplan & Litweka, 2008, p. 402; Debakey, 1995). DeBakey states that, “Having now come to age, telemedicine has the potential of having a greater impact on the future

of medicine than any other modality” (p.4). Research has also uncovered possible negative consequences of the increasing use of telemedicine which can range from a personal disconnect between clinicians and patients, changing roles of health professionals, disparities in health accessibility due to digital divides, and ethical issues in terms of informed consent in being forced to use telemedicine when patients may not be comfortable doing so (Kaplan & Litweka; Bauer, 2009). These benefits and challenges have gripped the debate around integrating health informatics since the first use of telemedicine; however, as healthcare advances through the evolution of health informatics technology, the integration of technology in healthcare is irrevocable and the only way to overcome these issues is to understand technology’s role within health and evaluate the usage of such modalities to ensure its correct and optimal use (Suggs, 2006).

In an early Canadian study, Dunn, Conrath, Bloor, and Tranquada (1977) evaluated different types of telemedicine technologies used by physicians to diagnose patients who lived in remote areas. The four applications tested were: colour television, black and white television, still-frame black and white television, and hands-free telephone. The study was conducted at Sunnybrook Medical Centre, in Toronto, Canada, with participants from surrounding rural areas. The researchers hypothesized that telemedicine was a cost-effective strategy for delivering health services to patients who lived in rural areas and evaluated the most effective and cost-efficient telemedicine applications used by physicians at that time. The results illustrated an inability to “...measure any significant differences related to diagnostic accuracy, tests requested, patient management practices, efficiency, and referral rates among the four telecommunication modes” (p. 28). The researchers suggested that telemedicine is a needed investment to improve healthcare service delivery for remote patients, however, updating technology is a wasted investment as

simple, reliable technologies, such as the telephone, are preferable for the Canadian healthcare system in the long-term.

In the early days, telemedicine research demonstrated a promising alternative in healthcare service delivery. However, researchers have neglected to fully explore the tangible benefits of telemedicine. In a recent systematic review of telemedicine benefits, Roine, Ohinmaa, and Hailey (2001) found that there is a lack of research focused on the overall benefits of telemedicine. Rather, there are many articles that have explored single pilot telemedicine projects, like Dunn et al. (1977), and the outcomes are only short-term and specific to the context. Roine, Ohinmaa, and Hailey maintain that, "...the assessment literature has yet to address aspects of telemedicine applications as they move into routine use, or their longer-term impact on health status, costs and organization" (p.770). As a result, the authors call for further research into the long-term benefits and challenges of telemedicine in order for the continued implementation of health informatics in an effective manner that will ensure the sustainability of these technologies.

Going one step further, Mair and Whitten (2000) claimed, "...research fails both to provide satisfactory explanations of the underlying reasons for patient satisfaction or dissatisfaction with telemedicine and to explore communication issues..." (p. 1517). This notion is echoed by Bath (2008) who stated, "a problem with the literature is that individual studies are either too specific, in which case generalizations to other situations are not possible, or too general and studies assume that the findings apply to all systems" (p.513). Mair and Whitten's (2000) hypotheses are reflected in their systematic review of thirty-two articles published between 1966 and 1998. The authors asserted that research conducted on telemedicine was superficial in nature and rarely investigated telemedical technologies outside of technological aspects, arguing that not only is more research paramount in understanding the contextual issues which influence telemedicine

use, but also to develop unique methodological approaches to thoroughly evaluate telemedicine through a sociotechnological lens.

As Mair and Whitten (2000) demonstrated, forty years after the introduction of telemedicine, the same questions about the benefits and challenges of health informatics remain. Thus, as technology evolves, researchers have new opportunities to understand the socialtechnical dimension of telemedicine (Kaplan & Litweka, 2008). These dimensions include not only economic benefits as Roine, Ohinmaa, and Hailey (2001) emphasized, but also interpersonal benefits and communication concerns highlighted by Mair and Whitten.

eHealth

Riva (2000) called eHealth the “integration of telehealth technologies with the Internet” (p.990). Inherent in this statement is the author’s inclusion of eHealth into the domain of health informatics. Expanding on the role of communication technology in health, Riva (2000) postulated that, “ehealth is not simply a technology, but a complex technological and relational process” (p. 990). In other words, eHealth is not only the evolution of telemedicine, but is also the catalyst for changing the practice of medicine far beyond the transmission of information. The most profound innovations, which distinguish telemedicine from its younger sister, eHealth, are twofold; first, the introduction of the Internet into health communication networks, and second, the advent of the electronic health record (EHR).

Synonymous with eHealth is the creation of the electronic health record, or EHR, which is a broad term used to describe a communication network with a database of patient information which healthcare professionals use to document patients’ health and visits to healthcare facilities. Through a systematic review of literature conducted in 2008, Hayrinen, Saranto, and Nykanen

concluded that the best definition of an EHR is “a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users” (p. 293). Through their analysis, the authors found that there are several incarnations of EHRs, depending on the country, type of medical services provided, needs of the health facility, and the funding available for such projects. Two implications of this finding are possibly detrimental to the future of EHRs: first, that the research into the content of EHRs is lacking, and second, that the divergent uses of EHRs are creating even larger lapses of interoperability. These implications suggest that future interdisciplinary communication in health on a facility, local, regional, national, and international levels will suffer, increasing patient risk.

Canadian integrations of the EHR are seen as important steps in improving patient safety, enhancing interdisciplinary communication, and reducing adverse medical situations (Alvarez, 2002; Gagnon et al., 2009; Romanow, 2002). Early Canadian research and government reports, such as those conducted by Alvarez (2002) and Romanow (2004), touted the potential benefits of EHRs. As a result, several health organizations jumped at the opportunity to implement their own version of the revolutionary system which was funded by the Canadian government. However, as Gagnon et al. discovered in 2009, the impact was not as promising and revolutionary as early predictions suggested. Gagnon et al. conducted a comprehensive review of EHR literature in an attempt to understand the true impact of the records in Canada. The aim was to produce “usable knowledge that could support decision makers responsible for the implementation of interoperable EHR in Canada” (Gagnon et al., n.p.) for the direct use of governmental institutions to develop policy and investment in EHRs.

The researchers found that out of the literature reviewed, much of the focus was on physicians and did not take into account patient, administrative, or other healthcare professionals’

perspectives. In short, “significant gaps remain in understanding the challenges related to developing, implementing, and maintaining health information systems” (Gagnon, et al., 2009, n.p.). Thus, years after the introduction of the EHR in Canada and over a decade of research, the support required and reasons for failures in past implementations remain uncovered. Gagnon et al. call for further research into not only the EHR but also other eHealth integrations from a variety of perspectives in order to integrate an interoperable EHR for all Canadians.

Like Canada, American scholars have heralded the EHR as an effective way to improve healthcare services while reducing overall costs (Goroll, Simon, Tripathi, Ascenzo, & Bates, 2009). Several hospitals in Massachusetts decided to implement an EHR with the end goal of creating a more efficient way to share clinical information. However, the project encountered many barriers, consequently the hospitals formed a coalition in order to pool resources and research the challenges and barriers of implementing the EHR. The coalition found that initial success of the EHR required “intensive practice support, commitment to collective action, clear goals, leadership from the physician community, governmental support, and a community-based focus” (Goroll et al., p. 136). Barriers included “inadequate standards for data representation and vocabulary, concerns about vendor instability and system obsolescence, system limitations, privacy and security issues, contracting demands, and practice inertia” (Goroll et al., p. 137). From the aforementioned requirements and barriers, the researchers concluded that although financial and government support is important, change must be managed at the organizational level, implying strong internal communication with employees about changes. As was found in the Canadian study conducted by Gagnon et al. (2009), organizational communication and interoperability between disciplines and facilities are critical components of EHR integrations.

Health informatics has been viewed as a way in which healthcare professionals can better exchange information and communicate (Coiera, 2003). EHRs are rarely used as a way in which to inform healthcare professionals of errors. Singh, Arora, Vij, Rao, Khan, and Petersen (2007) researched a health informatics application that notified healthcare professionals through computerized alerts of abnormal test results, called the “View Alert” system. The researchers focused specifically on the outpatient setting as they claim it is most prone to lapses in communication, and therefore medical errors (Singh et al.). The researchers investigated the

communication outcomes after physicians received an alert from the View Alerts system. Singh et al. (2007) studied the View Alert system at the Michael E. DeBakey Veterans Affairs Medical Centre in Houston, Texas. Using a weekly computerized tracking system to identify alerts, the researchers studied 1,017 alerts in a three-month period. The researchers found that in four percent of the cases, the physician did not communicate the abnormal results to the patient. Further, in 0.2% of the cases followed, the alerts were lost in the system. While there was no data on how paper-based notifications compare with these results, other studies of other systems report a much higher failure to communicate rate, thus future research must look into the varying informatics systems, which work effectively within a particular environment.

Pirnejad, Bal, and Berg (2008) evaluated an electronic information and communication system designed to close communication gaps between primary and secondary health professionals. Looking at a specific communication network called (English translation) the Trans-mural Exchange of Medication Data in Almere (TUMA, is Central-Patient-Index system used to coordinate primary care (physicians) and secondary care (pharmacists) providers through an electronic network. Using qualitative methods, the researchers first conducted interviews with various clinicians using TUMA, analyzed documents, and observed both primary and secondary care providers in their respective environments.

Outside of technical issues, such as minor system failures, the researchers found that information gaps still occurred between primary and secondary care providers, and that TUMA was a more inefficient way for the two levels of providers to communicate. For example, a pharmacist describes that the system is not intuitive and takes a little longer for a physician to input information needed by the pharmacists in the system, claiming, “there is a problem at the moment with respect to convincing GPs [general practitioners] to accept this responsibility...and

excuse themselves for being busy” (Pirnejad, Bal, & Berg, 2008, p.824). As a result, the authors decided that “the integration of information systems, therefore, requires changes in the organization of care practices and the way people use the system” (p.825). The authors underscored the need for both a readjustment in the way the organization views the role of its healthcare providers and in the way physicians and pharmacists see their role in the healthcare system. Although this study was narrow in scope and cannot be generalized, the importance of organizational communication in the overall success and continuation of electronic communication systems in healthcare, as was found in this study, is critical in advancing health informatics.

In a Scottish study, Bower, Barry, Reid, and Norrie (2005) analyzed eHealth applications focused on discovering the key issues that assisted or hindered the projects from success. The researchers claimed that “there has to date been little detailed research on ICT innovation in health care that has considered fully both the local and the wider impacts on the context into which the innovation is being introduced” (Bower et al., p.736-7). Through the two-year research project, researchers investigated four different projects including: videoconferencing, the use of laptops, a chronic disease management system, and a software audit tool for continuing healthcare. Three contributing factors to the success of eHealth projects are: the importance of internal champions for the technology, the availability of strong external information technology providers, and the support of internal information technology specialists. This study accentuated the importance of organizational support through information and communication technology integrations in both social and technical capacities. While this study cannot be generalized, the researchers plan to re-conduct the same study, with the inclusion of quantitative data.

Panteli, Pitsillides, Pitsillides, and Samaras (2007) analyzed the Network for Medical Collaboration (DITIS, in Greek), a system that synergizes the communication of a team of healthcare providers and the patient. In this particular situation, DITIS was used by patients in the Cyprus Association of Cancer Patients and Friends for the purpose of remaining in constant communication with their healthcare team. From 2000-2004, the researchers interviewed a number of patients and healthcare providers who used the system and found that initial concerns with the technology were not as critical in the last year of the study. In the beginning, the nurses who used DITIS exhibited what the researchers termed “technophobia”. However four years later, those nurses were no longer concerned with interacting with the technology and integrated many different types of applications into their daily routines (Panteli et al., 2007). Furthermore, the researchers note that integration has been very slow and organizational structures have been slow to adapt to the technology. This study underlines the importance of organization communication and training in integrating health informatics. Consequently, future research must explore ways to integrate eHealth applications in a more efficient manner at the organizational level.

In a case study of eHealth in Canada, Peddle (2007) investigated the Smart Labrador system in rural Labrador and focused on the socio-economic issues of the region. Peddle concludes that many of the issues that plague other eHealth projects in more populated centres are similar to those faced in rural Labrador. However, due to the extreme spatiality in Labrador, geographical issues drain many of the resources that would normally fund technological advances. The author postulated that “while technology has played a large role in changing the lived experience in Labrador, it has not completely overcome the bounds of geographic space in

the region” (Peddle, p. 611). Peddle found that the geographic dispersion in Labrador contributed to the failure of the program.

As was found by Peddle (2007), unique contextual factors in the Canadian environment can affect the extent to which health informatics can improve the healthcare system. Alvarez (2002) examined the potential of eHealth in an era where Canada faces unique challenges, public health finances are being stretched thin, and the geographic nature of the country requires an adequate system whereby medicine can be practiced at a distance (Alvarez, 2002; Naylor, 1999). Optimistically, the author postulated that eHealth has the potential to meld the current disjointed Canadian health system stating, “new ICTs transcend traditional health system divides, offering a means to develop more.... advanced data sharing, cooperation and cost-sharing between jurisdictions, professionals, and facilities” (Alvarez, 2002, p. 3). Nonetheless, Alvarez outlined challenges similar to those identified by previous researchers such as technological, financial, and organizational obstacles, which may hinder the integration of eHealth in Canada. The most significant of these hurdles is the lack of financial resources.

When eHealth was recognized as a viable solution for problems facing the healthcare system, health informatics researchers postulated that the questions left unanswered about the affect of telemedicine would now be answered through rejuvenation of the field, and although more research was conducted, several questions still remain. Like history repeating itself, a new era of mHealth is emerging, igniting hope that the unanswered questions from telemedicine and eHealth research will finally be answered.

mHealth

“Mobile healthcare, also known as mHealth, is the development, dissemination, and application of mobile information and wireless telecommunication technologies in the area of

healthcare” (Siau & Shen, 2006, p. 90). mHealth technologies allow healthcare providers the ability to access patient information and decision support electronically at point-of-care as mHealth is “portable, unobtrusive and discreet in nature [which] provides the potential to view, store, organize and synchronize large amounts of data” (Morrison, Ricketts, Jones, Johnston, Pitts, & Sullivan, 2009, p.1-2). In surveying the mHealth environment, Siau and Shen stated that the growth of such technologies depended on a successful integration at the organizational level. mHealth can be seen as a continuation of eHealth, as it incorporates similar systems and design strategies, but incorporates mobility and allows for point-of-care information. As early as 1995, scholars were exploring the possibility of hand-held computer use in the clinical environment (Barrett, Strayer, & Schubart, 2004). However, it has not been until recently that a clear research database has been developed on the clinical use of mobile devices.

In their qualitative study, Barrett, Strayer, and Schubart (2004) explored the use of personal digital assistants (PDAs) from the perspective of the physicians. Initial findings indicated that PDAs were readily accepted in the clinical environment, while many technical problems were encountered by the physicians. The most important concern voiced within the interviews were about security and patient confidentiality (Barrett, Strayer, & Schubart, 2004). The authors noted that future research directions should explore how physicians and other healthcare providers use the information on the PDAs.

Aziz, Pancsar, Netubeli, Paraskeva, Sheikh, and Darzi (2005) compared response times between a pager communication system and a mobile phone/PDA communication system. Looking at physician communication in a London, England hospital, Aziz et al. found that when using a PDA or mobile device, physicians answered calls more quickly and the failure to respond rate lowered significantly. Although it was a small study, only nine physicians were observed, the

researchers claimed that the results indicate a need to improve mobile communication systems within the hospital system from a pager system, to a mobile phone/PDA communication system. The researchers state that these preliminary, yet promising, findings signal the need for a larger scale trial of the system, including a look at the devices' affect on interprofessional communication.

Garrett and Klein (2008) examined nurses' use of wireless PDAs in a British Columbia hospital. The researchers found that the ability of the nurses to carry information around in a wireless device allowed for more efficient healthcare as the data required to treat the patient becomes available at point-of-care. The nurses stated that PDAs helped the administrative process of healthcare delivery as they were able to input changes to the patients' medications and other information on the spot instead of returning to the main nursing station to update the patients' files (Garrett & Klein, 2008). Furthermore, the authors concluded that "participants voiced sophisticated conceptualizations about the potential of these devices [PDAs] to support advanced nursing practice" (Garrett & Klein, p. 2152). Other studies looking at PDA use in a hospital setting found that the devices advanced knowledge and information about the patient at point-of-care, as well as facilitated better decision making when this information was made accessible more efficiently (Fischer, Stewart, Mehta, Wax, & Lapinsky, 2003; McAlearney, Schweikhart, & Medow, 2005).

mHealth technologies have evolved in recent years, and as a result, several different types of mobile devices have been introduced to the healthcare environment. In 2001, Young, Leung, Ho, and McGhee investigated the reasons why certain devices were preferred or adopted more often by healthcare organizations. The researchers compared two mobile devices, one which required a keyboard, and one which used a pen-like tool to input data. One hundred and thirty-

eight nurses from six different specialties who have between one to over five years of computer experience, were surveyed. Participants were asked to simulate three different nursing-record procedures twice, once with each device. The nurses did not choose one device over the other, instead, the researchers found that each device was preferred based on the needs of the device. For example, the keyboard device was preferred for entering data, however, the pen-based device was preferred for structured data input. As twenty-two percent of the nurses involved in the study had less than one-year of experience with computers, little typing experience may have caused some nurses to favour the pen-based option as pressing more than one button per command may have been too complex. This study illustrates the importance of choosing the most appropriate device based on user needs and their level of technological knowledge.

Chang, Lutes, Braswell, and Nielson's (2006) study researched the ability of a mobile device, known as the Pocket PC, to help nurses communicate amongst each other and with patients at point-of-care. Chang et al. define a Pocket PC simply as a handheld computing device which can store information, in this case patient information. Previously, nurses would communicate patient information through audio-recorded devices or by walking around the unit with the new nurses starting the shift. The Pocket PC allows for nurses to make patient notes electronically and communicate those notes electronically with other nurses and care staff without sitting at a desk. The study was conducted at a hospital within the United States of America, where paper-based communication methods were still used. Thirty five nurses participated in the study, but only twenty-six participants filled out the questionnaire. Although there was no statistically significant difference between the time it took to audiotape notes for an incoming nurse and the time it took to sync the Pocket PCs, anecdotally, participants were satisfied with the technology. One nurse noted that the system "enabled them to have more time

to provide quality patient care” (Chang et al., p.60). As well, participants noted that the Pocket PC allowed for quicker information intake during the beginning of the shift, and quicker patient information transfer at the end of a shift, as participants took notes throughout the shift and did not have to transfer them to audiotape or relay them face-to-face. However, a main limitation of the study is the inability of the researchers to adequately explain the discrepancy between the quantitative and the qualitative findings.

A more recent study by Ortega et al. (2009) compared the use of an early mHealth technology, the pager, with a new technology, the cellular phone, in an orthopedic surgical wing of an American hospital. In comparing the two devices, pagers are asynchronous, thus communication was not always direct and commonly required the mediation of a nurse or support staff. Alternatively, cellular phones are synchronous and allowed for direct communication between the surgeon and the nurse. Using stopwatches to time communication during elective orthopedic surgeries, the researchers found that mean intervals in total communication time dropped significantly between pages which were two hundred and fifty seconds, compared to cellular phones, which had a response time of thirty-two seconds. Another important finding related to communication interruptions, which dropped from ten per surgery with a pager to zero when using cellular phones. Finally, nurses were asked to rank their level of satisfaction with surgeon communication. Nurses ranked cellular communication ‘excellent’ twenty-nine times and pager communication ‘excellent’ eleven times. These findings indicate that cellular phones are more efficient communication tools for healthcare providers to communicate among themselves.

Interestingly, significant differences in communication time were not related to outdated technology, but to the additional communication involved in answering and responding to a page.

This emphasizes the importance of direct communication and decreasing the number of communication channels in healthcare service delivery. Ortega et al. (2009) concludes that, “direct wireless, cellular intraoperative communication improves communication times, communication accuracy, communication satisfaction, and minimizes intraoperative case interruption” (p.156). As a result, the researchers called for continued transition to wireless or cellular communication in order to reduce medical errors and increase patient safety. Although it is a thorough study, the researchers failed to study how the pager or cellular phone affects the communication between the surgeon and ancillary staff within the operating room. Further, communication was observed in simulations, not actual situations, thus possibly skewing the data.

Ways to improve communication between healthcare providers is constantly evolving, and Solvoll and Scholl (2008) postulate that technology holds the key to improvements in healthcare communications, specifically mobile technology. The use of asynchronous communication has the potential to reduce the number of interruptions that synchronous communication channels, such as mobile technologies, create (Coiera, 2003). While numerous studies have touted the benefits of mHealth applications, deeper investigation into the use of mobile devices has shown that they can be more disruptive to communication than previous health informatics technologies (Solvoll & Scholl).

