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Toward an Integrated Health Information System for Collaborative Decision Making and Resource Sharing: Findings from a Canadian Study

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ABSTRACT

This paper discusses a strategic planning process of a small Canadian hospital necessitated by the continual shortage of physicians and nurses; increasing budget deficit and uncertain financial future; change in community health needs; and the shift towards a regional governance model with emphasis on quality, accountability, and outcomes. Based on the hospital's documents and interviews with the senior management, we find that the hospital is moving toward a model of integrated health information system in collaboration with other hospitals in the region for quality decision making and resource sharing. This paper discusses technical and organizational issues that are likely to arise in and exert influence on the adoption of such a system in the future.

Keywords

Health information systems, Strategic planning, Information integration, Collaborative decision making

INTRODUCTION

Canada's health care system is one of the largest publicly funded health care systems in the world. In Canada, health services are financed by both the public and private sectors. Public sector primarily consists of municipal, provincial and federal governments as well as other social security programs. Private sector financing is through health insurance and out-of-pocket payments, and accounts for about 30% of the total cost. The Canadian Institute for Health Information (CIHI) is a primary institute that collects, analyzes, and disseminates information on health and health care in Canada to the public. While the government is always seen as trying to improve the public opinion on its performance with respect to the health care system, the CIHI has noticed a trend of increasing patient wait times and health care costs in Canada. For example, according to a 2005 survey of adults with health issues, 17% felt a complete restructuring of the system was needed and that Canadian adults waited a median of three weeks for specific diagnostic tests and four weeks for non-emergency surgery and specialists visits. The annual health care cost, which is about \$148 billion and constitutes almost 10% of the economic output, is also growing. In fact, in the last 23 years, the public and private health care cost in Canada has grown by over 300% (Ottawa: CIHI, 2007).

Against this backdrop of growing health care cost and budget deficit, decreasing resources (government funding and shortage of physicians and nurses), and uncertain financial future, a small hospital located in Ontario realized the need to review its existing resources, processes, and structures to understand how it can remain viable and decide where it wants to be in the next 10 years. In the following section, we discuss the strategic planning process initiated by this hospital.

THE NEED FOR STRATEGIC PLANNING FOR THE HOSPITAL

The hospital, called as Hospital A in this paper to maintain anonymity as requested by its senior management, is located in a city of about 32,000 residents in an industrialized and agriculturally rich region of Southern Ontario. The hospital, which is an integral part of the community, is governed by a board of prominent citizens in the area and serves about 6,000 patients per year. Similar to other hospitals in Canada, it is funded by the government with some support coming from its Foundation and charities. In the following section, we describe the hospital's strategic plan for the next 10 years based on our study of the hospitals' documents and interviews with the Manager-Information Services, the Vice President-Corporate Services (VPCS), and the Vice President-Patient Services & Chief Nursing Executive (VPPS).

In recent years, the hospital has been experiencing a continual shortage of physicians and nurses; increasing budget deficit and uncertainty in its financial future; change in community health needs as indicated by the decline in its core health services; and the national shift towards a regional governance model of health care with increasing emphasis on quality, accountability, and outcomes. Faced with these challenges, the hospital formed a steering committee composed of members from the Board, medical staff, senior management, and representatives from a local health integration network called LHIN to develop a strategic plan for the hospital that will ensure its viability and competitiveness for the next 10 years. Strategic planning provides a high level guideline to reach organizational goals and answers questions such as "Where we as an organization want to be in X number of years?" Such a plan is a responsibility of senior management and must include the following four steps: development of a mission statement; assessment of the organization's current state; determination of the desired future position; and development of the actual implementation plan (Engelhardt and Nelson, 2002). According to Tregoe and Tobia (1991), strategy is the vision of senior management which conveys the scope of an organization's products, markets, key capabilities, growth, and allocation of resources.

The hospital initiated a strategic planning process in July 2007 with a mission of maximizing impact on the bottom line while minimizing impact on the accessibility by its community to essential health care needs by making the best use of such resources as people, finance, and information and medical technologies. In order to assess the hospital's current state, the management made a comprehensive review of data from its core services such as emergency room (ER), medicine, intensive care unit (ICU), surgery, obstetrics along with market share and demographic data. After reviewing the data and consulting with the stakeholders, the management identified three distinct alternatives as the future of the hospital: a day hospital; a community-service based hospital; and an acute care hub. In the *day hospital model*, the hospital would operate for 12 hours only, and while there would still be some outpatient services, no emergency care would be provided. This model is based on the current regional program delivery model in which regional hospitals are merged together to provide health care services. In the *community-service based model*, the hospital would have satellite clinics, outpatient surgical program, and general medical services. Such a model would support urgent care and long-term/continuing chronic care beds. As an *acute care hub*, the hospital would have a 24-hour ER, acute care beds, and ambulatory care for cardiac, respiratory, and gastrointestinal patients.

In order to decide on which one of these models to follow, the steering committee used four criteria: adaptability with future needs and changing demographics; potential for collaboration with partner organizations; alignment with the LHIN and the Ministry of Health's Long Term-Care objectives; and sustainability in terms of resources and quality of care. Based on these criteria, the *acute care hub model* was found to be the most suitable and sustainable among the three options. The committee also realized that without an integration of its programs and services, the hospital would not be able ensure the level of quality and patient safety warranted by its strategic plan. According to Raghupathi and Tan (2002), two key dimensions of system integration are: internal integration, and external integration. Internal integration refers to the degree to which "systems and technologies are integrated with one another within an organization" whereas external integration refers to the degree "to which systems and technologies interface with outside organizations and agency computer systems." In order to understand the integration challenges brought about by this strategic plan, we need to identify the key players involved in this process.

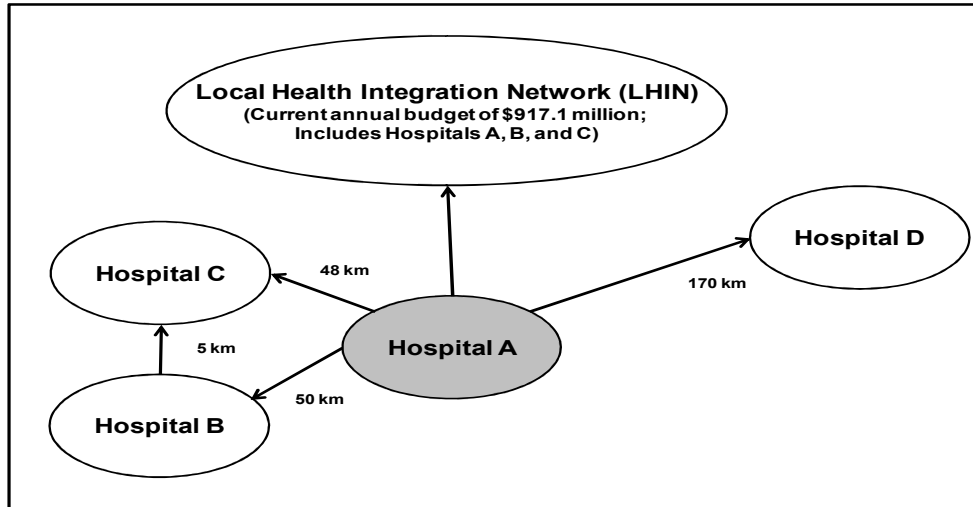


Figure 1. Geographical proximity of key players involved in the external integration process of Hospital A

Dimension of integration	Department/unit	Integration needs
Internal	ER	Standardize data and processes for internal health information system.
	Obstetrics	Align and integrate with medical/surgical (short term goal).
	Information Systems	Develop an integrated infrastructure for clinical decision making (discussed in the next section).
External	ER	Prepare for alignment with the regional health care system.
	Inpatient Chronic Continuing Care	Align and integrate with the LHIN.
	ICU	Align and integrate with Hospital B.
	Obstetrics	Align and integrate with Hospital C (long term goal).
	Rehabilitation	Align and integrate with Hospital C.
	Electronic Patient Record (EPR) Picture Archiving & Communication Systems (PACS) Catheterization Angioplasty Medical Image Database Electronic Results and Transcription	Align and integrate with Hospital D. Currently, there is a remote access to Hospital D through secured connection for limited services.
	Information Systems	Align and integrate with other health information systems for collaborative decision making through seamless flow of data. (Long-term IT strategic goal)

Table 1. Integration needs for Hospital A

As shown in figure 1, Hospital A would be collaborating with the LHIN, and other three major hospitals (B, C, and D). The LHIN is a community-based, non-profit organization funded by the Ministry of Health and Long-Term Care to plan, fund and coordinate health care services, and consists of hospitals, long-term care centers, community care access centers, mental health agencies, community health agencies, community health centers, community support services, addiction agencies, and assisted living services. The LHIN includes the hospitals A, B, and C and has a total budget of \$917.1 million for the current year. Hospitals B and C are two major hospitals in the city. Hospital D, which is located in another city about 170 km away, is a major medical research center and teaching hospital for the region. Table 1 summarizes the integration needs for Hospital A as suggested by the steering committee. In the following section, we discuss the IT infrastructure of Hospital A.