At Mount Sinai Hospital in Toronto, Ontario, Canada, an innovative communication practice, combining pager and web-based tools was developed in order to streamline nurse and physician communication. Locke, Duffey-Rosenstein, De Lio, Morra, and Hariton (2008) researched a Web-based Interdisciplinary Paging System (WIPS) designed through consultation with physicians and nurses (the users) which incorporates a web-based information system for

non-urgent messages, leaving the paging system only for urgent and time expired non-urgent messages. On the web-based interface, nurses are able to enter patient information and a time limit as to when the physician must complete the task by. Although initial trials showed some issues related to irregular situations, such as when family members requested to speak to a physician, both nurses and physicians indicated a desire to further the use of the communication system, as well as to expand the system to other professions. Physicians stated WIPS allowed them to manage time and workflow, while nurses stated that their ability to sort urgent and non-urgent messages eased communication with physicians.

Nonetheless, Locke et al. (2008) claimed that this pager system in healthcare is a highly disruptive mode of communication and created a stressful working environment. Further, the different codes for urgent and non-urgent matters create a climate of page desensitization, consequently delaying and hindering quality healthcare. The pager system had other flaws in that the nurse who sent the page had no indication if the page had been answered or the task requested been completed. This study illustrates how a lapse in communication can impede the delivery of quality healthcare services.

A systematic review of research on the influence of personal digital assistants (PDAs) on physician work practices and patient care by Prgomet, Georgiou, and Westbrook (2009) found that this mHealth technology improved error prevention, data management, response rates, and information accessibility. Thirteen quantitative studies published between 2000 and 2007, one Canadian in origin, were reviewed each of which found work practice benefits in using mHealth technologies. The researchers discovered that mHealth technologies were successful because the mobility of the technologies suited the chaotic healthcare environment and the information needs of the physicians. Nonetheless, the physical features of mHealth technologies, including the small

screens, which limit the ability of users to view and input information, were mutual issues in half of the studies reviewed. The contrast between the usefulness of mobile information and the limitations of physically smaller devices prompted the researchers to state that future research must focus on single device evaluation to investigate the physical benefits and limitations of different devices. Through this individualized research the most appropriate mobile devices for the healthcare environment can be found.

Archer (2007) claimed that mHealth as well as a fully electronic integrated healthcare system are important in fixing a fragmented health system which often results in medical errors, lack of coordination between healthcare providers, and system redundancies and duplication. For these reasons, the author postulated that an integrated mHealth system is required in order to keep the Canadian healthcare system afloat. Hinting at the failures of past information technology programs in healthcare, Archer (2007) emphasized that, “the real benefit of mobility support will come only when technology and process are built around a plan that embraces mobility, and where mobility is not an afterthought” (p.47). In other words, mHealth must be the central focus within the health system, not a periphery module. Furthermore, Archer highlighted the importance of interoperability in integrating and sustaining effective mHealth applications, stating that ineffective interoperability leads to fragmentation and “this fragmentation of records often leads to errors, duplication, lack of coordination...and many other problems including reduced quality of care, reduced effectiveness, and increased cost to society” (Archer, p.45). Thus, if mHealth is not effectively integrated and envisioned within the healthcare system, it will not fulfill its true potential, creating more issues within the system.

Archer (2007) missed two important factors in analyzing the nature of health informatics integrations. First, Archer noted that these questions can only be answered through empirical

research, which does not always allow for an exploration of contextual factors impacting successful or failed integrations. Second, Archer failed to take into account the affect that the end user has on the success or failure of a technological integration.

As with other challenges in the integration of health informatics, Archer claimed that the biggest challenges and research opportunities in the mHealth sector include: usability, adoption, interoperability, change management, risk mitigation, privacy and security, and return on investment. The author reinforced the importance of these issues in understanding how mHealth solutions can be integrated successfully.

The previous literature review highlighted very important concepts in understanding health informatics through their ability to assist in ameliorating communication inefficiencies in healthcare and in past integration successes and failures. The next section will look at theoretical frameworks which inform how to investigate and look at health informatics. It will begin with a broad look at sociotechnical theory and delineate into social interaction theory.

Chapter 5: Methodology

Approach and Rationale

Qualitative research is used in order to understand a particular problem in a specific context or situation (Creswell, 2007). Creswell says that qualitative research begins with “assumptions, a worldview, the possible use of a theoretical lens, and the study of research problems inquiring into the meaning individuals or groups ascribe to a social or human problem” (p.37). This definition emphasizes the ways in which qualitative research is carried out and where data is collected:

...in a natural setting sensitive to the people and places under study, and data analysis that is inductive and establishes patterns or themes... includes the voices of participants, the reflexivity of the researcher, and a complex description and interpretation of the problem, and it extends the literature or signals a call for action (Creswell, p.37).

When compared with quantitative research, it can be said that qualitative methods provide a glimpse into a particular phenomena through the lens of the individuals living it. In this study, qualitative methods were employed as it reveals a contextual account of unique elements and relationship intricacies of a phenomenon (Creswell 2007; Yin, 2003).

Trends within the health informatics field demonstrate that qualitative research is the investigative method most frequently used (Plummer, 2001; Rose, Schnipper, Park, Poon, Li & Middleton, 2005). Plummer discusses the methodological aspects of health informatics research and states that, “the value of qualitative research methods, specifically case study, has been gaining credibility as a feasible way to study organizational processes” (p.2). Limitations in articles reviewed previously in the literature review illustrate the need to research beyond quantitative data to understand the organizational context in which health informatics technologies are or are not being used.

According to Yin (2008), a case study is “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real life context, especially when the boundaries between phenomenon and context are not clearly evident” (p.18). In other words, it is a detailed investigation of a single subject or phenomenon that aims to understand a problem from a specific perspective within an ill-defined framework. In an exploration of methodological approaches in health informatics, case study research is popular because of its “ability to explore the complex interactions between technology and organizations” (Plummer, 2001, p.2), while acknowledging that the focus on case study methods have resulted in a lack of theory building in the field (Plummer; Kaplan, 2001a). Benbasat, Goldstein, and Mead (1987) state that, “With the rapid pace of change in the information systems field, many new topics emerge each year for which valuable insights can be gained through the use of case research” (p.370). In this study, a case-based approach was chosen for two main reasons, first because of the unique context of healthcare organizations and second due to the exploratory aims of the study.

Healthcare organizations are complex networks of specialists working in a sensitive and highly emotional environment, all of which affect communication. Looking at one specific case is an effective way to understand an issue as complex and novel as the integration of health informatics. Creswell (2007) postulates that in a case study “the researcher focuses on an issue or concern, and then selects one bounded case to illustrate this issue” (p. 74). Given that this study is exploratory in nature, looking at one specific case is most appropriate in understanding fundamental processes and challenges which are paramount to future explorations in the field. Only two units at The Organization employed mHealth technology, and only one, the PCCU, has a history of integrating previous eHealth systems, thus site selection was simple and avoided the issue of selection bias.

Semi-structured interviews comprises of structured questions but focuses on probing the interviewee's answers as a way of uncovering topics or themes not originally considered (Yeh & Kuo, 2006). In a study of health communication, Riege (2003) addressed validity and reliability of semi-structured interviews in a healthcare environment and found that semi-structured interviews are appropriate for use in studies which are exploratory in nature, when there is discussion of sensitive topics, and where standardized interview protocols are not conducive to the environment. Interviews allow for the inclusion of contextual factors through the use of narratives and explanation of specific examples. Since the research is exploratory in nature, and the different experiences of participants do not allow for standardized interview questions, semi-structured interview process was adopted.

While semi-structured interviews are well suited for the healthcare context, Riege (2003) postulated that interview biases become apparent in the sequence of interview questions. In standardized interviews, the differences in responses are attributed to the interviewee and not the interview protocol. Semi-structured interviews do not necessarily follow an exact sequence, in fact some participants were asked different questions based on their role within The Organization. To curtail any potential biases interview questions asked of the healthcare professionals in this study went through a pilot process with a nursing student who used similar mobile technology routinely in her practical nursing placements. This pilot testing screened for question clarity, biases, and inclusion of appropriate nursing terminology. Although the interview questions for the four HHS leaders were not pilot tested, they were reviewed by the researcher and thesis supervisor and screened for biases and clarity.

A main aspect of semi-structured interviewing is the ability to probe participant responses. This practice is helpful in exploratory studies to uncover themes that we not

anticipated in question development. However, this practice can lead to biased probing, and as Denzin (2009) suggests, “many interviews convey implicit demands to the respondent (i.e. social desirability) there is often an attempt to present a self that meets these demands” (p.137). To guard against socially desirable answers, the interviewer used neutral language in question wording and positively affirmed all answers to ensure that interviewees felt comfortable in truthfully detailing their experiences with mHealth technology.

Site Selection

As previously outlined, Hamilton Health Sciences (HHS) is a group of five hospitals and one cancer care clinic in Hamilton, Ontario. It employs 10,000 people, including administrative and medical professionals, as well as 1,400 physicians who work within the facilities (Hamilton Health Sciences, n.d.). Hamilton Health Sciences was chosen as the site for this study for many reasons. These reasons include: an abundance of health informatics integrations occurring concurrently, HHS’ status as a leader in the field of health informatics, and The Organization’s financial investment into health informatics research and innovation.

First, Hamilton Health Sciences has numerous health informatics integrations occurring concurrently. The many informatics projects occurring allow for a better case study selection and specifically an mHealth project. Further, past informatics projects integrated by HHS has resulted in industry acclamation. This past year, HHS received MEDSEEK’s 2009 eHealth Excellence Award for their integration of the ClinicalConnect program. ClinicalConnect is an online portal for physicians to enter patient health information from any computer with Internet access (Hamilton Health Sciences, April 2009a). This demonstrates a history of health informatics integration and investment in improving healthcare service delivery, which makes HHS an excellent site for this study.

In addition, there are several journal and industry articles written about the informatics projects occurring at HHS. The articles focus on the successes and obstacles of informatics integrations at HHS. This knowledge exchange shows The Organization's desire to improve healthcare service delivery in other facilities as well as their own. Some articles are written by HHS employees illustrating The Organization's openness to research and investment in the expansion of health informatics into other facilities.

Finally, The Organization's financial investment in health informatics demonstrates HHS' priority in advancing health informatics technologies. As previously mentioned, in Ontario, healthcare organizations are financially responsible for the majority of the funding of its own informatics projects. As a result, the financial investment made by HHS shows their commitment to the betterment of healthcare service delivery through health informatics.

Within HHS, the Pediatric Critical Care Unit (PCCU) housed at McMaster Children's Hospital is the selected study site for three reasons: mHealth use, different healthcare providers using the technology, and history of piloting health informatics technologies. First, the PCCU is currently in a three-year mHealth pilot project which began in May 2009. Second, there is a range of healthcare providers using the technology in the ward, including nurses, respiratory therapists, and physicians. Finally, only two units within HHS are employing mHealth technologies; PCCU has a history of piloting other health informatics technologies. Thus, this unit best fits the aims of the study which is to understand how mHealth technology impacts interdisciplinary communication within an Ontario hospital.

Data Collection Procedures

Following ethical approval, organizational documents were gathered through the Hamilton Health Sciences (HHS) online site, scholarly resources, and directly from HHS executives (See

Appendix F). The main organizational document used was the strategic plan titled, “Vision 2010: Future Priorities” and was given to the researcher by one participant. This document was lengthy and included an extensive justification for the use of information and communication technologies at Hamilton Health Sciences. Other organizational documents were taken from The Organization’s website and included shorter documents describing technological integrations occurring at HHS. Internal newsletters, called “The Insider” were collected online through the public relations section of the HHS website. Only newsletters from 2007 to 2009 were included as they were most recent. A total of 6 documents and 17 newsletter articles were included in the document analysis. Documents which were excluded were those that had did not include information about technological integration or strategic planning at HHS.

Next, interviewing, which was divided into two phases, first HHS leaders and phase two, where healthcare providers were solicited as potential interviewees. The researcher contacted eight HHS leaders who were key decision-makers at The Organization through email, and four agreed to be interviewed in person and one through email. Three of these participants were female, and two were male. These interviews were conducted in the leaders’ offices and lasted between thirty and fifty minutes in length, were tape-recorded, transcribed later by the researcher, and were member checked for accuracy.

After the initial round of interviews was completed, phase two of interviewing began where healthcare providers who use mHealth technologies were interviewed. One participant from the initial round of interviews provided contact information for the PCCU, which made it easier for the researcher to gain access to willing participants. From this initial email, one participant was recruited and agreed to be interviewed. Through snowball sampling conducted on the day of the interviews, six additional participants were interviewed. Due to the constant

changing nature of the PCCU, interviews were not able to be scheduled before the interview. The interviewees included: five registered nurses, a respiratory therapist, and a physician. Six out of the seven healthcare providers were female. Each interview lasted between ten and twenty-five minutes in length, were semi-structured, tape-recorded, transcribed by the researcher, and later member checked for accuracy. To allow for longer interviews, they were conducted on the PCCU floor.

Including both key informant and healthcare provider participants, a total of eleven interviews were conducted, ten in person, and one through encrypted email. Five of the interviewees, at the time of the interviews, were in decision-making roles within The Organization, and four of these did not use mHealth technologies in their daily work routine. The other six interviewees were healthcare professionals using mHealth technologies in their daily work routine.

Just as information and communication technologies have assisted in enhancing certain aspects of healthcare service delivery, so have they opened up opportunities for different methods of gathering data in research (Mann & Stewart, 2002). Opdenakker (2006) suggests that email interviewing is appropriate when there is limited time and financial resources to conduct the interviews through other methods and when social cues are not important to the collection of information. As the participant in this research study has a hectic work schedule, an interview could not be arranged, thus an email interview was agreed upon. Further, Opdenakker suggests that in order for email interviews to be successful there must be significant technical knowledge of both the interviewer and interviewee for data collection to be successful. In this research study, the interviewee has used email daily for work purposes, as well the interviewee suggested the use of email for conducting the interview illustrating her confidence in using the medium.

Email based data gathering techniques are quite novel yet the popularity of the medium for collecting data has pushed scholars to develop techniques for conducting interviews over email. Meho (2006) suggests that the most important technique in email interviews is that the questions are clear and leave no room for misunderstanding. Unlike face to face interviews the researcher is unable to clarify questions during the interview, thus extra care must be taken to ensure that the questions are self-explanatory. Second, Meho and Tibbo (2001) postulate that questions embedded in the email message, not as an attached document, have resulted in higher response rates. As a result of these two techniques, the researcher reviewed questions to ensure clarity and embedded questions in the email message.

Bampton and Cowton (2002) state that email interviews can compliment face to face interviews as “the e-interview can be just one of the forms of interview used, and interviews themselves may complement (as in our project) or be complemented by other research methods” (n.p.). Mann and Stewart (2002) claim that computer mediated communication, including email communication, can never achieve the highly interactive, rich, and spontaneous communication associated with face to face communication as human and social cues are not available. However, other scholars, such as Galegher *et al.* (1998) posit that the lack of spontaneity in email communication allows for slower, more thoughtful speech. Further, some scholars postulate that the lack of visual cues through online communication lessens the occurrences of bias and prejudice in data collection (Selwyn & Robson, 1998; Wallace, 1999). In no way should email interviewing replace those conducted face to face, it can provide additional opportunities for researchers to access participants who are not available because of time or geography.

Data Analysis Procedures

Data was analyzed following grounded theory analysis procedures outlined by Glaser and Strauss (1967); even though this study is a case study, grounded theory analysis procedures are more rigorous than case study data analysis procedures and follow an iterative process for uncovering important themes. As defined by O’Leary (2004), grounded theory researchers “work inductively to generate theories strictly from the data” (p.96). In this study, grounded theory was used solely as a method of analyzing data collected through qualitative means. Allan (2003) described coding in grounded theory as “a form of content analysis to find and conceptualize the underlying issues amongst the ‘noise’ of the data” (n.p.). Combining documents and interviews, grounded theory data analysis procedures were followed, and the steps taken in this particular study are outlined below.

Following grounded theory methods, microanalysis was conducted on both organizational documents and the eleven interview transcripts. Microanalysis is the analysis of data word by word and the “coding of meaning found in words or groups of words” (Strauss & Corbin, 1998, p.68). In this study, over one hundred different concepts were uncovered. Allan (2003) describes a major downfall to microanalysis in which multiple concepts uncovered create confusion and divergent data. However, in this study, the several concepts originated helped to unify the large amount of data collected in that all the concepts were compiled into ten themes and then finally into four major categories, one ancillary category, and fourteen subcategories.

The refining process was completed in two steps. First, all the concepts were written onto individual pieces of paper with the number of times that particular concept was repeated in the data, and then placed on the floor next to the corresponding data coded. With all the concepts lined up on the floor, ten categories were created, and the concepts were arranged underneath that heading. Those that did not fit under a category were placed under a miscellaneous title and

placed to the side. From these ten categories, similar categories, or categories which contradicted each other were grouped creating four main categories. Focused coding ensures that the most significant data is recoded and emphasized in analysis. After initial coding, or microanalysis, the four emergent categories were given a unique highlighter colour and the data was recoded accordingly.

Charmaz (2003) says that analytic memos assist researchers in: thinking about the data, establish categories, uncover gaps in interviews, and delineate intervening conditions. Analytic memos were used to help the researcher reflect on connections and contradictions in the data. These memos were kept separate from the data during coding processes but used in the analysis to explore recurring or contradicting themes within the categories.

Trustworthiness

Trustworthiness is a critical component of qualitative studies (Cao, 2007). Consequently, the following strategies were employed in order to ensure a high level of trustworthiness. First, multiple data sources (literature review, analysis of organizational documents, and semi-structured interviews) were triangulated in order to gather data from multiple sources to enrich the variety of data. As advised by Allan (2003), after data collection was completed and before data analysis begins, transcription verification was conducted in order to ensure there was no interpretation bias in transcribing interviews. Transcription verification was conducted electronically where the researcher transcribed interviews verbatim and emailed them to each participant. The participants were asked to review the transcript note any misunderstandings in the interview and any other mistakes they notice. The revised interview was then sent back to the researcher. Although reminders were made to non-responders, not all interviewees responded; only seven of the eleven interviewees confirmed the accuracy of the interview transcripts. Of the

seven transcription verification checks sent, only two responded with changes, both of which were minor grammatical corrections. Finally, a researcher journal was kept throughout the study in order to guard against researcher bias. Through this journal, the researcher wrote about events, feelings, and intuitions about the data and changes in the research process that the researcher felt were significant. The journal was an important tool used to separate actual data collected and the researcher's intuitions about the data and research processes.

Role of the Researcher

Hatch (1996) explains that in qualitative research, the researcher is an integral aspect of the research and the researcher's biases must be explored in order to understand the research. The researcher in this study is not part of the environment being studied. Further, prior to the study, the researcher had no contact with The Organization or any member of HHS. The researcher is not a healthcare provider, as such she has never used health informatics technologies. Glaser & Strauss (1967) state that researchers must acknowledge potential biases prior to research as to prevent these biases from affecting the study. A potential bias may occur as the researcher's healthcare provider uses health informatics technologies and experiencing the successful use of the technology may lead to biases the researcher's perspective when investigating The Organization. Recognizing this bias is critical in conducting neutral case study research.

Chapter 6: Data Analysis

Two sets of data were collected for this project: interviews and HHS internal documents. HHS internal documents can be characterized as non-published white papers and were combined with interview data to ease the flow of analysis results in so far that quotations were used to emphasize major categories. As was explained in the methodology, the data was analyzed using grounded theory procedures, and through this process categories emerged from the data (Glaser & Corbin, 1967). The main categories are structured in the analysis to reflect the steps taken by HHS to integrate health informatics. One hundred and six categories were initially coded in the data and then grouped into four: environmental scanning, integration practices, information sharing and communication with new health informatics, and evaluation. These four categories are further explained through fourteen subcategories and one ancillary category which will be discussed below.

General Findings

The first category, *environmental scanning*, examines HHS' methods for gathering information from multiple environments, and investigating where health informatics improvements can, and or, need to be made. This category is broken up into five subcategories: organizational culture, technological panacea, health informatics leader, employee consultation, and environmental changes. The first three subcategories explore internal environmental factors which may influence mHealth integration at HHS, while the fifth sub-category focuses on influential external conditions. The fourth subcategory, employee consultation, investigates methods used by HHS to consult users on health informatics technologies.

Category two, *integration practices*, looks at the strategies HHS employs to integrate technology into healthcare practices. There are two subcategories: communicating organizational

change and training practices. An ancillary subcategory in this section includes a discussion on information and communication technology space at HHS.

A third category, *information sharing and communication with new health informatics*, emphasizes the distinction found in the process of data collection between information sharing and communication in a healthcare setting. Information sharing focuses on the charting and sharing of health information that would appear in a patient's medical record, while communication refers to discussions between healthcare providers about patient care, but would not appear in a patient's medical record. The second major focus of this category is exploring the communicative affects of mHealth technologies and the benefits and challenges of mobility in the healthcare environment, ergonomic design challenges, and privacy and security considerations.

Finally, the fourth category, *evaluation*, uncovers the methods used by HHS to evaluate training and health informatics integration. Within this category, indicators of success used by HHS will be discussed. The two subcategories explored in this section are project and training evaluation measures

Category 1: Scanning the Environment

According to Drucker (1993) healthcare organizations are the most difficult to manage and lead. The complexity of coordinating various professions, patients, and most importantly in Canada, the government, explains Golden (2006), requires constant surveillance of multiple environments by healthcare leaders. The Organization must have an understanding about what is occurring internally as well as externally in order to prepare for potential obstacles when considering a health informatics integration. There are various external sources from which The Organization gathers information about the current state of healthcare, health informatics technologies, and new processes of other healthcare organizations which are similar in terms of

geography, size, and specialty. A key member of HHS leadership Matthew Heath⁴ (personal communication, September 14, 2009) indicates that other teaching hospitals such as those located in London, Toronto, Kingston, and Ottawa, as well as hospitals located in the same Local Health Integration Network (LHIN) as HHS are main information sources. To a lesser extent, journals and conferences are also rich sources of information which assist HHS leaders in understanding and recognizing and understanding changes occurring in healthcare. HHS constantly surveys and evaluates of other health informatics technologies for the affects on healthcare service delivery and their potential fit within The Organization. HHS leaders take this information gained from external sources and uses it to inform internal health informatics strategy.

To be able to make these decisions, leaders must have a firm understanding of the needs and readiness of HHS. According to HHS leaders (Matthew Heath, Tom Paladin, Lina Sussex, personal communications, September 2009) these indicators include: the amount of technological change, employee turnover, openness to change, physical changes, and the availability of resources. These indicators assist HHS leaders in deciding if health informatics technologies should be integrated, if so which ones, and where within The Organization they should be first tried.

Organizational Culture

Culture is an abstract concept that represents the “value system we use to deal with other individuals, the community, authority, and to deal with the world. It manifests itself through our behaviours when we are confronted to other people and to the world” (Demeester, 1999, p.31). In a healthcare organization, as in other organizations, the culture can determine which technology, if any, will fit. Organizational cultures vary, and as such, these unique organizational intricacies

⁴ All names have been changed to protect the identity of the participants. For a complete list of participants and interview length, see Appendix C.

“need to be considered during design and implementation so that the technology is received and used as beneficially intended” (Kaplan & Liteka, 2008, p.404). Looking HHS’ culture, three main characteristics emerged: the changing employee perceptions of health informatics, the idealistic views that technology will solve health problems, and the view that HHS considers itself to be a leader in Canadian health informatics use.

Matthew Heath discusses the evolving employee base as a challenge, “fifteen years ago, staff were not very text savvy, even five years ago I couldn’t get a doctor to talk about technology. Now they all want their iPhones and so things are starting to push the other way...” (personal communication, September 14, 2009). This pendulum shift is a main challenge for The Organization as The Organization itself was not ready for this shift; however, compelled senior management to take notice and invest resources into health informatics technologies. Nonetheless, this shift has created the problem of ‘backdooring’ technology which has negative implications for health informatics integrations at HHS.

The changing employee base is creating a gap as the younger generations are comfortable with technology and are finding new ways to incorporate it in to their work routines ahead of organizational integration. Matthew Heath refers to this as ‘backdooring’ technology where employees use unsanctioned technologies in their work. Lina Sussex supplies an example of technological backdooring, “when you order a USB key, the only kind you get here is an encrypted one, unless you buy one at Staples, and you’re not supposed to be doing that, and there are policies that go along with that” (personal communication, September 16, 2009). These challenges impede an effective integration of health informatics systems as they create security concerns and override other systems put in place by The Organization. Through the process of scanning both the internal and external environments, HHS decides whether or not to bring in a

technology. However, by employees backdooring technology, this process is interrupted and can lead to both a slowing of health informatics integrations as HHS leaders must deal with the backdoored technology. Secondly, The Organization may have to incorporate the contraband technology to appease some employees even though it may not be the most appropriate technology for HHS and may create challenges for future health informatics integrations. Either of these scenarios affect the integration of health informatics technologies, however, the backdooring of technology alludes to the fact that HHS employees see the intrinsic value of technology to improve their work routines. Further, this perception is consistent with The Organization's view of technology as a panacea for healthcare inefficiencies.

Technological Panacea

A panacea is defined as a cure-all for problems and challenges (Soanes, 2001). A technological panacea is defined as the thought that challenges can be overcome directly and, to a large extent, through the integration of technology (Kimmel & Deek, 1995). Organizational documents and interviews with HHS leaders have illustrated a bias towards the view that technology is a panacea for many issues surrounding healthcare service delivery at HHS:

It is well recognized and supported by research that the use of information technologies can have a significant role in helping to address these healthcare trends and challenges and to help to improve efficiencies, enhance patient safety, and enable providers, patients, and the community to make more informed health decisions. (Hamilton Health Sciences, 2006, p.6)

This quotation hints at the characterization of HHS as a forward-thinking organization because The Organization focuses on trends and helps curb these challenges through the use of health informatics. That being said, emphasis on technological solutions may push HHS leaders towards health informatics and as a result may disregard other solutions to solve organizational issues. HHS considers itself to be a leader in health informatics, and the pressure to constantly be

innovative may also cause predisposition towards technological solutions.

Leader in Health Informatics

Health informatics is relatively new, and therefore, best practices have not been fully researched by the academic community. Consequently, healthcare organizations are turning to each other for assistance and advice in integrating health informatics technologies. Organizations such as HHS who invest in health informatics are seen as leaders in the field, and thus are repeatedly looked to for advice regarding new technologies and effective integration practices. “Hamilton Health Sciences is playing an important supporting role when it comes to improving the continuum of care across the region by helping smaller health care organizations” (Hamilton Health Sciences, September 2008, p.4). HHS, as a self-professed leader in the health informatics field, is looked to by other healthcare organizations for guidance with regards to innovative health informatics technologies:

Back around 2001 and 2002, just after I got here, nobody knew of work here, it was all about Toronto and we never set out to change that, we just started plugging along. All of a sudden, I get all these venders coming out, saying, ‘Matthew, tell me what you’re doing up there, I was down south and they heard Matthew was doing something, so you better get up there and find out’. (Matthew Heath, personal communication, September 14, 2009)

Receiving such attention places pressure on The Organization to constantly improve and be innovative. HHS won MEDSEEK’s 2009 eHealth Excellence Award “...for the exceptional efforts it [HHS] has made to provide safe, high quality care as well as provide a total user experience throughout the entire health care system,’ said Peter Kuhn, MEDSEEK’s Chief Operating Officer” (Hamilton Health Sciences, April 2009a, p.1). Industry acclimation boosts morale and reaffirms to The Organization that health informatics integrations are making positive changes. Also, it demonstrates to The Organization that they are role models in the healthcare field, which inevitably leads to certain pressures to continue to innovate.

Failing to incorporate health informatics into the practices at The Organization would affect the role of HHS as a teaching hospital. As Matthew Heath explains, there are certain expectations placed on The Organization to be innovative:

As an academic teaching hospital, how many more years before people aren't going to want to come and learn here because they don't want to be doing it the old way? They want to be able to communicate fast, they want to instant message their colleague down the hall, they want to be able to document online, and do it once, and only once. (personal communication, September 14, 2009)

Integrating health informatics technologies are necessary for HHS to uphold its status as a leader and educator in healthcare. The above excerpt highlights the importance of streamlining communication through the use of health informatics and how creating efficient means of communication is imperative to HHS' status as an innovator.

HHS' status as a teaching hospital and an award winning organization for health informatics technologies contributes to the expectation for HHS to be innovative. This pressure influences decisions to integrate health informatics and the extent to which these new technologies are used within HHS in that The Organization is bound to innovate due to expectations by a host of external parties including future employees. HHS' culture influences decisions, however it only illuminates organizational readiness, technological perceptions, pressures, and expectations of organizational innovativeness, it does not assist in deciding which technologies to be integrated. According to Burke and Chidambaram (1999), the decision of which technology to integrate must come from the users, thus employee consultation is a critical aspect of environmental scanning.

Employee Consultation

Managing the information flooding in from various sources is a large task, and it involves gauging organizational readiness and which, if any, health informatics technologies would

provide the most positive impact on The Organization. This involves a strong communicative focus within The Organization allowing the voices of the employees (users of the technology) to be heard, “we try and keep an ear out for what people [HHS employees] are clamoring for. We do have what’s called an “Opportunity Request” and it’s an online form that people can fill out saying that they’d like to implement a new technology, or upgrade another technology” (Matthew Heath, personal communication, September 14, 2009). This illustrates one tactic used to understand employee readiness and the extent to which technology is being requested within HHS. This approach appears to be passive in that employees have to request health informatics technologies, rather than HHS leaders actively surveying the environment, assessing needs, and measuring readiness. One participant reported that “when you are making decisions for a critical care unit, where 90% of the users are nurses, or the respiratory therapist, those are the people you need to go and talk to and see what works for them, and the other people can adapt around that” (Gina Danby, personal communication, November 17, 2009). Employee consultation should be an active process in which the potential users are involved in choosing the technology to be integrated.

Burke and Chidambaram (1999) discuss the importance of empowerment and ownership in implementing new technology. HHS employs this strategy as Tom Paladin describes that, “if they [employees] feel like they are owning it, and they’re driving it a little bit, then they are way better at taking the message out. They become champions, they become super users” (personal communication, September 15, 2009). Tom Paladin expands on Burke and Chidambaram in stating that effective communication with and buy-in from employees assists in the integration of health informatics technologies and the positive perceptions of these technologies.

Employee consultation at HHS occurs simultaneously with environmental scanning

processes. Employees “were invited to go down to a room and tour around to see which devices they liked and then they evaluated them. It was from that device fair that they [Information Technology and Clinical Informatics Departments] actually picked what was coming in” (Gina Danby, personal communication, November 17, 2009). This event, in coordination with ongoing “Opportunity Requests” suggests an ineffective employee consultation process:

The problem with that was they didn’t have clinical people come down, everybody was invited to go, but when you’re working at the bedside and you’re busy, and you don’t even have time to have lunch. These are not the people who are going down to fiddle around with devices for an hour. (Gina Danby, personal communication, November 17, 2009)

This demonstrates a missed opportunity by HHS leaders to effectively assess user needs as one participant explains, “I don’t think it does anybody any good to have a thousand surgeons pick a device that the nurse is going to be the one to use for the next 12 hours” (Gina Danby, personal communication, November 17, 2009). Further, the environment in which the potential technologies were evaluated did not effectively reflect the circumstances in which they would be used in the PCCU. One participant explains how the discrepancy affected the use of the technology once integrated:

There was a day where they had a bunch of different companies come in and show us their tablets and things. We got to try them up, pick them up, type stuff into them and then there was an evaluation part at the end where you evaluated each one, so I did that...But now that I use it I don’t like it. (Anna Crest, personal communication, November 17, 2009)

Inadequate consultation processes affect the ability of The Organization to choose the most appropriate technology, which can result in employees non-use of the technology. Further, another participant stated that a critical communication gap is apparent in the consultation process as there is a lack of clinical input in deciding on the health informatics technology to integrate:

I think many times there were decisions made by the information technology (IT) camp that were independent of what our needs in the PCCU were. The IT camp doesn't necessarily seek feedback from us that might be helpful in helping them to make decisions on what the best product is for us. (Amanda Nichol, personal communication, November 17, 2009)

These concerns by employees, demonstrate a problem in the consultation processes. Alarming is that these processes occur at the beginning of the integration and alludes to potential problems in the future when integrating these technologies. Understanding the internal environment, specifically organizational culture, is a crucial aspect in choosing pilot sites, ultimately affecting the future success of the application in The Organization (Tom Paladin, personal communication, September 15, 2009). While employees were asked for their opinion, measures taken by HHS were passive and informed by unsuitable individuals, namely those who were not the users. This indicates that there is a miscommunication between HHS leaders and users and that this miscommunication continues further in the implementation process and results in many challenges.

Environmental Challenges

The Organization notes two main external challenges in integrating health informatics technologies including: the lack of resources from the government, compounded by the rapidity with which previous health informatics technologies become obsolete. Pressures from external forces and the government to improve technology are illustrated in HHS' strategic plan, Vision 2010 where it is stated that "financial struggles will continue as the government continues to reform healthcare and adjust to changes in demographics" (Hamilton Health Sciences, 2006, p.5). This illustrates the need for HHS to survey the external environment to anticipate future challenges, evaluate these repercussions for HHS, and research potential solutions.

The Canadian and Ontario governments have created agencies, eHealth Ontario and

Canada Health Infoway, to function as resources to assist healthcare organizations plan health informatics integrations. Vision 2010 states that, “the advent of LHIN4 and its eHealth strategy as well as the provincial and federal projects to move to an eHealth landscape will all have a profound impact on our ability to guide ourselves and define our investments” (Hamilton Health Sciences, 2006, pg. 3). That being said, at no point was eHealth Ontario noted as a potential source of information or an aid in integrating technology. Interestingly, Matthew Heath (personal communication, September 14, 2009) notes that the money invested into Canadian Health Infoway has largely gone to consultant work and has not resulted in any significant progress at the organizational level. As an aside, during the data collection process eHealth Ontario was being heavily criticized for its lack of results, and a scathing audit was released discussing eHealth’s failures and the wasting of billions of taxpayer dollars. Heath’s assessment of the inefficiencies at eHealth Ontario concurs with McCarter’s (2009) findings which were outlined earlier in this paper.

Financing health informatics is the sole responsibility of the health organization, as little to no funding is acquired from eHealth Ontario or Canada Health Infoway. Matthew Heath compares the healthcare sectors’ investment in technology to the financial industry:

Some banks were investing up to upwards of 18% of their operating budget.... Health care is investing around 2%. And that is where there was hope that Canada Health Infoway and some of these other things [eHealth Ontario] would. Like that’s what those big pockets of money were for, a lot of that has gone to consultants to this point, it hasn’t really gone to really funding a fundamental change of doing things. (personal communication, September 14, 2009)

These differences illustrate how critical government financial support is to improve health informatics use and highlights how the effective allocation of resources, is imperative to the success of health informatics integrations.

One of the factors that influenced HHS senior management’s decision to prioritize health

informatics is the astounding rate of deaths caused by medical errors. As Tom Paladin explains:

The Ross Baker Study looked at adverse events, and it found that between ten and twenty thousand people a year were dying in hospitals from mistakes. These are what we call preventable mistakes in hospitals. HHS paid attention to that right at the beginning and bought into the fact that we needed to pay attention to the basics of what we're doing. We don't need to do new things, we didn't need to do more things, we just needed to do what we're doing better. (Tom Paladin, personal communication, September 15, 2009)

This findings illustrates HHS' focus on health informatics in assisting healthcare providers to complete their daily tasks both efficiently and effectively. External reports, such as Baker, Norton, Flintoft, Blais, Brown, Cox, et al.'s (2004) findings of adverse medical events influences priorities within The Organization and refocuses investment to address such concerns.

An avalanche of demographic changes in the Canadian population is threatening the structure of the healthcare system. By 2031, 28.6% of the Canadian population will be over sixty-years old (Romanow, 2002) and as a result, HHS leaders are anticipating an increased demand for healthcare services. Efficient healthcare service delivery is a critical component in overcoming the challenges of an aging population, record government deficits, and labour shortages. Health informatics is viewed as a way by both HHS and Canadian scholars to improve efficiency (Alvarez, 2002; Romanow, 2002). Effective environmental scanning is critical to the recognition of these challenges, surveying potential health informatics solutions, and assessing organizational readiness for these solutions. HHS' external scanning processes are thorough, however internal measures, such as employee consultation, could be more active.

Category II: Integration Practices

Integrating health informatics technologies requires the coordination of several individuals within The Organization including: the Clinical Informatics and Information Technology departments, managers, HHS leaders, and most importantly the users. After a

particular technology is decided upon, employees are notified about the new technology being integrated followed by training sessions about the incoming technology. Communication and training are vital to the integration process and are the focus of this category. Communication is separated into two components, first communicating organizational change, and second HHS leader and user communication. Lastly training procedures at HHS will be explored, while the final category will address training evaluation measures.

Communicating Organizational Change

For an organization as large as HHS, communicating with employees is a challenge for two reasons. First is the size, and second is number of the diverse professions working within The Organization. As Tom Paladin describes, the size of The Organization is so large that communication with employees is referred to as marketing “because there are ten thousand employees here and there are fourteen hundred doctors, there is no way to get to each of them separately and so we have to blitz them with a whole array of channels” (Tom Paladin, personal communication, September 15, 2009). Marketing tactics are used to communicate with employees about changes, and includes the use of The Insider, an internal newsletter released quarterly highlighting events at HHS. This tool is one of the channels used by HHS to inform employees about changes. Participants reported that they then learn about technological implementations through emails from managers, flyers posted in the break room, and through discussions with clinical managers (Teresa Newcastle, Christina Broadview, Terry Brunswick, personal communications, November 17, 2009). These tools help communicate change, however, more detailed information about health informatics integrations require a more strategic approach which incorporates the resources of the Clinical Informatics department.

To overcome the challenge of the diverse professional roles within HHS, The

Organization has recently created a department, Clinical Informatics, whose main role is to communicate with employees about incoming technologies. Matthew Heath describes the need for and role of the department:

Eighteen months ago, we created a new department called Clinical Informatics. All of the people in that department are professionals, not IT people, but nurses, RTs [Respiratory Therapists], and diagnostic imagists. They understand what is going on the floor and they work with IT to learn the technology to become the bridge between clinicians and IT. Clinicians on the floor tend to trust them more, because they say, 'well you are in our end, so you obviously know what I'm going through, and you've come out of the Emergency Department and so obviously you know what the challenges are and our unique environment'. (personal communication, September 14, 2009)

This unique and powerful tool being used to communicate organizational change is important in the healthcare environment due to the variety of professional and employee roles. While Matthew Heath jokes that "doctors only listen to doctors" (personal communication, September 14, 2009), it illustrates the influence of subcultures within HHS where similar professionals form cliques between members of their respective professions. Thus, a strategic communication plan is required when The Organization is integrating health informatics technologies. Tom Paladin describes the methods used to overcome the challenge of communicating with employees:

We have to go to all the places where they are. With physicians, we will send them an email, but not all doctors read emails, so the email has to come from the right person for them to pay attention to it, usually something from their boss, the chief of staff. (personal communication, September 15, 2009)

Balancing the communication characteristics and needs of users is an immense endeavour with an organization as large and as diverse as HHS and requires additional human resources. As participants report that communication gaps between themselves and HHS leaders are still creating issues in the integration of health informatics.

HHS leaders emphasize that two-way communication between users and leaders is critical to the effective integration of health informatics technologies:

What we do is we go in and we try to get at them as early as possible and help them understand why we are doing it, and where we're going and help them be a part of it. Listening, every time they complain, we listen, and we say, 'ok what can we change and improve because of that complaint'. We try to hear all that stuff. That is really important. (Tom Paladin, personal communication, September 15, 2009)

However, participants reported that “information, is not always shared back and forth between the two camps, that’s the clinical camp and IT camp, as well as it could be” (Amanda Nichol, personal communication, November 17, 2009). These contradicting statements illustrate the gaps and misunderstandings inherent in implementing new technologies at HHS. It appears that leaders think they are communicating and consulting effectively while the users feel they are disregarded and ignored. Further into the integration process, one participant highlights that calls for system changes appear to go unheard, “I think that they [information technology & clinical informatics departments] think that they executed it really well, they educated their system and we were telling them that it doesn’t work and that there were so many huge problems” (Gina Danby, personal communication, November 17, 2009). In other words, there appears to be disconnect in communication between leaders and employees resulting in the employees perceiving that the system does not address their needs.

These communication issues are continuing to influence the effectiveness of mHealth integrations. While some issues have been recognized by HHS leading The Organization to invest in a solution, the development of a Clinical Informatics department, other communication issues still arise. HHS recognized the importance of improving internal communication and invested financial and human resources to ameliorate communication deficiencies. That being said, there are still areas in which to improve communication.

Health Informatics Training

Training resources have evolved at HHS along with technological advances and the changing employee demographic. When HHS started to introduce electronic documentation and other health informatics technologies, the training needs of the employees were quite different. Lina Sussex explains that “when you move from paper charting to online documentation, you need keyboarding skills, and you need mouse skills” (personal communication, September 16, 2009). As a more computer literate generation of healthcare providers enter the workforce there is less of a focus on these basic computing skills, thus allowing for a prolonged focus on the use of sophisticated electronic systems.