TOWARD AN INTEGRATED HEALTH INFORMATION SYSTEM

As outlined in Table 1, Hospital A needs to have an integrated IT infrastructure to meet its internal integration needs for clinical decision making. Figure 2 shows the hospital’s IT integration strategy that has been continually evolving since the last decade. We now briefly describe various components of this IT architecture.

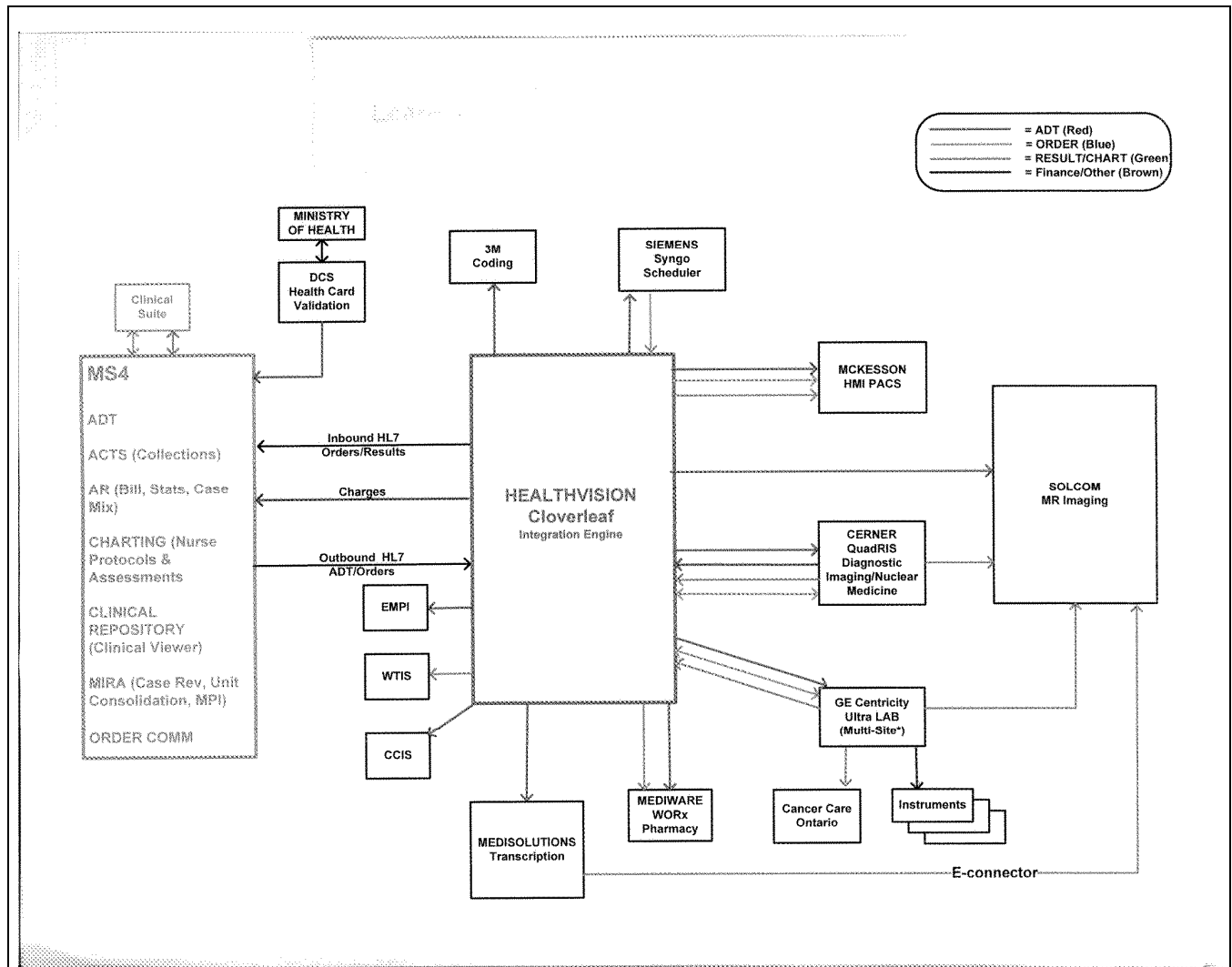


Figure 2. Integrated IT architecture for Hospital A (Source: Hospital document)