The training on the tablets in the PCCU were broken into “four, four hour sessions and one of the sessions was the technology where they got to actually play around with the tablet and the laptop” (Gina Danby, personal communication, November 17, 2009). The amount of training a user received depended on the employees’ role within the organization. For example, a physician received minimal (Amanda Nichol, personal communication, November 17, 2009). Training sessions included “process and practice changes along with the technology application in clinical settings” (Marisa Pinto, personal communication, November 17, 2009). In other words, training focused on work routine changes, processes required to navigate the system, and a small section on kinesthetic learning.

Participant descriptions of the training sessions varied from stating that they were complicated, to a lack of time devoted to physical interaction with technology. Terry Brunswick describes the training sessions, “you definitely learn the theory behind the tablet. But it’s like anything, you show up to the class, unless you’re hyper-intelligent, you’re not going to remember everything the next day and everything you learned... mostly, it comes with practice” (Terry

Brunswick, personal communication, November 17, 2009). One nurse commented that, “The guy was trying to teach us something, and he was not very effective in his teaching, somehow I just didn’t get it” (Teresa Newcastle, personal communication, November 17, 2009). There appears to be two main problems in the training procedures at HHS. First, there is not enough practical application, and second, the teaching itself is ineffective. One may say that these problems can be attributed not to training procedures per se, but to varying personal needs. Vishwanath, Brodsky, Shaha, Leonard, and Cimino (2009) suggest that training should be designed and delivered based on the personality of the individual trainee. It appears that the “one-size fits all” approach used in mHealth training is not effective as noted by participants. Inadequate training affects the ability of the user to integrate the technology into their work routines.

In addition to learning how to use the technology, employees are educated on the privacy and security changes that accompany the new technologies. Lina Sussex (personal communication, September 16, 2009) explains that privacy education is a multi-pronged approach and is constantly evolving alongside information and communication technologies. The data demonstrates that HHS recognizes the importance of training, however, the extent to which training is evaluated will be discussed in category four.

Ancillary Subcategory: Information and Technology Space at HHS

Health informatics is a priority within HHS, as witnessed by the financial and human resources devoted to the integration of such technologies. Two years ago HHS revamped a space which is now devoted to the Information Technology and Clinical Informatics departments. The new workspace is “a centralized high-tech hub for the entire HHS organization... At a cost of approximately \$1.5 million, the new facility has been built and designed to inspire collaboration and innovation” (Hamilton Health Sciences, October 2008b, p.4). This space, which is equipped

with the latest hardware, and design technology, is at the centre of health informatics improvements at HHS and facilitates collaboration between the two departments.



The large, open concept space is separated into three main areas first on the left are offices for Information Technology and Clinical Informatics managers, as well as large conference areas. The center area, which is focused on in the picture⁵, are the cubicles of system designers, clinical informatics staff, and other employees involved in health informatics integration. On the right side are desks for vendors and other external support working at HHS temporarily, usually not longer than one-week periods of stay. Cubicle wall heights are lowered to allow for easier communication between colleagues. The grouping of four cubicles, called a pod, have a rollout table which can be combined to create a communal desk in the centre of the pod used for group meetings or when collaborating on a project. The design of this space exemplifies HHS' commitment to health informatics, as well as the importance of collaboration in the development of a health informatics integration.

This space is critical to the recognition of the importance of health informatics within the organization, "We've taken a big leap forward you know, 18 months ago, when we opened the offices we're in. This was designed as an innovation centre geared towards trying things out" (Matthew Heath, personal communication, September 14, 2009). This type of pilot testing within The Organization facilitates a more effective integration of technology. It does so by ironing out any mistakes or flaws within the system before introducing the technology to the users. However,

⁵ Picture (Hamilton Health Sciences, October 2008, p 4)

the system design and testing is relegated to the Information Technology department and does not include any user input. This can be seen as a flaw in the design of health informatics as researchers (Aarts, Peel & Wright, 1998; Kaplan, 2001a) emphasize the importance of user input early in the design of the technology. Nonetheless, the information technology space at HHS is an innovative approach to health informatics integrations.

Category III: Information Sharing and Communication Using Health Informatics

The purpose of this study is to understand the extent to which mHealth technology influences communication in a healthcare environment. In the PCCU, several mHealth applications are used, including: tablets, computer on wheels (COWs), and laptops. Physicians use iPhones and remote monitoring through online portals, however, the focus is the use of mHealth at point-of-care, thus only tablets, COWs, and laptops will be included in the analysis. The software on the tablet is the same used on other health informatics technologies which may or may not be mobile. However, the benefits and challenges of the system apply to mHealth technologies and thus must be discussed.

Information Sharing and Communication

Communication between healthcare providers is one of the most important aspects of effective healthcare delivery. Health informatics can be seen as an essential tool in facilitating and enhancing communication (Coiera, 2003). In this case study, mHealth technologies were not used for the purposes of communicating between healthcare providers, rather, they were used for information sharing between healthcare providers. “It doesn’t really help you communicate during a regular working day. Having a tablet, you always have the information in the palm of your hand” (Terry Brunswick, personal communication, November 17, 2009). The difference, although slight, is the fact that information sharing focuses on information directly logged in a

patient's medical record, while communication is information shared outside of the confines of a patient's medical record. mHealth technologies in the PCCU are not used for communicative purposes as the system itself is not adequately built to allow for such communication events:

You can go to a nursing notes section and you can type in a note, the problem is, once you close your notes, it goes into the system, so when I look at the flow sheet, I have no way of knowing that a note has been written. So unless I'm looking for something, I don't know that its there. (Gina Danby, personal communication, November 17, 2009)

As the system is not capable of effectively communicating messages outside of the confines of a patient's medical record, these functions are rarely used, "It limits your options as far as descriptions and you can't make a patient note" (Terry Brunswick, personal communication, November 17, 2009). Further, accessing information about a patient through mHealth technologies were inhibited or slow:

If I truly need a result on a lab, on a radiologic exam or from a consultation, if I want that done quickly, I just call the lab, or call radiology, or call the radiologist or call the consultant. The electronic form is a form of communication, it's a slow one...there are faster avenues of communication. (Amanda Nichol, personal communication, November 17, 2009)

These communication concerns explain a main reason as to why mHealth technologies are not used in that capacity on the PCCU floor, and face-to-face communication was favoured over electronic communication. As Christina Broadview noted, "I prefer doing things verbally if I can, over the phone or face to face, that's getting the information quickly whereas email is a little bit slower" (personal communication, November 17, 2009). This could be due to a number of reasons, such as the small unit, the lack of email users, and receiver technological preference. Nonetheless, it is interesting to note that in the healthcare environment, speed and accuracy of information is of utmost concern. In the PCCU, communication through mHealth technology is

not used mainly for these reasons. However, these technologies are used to share information at point-of-care.

Information sharing through mobile devices at point-of-care is a direct result of the electronic health record (EHR): “I am faster at doing it [finding information]... and in the end, it is more convenient, when you’re looking up information” (Anna Crest, personal communication, November 17, 2009). Healthcare providers expressed varying opinions about the benefits and challenges of information sharing through mHealth technologies. Benefits included an improvement in legibility of provider notes, ease of information retrieval, and computer initiated documentation of vital signs. Information via electronic documentation is easier to retrieve at point-of-care:

To have a computer at the bedside is wonderful. You can pull up all of your labs, you have access to Internet if there is anything that you want to look up. You have access to everything in the hospital, all your lab reports, your chest x-rays, it’s just one touch and they are there. They are phenomenal. I love the computers, and I couldn’t imagine not having them. (Gina Danby, personal communication, November 17, 2009)

Benefits were illustrated through comparisons with old information sharing procedures as in the past “you get holes, it’s not black and white... so the nice thing about [electronic] notes is that you get more information” (Terry Brunswick, personal communication, November 17, 2009). Other providers discussed benefits of having information documented electronically through electronic vital signs, “I do like pulling your numbers from your monitor to the computer that way, sometimes you’re busy and you don’t get a chance to write them down, you don’t have to worry, you can go back and they are all right there” (Kirsti Maki, personal communication, November 17, 2009). These benefits of information sharing through mHealth technologies highlight how accessing information is easier, below work routine benefits are explored.

Furthermore, interviewees expressed direct work routine benefits of having mobile

information, “If we need to look up anything, or show the doctor anything, I will also use it to search the databases that are online for us, and applications to help us look up medications, policies and procedures” (Christina Broadview, personal communication, November 17, 2009). Information access seems to be at the root of healthcare providers’ optimism towards mHealth technology both in the accessibility and convenience afforded by mHealth to access information and the ability to input information at the point-of-care, “I’ve used it as a prime mode of getting results from the lab” (Amanda Nichol, personal communication, November 17, 2009).

Interestingly, one participant reported that although there were technical impediments with the tablets, the mobile benefits gained outweighed those hindrances, “I do like the mobility aspect of it, that’s one of the reasons I prefer using the tablet, even though it’s not superfast. It’s that I can bring it in to a patient’s room, walk right up to the side of the bed, sit down or stand there and record” (Terry Brunswick, personal communication, November 17, 2009). Information at the bedside assists healthcare providers in accessing and inputting information at point-of-care.

Issues associated with the design of the system include increased time to finish simple tasks. Healthcare providers reported that system designers were not “considerate of the time commitment that is required to actually enter the data” (Teresa Newcastle, personal communication, November 17, 2009), and as a result, providers do not use mHealth technologies often. Further, a common issue with technology is unreliability in regards to unpredictable computer crashes, unwanted deletions, and lost information. Healthcare providers in the PCCU, mHealth users, expressed the following concerns, “when your computer crashes, it would crash or kick us out in the middle of doing something, and it kicks you out” (Kirsti Maki, personal communication, November 17, 2009):

I think it’s far too many steps to get your visual flow sheet up. I like to have it up right when I’m talking and giving a report, but you know you have to enter each

time and it's fifteen different steps and finally you have your visual flow sheet in front of you. People, I think, aren't even bothering because it's so time consuming. (Teresa Newcastle, personal communication, November 17, 2009)

Sometimes the computers are down and it's hard to input information, sometimes there are no spots to input what you want to put. For example, for gastric residuals, they didn't have anything anywhere to document it. Yesterday I had an insulin infusion and I had it at 3 decimal points and I couldn't document it, because it only allowed you to put in 2 decimal points, so I couldn't actually document what the actual infusion was. So there have been a lot of things like that that come up a lot where you can't actually document accurately and you have to call IT and they have to either change the program or tell you some way to document this is what is actually happening, and I find that you're writing a lot of extra notes. (Anna Crest, personal communication, November 17, 2009)

The inefficiencies and inaccuracies associated with inputting information on mHealth devices contribute to the lack of use of the technologies by most participants. However, most alarming are the potential sources of error within the system. Amanda Nichol explains a current problem with electronic documentation:

There are limitations within the current electronic medical record that we use, so for example, getting back to fluids, when the nurses input new information about fluids, they only have a choice of say 15 different IV fluids, and if I have happened to order a 16th fluid, that's not part of that stocked database, then there is difficulty in how do I identify that fluid at hand and it may just get charted as an 'other'. In that situation, I don't know what's running. Or it might get incorrectly charted, which has happened a number of times, it was just, somebody says, oh well it's not a choice, so I'll just pick this one. And so, an incorrect fluid was actually perpetuated in a patient's chart. So the nurse knew that it was this fluid that was hanging, but anyone else looking after this patient, might think that this fluid is hanging and make decisions based on what's in the electronic medical chart. So because there's not 100% accuracy in an electronic medical chart, it is a potential source of error when we're relying on that information to subsequently manage a patient. (Amanda Nichol, personal communication, November 17, 2009)

These limitations impede the effective use of mHealth technologies and safe delivery of healthcare services in the PCCU, and indicates a lack of trust in the overall electronic documentation system. Sinnott, Stell, and Ajayi (2006) suggest that trust must be established between the healthcare providers and the technology in order for the effective use of the

technology. As illustrated above, if healthcare providers do not trust the information they are receiving, the use of the system will be hindered as supplementary information seeking measures are required to adjunct the information received through the electronic system, thus negating the purpose of integrating mHealth technologies. Integrating an electronic information system in a healthcare environment is an intricate process of incorporating speed, accuracy and completeness of information to ensure the effective use of the system. In the PCCU, participants report that not all three components are incorporated effectively in mHealth technologies as the participants discuss the supplementary communication channels used to augment information gathered from the information system.

As will be explored below, the privacy and security measures implemented at HHS also contribute to these inefficiencies.

Privacy and Security

Privacy and security issues add to the communication and information sharing inefficiencies with mHealth technologies in the PCCU. Privacy policies are important for the safety of patients, and The Organization has realized the importance of privacy and security as is illustrated by the elevation of resources for the privacy office. The additional resource allocation privacy concerns has stemmed from The Organization “moving into the realm of documenting more online and eliminating a lot of our paper based health information, and with that comes a problem of in terms of who can see the information and how much they can see” (Lina Sussex, personal communication, November 17, 2009). These considerations are critical in developing a system and integrating mHealth technologies. mHealth technologies pose a different concern than earlier health informatics devices as mHealth technologies are mobile and can be lost or misplaced. Systems put in place to protect health information on mobile devices include: laptop

encryption, password protected personal digital assistants, and a firewall protected virtual private network (Lina Sussex, personal communication, September 16, 2009). However, these extra privacy and security procedures tend to create inefficiencies in entering information as several participants state, “just logging in for instance, takes forever” (Terry Brunswick, personal communication, November 17, 2009) and “it logs you off so quickly” (Teresa Newcastle, personal communication, November 17, 2009). Other participants have discovered solutions to overcome these concerns, “it’s more cumbersome to go into the computer every time you do something, so I find if I can just do it every four hours or every two hours going in and to update my charting” (Christina Broadview, personal communication, November 17, 2009). These concerns are legally necessary for the security of patient health information and although may be inefficient for healthcare providers, HHS is bound by law to integrate such measures.

Mobility

In a healthcare environment, healthcare providers rarely work alone at a desk; therefore information must be able to move with the provider, in fact “experience to date shows that mobile technology can be used to provide the right information at the right time and in the right place, reduce the time that is spent searching for information and more time providing patient care” (Hamilton Health Sciences, 2006, p.13). Accordingly, mobile health has become a priority within HHS to improve information access and interprofessional communication at point-of-care. This priority is communicated to employees:

The expansion of the wireless network within Hamilton Health Sciences will enable physicians to use ClinicalConnect on personal digital assistants (PDAs), giving them access to all available patient information while they are present with a patient. reducing the wait time for results, increasing patient satisfaction and patient safety. (Hamilton Health Sciences, October 2007b, p.4)

These benefits of mHealth technology illustrate the importance of moving information entering to point-of-care. Matthew Heath comments, “We do a lot of technological integrations in the areas of diagnostic imaging and the lab, but when you look at what our bread and butter is, which is at the bedside, we have done very little” (personal communication, September 14, 2009). This illustrates recognition of the importance of point-of-care information access, resulting in a shift in the priorities of health informatics integration at HHS. This priority is brought to fruition through the introduction of mHealth technologies in the PCCU.

The mobility of information affords healthcare professionals flexibility in where information can be entered into a patient’s medical record. Lina Sussex (personal communication, September 16, 2009) explains that since the introduction of mHealth technologies, the number of incomplete medical records is substantially lower. Further, areas within The Organization where healthcare providers previously congregated to enter data are no longer needed because they can input information from anywhere there is Internet access (Lina Sussex, personal communication, September 16, 2009). This illustrates the changes to a healthcare provider’s work routine, as well as indirect organizational benefits from mHealth technologies.

Ergonomic Design Challenges

With mHealth, the physicality of the technology is important in its use. Participants articulated some of the concerns of mHealth technologies, including: sensitive inputting devices, the device’s weight and size, and its small screen:

It was very sensitive the pen touching, it would take a number of times to get it to work, it wouldn’t do what I was trying to get it to do. That was the main thing, I haven’t used it in a long time. I’ve avoided it at all costs. I need a mouse. It might have been the pen touch that was the main thing I didn’t like. (Kirsti Maki, personal communication, November 17, 2009)

It's large, I find I need to sit down with it. I mean I'm a big guy. I don't know how much it weighs, three pounds maybe, but having it on my forearm after you've done that five times throughout the day, walking around to every bedside, you are starting to notice it. (Terry Brunswick, personal communication, November 17, 2009)

You can't use them to write on, or they are far too time consuming, the little squares with the letters on the keyboard are far too small and someone like me with shaky hands, it's just a waste of time. (Teresa Newcastle, personal communication, November 17, 2009)

Cumbersome to hold, especially because you're writing with one hand, so you're always going to have to hold it with that one arm and it often gets tired, they are not easy to rest anywhere. They are not a nice rounded shape so that you can you know rest it on your hip or hold it against your arm its very square and like sharp edges, so is just uncomfortable that way. (Christina Broadview, personal communication, November 17, 2009)

Participants reported that the major concern in using a laptop or a COW was the short amount of battery life hinders its mobility because it has to be plugged in (Gina Danby, personal communication, November 17, 2009). Healthcare providers have a quite physical job in which many of the times requires the use of both hands, as such mHealth technologies often got in the way of delivering healthcare services. Unlike other health informatics, mHealth technologies have an added challenge of physicality, which can hinder the use of the devices.

Category III explored the use of mHealth technologies to access, input, and transfer information in the delivery of healthcare services. System capabilities did not allow for effective interprofessional communication between the users and poor ergonomic design prevented users from using the tablets at the bedside. However, the increased access to information and ability to input information eliminated some work routine inefficiencies for users. The next category will look at the measures taken to evaluate both the pilot project in the PCCU and the training received by users.

Category IV. Evaluation

Coiera (2003) postulates that health informatics system design and evaluation are linked processes, and as such should occur concurrently. After the integration of health informatics technologies, an organization must perform an evaluation in order to discover best practices, uncover inefficiencies, and decide if the system should be expanded. As previously discussed, success in the health informatics arena is organizationally defined while failures are often visible through budget overages, poor time management, and non-use of the technology (Kaplan & Harris-Salamone, 2009). The following category is separated into two subcategories project and training evaluation.

Project Evaluation

HHS uses two methods to evaluate its integrations, one quantitative and one qualitative. At HHS the marking of milestones is used to evaluate the progress of an integration quantitatively and qualitatively through user feedback:

We analyze by milestones then we try to get feedback from the day-by-day feedback from people who are implementing the project. Measurements of success are usually laid out in the milestones that we set ...because a lot of the projects depend on other projects being completed, so timelines are pretty tight. (Tom Paladin, personal communication, September 15, 2009)

Timelines, in conjunction with employee feedback, are used to evaluate the extent to which the integration is effective and unearth improvements which need to be made to the system. Looking at the integration from the employees' perspective, through feedback sessions, opinions are heard about the workings of the technology and any required changes; "we will be giving feedback shortly because we feel that the tablets [are not working], so we are getting rid of those and bringing something different in" (Gina Danby, personal communication, November 17, 2009). However, these feedback sessions are conducted at the administrative level, and the healthcare professionals are not directly involved in these feedback sessions; rather, their complaints are

voiced through the clinical administrator of each floor. Feeding the perception that healthcare professionals' concerns are being ignored.

This two-pronged evaluation system is the only evaluation mentioned by any of the participants. This evaluation is used when mHealth technologies are expanded into other HHS units. Resource constraints influence the ability of HHS to first evaluate and second expand the project beyond the pilot, “we usually apply successful strategies to subsequent clinical settings, however sometimes we are challenged by short timelines, or urgencies in implementations or even shortages in clinical staffing resulting in education delay” (Marisa Pinto, personal communication, November 17, 2009). This quotation implies that the milestones used to evaluate the success of health informatics integrations at HHS may be hindering its expansion and overall success. Marisa Pinto emphasizes the extent to which the lack of resources creates issues throughout the process of mHealth technological implementations, and can actually infect the expansion of such technological integrations in regards to less evaluation procedures.

The mHealth project at the PCCU was recently expanded to another site, . “On November 17, electronic clinical documentation was further expanded to include the Diabetes Clinics at MUMC [McMaster University Medical Centre]” (Hamilton Health Sciences, December 2009, p.4). It is not clear in the data collected the extent to which evaluative measures informed this decision to expand the pilot project.

Training Evaluation

Training fluctuates and evolves alongside the needs of employees and the technical requirements of the device (Lina Sussex, personal communication, September 16, 2009). As previously mentioned, when health informatics technologies were first integrated, keyboard and mouse training sessions were imperative, but now those training sessions have subsided as

employees regularly use these tools both at work and at home. Through the data, it is clear that training is a priority in implementing health informatics at HHS. However the measures used to evaluate training is quite limited. Narrow evaluations create issues in understanding The Organization's readiness for current, as well as future, technological integrations. Marisa Pinto (personal communication, November 17, 2009) claims that training sessions always include a formal evaluation process including follow-ups. These evaluations, "help identify further learning needs/gaps should an individual's performance demonstrate a need to have additional sessions or if there is a general staff need to re-enforce learning" (Marisa Pinto, personal communication, November 17, 2009). Although these measures were noted by the main educator and trainer, not one of the healthcare providers participants mentioned the follow-up training sessions when asked to describe training sessions. This insinuates that these evaluation measures are not mandatory or consistent. As a result, there is an inability of HHS to improve training sessions where necessary.

Category IV has explored the extent to which evaluations are conducted of health informatics integrations and training sessions and found that while attempts are made by HHS to assess integrations and training, do not solicit the users' perspectives directly, thus these measures may not adequately reflect the successes and challenges occurring in The Organization. The following advanced analysis and recommendations sections will expand on the major findings explored in the previous four categories as well as incorporate previous literature deductions and theoretical perspectives.

Advanced Analysis

In investigating the communicative affects of mHealth technologies at Hamilton Health Sciences, it was discovered that the findings did not occur in a vacuum but in a complex system with connecting and interrelated parts. This research study has discovered the practices and procedures put in place by HHS to integrate mHealth technology. It has also illuminated the use and perceptions of mHealth technology within The Organization. Through this exploration, as well as an understanding of the literature, the following model was developed. Figure 1 illustrates the procedures, intervening conditions, and pressures involved in the implementation of mHealth technologies. This model was developed from the findings of this study, theoretical perspectives from the literature, and other models aimed at explaining health informatics integrations.

The model illustrated in Figure 1⁶ is an exploration of best integration practices and is meant to assist various organizations in understanding the process by which a technology can be integrated into an organization, as well as illuminating the intervening factors which create obstacles to effective technological integration. Any organization can use the integration model to assist in the planning and integration of technology, not just healthcare organizations.

⁶ The model will be referred to as the integration model for the remainder of the paper

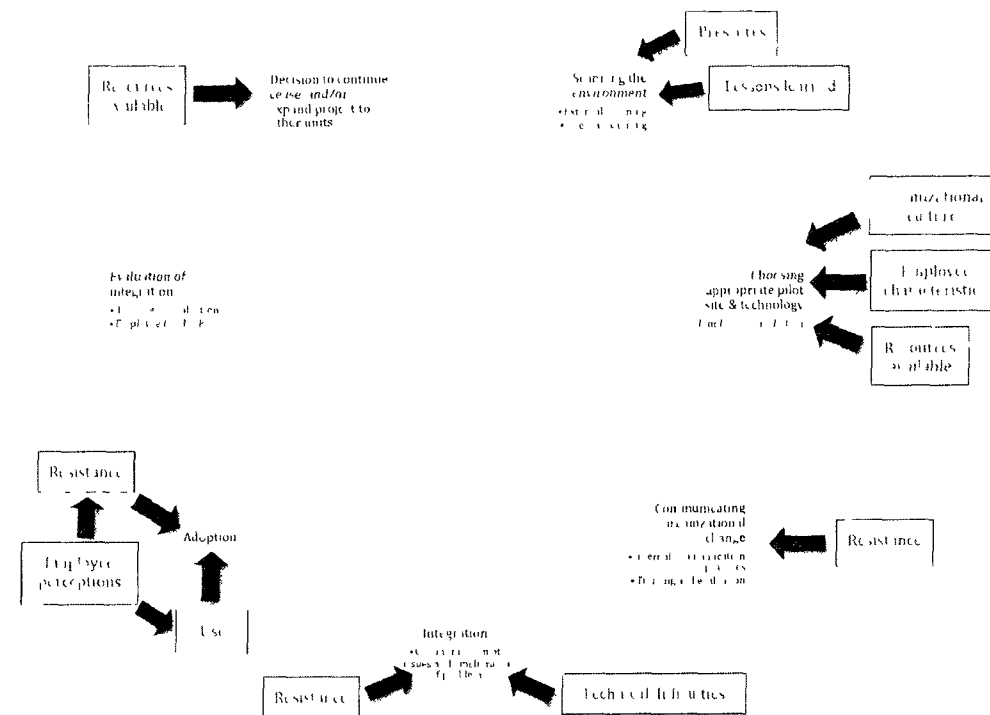


Figure 1: *The Integration Model*

Looking at the model in Figure 1 there are obvious observations such as its cyclical shape, the seven steps in the cycle and twelve intervening conditions affecting each step. The length of time required for each step is not noted as it will vary depending on the size of the organization, the aims of the technological integration, and history of successful technological integrations at the organization. Thus, the model presented in Figure 1 discusses solely the sequence of steps, not the length of time required for each. Further the intervening conditions are represented in external boxes and arrows pointing at the step it influences. These mitigating factors influence the ability of the organization to proceed efficiently and effectively to the next step in the model.

The following advanced analysis will first justify the shape of the integration model, and explain each step of the model, and any intervening conditions of that particular step, starting with the first step “Scanning the Environment”.

Scanning the Environment

Scanning the environment was first described by Aguilar (1967) as the task of searching for information which will help to track the course for an organization’s future. At Hamilton Health Sciences information is gathered in both external and internal environments to explore new and successful technologies as well as assess the viability of these technologies at The Organization. As a leader at HHS explained, “part of my job is to research... and try to get a sense of what is out there, what’s good, what’s not good” (Matthew Heath, personal communication, September 14, 2009). The information gathered is then used in combination with an internal scan of what The Organization itself is ready for. HHS is a teaching hospital, and as was explained by Matthew Heath, this type of healthcare organization is expected to employ the most innovative technologies and practices. The understanding of the expectations of a teaching hospital help influence which technologies are employed, and which ones are passed over. Further, this expectation places certain pressures on The Organization to innovate, and thus is an intervening condition when HHS scans its environments.

Pressures and lessons learned from past integrations influence the integration of a technology. Pressures, such as the expectation of HHS to be innovative because HHS it is a teaching hospital, is only one among several within the Canadian healthcare environment. Vision 2010 outlines pressures which influence the way in which information is not only located, but also influences the directions of The Organization, “key technology trends will also influence our information technology directions...financial struggles will continue as the government continues

to reform healthcare and adjust to changes in demographics” (Hamilton Health Sciences, 2006, p.4-5). These two pressures illustrate the potential of external forces to influence the information gathering process as well as steer the direction of the organization.

A second intervening condition is institutional knowledge gained from past technological integrations. One participant explained, “we’re a little bit limited by decisions we made back then, but always cognizant every time we get an upgrade, what are those things are that we can do better” (Lina Sussex, personal communication, September 16, 2009). This implies that the internal environment, including institutional knowledge of past integrations inform the health informatics direction of The Organization. Further, it demonstrates the value in learning from past decisions to be able to improve future health informatics integrations.

These intervening conditions guide The Organization in deciding if technologies can solve issues, in choosing which technology to implement depending on external pressures, and how to implement it. From this information gathering, a pilot site and an appropriate technology are chosen.

Choosing the Appropriate Technology and Pilot Site

After the decision is made that integrating technology is required and the environments are scanned for information and organizational readiness, The Organization then chooses the technology to integrate, and the pilot site to integrate it. At HHS, the pilot site is chosen first and then these users choose the technology as it is well supported that user participation in early stages enhances user acceptance, encourages realistic user expectations, facilitates user ownership, and decreases resistance (Lorenzi et al., 1997). Fit, as described by Kaplan (2001b) and Aarts, Peel, and Wright (1998), states that the user’s needs and work routines should be the factors when for choosing the appropriate technology. Each unit in a healthcare organization

provides a unique service which requires different technological systems, thus the pilot site must first be chosen and then the users from that site chose the technology. User consultation during this phase is a key tool ensuring that the technology integrated will best suit the needs of the users, as insufficient consultation can deter the success of the integration (Aarts, Peel & Wright; Kaplan; Tsiknakis & Kouroubali, 2009).

The selection of a technology and a pilot site at HHS is a critical decision in the overall success of a technology and is influenced by three factors: the organizational culture, employee characteristics, and resources available. Choosing the correct pilot site is important because the healthcare environment is constantly changing, and the users in the pilot group must be open to change and able to handle potential technical difficulties. The unique culture of the pilot group determines the viability of the technology as the users must see technology as a tool in empowering and enabling their work, otherwise the system will not be used (Lorenzi et al., 1997). One participant explained that HHS tries to “pick places that are comfortable with change and have a reputation with being comfortable with IT and are innovators. Places that aren’t currently overwhelmed with change because picking the right pilot group is very important” (Tom Paladin, personal communication, September 15, 2009). This implies that not only does the culture of the pilot site have to be open to change, but it also has to employ users that are technologically literate and see technological advances as enhancing, not threatening to their work routines. Literature on determining technological readiness from an organizational culture level is quite extensive, and Snyder-Halpern (2001) suggests there are sixty-four characteristics used to determine the readiness of an organization. As such, this level of analysis is outside the scope of the integration model, thus the description of organizational culture in the integration model is simplistic.

As a younger generation is entering the workforce the characteristics of HHS employees are changing. Employees expect technology to be implemented as they recognize that health informatics can improve their work routines and are intrinsic to the delivery of quality healthcare services (Spitzer, 2009). For example, the request for new technology is “coming from health care professionals and its interesting, there wasn’t this request for information technology ten years ago” (Tom Paladin, personal communication, September 15, 2009). In previous integrations, the Information Technology department spent much of the time selling the importance of health informatics to employees and leaders at HHS. However, younger, more computer literate healthcare providers are entering The Organization, and these employees are open to technology and thus push HHS to incorporate new health informatics. The technical knowledge of these employees assists The Organization in choosing more appropriate technologies.

Human and financial resources are important conditions in deciding if, which, and to what extent health informatics technology can be integrated. HHS noted in Vision 2010 that financial resources are required to effectively integrate technology into The Organization and that insufficient investment in the past has led to inadequate integrations, “we have some of the technology partially implemented but further investment is required more importantly in the area of staffing to support the implementation or the workflow changes” (Hamilton Health Sciences, 2006, p.12). Thus the amount of human and financial resources available to The Organization has the potential to influence the choice of technology and where the technology is integrated.

The decisions made in this step of the integration model are the foundation of the technological integration and thus are imperative to the overall success of health informatics

technologies at The Organization. Thus, the most time must be spent on this step as a mistake or wrong decision at this step has implications for every future step in the integration.

Communicating Organizational Change

Once the pilot site and technology have been chosen, the integration must be effectively communicated to affected employees. Communicating innovations is the foundation of the diffusion process as it is “the information exchange by which one individual communicates a new idea to one or several others” (Rogers, 2003, p.18). Through this interaction, innovations are discussed and the diffusion process commences. The recognition of the importance of effective change management and communication resulted in the creation of the Clinical Informatics department within HHS. Clinical informatics at HHS is comprised of healthcare providers whose main role is to communicate technological integrations to other providers. The clinical informatics department at HHS exemplifies Rogers’ (2003) concept of homophily and heterophily. He suggests that the two parties communicating should share a common language, thus the need for a ‘bridge’ between healthcare providers and the information technology department is required. According to Rogers, the degree of homophily between the individuals implementing and using the technology influences the effectiveness of communication. Rogers claims that, “One of the most distinctive problems in the communication of innovations is that the participants are usually quite heterophilous” (p.19). This implies the necessity of a common language or knowledge base between the two groups of individuals in order for diffusion to be effective. Tom Paladin (personal communication, September 15, 2009) explains that the success of the Clinical Informatics department to effectively communicate change is that they speak the same language and have the same concerns.

Training is a critical step in communicating change as it is the first time that the users will see and use the technology. Prior to training, employees may be informed of the changes coming and how it will affect his/her work routines. However, training is when users are first introduced to the technology and its system. In addition to communicating change, the Clinical Informatics department trains healthcare providers on new health informatics integrations. Kirkpatrick (1998) claims that evaluation of training justifies the future use of training, the training department, and investments in the improvement of training resources. The effectiveness of these training sessions is imperative to the eventual use and sustainability of the technology as a result evaluations of these training procedures must be conducted to understand where more education is required in future training sessions.

Resistance is a constant challenge for The Organization because “what we’re asking them to do is to make lots of big changes” (Tom Paladin, personal communication, September 15, 2009). Resistance at this stage of the integration model is due to individuals feeling overwhelmed by change and loss of control over changes they feel affect their work routines (Lorenzi et al., 1997). Although employee consultation in the previous stage of the integration model reduces such resistance, The Organization is large, and as such, there will always be resistance. Education and training sessions must address these concerns in order to reduce resistance and obtain broader support by users for the technological integration.

Communicating organizational change is the last step prior to the integration of health informatics technology within The Organization. This step ends the planning stage of the integration model and in the next step integration of the technology begins.

Integration

Integrating a technology is a multi-step and complex endeavour which requires the commitment of many individuals and resources within The Organization, while the physical act of integrating the technology, called “going live”, only takes a matter of moments after the correct infrastructure is put in place. This step illustrates the small amount of time from first going live to the constant support required in the initial weeks of going live. In the first two weeks of going live employees from the Clinical Informatics department are stationed at the pilot site at all times. These employees are stationed at the site to assist in ameliorating technical difficulties and communicate employee issues to HHS leaders and the Information Technology department.

Just as in the previous step, resistance is an intervening condition which affects the integration of the technology. The same anxieties such as loss of control and being overwhelmed with change, which created resistance in the previous step, continues in this step of the integration model. What is different in this step is that technical difficulties feed into user resistance. Gina Danby (personal communication, November 17, 2009) highlighted that the transition from training and education to going live is not as smooth because of the intricacies of situations not addressed in the training sessions. As a result technical difficulties or situational uncertainties creates resistance which influence the integration of the technology.

Adoption

Adoption of a technology is a complex issue that is outside the scope of this particular research project. In the integration model adoption refers to the use of the technology after the initial integration. Integration and adoption are separated into two steps to differentiate the introduction of the technology and its use after the Information Technology and Clinical Informatics departments at HHS cease constant physical support. Adopting the technology and

using it purposefully in everyday work routines incorporates three intervening conditions including: employee perceptions, resistance, and use.

Kaplan (2001a) suggests that the conversations about technology influences the way the technology is not only viewed, but more importantly how it is used. In other words, social interaction, places importance on the users' conversations about technological integrations which create perceptions about the usefulness of the technology. This type of informal communication frames the technology in a way which influences employee perceptions about health informatics integration. These perceptions do not directly affect adoption but rather fuel resistance to the use of the technology or encourage use of it. As participants highlighted throughout interviews, there will always be resistance to technological integrations, however as employees become more computer literate, are open to technological advances, and there is a deeper understanding of the potential of health informatics, this resistance is subsiding.

Technological adoption is a complex issue but for the purposes of this model illustrates the importance of perceptions and social constructions of technology through discussions about the artefact. Following the adoption of technology the integration must be evaluated for two purposes, first the effectiveness of the technology and the pre-integration training sessions.

Evaluation of Integration

It is well understood that evaluating a technological integration is important in both understanding how to improve practices in the next project as well as ameliorating any issues in the current integration. The success or failure of a technological integration is difficult to determine in a small amount of time. If The Organization is to expand the project to other units, decisions must be made before a longitudinal investigation into the affects of the technology on the overall workings of the users. What can be understood are the immediate benefits and

challenges faced by the users of the technology. Two main evaluations must occur at this stage of the integration model: training re-evaluation, and an evaluation of the immediate benefits and issues perceived with using the technology.

As was discussed in earlier stages of the integration model, training evaluations are important tools in understanding the effectiveness of the training and where more support is required to improve these sessions. An evaluation of the training after the adoption stage allows users to better assess the adequacy of the training and highlight any education gaps noticed in using the technology (Kirkpatrick, 1998). Research suggests that the results of training are best measured after trainees are able to apply the skills and knowledge in their work situations (Kirkpatrick). As a result, pre and post training evaluations are most effective in measuring the changes and illuminating the gaps in trainee knowledge of the new technology.

HHS measures the success of a technological integration through the achievement of pre-determined milestones. While quantitative data is important when integrating a technology and ensuring that it is on time, it does little to understand the employees' perspectives on the effectiveness and usability of the technology in their work routines. During the integration stage, members of the Clinical Informatics department report at a predetermined time every day to update the leaders at HHS and the Information Technology department of the successes and issues with the new technology that day. After the initial going live stage is over and the Clinical Informatics team leaves, there are meetings with managers of the pilot site to discuss successes, challenges, and opportunities for expansion with the newly integrated technology. A mix of qualitative and quantitative evaluation procedures assist in illustrating problems and allowing for an explanation of the quantitative data from the users' perspectives. From this data collected and evaluation conducted, The Organization then decides how to progress on the integration.

Decision

Once these technologies are introduced, research participants highlighted the changes in the way that information is charted using mHealth technologies, including what needs to be documented and when it is put into the patient's file. Sociotechnical approaches "increase our understanding of how information systems or novel electronic communication techniques are developed, introduced, and become a part of social practices" (Berg, Ash, & van der Lei, 2003, p.297). Healthcare organizations are all connected and require information sharing, thus a change in the way that one particular group of healthcare providers share information creates challenges and new communication policies for other providers within HHS. Tom Paladin explains that "measurements of success are usually laid out in milestones because a lot of the projects depend on other projects being completed" (personal communication, September 15, 2009).

Technological integration is constantly evolving and in an interconnected organization, especially a healthcare organization like HHS, changes in one part has repercussions and creates need in other areas. "HHS and ICT in particular has struggled to keep pace with the flood of new project and service requests and the demand for ICT services continues to grow significantly" (Hamilton Health Sciences, 2006, p. 11). Thus, a realistic assessment of organizational resources is required to decide if the integration should continue, cease, and or expand to other units within The Organization.

Assessing technological integrations is not about labeling various technologies as successes or failures, but, as Bijker (2010) suggests, should be focused on understanding the process not the product. If this is to be true, one should not investigate the technology directly but the extent to which technology is perceived by its users. This advanced analysis has given more substance to the findings from the study at HHS by connecting it with sociotechnology theories

as well as previous integration models developed by health informatics researchers. These models, compared with the findings from the research conducted at HHS, have illustrated a more comprehensive demonstration of the intervening conditions as well as the processes that are involved in implementing health informatics technologies. Although this model does not address every single step, concern or intervening condition, the steps and challenges included highlight the aspects found in the case study and those supported by the literature. The following section will connect findings with recommendations that HHS can integrate to improve future health informatics integrations.

Recommendations

Overall, HHS has made efforts to improve its integration practices; most notable is the recent investment in the Clinical Informatics department to become a communication bridge between the users and developers of health informatics technologies. That being said, integrating technology in a healthcare organization can be an intricate process, one that can be constantly improved through research, evaluation, and practice. From this analysis, three main recommendations for The Organization are explored below, including: improving employee consultation procedures, training, and training evaluation practices. In addition, a short discussion on communication problem diagnosis recommendations will be incorporated.

Much like environmental scanning is used to understand what is occurring in other organizations, employee consultation is a tool used to understand which technologies, if any, are most appropriate for users (Rahimi, Timpka, Vimarlund, Uppugunduri, & Svensson, 2009). In deciding which mHealth technology to incorporate into the PCCU, employees were invited to a device fair, tried different devices, and evaluated those devices. Problems this process are, first, that some employees picking the technology were not going to be using the device in their work

routines. Second, insufficient time was afforded to work with the mHealth technologies to make an informed decision.

Improving this process starts with a better understanding of the communicative and information needs of the users and developing a more elaborate employee consultation process in which these needs are explored fully. Participants commented that PCCU is a unique unit because the way in which a patient's information is charted is different from the rest of the hospital as their patients are critically ill children and only abnormal medical events are recorded. Thus regular pre-fabricated options in the electronic documentation system are not well suited for a pediatric critical care unit. A deeper understanding of user needs can be gathered through interviews, focus groups, and, or observation. The healthcare environment is a fast-paced environment, thus information gathering methods may be more fruitful through observation where employees are not removed from their tasks.

Another way to improve employee consultation would be through a more thorough device trial. Participants reported that the device fair held was not opportunistic for the clinicians who would be using the technology. Others reported that through the device fair they chose the tablets that were integrated, but now do not find them appropriate for their work routines. A more practical way to have users choose incoming technology would be to host a smaller showcase in the pilot site and make it available for longer periods of time. This would allow for users to retry devices if necessary and potentially allow more users to try the various devices. Choosing an appropriate technology which fits the needs of the users and empowers them through the consultation process is an important first step in the integration of health informatics technologies and should not be downplayed or rushed.

mHealth technologies employed at HHS although having extra communication functions, were not used by the healthcare providers. Coiera (2003) postulates that healthcare organizations have incorrectly integrated health informatics technologies because the integrations were technologically driven, not problem driven. Problem driven integrations concentrate on understanding a problem within an organization and then researching potential health informatics integrations which could assist in ameliorating the problem. In other words, Coiera encourages a user-centered approach in which the issues facing the user drive the technological integration. Central to this approach is the correct diagnosis of a communication issue, if one exists, through employee consultation. Therefore employee consultation is a multi-step venture that must be conducted in a variety of manners in order to ensure that the correct issue is diagnosed and the appropriate technology is chosen.