CloverLeaf by HealthVision is the most critical component in this architecture, and is being used by both Hospital A and B as their primary integration engine. HealthVision is active in promoting healthcare technology standards through certification, association participation, and leadership. Some health care initiatives it is currently undertaking are: Health Level 7 Working Groups, Integrating the Healthcare Enterprise (IHE), Workgroup for Electronic Data Interchange (WEDI), eHealth Initiative etc. McKesson's product HMI PACS (Horizon Medical Imaging for Picture Archiving and Communication System) is being used for storing images. There is a strategic relationship between HealthVision and McKesson, and therefore, many McKesson customers are using CloverLeaf. There is an HL7 messaging system in the central admitting section of Hospitals A and B that has all information in it such as a patient's medical record number, account number, diagnosis, when and what she was there for, where she was located in the hospital, etc. All that information comes into the CloverLeaf integration engine, from where it is broadcast to every other unit such as lab, radiology, health records etc. For magnetic resonance imaging (MRI), a SolCom device is used.

Similarly, Cerner's device called QuadRIS is used for Diagnostic Imaging and Nuclear Medicine. General Electric's Centricity is used for electronic medical record (EMR) system. For EMR, Hospital A was initially using MediPatient developed by MediSolution, which has a suite of products for units such as lab, radiology etc. However, a problem with MediPatient was that it was an "all in one" vendor solution that did not interface with other vendors' products. Since Hospital B was already using GE's Centricity, Hospital A decided to enter into partnership with Hospital B for the purpose of resource sharing which resulted in a significant cost saving for Hospital A. Furthermore, the partnership extended further as they started sharing technical staff and created a virtual common service desk (for email, web, and telephone services) for both the hospitals. In pharmacy, Mediware's WORx is being used which has several useful features such as knowledge based dispensing, integrated decision support, prescription tracking, inventory monitoring and reporting etc. For transcriptions, a MediSolution product is being used. EMPI, WTIS, and CCIS are government projects that have come in the last 5 years to the hospitals. EMPI is a huge master patient index for the whole of Ontario to which every hospital sends their patients' information. WTIS refers to Wait Time Information Systems which optimizes wait times for services such as CT and MTI. Currently, Hospital A sends its radiology information to Hospital B for optimization. CCIS refers to Critical Care IS. CCIS was initially employed in ER. Currently, its use is growing and has been adopted through out the province. ADT refers to Admission, Discharge, and Transfer. ADT data are regularly sent to CloverLeaf engine for analysis and dissemination purpose. Senior management makes comprehensive use of this data to assess the trend in patient admission, discharge, and transfer processes. DCS is a company outsourced by the Canadian government to validate health cards given by patients in hospitals and health care centers. Siemens's Syngo Scheduler is optimization software for patient scheduling.

DISCUSSION AND CONCLUSION

Integration issues, over the years, have been studied across many disciplines and occupy a central place in several management domains. For example, in strategy literature, Lawrence and Lorsh (1969, p. 34) defined them as "...the process of achieving unity of effort among the various subsystems in the accomplishment of the organization's tasks..." In Information systems, we find emphasis on the technical means of integration. For example, organizational integration is the key idea underlying the development and use of widely popular Enterprise Resource Planning (ERP) systems. ERP posits using information technology to achieve a capability to plan and integrate enterprise-wide resources by integrating the applications and processes of various functions such as design, production, purchasing, marketing, and finance of an enterprise. Another perspective focuses on viewing integration as the extent of standardization and interlinking of business processes through technology (Malone et al., 1999; Venkatraman and Zaheer, 1990).

While there may be differences in focus across disciplines, the notion of integration is central to the understanding of complex organizations and their information systems, which have developed significantly over the last few decades. Organizational integration refers to the extent to which distinct and interdependent organizational components constitute a unified whole (Barki and Pinsonneault, 2005). In the health sector, organizational issues play critical roles in the implementation and adoption of information systems (Berg, 1999). In his survey of medical informatics, Collen (1995, p.464) states, "Developing a comprehensive medical information system is a more complex task than putting a man on the moon had been." Several studies published in information systems journals point out that it is very difficult to transport information systems in the medical field to a new context from the context they were initially developed (Heeks, 2006; Levitt, 1994; Schoenbaum and Barneu, 1992; Barley, 1986).