Training is an important tool in educating users on how to use the incoming device. In the PCCU, users were trained according to their use of mHealth. There were four sessions, and employees signed up for sessions based on individual availability. Healthcare provider participants commented that the training provided allocated little time to work with the devices, and that the majority of learning occurred once the device went live and participants had to use it daily. This suggests that the training sessions were not tailored to the technical or learning needs of the users. A way in which to rectify this gap in training is to understand how employees learn before the training sessions are developed. Each person has a unique way of learning, and Vishwanath et al. (2009) suggest that training should be designed and delivered based on the personality of the individual trainee. By segmenting training sessions not only by availability, but also by the methods used to teach, and technological literacy level, more employees can be

trained according to their needs. These recommendations for improving training, if incorporated, can only be assessed through formalized evaluations.

Literature suggests that training evaluations are imperative to the improvement of the education process and should be a staple in any training session (Pearson & Brew, 2002). Data from HHS suggests the training evaluations are not thoroughly conducted. Simple measures can be taken to improve evaluation measures at HHS. Marisa Pinto (personal communication, November 17, 2009) states that she conducts a formal evaluation at the end of her training sessions. This suggests that formal evaluations are not mandated, thus, a formal evaluation should be developed and made mandatory at the end of each session. It is important in implementing a formal evaluation that they be used to improve future training sessions through assessments on the material, venue, availability, and instructor. Kirkpatrick (1998) suggests that the results of training are best measured after users are able to use the technology in real work situations. Thus, formalized evaluations must be conducted after the training sessions are completed, and then again after the technology has been integrated.

In addition to training evaluations, the entire integration should be assessed in order to decide if the integration was effective, where improvements can be made, and the appropriateness for expansion. In their model, Aarts, Peel, and Wright (1998) suggest that evaluation is not the end of a cycle but a practice which permeates the entire implementation process. This means that constant evaluations and assessments of what is occurring within The Organization must be conducted in order for a smooth and effective implementation. From the data, it appears as though only timelines and infrequent feedback sessions are used to assess the current state of an integration and to base decisions on. These assessments do not sufficiently paint enough of a picture of the integration process. Improving the evaluation process would be to survey users

throughout the entire integration. One employee from the Clinical Informatics department should oversee these anonymous evaluations as they are a neutral party and are not in a position of power. These surveys should incorporate both quantitative and qualitative questions where the user is asked questions on functionality, use, and technical issues. The holistic evaluation of training and integration processes is a key tool for HHS leaders to understand where resources need to be allocated, improvements need to be focused, and if this health informatics technology can, or should be expanded.

Outcomes

The aforementioned recommendations are based on findings from this case study, previous literature, and theoretical frameworks and serve as potential ways to improve the integration of health informatics at HHS. Potential outcomes that result from integrating these recommendations include: enhanced employee consultation resulting in more informed technology decisions and more rewarding training sessions for employees stemming from improved evaluation. These recommendations can result in a more effective integration of health informatics from an informed decision making process. Overall these recommendations focus on a more user-centered integration where HHS employees are meaningfully involved in the multiple steps required to integrate health informatics technologies.

Limitations

The healthcare environment limited this research in two ways, first, data collection procedures, and second, the ability of the findings to be generalized to the population. As mHealth technology is relatively new, the cases available for study in Ontario were limited. The reasons for choosing Hamilton Health Sciences were previously mentioned, however, it must be noted that there are only a select number of health facilities within Ontario who employ mHealth

technology. Further, within Hamilton Health Sciences, there are two units using mHealth, and only the PCCU has used the technology for a substantial amount of time to allow for the reasonable exploration of changes in communication patterns. Although the number of possible participants was reduced, the data collected from these select participants was rich.

Data collection procedures had to be adjusted throughout the study as the hectic hospital environment and busy schedules of the healthcare providers reduced the availability of the participants. Due to the constant changing needs of the PCCU at McMaster's Children's Hospital, healthcare providers were solicited on a random day when the researcher was on site. Potential interview participants could not be scheduled prior to the interview because of the instability of the PCCU floor. To overcome this challenge, a gatekeeper was used to help obtain willing participants on the day of the interviews. Thus, the sample was confined to the perspectives of healthcare providers working that particular day.

Second, the hectic work schedule of the participants limited the length of the interviews to 15-20 minutes at a maximum. In order to overcome this time constraint, participants were interviewed on the unit floor to cut down on traveling time, and allow for longer interviews. Also, the researcher obtained permission and contact information from the participants to follow up through electronic communication to expand on any responses that required more information.

As the aim of this study was exploratory in nature, and qualitative methods were used, smaller sample sizes are acceptable. However, HHS is a multi-campus health facility with 10,000 employees, thus the perspectives of eleven employees do not necessarily reflect the view of the entire organization. In addition, each of the six HHS sites has unique cultures which again impede the ability of the results to be generalized to HHS as an organization as each culture may affect the results. That being said, the purpose of this study was not generalize the results but to

understand the phenomena more deeply. As such, these limitations are not shortfalls of this study but important factors to consider in future research.

Chapter 7: Conclusion

While interning at a community healthcare organization in Northern Ontario, the researcher began questioning if communication through telemedicine, which was used quite extensively in northern regions, was effective or if there were more appropriate channels for healthcare providers to communicate with healthcare receivers. Through a directed study completed in the researcher's undergraduate program health informatics theories and models were explored to answer these questions. This first exploration into health informatics led the researcher into graduate studies to further investigate the phenomena of technology use to improve health communication. Initial reviews of the literature suggested that the use of health informatics were not unique to northern or rural postal codes and were an opportunity for all healthcare organizations to improve information sharing and communication regardless of geographic locale. As a result, the initial interest in northern areas was revised and an urban healthcare organization with a documented history of health informatics integration researched.

The literature reviewed suggested that there was a shift towards sociotechnical approaches in health informatics research. Many scholars demonstrated the importance of a sociotechnical lens in understanding health informatics especially Coiera (2003) who claimed that the non-technical aspects of health informatics are the most informative in evaluating health informatics integrations. Little informatics research has taken a sociotechnical approach, and as a result, there is little understanding of the reasons for certain health informatics technologies to fail and others to succeed (Kaplan, 2001a; Rahimi et al., 2009). A stronger focus on the cultural, political, organizational, and power issues inherent in healthcare organizations better illuminate struggles within the organization. As a result, this study used the theoretical lens of sociotechnology which allowed for a deeper understanding of the non-technical aspects of mHealth integration at HHS.

Early obstacles slowed initial access to The Organization. However, after these were overcome, only small issues arose. Fortunately, the flexibility and openness of HHS allowed for the researcher to navigate alternative avenues to collect data. That being said, some limitations were incurred through the research process due to the hectic healthcare environment and exploratory aims of the study.

Future Research

From the findings of this research, future research can extrapolate on the role of the Clinical Informatics department at HHS. The Clinical Informatics department which acts as a “bridge” department communicating between the users of the technology and the Information Technology department, is an intriguing phenomenon to study in the field of organizational communication. The complexity of The Organization’s environment, such as the number of employees, sites, and different healthcare provider groups necessitate additional focus on organizational communication. This unique approach to internal communication is fascinating, and its early success at HHS should be explored in depth to create a model of the processes. Research questions should center on the extent to which specialized internal communication departments focused on communicating organizational change influence the integration of health informatics technologies.

Health informatics research is critical as Coiera (2003) states, “...it is likely that in the next century, the study of informatics will become as fundamental to the practice of medicine as anatomy has been to the last” (p. xxi). This statement illustrates the immense need for health informatics research, in Canada as health informatics plays, and will continue to play a critical role within the healthcare system. Research into health informatics in Canada has been haphazard and as such, benefits of health informatics have not been fully realized leading a lag in the

integration of health informatics (Strauss, 2010 April). Understanding health informatics is critical in developing a model for healthcare organizations to effectively use in the integration of health informatics technologies that are sustainable in the long term. Without such explorations Canada will continue to fall behind the rest of the world in health informatics use.

Health informatics research is also required as in the next couple of decades there will be an increased burden on the healthcare system, caused by, among other issues, the aging population, increasing healthcare costs, and a limited number of health professionals (Bergman et al., 1997; Pare & Sicotte, 2001). These challenges and opportunities are forcing the provincial, territorial, and federal governments to take proactive measures to alleviate some of the burden on the healthcare system. Researchers have demonstrated that integrating health informatics technologies are a key tool in improving the efficiency of healthcare service delivery (Archer, 2007). Simply put, health informatics can no longer be ignored and undermined, thus research must be conducted in order to investigate and explore the best applications, the most favourable health environments to apply mHealth technologies, and the optimal ways to implement these applications.

Healthcare is a service that every Canadian depends on and through taxes pays for. With rising government deficits, the rising costs of healthcare, and an aging population the availability of this service is at risk. Researchers from several disciplines and numerous countries have touted the benefits of health informatics technologies to improve the delivery of healthcare services in that these systems allow for a more efficient flow of information and communication between the professionals who provide healthcare and between those providers and the patients who receive healthcare. This case study has illustrated the potential of mHealth technologies to improve the efficiency in healthcare service delivery. Moreover, the researcher has developed a model in

which to understand the steps and intervening conditions which influence the integration of a technology. Finally, as communication is critical to the delivery of healthcare services, further investment in and recognition of the importance of communication and sociotechnical approaches is needed to further the health informatics use.

References

- Aarts, J., Peel, V., & Wright, G. (1998). Organizational issues in health informatics: A model approach. *International Journal of Medical Informatics*, 52, 235-242.
- Adler, R. B., Rosenfeld, L.B., Proctor II, R.F., & Winder, C. (2006). *Interplay: The process of interpersonal communication* (Canadian ed.). Toronto: Oxford University Press.
- Allan, G. (2003). A critique of using grounded theory as a research method. *Electronic Journal of Business Research Methods*, 2(1), 1-10.
- Alvarez, R. C. (2002). The promise of e-Health: A Canadian perspective. *Ehealth International*, 1(4), n.p.
- Aguilar, F.J. (1967). *Scanning the business environment*. New York: Macmillian.
- Archer, N. (2007). Mobile eHealth: Making the case. In I. Kuschu (Ed.), *Mobile government: An emerging direction in e-Government* (pp. 155-170). Hershey: IGI Publishing.
- Argyris, C. (2004). *Reasons and rationalizations: The limits to organizational knowledge*. New York: Oxford University Press.
- Argyris, C., & Schön, D.A. (1996). *Organizational learning II: Theory, method, and practice*. Don Mills: Addison-Wesley Publishing Company.
- Ash, J. S., Berg, M., & Coiera, E. (2004). Some unintended consequences of information technology in health care: The nature of patient care information system-related errors. *Journal of the American Medical Informatics Association*, 11(2), 104-112.
- Aziz, O., Pancsar, S.S., Nctubeli, G., Paraskeva, P., Sheikh, A., & Darzi, A. (2005). Handheld computers and the 21st century surgical team: A pilot study. *BMC Medical Informatics and Decision Making*, 5(28), n.p.
- Baker, G.R., Norton, P.G., Flitoff, V., Blais, R., Brown, A., Cox, J., ... Tamblyn, R. (2004). The

- Canadian adverse events study: The incidence of adverse events among hospital patients in Canada. *Canadian Medical Association Journal*, 170(11), 1678-1686.
- Balka, E., Rodje, K., & Bush, C.G. (2007). Rose-coloured glasses: The discourse on information technology in the Romanow report. *Canadian Journal of Communication*, 32(3), 475-495.
- Balka, E., Doyle-Waters, M., Leczarowicz, D., & FitzGerald, J.M. (2007). Technology, governance and patient safety: Systems issues in technology and patient safety. *International Journal of Medical Informatics*, 76S, S35-S47.
- Barrett, J. R., Strayer, S.M., & Schubart, J.R. (2004). Assessing medical residents' usage and perceived needs for personal digital assistants. *International Journal of Medical Informatics*, 73, 25-34.
- Bashshur, R. (1997). Telemedicine and the health care system. In R. Bashshur, J. Sanders, & G. Shannon (Eds.). *Telemedicine and practice* (pp.5-36). Springfield: Charles C. Thomas Publisher.
- Bates, D.W., Cohen, M., Lape, L.L, Overhage, M., Shabot, M.M., & Sheridan, T. (2001). Reducing the frequency of errors in medicine using information technology. *Journal of the American Medical Informatics Association*, 8(4), 299-308.
- Bath, P.A. (2008). Health informatics: Current issues and challenges. *Journal of Information Science*, 34(4), 501-518.
- Bauer, K. (2009). Healthcare ethics in the information age. In R. Luppigini & R. Adell (Eds.), *Handbook of research on technoethics: Volume 1* (pp. 170-185). Hershey, PA: IGI Global Publishing
- Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly*, 11(3), 369-386.

- Berg, M. (2001). Implementing information systems in health care organizations: Myths and challenges. *International Journal of Medical Informatics*, 64, 143-156.
- Berg, M., Aarts, J., & van der Lei, J. (2003). ICT in health care: Sociotechnical approaches. *Methods of Information in Medicine*, 42, 297-301.
- Bijker, W. E. (2010). How is technology made? That is the question!. *Cambridge Journal of Economics*, 34, 63-76.
- Bonneville, L. (2005). A paradigm shift in the evaluation of information technology in health care. *Telemedicine Journal and e-Health*, 11(4), 477-480.
- Bonneville, L., & Parc, D.J. (2006). Socioeconomic stakes in the development of telemedicine. *Journal of Telemedicine and Telecare*, 12(5), 217-219.
- Bower, J.D., Barry, N., Reid, M., & Norrie, J. (2005). Designing and implementing e-health applications in the UK's national health service. *Journal of Health Communication*, 10, 733-750.
- Burke, K., & Chidambaram, L. (1999). An assessment of change in behavioural dynamics among computer-supported groups: Different factors change at different rates. *Industrial Management and Data Systems*, 99(7), 288-295.
- Cao, G. (2007). The pattern-matching role of systems thinking in improving research trustworthiness. *Systemic Practice & Action Research*, 20, 441-453.
- Cartelli, A. (2007). Socio-technical theory and knowledge construction: Towards new pedagogical paradigms?. *Issues in Informing Science and Information Technology*, 4, 1-14.
- Chang, K., Lutes, K.D., Braswell, M.L., & Nielson, J.K. (2006). Nurses' perceptions of using a pocket PC for shift reports and patient care. *International Journal of Healthcare*

- Information Systems and Informatics*, 1(1), 52-64.
- Charmaz, K. (2003). Qualitative interviewing and grounded theory analysis. In J.A. Holstein & J.F. Gubrium (Eds.), *Inside interviewing: New lenses, new concerns* (pp. 311-330). Thousand Oaks: Sage Publications.
- Coakes, E. (2006). Storing and sharing knowledge: Supporting the management of knowledge made explicit in transnational organisations. *The Learning Organization*, 13(6), 579-593.
- Coiera, E. (2000). When conversation is better than computation. *Journal of the American Medical Informatics Association*, 7(3), 277-287.
- Coiera, E., Jayasuriya, R., Hardy, J., Bannan, A., & Thorpe, M. (2002). Communication loads on clinicians in the emergency department. *Medical Journal of Australia*, 176(9), 415-418.
- Coiera, E. (2003). *Guide to health informatics* (2nd ed.). New York: Oxford University Press.
- Coiera, E. (2009). Building a national health IT system from the middle out. *Journal of the American Medical Informatics Association*, 16(3), 271-273.
- Coiera, E., & Tombs, V. (1998). Communication behaviours in a hospital setting: An observational study. *British Medical Journal*, 316(7132), 673-676.
- Collen, M. F. (1986). Origins of medical informatics. *The Western Journal of Medicine*, 145, 778-785.
- Creswell, J.W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks: Sage Publications.
- Culler, S.D., Atherly, A., Walczack, S., Davis, A., Hawley, J.N., Rask, K.J., Naylor, V., & Thorpe, K.E. (2006). Urban-rural differences in the availability of hospital information technology applications: A survey of Georgia hospitals. *The Journal of Rural Health*, 22(3), 242-247.

- DeBakey, M. E. (1995). Telemedicine has now come of age. *Telemedicine Journal*, 1(1), 3-4.
- Demeester, M. (1999). Cultural aspects of information technology implementation. *International Journal of Medical Informatics*, 56, 25-41.
- Denzin, N. (2009). *The research act: A theoretical introduction to sociological methods*. New Brunswick: Aldine Transaction.
- Drucker, P.F. (1993). *Managing for the future: The 1990s and beyond*. New York, NY: Dutton.
- Dunn, E.V., Conrath, D.W., Bloor, W.G., & Tranquada, B. (1977). An evaluation of four telemedicine systems for primary care. *Health Services Research*, 19-29.
- Dykes, P. C., Hurley, A., Cashen, M., Bakken, S., & Duffy, M.E. (2007). Development and psychometric evaluation of the impact of health information technology (I-HIT) scale. *Journal of the American Medical Informatics Association*, 14(4), 507-515.
- Dwivedi, A.N., Bali, R.K., Raouf, N.G., Naguib, A., & Nasaar, N.S. (2006). The efficacy of the m-health paradigm: Incorporating technological, organizational and managerial perspectives. In R.S.H. Istepanian, S. Laxminarayan, & C.S. Pattichis (Eds.), *M-health: Emerging mobile health systems* (pp.15-32). New York: Springer Science Business Media.
- Edwards, A., Fitzpatrick, L. A., Augustine, S., Trzebucki, A., Cheng, S. L., Presseau, C., Mersmann, C., ...Kachnowski, S. (2009). Synchronous communication facilitates interruptive workflow for attending physicians and nurses in clinical settings. *International Journal of Medical Informatics*, 78(9), 629-637.
- Esmail, N., & Walker, M. (2005). *How good is Canadian health care? An international comparison of health care systems*. Vancouver, BC: Fraser Institute.
- Fischer, H.R., Reichlin, S., Gutzwiller, J.P., Dyson, A., & Beglinger, C. (2006). Telemedicine as

- a new possibility to improve health care delivery. In R.S.H. Istepanian, C.S. Pattichis, & S. Lazminarayan (Eds.) *M-Health: Emerging mobile health systems* (pp.15-33). New York: Springer Science Business Media.
- Fischer, S., Stewart, T.E., Mchta, S., Wax, R., & Lapinsky, S.E. (2003). Handheld computing in medicine. *Journal of the American Medical Informatics Association*, 10(2), 139-149.
- Fitzgerald, G. (1998). Evaluating information systems projects: A multidimensional approach. *Journal of Information Technology*, 13, 15-27.
- Fortescue, E.B., Kaushal, R., Landrigan, C.P., McKenna, K.J., Clapp, M.D., Federico, F., Goldmann, D.A., & Bates, D.W. (2003). Prioritizing strategies for preventing medication errors and adverse drug events in pediatric inpatients. *Pediatrics*, 111(4), 722-729.
- Foucault, M. (1973). *The birth of the clinic: An archaeology of medical perception*. Translated from the French by A. M. Sheridan Smith (1st American ed.). New York: Pantheon Books.
- Gagnon, M.P., Shaw, N., Sicotte, C., Mathieu, L., Leduc, Y., Duplantie, J., Maclean, J., & Légaré, F. (2009). Users' perspectives of barriers and facilitators to implementing EHR in Canada: A study protocol. *Implementation Science*, 4, n.p.
- Garrett, B., & Klein, G. (2008). Value of wireless personal digital assistants for practice: Perceptions of advanced practice nurses. *Journal of Clinical Nursing*, 17, 2146-2154.
- Glaser, B.G., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York: Aldine Publishing Company.
- Golden, B. (2006). Change: Transforming healthcare organizations. *Healthcare Quarterly*, 10(Special Issue), 10-20.
- Goroll, A. H., Simon, S.R., Tripathi, M., Ascenzo, C., & Bates, D.W. (2009). Community-wide

implementation of health information technology: The Massachusetts health collaborative experience. *Journal of the American Medical Informatics Association*, 16, 132-139.

Hamilton Health Sciences (n.d.). Retrieved October 1, 2009 from

<http://www.hamiltonhealthsciences.ca/>

Hamilton Health Sciences (2006). *Vision 2010: Future Priorities*. Hamilton, ON: Author.

Hamilton Health Sciences (2007b, October). *ClinicalConnect is a one-stop shop for healthcare professionals*. Hamilton, ON: Author.

Hamilton Health Sciences (2007, December). *Hamilton Health Sciences installs advanced computer security*. Hamilton, ON: Author.

Hamilton Health Sciences (2008, September). *Regional partnerships improve the patient care continuum*. Hamilton, ON: Author.

Hamilton Health Sciences (2008b, October). *IT happens here at Hamilton Health Sciences' new high-tech hub*. Hamilton, ON: Author.

Hamilton Health Sciences (2008, December). *Prepackaged medications enhance patient safety at Hamilton Health Sciences*. Hamilton, ON: Author.

Hamilton Health Sciences (2009a, April). *Hamilton Health Sciences wins MEDSEEKS' 2009 eHealth excellence award*. Hamilton, ON: Author.

Hamilton Health Sciences (2009, December). *Diabetes clinics implement eCare*. Hamilton, ON: Author.

Hatch, M.J. (1996). The role of the researcher: An analysis of narrative position in organization theory. *Journal of Management Inquiry*, 5(4), 359-176.

Heathfield, H.A., & Wyatt, J. (1993). Philosophies for the design and development of clinical

- decision support systems. *Methods of Information in Medicine*, 26(9), 910-934.
- Herrman, H., Trauer, T., & Warnock, J. (2002). The roles and relationships of psychiatrists and other service providers in mental health services. *Australian and New Zealand Journal of Psychiatry*, 36(1), 75-80.
- Herrmann, T., Loser, K., & Jahnke, I. (2007). Sociotechnical walkthrough: A means for knowledge integration. *The Learning Organization*, 14(5), 450-464.
- Information Technology Association of Canada (2004). *The issue: ICT in health care*. Ottawa: Author.
- Istepanian, R.S.H., Laxminarayan, S., & Pattichis, C.S. (Eds.). (2006). *M-health: Emerging mobile health systems* (pp.15-32). New York: Springer Science Business Media.
- Jha, A.K., Doolan, D., Grandt, D., Scott, T., & Bates, D.W. (2008). The use of health information technology in seven nations. *International Journal of Medical Informatics*, 77(12), 848-854.
- Kaplan, B. (1997). Addressing organizational issues into the evaluation of medical systems. *Journal of the American Medical Informatics Association*, 4, 94-101.
- Kaplan, B. (2001a). Evaluating informatics applications - some alternative approaches: Theory, social interactionism, and call for methodological pluralism. *International Journal of Medical Informatics*, 62, 39-56.
- Kaplan, B. (2001b). Evaluating informatics applications: Clinical decision support systems literature review. *International Journal of Medical Informatics*, 64, 15-37.
- Kaplan, B., & Harris-Salamone, K. D. (2009). Health IT success and failure: Recommendations from literature and an AMIA workshop. *Journal of the American Medical Informatics Association*, 16(3), 291-299.

- Kaplan, B., & Litewka, S. (2008). Ethical challenges of telemedicine and telehealth. *Cambridge Quarterly of Healthcare Ethics*, 17(4), 401-416.
- Kealey, L. (2002). Historical perspectives on health care in Canada. In J. Ruggeri & W. Yu (Eds.) *Health care in Canada: Demographic and fiscal issues* (pp.131-151). Fredericton: University of New Brunswick, Policy Studies Centre.
- Kirkpatrick, D.L. (1998). *Evaluating training programs: The four levels* (2nd ed.). San Francisco: Berrett-Koehler Publishers.
- Kimmel, H. & Deck, F.E. (1995). Instructional technology: A tool or a panacea?. *Journal of Science Education and Technology*, 4(4), 327-332.
- Kuziemy, C.E., Borycki, E.M., Purkis, M.E., Black, F., Boyle, M., Cloutier-Fisher, D., Fox, L.A., MacKenzie, P., ... Wong, H. (2009). An interdisciplinary team communication framework and its application to healthcare 'e-teams' systems design. *BMC Medical Informatics and Decision Making*, 9(43), n.p.
- Layman, E.J., & Watzlaf, V.J. (Eds.). (2009). *Health informatics research methods: Principles and practice*. Chicago: American Health Information Management Association Press.
- Lenz, R., & Reinchert, M. (2006). IT support for healthcare processes: Premises, challenges, and perspectives. *Business Process Management*, 61(1), 39-58.
- Leonard, M., Graham, S., & Bonacum, D. (2004). The human factor: The critical importance of effective teamwork and communication in providing safe care. *Quality and Safety in Health Care*, 13, i85-i90.
- Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G.R., Reznick, R., Bohnen, J., Orser, B., ... Grober, E. (2004). Communication failures in the operating room: An observational classification of recurrent types and effects. *Quality & Safety in Health Care*, 13, 330-

334.

- Locke, K.A., Duffey-Rosenstein, B., De Lio, G., Morra, D., & Hariton, N. (2008). Beyond paging: Building a web-based communication tool for nurses and physicians. *Journal of General Internal Medicine*, 24(1), 105-110.
- Lorenzi, N.M., Riley, R.T., Blyth, A.J.C., Southon, G., & Dixon, B.J. (1997). Antecedents of the people and organizational aspects of medical informatics: Review of the literature. *Journal of the American Medical Informatics Association*, 4(2), 79-94.
- Mair, F., & Whitten, P. (2000). Systematic review of studies of patient satisfaction with telemedicine. *British Medical Journal* 320, 1517-1520.
- Marshall, S., Harrison, J., & Flanagan B. (2009). The teaching of a structured tool improves the clarity and content of interprofessional clinical communication. *Quality & Safety in Health Care*, 18, 137-140.
- Matusitz, J., & Breen, G. (2007). Telemedicine: Its effects on health communication. *Health Communication*, 21(1), 73-83.
- McAlearney, A.S., Schweikhart, S.B., & Medow, M.A. (2005). Organizational and physician perspectives about facilitating handheld computer use in clinical practice: Results of a cross-site qualitative study. *Journal of the American Medical Informatics Association*, 12(5), 568-575.
- McAlearney, A.S., Chisolm, D.J., Schweikhart, S., Medow, M.A., & Kelleher, K. (2007). The story behind the story: Physician skepticism about relying on clinical information technologies to reduce medical errors. *International Journal of Medical Informatics*, 76, 836-842.
- McCarter, J. (2009). *Ontario's Electronic Health Records Initiative*. Toronto: Government of

Ontario.

Merrell, R.C. (1995). Telemedicine in the 1990s. *Journal of Medical Systems*, 19(1), 15-18.

Morrison, K., Ricketts, I.W., Jones, M.C., Johnston, D.W., Pitts, N.B., & Sullivan, F.M. (2009).

Pocket interview: A secure electronic data collection and diary tool. *Ehealth International*, 1-9.

Naylor, C.D. (1999). Health care in Canada: Incrementalism under fiscal duress. *Health Affairs*, 18(3), 9-26.

Norris, A.C. (2002). Current trends and challenges in health informatics. *Health Informatics Journal*, 8, 205-215.

O'Leary, Z. (2004). *The essential guide to doing research*. Los Angeles: Sage Publications.

Ortega, G.R., Taksali, S., Smart, R., & Baumgaertner, M.R. (2009). Direct cellular vs. indirect pager communication during orthopaedic surgical procedures: A prospective study. *Technology and Health Care*, 17, 149-157.

Panteli, N., Pitsillides, B., Pitsillides, A., & Samaras, G. (2007). An e-healthcare mobile application: A stakeholders' analysis. In L. Al-Hakim (Ed.), *Web Mobile-Based Applications for Healthcare Management*. Hershey: IRM Press.

Parker, J., & Coiera, E. (2000). Improving clinical communication: A view from psychology. *Journal of the American Medical Informatics Association*, 7(5), 453-462.

Parsons, T. (1964). *Essays in Sociological Theory* (Revised ed.). New York: Free Press.

Pearson, M., & Brew, A. (2002). Research training and supervision development. *Studies in Higher Education*, 27(2), 135-150.

Peddle, K. (2007). Telehealth in context: Socio-technical barriers to telehealth use in Labrador, Canada. *Computer Supported Cooperative Work*, 16, 595-614.

- Pirnejad, H., Bal, R., & Berg, M. (2008). Building an inter-organizational communication network and challenges for preserving interoperability. *International Journal of Medical Informatics*, 77(12), 818-827.
- Pirnejad, H., Bal, R., Stoop, A.P. & Berg, M. (2007). Inter-organisational communication networks in healthcare: Centralised versus decentralised approaches. *International Journal of Integrated Care*, 7, 1-10.
- Plummer, A.A. (2001). Information systems methodology for building theory in health informatics: The argument for a structured approach to case study research, *34th Hawaii International Conference on System Sciences* (pp. 1-10). Hawaii.
- Point of Care Systems* (n.d.). Retrieved March 2, 2010, from <http://medical.webends.com/kw/Point-of-Care%20Systems>
- Prgomet, M., Georgiou, A., & Westbrook, J.I. (2009). The impact of mobile handheld technology on hospital physicians' work practices and patient care: A systematic review. *Journal of the American Medical Informatics Association*, 16, 792-801.
- Protti, D. (2008). e-Health in Canada: Lessons for European health systems. *Eurohealth*, 14(3), 30-32.
- Rahimi, B., Timpka, T., Vimarlund, V., Uppugunduri, S., & Svensson, M. (2009). Organization-wide adoption of computerized provider order entry systems: A study based on diffusion of innovations theory. *BMC Medical Informatics and Decision Making*, 9(52), n.p.
- Riege, A.M. (2003). Validity and reliability tests in case study research: A literature review with "hands-on" applications for each research phase. *Qualitative Market Research*, 6(2), 75-86.
- Rigby, M., Forsstrom, J., Roberts, R., & Wyatt, J. (2001). Verifying quality and safety in health

- informatics services. *British Medical Journal*, 323, 552-556.
- Riva, G. (2000). From telchealth to e-health: Internet and distributed virtual reality in health care. *CyberPsychology and Behaviour*, 3(6), 989-998.
- Roine, R. Ohinmaa, A., & Hailey, D. (2001). Elements for assessment of telemedicine applications. *International Journal of Technology Assessment in Health Care*, 17(2), 190-202.
- Rogers, E. M. (2003) *Diffusion of innovations* (5th ed.). New York: Free Press.
- Romanow, R.J. (2002). *Building on values: The future of health care in Canada*. Ottawa: Government of Canada.
- Rose, A. F., Schnipper, J. L., Park, E. R., Poon, E. G., Li, Q., & Middleton, B. (2005). Using qualitative studies to improve the usability of an EMR. *Journal of Biomedical Informatics*, 38(1), 51-60.
- Schoop, M. (1999). An empirical study of multidisciplinary communication in healthcare using a language-action perspective. *Proceedings of the Fourth International Workshop on the Language Action Perspective on Communication Modelling (LAP 99)*, pp. 59–72, Department of Informatics, International Business School.
- Siau, K., & Shen, Z. (2006). Mobile healthcare informatics. *Medical Informatics and the Internet in Medicine*, 31(2), 89-99.
- Simmons, J. (2001). Creating portals to quality: How Internet is changing health care delivery to consumers. *The Quality Letter for Healthcare Leaders*, 13(7), 2–10.
- Singh, H., Arora, H.S., Vij, M.S., Rao, R., Khan, M., & Petersen, L.A. (2007). Communication outcomes of critical imaging results in a computerized notification system. *Journal of the American Medical Informatics Association*, 14(4), 459-466.

- Sinnott, R.O., Stell, A.J., Ajayi, O.O. (2006). Initial experiences in developing e-Health solutions across Scotland. *Workshop on Integrated Health Records: Practice and Technology*. Edinburgh, Scotland.
- Skinner, B.J. (2009). *Canadian Health Policy Failures: What's wrong? Who gets hurt? Why Nothing Changes*: Frasier Institute.
- Soanes, C. (Ed.) (2001). *Oxford dictionary of current English* (3rd ed.). New York: Oxford University Press.
- Solvoll, T. & Scholl, J. (2008). Strategies to reduce interruptions from mobile communication systems in surgical wards. *Journal of Telemedicine and Telecare*, 14(7), 389-392.
- Spitzer, R. (2009). Clinical information and sociotechnology. *Nurse Leader*, 7(3), 6-7.
- Stebbing, C., Wong, I. C. K., Kaushal, R., & Jaffe, A. (2007). The role of communication in paediatric drug safety. *Archives of Disease in Childhood*, 92(5), 440-445.
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks: Sage Publications.
- Strauss, S. (2010, April). *A journalist trying to explain to ordinary people what they fundamentally don't understand about EHRs: Why they aren't here already for care-at-a-distance*. Keynote address presented at the Advances in Health Informatics Conference, Waterloo, Ontario.
- Suggs, L.S. (2006). A 10-year retrospective of research in new technologies for health communication. *Journal of Health Communication*, 11(1), 61 - 74.
- Susman, G.I. (1976). *Autonomy at work: A Sociotechnical Analysis of Participative Management*. New York: Praeger.
- Te'eni, D., Sagie, A., Schwartz, D.G., Zaidman, N., & Amichai-Hamburger, Y. (2001). The

- process of organizational communication: A model and field study. *IEEE Transactions on Professional Communication*, 44(1), 6-20.
- Tsiknakis, M., & Kouroubali, A. (2009). Organizational factors affecting successful adoption of innovative eHealth services: A case study employing the FITT framework. *International Journal of Medical Informatics*, 78, 39-52.
- Turner, J.H. (1988). *A theory of social interaction*. Stanford: Stanford University Press.
- Turner, J.W. (2003). Telemedicine: Expanding health care into virtual environments. In A.M. Maki, K.I. Dorsey, & R. Parrott (Ed.), *Handbook of health communication* (pp. 515-535). Mahwah: Lawrence Erlbaum Associates.
- Vayda, E. & Deber, R.B. (1992). The Canadian health-care system: A developmental overview. In C.D. Naylor, *Canadian health care and the state: A century of evolution* (pp. 125-140). Montreal: McGill-Queen's University Press.
- Vishwanath, A., Brodsky, L., Shaha, S., Leonard, M., & Cimino, M. (2009). Patterns and changes in prescriber attitudes toward PDA prescription-assistive technology. *International Journal of Medical Informatics*, 78, 330-339.
- Whan, P., Brown, N.A., & Wootton, R. (2006). A bibliographic snapshot of the telemedicine citation literature. *Journal of Telemedicine and Telecare*, 12 (suppl. 3), 95-102.
- Yeh, H.D., & Kuo M.C. (2006). Key factors to activate dialogue through perspectives of organisational learning within Chinese organisations in Taiwan. *International Journal of Learning and Intellectual Capital*, 3(1), 57-73.
- Yin, R.K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks: Sage Publications.
- Yin, R.K. (2008). *Case study research: Design and methods* (4th ed.). Thousand Oaks: Sage

Publications.

- Young, P.M.C., Leung, R.M.W., Ho, L.M., & McGhee, S.M. (2001). An evaluation of the use of hand-held computers for bedside nursing care. *International Journal of Medical Informatics*, 62(2-3), 189-193.
- Zinn, C. (1995). 14,000 preventable deaths in Australian hospitals. *British Medical Journal*, 310 (6993), n.p.

APPENDIX A

Consent Form

Researcher: Victoria Aceti, Master's student
 Department of Communication, University of Ottawa
 Supervisor: Dr. Rocci Luppici
 Department of Communication
 200 Wilbrod
 Ottawa, ON

Email: vaceti087@uottawa.ca or rluppici@uottawa.ca

Purpose: The purpose of this research is to explore the varying uses of m-health solutions within the different Hamilton Health Sciences campuses. I am inviting all interested health professionals, information technology workers, and administrators within the Hamilton Health Sciences organization to participate in semi-structured interviews lasting 20-40 minutes in length.

Procedure: Those agreeing to participate can expect the following to happen. After the consent form has been signed and all questions regarding the research answered, I will turn the tape recorder on and begin asking questions. The length of each answer will depend on the interviewee and some questions not on the formal interview question list may be asked depending on the interviewees answers.

Risks: Although electronic communication will take place over a secure network, please be informed that there are certain security risks as transcripts sent over email are not completely secure.

Benefits: In participating in this study, the participant will not only be aiding the researcher in exploring m-health solutions in a Canadian medical environment, but also in furthering the understanding of m-health solutions and its impact within healthcare settings.

Conservation of Data: The data collected by the researcher through a tape recorder and written notes will be kept securely in the supervisor's office. Only the researcher and supervisor will have access to the data. The data will be destroyed 5 years after the thesis is submitted.

Confidentiality: All data produced from the study will be stored securely in the supervisor's office located at 200 Wilbrod, Ottawa, ON. Only the researcher and supervisor will have access to the data, which includes the tape recordings, transcripts and any written notes by the researcher. Pseudonyms are being used in the research results and participants will not be identified in any future publications.

By initialing in the space below, you are agreeing that you are aware that the interview you are participating in will be tape recorded.

_____ Participant's initials

Voluntary Participation: It is your choice to take part in the study. There will be no penalty if you chose to not participate or to stop participation at any time during the research project. In the event that you wish to withdraw from participating, it will be your decision if you would like the data collected from interviews up to that point can be used in the study. You can chose how involved you would like to be and you do not have to answer any questions you do not feel comfortable in answering.

Acceptance: I, (participant's name printed) _____
agree to participate in the research study listed above conducted by Victoria Aceti of the Department of Communication, which is under the supervision of Dr. Rocci Luppisini.

If there are any questions about the study, the participant may contact the researcher or her supervisor.

There are two copies of this consent form, one of which is the participant's to keep.

Signature of the Participant:

Date: _____

Signature of the Researcher:

Date: _____

Contact Information

Research Ethics Board (University of Ottawa)

If you have any questions regarding the ethical conduct of this study, you may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 159, Ottawa, ON. K1N-6N5, Canada; Tel.: 613-562-5841; Email: ethics@uottawa.ca

Researchers

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Telephone: 613-562-5800 ext. 2510

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Victoria Aceti: 414-169 Lees Avenue, Ottawa, ON.

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APPENDIX B

Letter of Recruitment

Hello,

My name is Victoria Aceti and I am a Master's student at the University of Ottawa in the Department of Communication. I am looking for anyone who uses m-health solutions in their workplace on a regular basis and would like to discuss their experiences with the technology.

As a participant you will be asked to volunteer for an interview lasting approximately 20-40 minutes. The questions will revolve around your use of mobile e-health devices in your daily work routine. You will *not* be asked for any patient or confidential information. The purpose is to gain an understanding of the use of m-health devices in communication with other health professionals, not patients.

Please note that if you do choose to participate, you do have the right to withdraw from the study at any time.

The University of Ottawa Research Ethics Board, has approved my research and I am now looking to recruit volunteers. I have been in contact with Hamilton Health Sciences management, and they have agreed to allow me to conduct research on this topic within the organization. I will be in the Hamilton area during the second and third week of September 2009.

Please be aware that Hamilton Health Sciences is in no way affiliated with the study.

If you are interested in participating or have any questions about the research, please contact me via e-mail at vacet087@uottawa.ca. You may also contact my research supervisor, Dr. Rocci Luppici, a professor at the University of Ottawa, at rluppici@uottawa.ca.

Sincerely,

Victoria Aceti

APPENDIX C**Participant List**

Interview 1: September 14, 2009 (Length: 48 minutes: 56 seconds)
Matthew Heath

Interview 2: September 15, 2009 (Length: 31:09)
Tom Paladin

Interview 3: September 16, 2009 (Length: 37:15)
Lina Sussex

Interview 4: November 17, 2009 (Length: 25:36)
Gina Danby

Interview 5: November 17, 2009 (Length: 18:45)
Terry Brunswick

Interview 6: November 17, 2009 (Length: 11:09)
Kirsti Maki

Interview 7: November 17, 2009 (Length: 21:28)
Teresa Newcastle

Interview 8: November 17, 2009 (Length: 15:04)
Christina Broadview

Interview 9: November 17, 2009 (Length: 10:39)
Anna Crest

Interview 10: November 17, 2009 (Length: 12:29)
Amanda Nichol

Interview 11: November 17, 2009 (Length: n/a)
Marisa Pinto

APPENDIX Da**Participant Interview Protocols
(In-Person)**

Interviewer begins with interviewer introducing herself and thanking interviewee for participating.

Next, the interviewer explains her research project, while NOT divulging the specific aims of the study.

The interviewer offers to send the interviewee a copy of the final report.

BEFORE recording, the interviewer shows the interviewee the consent form and asks the interviewee to sign it.

After the consent form is signed, the interviewer asks if the interviewee minds being tape-recorded.

After these procedures, the interview begins.

APPENDIX Db**Participant Interview Protocols
(Electronically)**

Thank you for participating in this study. The questions below are meant to investigate training and evaluation procedures at Hamilton Health Sciences. Please return the attached consent form with the answers. Please feel free to contact me if you have any questions.