The idea of using information systems to integrate organizational functions is not new as Diebold (1952, p.91), more than a half-century ago, correctly envisioned that “... *the new technology will ultimately bring many of the office functions into closer contact with the production functions.*” Similarly, Blumenthal (1969), as early as 1969, proposed an integrated framework and architecture for organizational information systems. However, the idea was not successfully used until the late 1980s. While there are unparalleled performance benefits in integrating information systems, achieving effective integration remains very problematic due to the numerous technical and organizational challenges (Joshi and Lauer, 1999). Alsène (1999) asserts that integration is problematic not only because there are numerous technical and organizational problems to be solved (connectivity among computer systems, modeling of the enterprise, resistance to change etc.), but also because of the imprecision and confusion of terms. Despite significant advances in this topic, organizational integration remains a challenging domain for research and practice, and has been identified as one of the most important strategic goals for executives in organizations.

It has been noted that strategic alliance among hospitals and physicians is increasing (Burns and Bazzoli et al. 2000). Integrated and collaborative health care management can facilitate the sharing and use of information and identify areas of complementarity and substitutability among health care actors through economies of scope (Cuellar and Gertler, 2006). Health Care organizations are pivoted around the work of professionals and therefore, any potential benefits that information systems may bring to the organization have to be realized through the strategic usage of such systems by health care professionals (nurses, doctors, technicians and so on). Furthermore, it is important to embrace a socio-technical approach while examining the adoption of health care information systems because a heterogeneous network of people is involved in the delivery of patient care (Berg, 1999). For example, an emergency ward, an outpatient clinic, or an in-patient department can be described as a cross functional unit where professionals from various departments work together and information systems, tools, documents, machines, work routines are all reflective of the work practices of that unit. Roles and responsibilities of health care professionals such as nurses and doctors are interdependent on each other and the introduction of any new technological component could affect the architecture of the entire work environment (Barley, 1986). In such a scenario, organizational integration is not just a simple interlinking of computer applications because it stipulates a dialectical understanding and consideration of a wider interaction of technology with the organization in terms of changes to the work procedures, practices, and organizational requirements (Orlikowski, 1992). The challenge of integration in Canadian hospitals is significantly larger for managers because unlike privately owned businesses with a hierarchical chain of commands, Canadian managers do not have much direct influence on health care professionals.

While the integration of services with larger partners provides sustainability and greater access to expertise resulting in higher quality and safer services for the community, it is imperative that the strategic planning be in alignment with the strategic goals and objectives of the organization (Austin and Boxerman, 1997). Furthermore, hospital–physician integration takes on a variety of forms, reflecting different types of risk sharing, integration of operations, degrees of exclusivity, and capital investment (Snail and Robinson, 1998; Burns et al. 2000). Martin et al. (2007) proposed a framework in which they identified four types of integrations as necessary for the successful deployment and adoption of health information systems in hospitals: technical integration of disparate systems; integration of workplace procedures; integration of the system with work practices; and integration of the system with wider organizational requirements. Based on this framework, we will discuss some potential integration challenges for Hospital A.

Technical integration of disparate systems: The current state of IT infrastructure depicted in figure 2 can be described as one showing fragmented organic growth because the hospital has evolved and assembled a collection of disparate systems interfaced by an integration engine called *CloverLeaf*. In the words of the Manager-Information Services,

“All the software that you see around here, these are all [provided by] different vendors. You see, 3M, Siemens, McKesson, Cerner, GE, SolCom, Medware...these are all different vendors. That’s the way we work here. We buy what we feel is the best software for the area, so if I’m going into radiology and I’m buying a radiology system, I don’t care if it’s a HealthVision or whatever. I’m buying the best product for me, and HealthVision can make it work. As long as CloverLeaf can make it work by translating messages. That’s basically it...”

While the need for integrated responses and higher care quality is increasing as revealed in the following paragraph:

“Well, there are growing information demands from clients. We are in the electronic age. People can go to any country in the world and they can go to ATM or Internet and routinely access their financial information....their money is always at their finger tips. The clients today want access to their information. For example, they want to book appointment online. Most of them just want to make sure that their doctor

has it or that their health care provider has it. So they want to know that suppose if a patient resident of Town A shows up in Town B hospital, will the physician in that Town B hospital, be able to access their records in Town A hospital and know what happened two weeks earlier when they showed up for their gall bladder surgery?. Those are the kinds of demand that are coming out from the patients.”

The strategic plan as discussed above stipulates that Hospital A employ an integrated infrastructure for its clinical decision making going forward. However, it became apparent to us that the modules in the existing IT architecture were added not strategically but reactively due to two main reasons: systems were added to the IT infrastructure when an acute need was felt; and when funding from the government was available to purchase such systems. How can a publicly funded hospital such as Hospital A plan ahead of time and come up with a truly integrated IT architecture that is not developed on an ad-hoc basis?