APPENDIX E

Interview Questions

Participant 1:

I'd like to start by asking you some questions about your professional background.

1. What are your duties and role within HHS? (Probe: stakeholders involved in the tech management/decision making to see where his actions/processes fit into the org structure.)

I'm going to focus the next questions on decision-making aspects at HHS with regards to health informatics.

2. How are decisions made about bringing in a new technology? Is it a collaborative effort with health professionals, technology department, patients, or is it top-down?
3. In a 2006 project profile you wrote, "The adoption of technology at HHS is now in high gear as decision makers begin to see its full potential". How are things different now compared to before 2006? (If no, let Mr. Heath explain, If Yes: Probe for is that still the case?)
4. When deciding whether to implement a new technology, what types of ethical issues are discussed? – security... etc.
5. Can you recall a time when an ethical issue hindered the implementation of that technology?
6. How are technological changes communicated with employees? (Probe for resistance and if there is demographic differences in who resists and who accepts)
7. How is resistance (if any) dealt with?
8. Can you explain the process by which training is administered after the decision is made to implement a new technological application? (volunteer basis, obligatory, can it be refused...etc?)
9. During your 2002 implementation of the SOVERA record keeping system, SARS broke out. How do you think that affected future decision making in the area of e/mhealth? (Probe for communication issues, social and ethical issues (e.g., public push for participatory decision-making/approval).
10. How do you think those lessons learned will help in future implementations, as well as in prepared for future pandemics? (Probe for communication issues)
11. Last year around this time, you opened an IT innovation centre. What inspired that idea? (Probe for meet the needs/demands within their organization, to their client base, and to the general public)
12. How is having the IT department in one place impacting health informatics at HHS? (Probe for communication, innovation)

I like to round up the interview talking about the communicative benefits and challenges associated with health informatics.

13. The Microsoft Unified Communication system was recently integrated into HHS. Can you explain how this system has impacted communication between health care providers? Between providers in different healthcare organizations?

14. Is this system available on mobile devices? Do providers tend to use it on mobile more so than desktop options?
15. In 2006 project profile you discussed HHS supporting a highly mobile workforce and a virtual healthcare community. What new initiatives are being taken by HHS to support this vision?
16. HHS has won awards and industry acclaim for not only their technological innovations, but also the manner in which they are implemented. In your professional opinion, what is it about HHS that makes it such a technological leader in its field? (Probe for non-tech innovations that HHS has implanted like strategies to involve stakeholders in decision-making, cross-department/team efforts to communicate/reach decisions that are mutually acceptable to all and not in conflict with ethical/legal/cultural values of the clients served).

Participant 2:

I'd like to start by asking you some questions about your professional background.

1. What are your duties and role within HHS? (*Probe: stakeholders involved in the tech management/decision making to see where his actions/processes fit into the org structure.*)

I'm going to focus the next 4 questions on decision-making aspects at HHS with regards to health informatics.

2. How are decisions made about bringing in a new technology? Is it a collaborative effort with health professionals, technology department, patients, or is it top-down?
3. When deciding whether to implement a new technology, what types of ethical issues are discussed? – *security... etc.*
4. How are technological changes communicated with employees? (*Probe for resistance and if there is demographic differences in who resists and who accepts*)
5. How is communication handled differently in the Clinical Informatics department?
6. How is resistance (if any) dealt with?
7. Can you explain the process by which training is administered after the decision is made to implement a new technological application? (*volunteer basis, obligatory, can it be refused...etc?*)

I'd like to discuss the Interprofessional Electronic Clinical Documentation project in the Pediatric Intensive Care Unit.

8. Can you describe what the project is?
9. What areas of health service delivery it is aimed at improving?
10. Is it available on mobile devices? If so, what types and are their downfalls or benefits to being mobile? If not, will it be available in the near future?
11. What are the associated risks with electronic documentation? (*Probe: ethical, social, security, legal, communication*)

I like to round up the interview talking about the communicative benefits and challenges associated with health informatics.

12. What are major indicators for HHS that a technology project is working or failing? (*Probe for communication, social and ethical issues*)

13. It was just announced that an OSOS system will be implemented into HHS. Can you explain how you see this system impacting communication between health care providers? Between different healthcare organizations?
14. How do you meet technological needs/demands within the organization, to your clients, and the general public?
15. HHS has won awards and industry acclaim for not only their technological innovations, but also the manner in which they are implemented. In your professional opinion, what is it about HHS that makes it such a technological leader in its field? *(Probe for non-tech innovations that HHS has implanted like strategies to involve stakeholders in decision-making, cross-department/team efforts to communicate/reach decisions that are mutually acceptable to all and not in conflict with ethical/legal/cultural values of the clients served).*

Participant 3:

I'd like to start by asking you some questions about your professional background.

1. What are your duties and role within HHS? (Probe: stakeholders involved in the tech management/decision making to see where her actions/processes fit into the org structure.)
2. How are decisions made about bringing in a new technology? Is it a collaborative effort with health professionals, technology department, patients, or is it top-down?
3. When deciding whether to implement a new technology, what types of ethical issues are discussed? – security... etc.
4. Can you recall a time when an ethical issue hindered the implementation of that technology?
5. How are ICT privacy policies communicated to employees? Clients?
6. Are there any ethical or privacy training or information sessions when a new technology is implemented?

Now I would like to speak to you about mobile technologies at Hamilton Health Sciences.

7. In your professional opinion, what is the single biggest privacy concern with regards to mobile informatics?
8. Can you give me an example, without being specific, of a situation in which an ethical, security, or privacy breach on an electronic device occurred? What lessons were learned from that situation?
9. In a journal article published in 2007 about the SOVERA system, it discussed the benefits of the technology as enabling physicians to review and update their charts from the comfort of their own home. Is this the case? And if so, how are privacy issues addressed in this type of situation?
10. In HHS company policy, it states that confidential information cannot be communicated in public areas. How is this regulated or communicated with employees using mobile devices?
11. HHS has won awards and industry acclaim for not only their technological innovations, but also the manner in which they are implemented. In your professional opinion, what is it about HHS that makes it such a technological leader in its field? (Probe for non-tech innovations that HHS has implanted like strategies to involve stakeholders in decision-making, cross-department/team efforts to communicate/reach decisions that are mutually

acceptable to all and not in conflict with ethical/legal/cultural values of the clients served).

Participant 4:

1. Can you briefly explain your role at Hamilton Health Sciences? (e.g. daily roles, main responsibilities)
2. After an employee has gone through a training session, are there evaluation tools used to assess how much the employee has learned in the session? If yes, can you explain and provide a sample of the tool. If not, why is there no evaluation?
3. Are there any follow-up with employees to see how the training helped them once an information technology was implemented and they have had to use it in their regular work routine? If yes, can you explain and provide a sample of the tool. If not, why is there no evaluation?
4. Have there been any instances where follow-up training sessions were scheduled for a new information technology that has been implemented?
5. How is training and evaluation fed into how new information technologies are expanded to other areas? If it is not part of the strategy, why? Can you see a time when it will be?
6. Which people/roles are responsible for reviewing the training and deciding whether the integration effort is successful and whether it is to be extended to other units?

Healthcare Professional Participants:

I'd like to start by asking you some questions about your professional background.

1. What is your job at Hamilton Health Sciences?

I'd like to ask you some questions on your use of mHealth applications in your work routine.

2. What mHealth technologies do you use? (*Probe for most used; most used for CMN*)
3. How do you learn that a new technology is being implemented? (*Probe for internal CMN; Clinical Informatics*)
4. How important does the way (ie. face-to-face, telephone, email, etc.) in which you communicate with colleagues factor into your ability to deliver health services? Are there channels that you favour? (*Probe for situations, messages, and receivers*)
5. Can you think of an example of how communication with colleagues has changed since using mHealth?
6. What challenges have you encountered as a result of mHealth? How did you get around these challenges? (*Probe for CMN issues, connection issues, technical issues*)
7. Can you think of an example when you have had a success with mHealth?
8. What was the most effective training session you attended? Why? (*Probe: One on One, eLearning*)
9. How would you describe your opinion on mHealth technology?
10. If you were to recommend m-health technology to colleagues in other health organizations, what would be the one piece of advice you would give them?
11. Is there anything that you would like to add about your use of mHealth?

APPENDIX F

Documents Collected

Title	Date Created	Source	Length
"Vision 2010: Future Priorities"	2006	Research Participant	44 pages
"What is eCare?"	2009	Hamilton Health Sciences	1 page
"eCare Pilot Project"	2009	Hamilton Health Sciences	4 pages
"Mobile Tablet at Hamilton Health Sciences"	2009	Hamilton Health Sciences	4 pages
"2008/2009 Annual Report"	2009	Hamilton Health Sciences	12 slides
"Corporate Initiatives Rollout"	October 2009	Hamilton Health Sciences	65-74 of 114 pages
"The Insider" Internal Newsletter		Hamilton Health Sciences	Placement
ICT 2010 Vision: Phase I	October 2007		Page 2/4
ClinicalConnect is a one-stop shop for healthcare professionals	October 2007		Page 4/4
Sovera Upgrade Notification	October 2007		Page 4/4
Hamilton Health Sciences Installs Advanced Computer Security	December 2007 & January 2008		Page 1/4 & Page 4/4
Just Click "Next"	May 2008		Page 2/4
Regional Partnerships Improve the Patient Care Continuum	September 2008		Page 4/4
Cisco Security Agent Goes Live	October 2008		Page 3/4
IT Happens here at Hamilton Health Sciences' new High-Tech Hub	October 2008		Page 4/4
Vision 2010 - Achieving the Promise of the Electronic Health Record	November 2008		Page 2/4
Prepackaged medications Enhance Patient Safety at Hamilton Health Sciences	December 2008		Page 3/4
ICT Launches Single Sign-On for all Citrix Users	March 2009		Page 1/4
Hamilton Health Sciences wins MEDSEEKS' 2009 eHealth Excellence Award	April 2009		Page 1/4
eRecords	April 2009		Page 2/4
Hamilton Health Sciences Nursing Research Project will Improve	May 2009		Page 2/4

Allocation of Nursing Staff Resources			
eCare Update	July 2009		Page 1/4
eCare	October 2009		Page 2/4
Diabetes Clinics Implement eCare	December 2009		Page 4/4

APPENDIX G

Tablet Description



Motion C5 Mobile Tablet For Clinical Documentation



The Motion C5 is a wireless, mobile, computer that you can take to the patient's bedside, the med cart or the nursing station. This can result in:

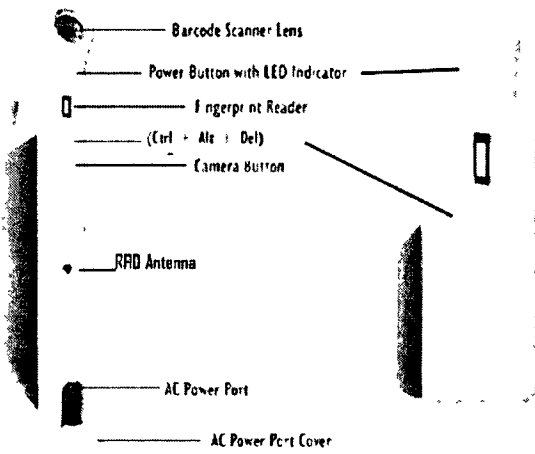
- Increased mobility and accessibility
- Greater access to data at the point of care
- Elimination of duplicate efforts
- Facilitation of real-time documentation
- Increased patient safety

It's weight is a bit over 3 lbs with a 10.4" display screen. It was built to withstand the rigors of the healthcare environment.

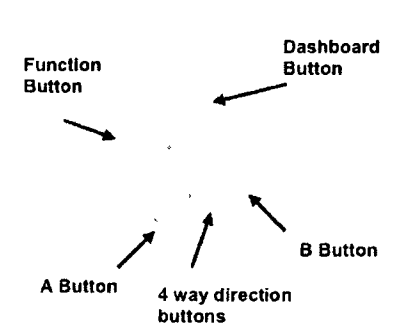
It is highly sealed and easy to disinfect with a sealed display, sealed speaker and buttons, liquid-resistant coating over microphones, and a sealed fan assembly.

The Motion C5 may be attached to a keyboard and mouse when placed into a docking station. When being used as a mobile device, a specially designed "Digitizer Pen" is the device used to maneuver through the screens and input data.

Side View



Top Right Corner



To Turn On: Press the Power Button. It will turn green.

To Turn Off: Press and hold the Power Button for about five (5) seconds.

Buttons

- Dashboard Button - Shift F12
- Function & A - Rotate Screen
- Function & B - Esc
- Function & Arrow Up - Page Up
- Function & Arrow Down - Page down
- A - Launching Citrix Application
- B - Bar Code Reader

Digitizer Pen

The documentation on the tablet may only be made with the specially designed pen. This allows for one to rest their hand on the tablet without causing anything to happen.

Holding the tip on the tablet for two (2) or three (3) seconds provides the same response as pressing the right mouse button.

Tablet Input Panel

Data input is completed by using either the:

On Screen Key Board



Or

Writing Pad



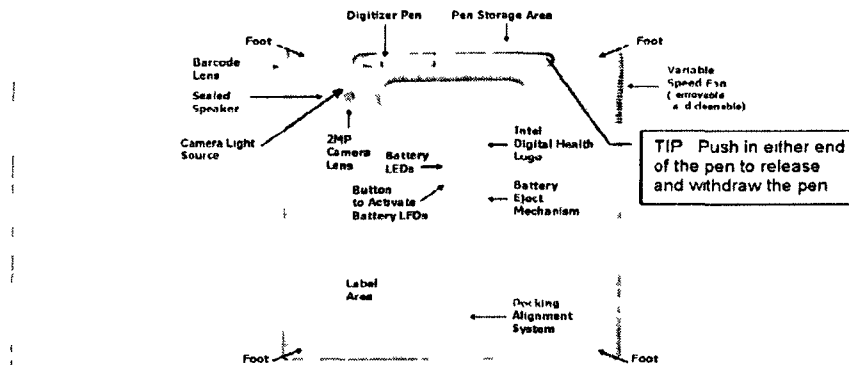
Erasing a Word

To Erase a Word:

- scratch back and forth 2 or 3 times
- use a straight line, not a circle
- start and stop just outside the word

this is how to ~~erase~~

Back View



Battery Life and Care

When not in use, place your tablet in its powered docking station. This will help keep the battery at full power during your shift so you may not need to change the battery during this time. However, if your power gets to 15-20% you should either change the battery or charge it.

Important Points

- Battery life is approximately 3 and 1/2 hours dependent on use
- Charge Time approximately 2 hours to fully recharge
- Can I Hot Swap Batteries? (i.e. change battery without logging off and logging back on)
 - Yes, as long as power is being supplied to the tablet by either the docking station or with the power cord plugged directly into the C5

Checking your battery power level:

To check the power level while you are on battery power, move the pen over the Power Meter icon, shown here, in the system tray at the bottom-right corner of the Motion C5 display. Hovering over this icon shows the number of hours of battery power and the percentage of battery power remaining. (Also, the blue area on the battery icon, representing available power, changes to 1/2 blue and 1/2 silver then to almost all silver as the battery discharges.)



Charging the battery

When the Motion C5 (with a standard battery) is connected to AC power (plugged in), the battery automatically charges until it reaches full charge, even while the Motion C5 is being used. The Battery LED is the one in the middle with the picture of the battery to the right.

Battery LED Status

- Steady green 100% charged
- Amber charging
- Amber slow blink 10% battery remaining
- Low power warning balloon displayed
- Amber fast blink - 3% battery remaining, goes to hibernate/saves data



When the battery discharges to 10% a pop up balloon "low battery message" appears. At 10% power, the battery LED slow blinks amber. If you ignore or do not see the warning, then when the Standard Battery reaches 3%, battery LED fast blinks amber and the system enters Hibernation mode.

When you try to reboot or power on the tablet the green power LED will flash momentarily but the C5 will not reboot.

- Attach the tablet to AC and power on
- Tablet resumes from hibernate mode
- A low power message may still be present
- Tap on the x to close it

Extending Battery Life

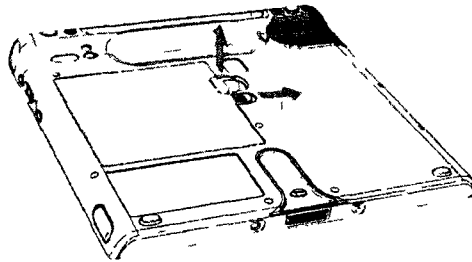
- Place your tablet in standby or hibernate mode when not using it during your work day
- Charge your tablet using the docking station
- Fully charge your battery overnight
- Reboot at least once a week

Removing and replacing the battery

Before you remove the battery, ensure that the C5 is plugged in, turned off, or in Hibernate or Standby mode.

To remove the battery

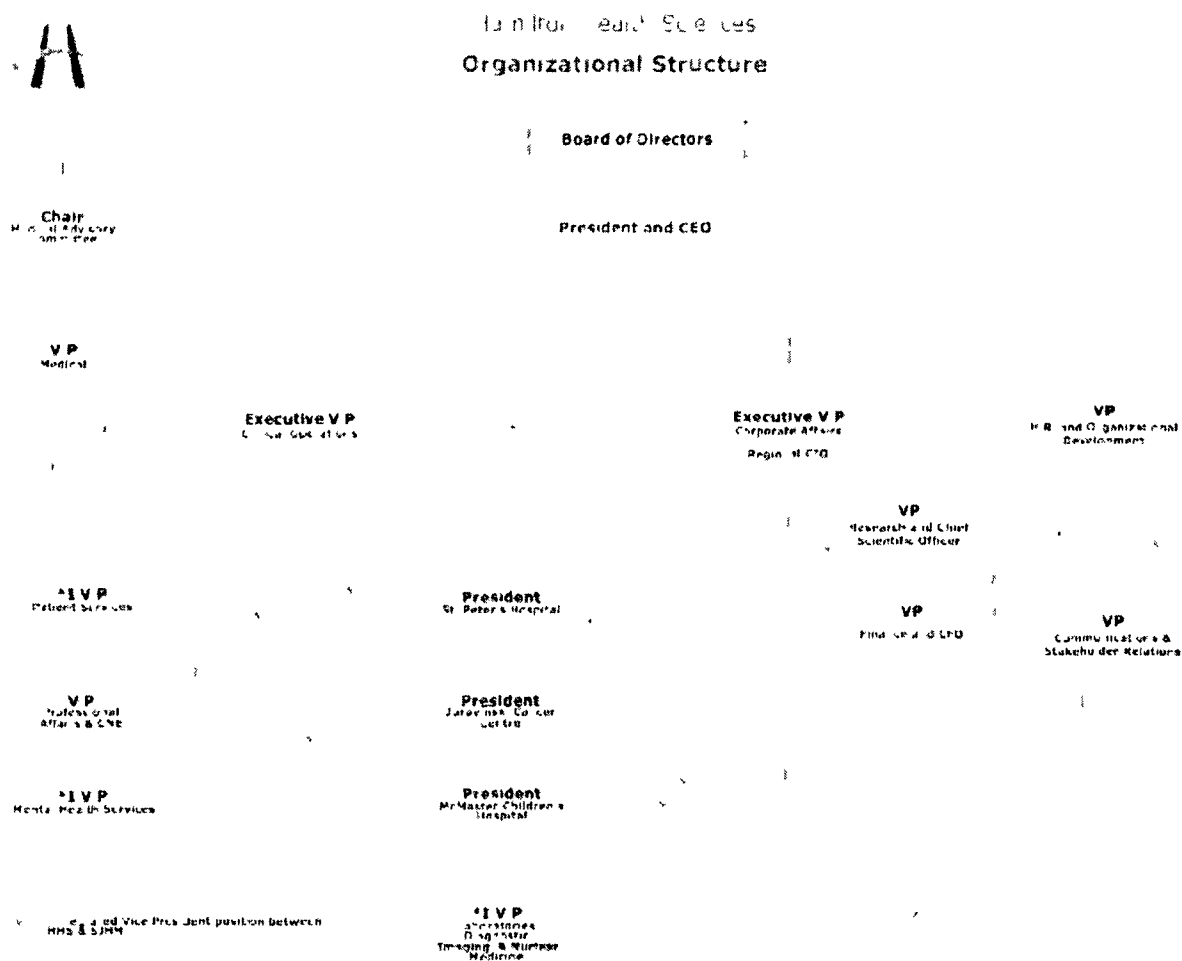
- With the back of the unit facing you, slide and hold the battery latch
- Insert your finger under the finger grip and remove the battery from the battery compartment.



The Tablet is Not Working - Call the Help Desk (43000) if the tablet is not working, or not working properly.

APPENDIX H

Hamilton Health Sciences Organizational Chart (Hamilton Health Sciences)



April 24 09