The integration of workplace procedures: From the perspective of workplace procedures, the hospital is viewed as a conglomeration of several functional units such as nursing, diagnostic imaging, lab, allied health (direct services and support), rehabilitation and physiotherapy, indirect support (housekeeping and pharmacy), material handlers (supplies), and health and medical record keeping. Allied health supports nursing. From the service perspective, the hospital is viewed as offering *clinical services* and *corporate services*. Clinical services include operations, diagnostics and health services, in-patient, special services, and outreach. Corporate services include decision support, budgeting, operations planning, service delivery and all non-nursing services.

While we did not see any functional integration of health care procedures currently, there was some evidence of resource sharing. In the words of the Manager-IS,

“We have introduced a shared IT service so we have integrated our department with the IT department of Hospital [B] and what we have now structured basically is one service supporting two clients... As that evolved we started using a lot of common systems and a lot of servers reside at Hospital [B] and their staff were doing some of our support and our staff were doing some of their support, so last year we decided that it didn't make lot of sense with two separate entities [and merged both the IS departments].”

“We have now formed a common virtual service desk, so if you are in Hospital [A] or [B]... whether it's computer work request on line, e-mail, or telephone, it's a central service desk, and there are actually a couple of staff members who are located in hospital [A] daily, but we do have a rotating kind of system for technical work, brake fix and those types of things.”

Integrating the system with work practices: Currently, the hospital considers physicians as privileged who are not supervised by anybody and work under the collaborative partnership model. They are responsible to the Board of Directors of the hospital and are not considered employees of the hospital. We found that the level of work practice integration between physicians and nursing staff was almost non-existent in Hospital A. However, we saw some changes in their work practices due to the introduction of a new system. The Manager-Information Systems describes it very well:

“Here at [B], we put in a new ER system last year. It was a whole process of change in the ER around implementing that system. They had to start doing things differently based on what the system allowed them to do. We took a lot of paper out of the equation, and there is still another phase of this ER project that we have yet to put in that will eliminate even more paper, but I do know that we had our applications specialist again for the project, and she worked a lot with the ER staff and the management of the ER staff changing the way that they processed patients through admitting, triage, and into a bed, so the system definitely forced their hand in some things and for the good. Most of it was for the good. It forces people to do things a certain way. When you've stuff on paper, people can do their own thing on paper. There are no constraints. The only constraint is you're being told you should do it this way, but that doesn't necessarily mean that person is going to do it that way. With a computer system, if you have to fill this in, you have to fill this in. These are required fields and you cannot not fill those things out, so there are some things that the system makes people do that gives us better data at the end of the thing.”

Integrating the system with wider organizational requirements: As shown in figure 1, Hospital A has wider integration requirements with Hospitals B, C, D and the LHIN. Although Hospital A is a member of the LHIN, it still transfers its data to the LHIN through fax and uses its own local ID to identify a patient, thereby making it difficult to share, standardize, and manage information across the LHIN. In fact, all the five hospitals in the LHIN use their own unique numbers to identify their patients. In addition to the lack of data standards among the actors shown in figure 1, the privacy issue regarding patient data seems even more challenging. The increasing complexity in the delivery of medical

services has consistently increased the need for specialized skill-sets, collaboration among several hospitals, and inputs from various government agencies. The paradigm shift in the health care industry is apparent as it is clearly moving from isolated treatment episodes to a continuous treatment process involving multiple health care professionals and institutions (Lenz et al., 2007). Several people located in different geographical locations need to have access to patient data for providing health care. The end result is that we have now an industry which today is highly regulated and privacy issues are of prime concern. The privacy and security of health care data is one of the most serious challenges that these hospitals are likely to face when they go for wider organizational integration. In the words of the Vice President-Corporate Services (VPCS):

“In the healthcare business we deal with information and compliance requirements placed by several regulators. The biggest regulator (in our business) would be the chief privacy officer for province, and then there is an interface with the twelve professional colleges. All the colleges have some involvement with the hospital from regulatory perspective.”

In conclusion, we find that while there is a strong financial and regulatory motivation for Canadian hospitals to move toward integrated health information systems, they are likely to face several integration challenges. A majority of these challenges are socio-technological in nature and are deeply embedded in the development history of the health care professions, organizational context, and country specific legislations which govern these professions.

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