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Health Information System Implementation in a Complex Acute Care Environment: A Sociotechnical Analysis

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ABSTRACT

With the increase of information systems in health care, there is a growing need to better understand factors that contribute to the implementation and use of such technology. This secondary analysis explored the implementation of a health information system in a large acute care hospital from the perspective of hospital leadership and the health information system developers. The purpose of this study was to: (a) explore a group of interprofessional leaders' perceptions of social and technical factors which impacted an HIS implementation within an acute care hospital organization; and, (b) uncover how the various social and technical forces contributed to, or prevented, successful implementation of the HIS in relation to nursing practice and education.

A directed content analysis approach was used to obtain an understanding of participants' perceptions regarding health information system implementation and use. Sittig and Singh's (2010) sociotechnical framework was chosen as a theoretical framework to guide the analysis of focus group (n=17, in 3 separate groups) and interview data (n=10) from a longitudinal study at an acute care hospital in Ontario, Canada.

Several benefits of the health information system implementation were realized including increased organizational transparency regarding patient flow and improved communication among managers and directors. Findings also indicated that implementation was compromised by problems with inaccurate data stemming from poor interoperability with other health information systems, insufficient training, and turnover of leadership during the implementation process. This type of research is important to support future implementation of information and communication technologies and

contribute to a growing body of knowledge regarding the implementation of health information systems in complex healthcare environments. The consolidated evidence generated from this content analysis also has implications for the nursing profession and development of clinical practice. Further evaluation measures must be undertaken to more fully understand the role of nurses in health information systems implementation and optimize the use of these technologies in supporting nursing practice and improving patient care.

Keywords: nursing, sociotechnical, health information systems, implementation, hospital

COAUTHORSHIP STATEMENT

Maximillian Besworth completed the following dissertation under the supervision of Dr. Lorie Donelle, Dr. Richard Booth, and advisor Dr. Deborah Compeau, who will be co-authors on the publication resulting from the manuscript.

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PART ONE

INTRODUCTION

Health Information System Implementation in Acute Care Hospitals

Within the global context, health care is becoming increasingly complex (Aretz, 2011). This is especially true for acute care settings, where the delivery of health services is complicated by rising patient acuity, greater complexity of organizational factors (e.g., structure, culture, and policy), and an increased need for communication, role clarity, and leadership (Hughes, 2008). As a result, current efforts in healthcare have focused on the management of healthcare data and information through *information and communication technology* (ICT) (Kabene, King, & Gibson, 2010). In particular, ICTs, defined as any technology that processes and communicates data (Kabene et al., 2010), have been widely implemented within various healthcare environments (including acute care hospitals) to assist healthcare providers toward managing various patient care elements (Arvanitis, 2014).

Health information systems (HIS) are an example of a specific type of ICT. Operationally, HIS usually refer to “any system that captures, stores, manages, or transmits information related to the health of individuals” (Amorim & Miranda, 2015, p. 170). Health information systems serve a multitude of user populations for a wide array of purposes. Some of these functions include enabling decision-makers to identify organizational concerns and provide recommendations toward the appropriate allocation of resources (World Health Organization, 2008). Other times, HIS are more specialized technology working directly to support the diverse informational needs of clinical leadership (e.g., staffing, organizational census, wait times), clinicians (e.g., past medical

history, primary and secondary diagnoses, allergies), as well as other healthcare providers.

The implementation process is an extremely important phase of a series of events related to the lifecycle of an HIS (i.e., design, development, implementation, and evaluation) (Yusof, Papazafeiropoulou, Paul, & Stergioulas, 2008). Despite an impressive amount of research studying elements of HIS in healthcare environments, failures of this form of technology are still extremely common in the literature (Irizarry & Barton, 2013; Johnson, 2011; Pai & Huang, 2011). It has been suggested that an ongoing challenge to the implementation of HIS is the dynamic and complex context of most healthcare environments (Sittig & Singh, 2010). Along with the complexity of the environments where HIS technology is commonly located, implementations of this form of technology are also further complicated by various *social* elements (e.g., hierarchies, workflow, communication patterns, and attitudes towards the system) that exist within hospital organizations. Sittig and Singh (2010) identified several socially mediated factors that are commonly present within hospital environments, including: organizational policies, unit specific pressures, and experience of the end-users (e.g., nurses, physicians). For example, the introduction of clinical technology like HIS into acute care hospitals is often accompanied by significant changes in clinician workflow, altered communication patterns between providers, and typically requires extensive user training (Koppel et al., 2005). Correspondingly, the implementation of HIS also introduces a range of *technical* factors into healthcare environments. Researchers have repeatedly highlighted the neglect of clinicians' needs (e.g., intuitive interface navigation, use of HIS at point of care, regular access to computers) relative to technical system

components (Courtney, Demiris, & Alexander, 2005; Leatt, Shea, Studer, & Wang, 2006; Studer, 2005).

Health Information System Implementation and Nursing

As reported in the research literature examining health technology used to support clinical practice, the implementation of HIS into a clinical environment will inevitably affect both nursing practice and the related processes of patient care (Gephart, Carrington, & Finley, 2015; Huston, 2013; Koppel et al., 2005). However, there is a sizable gap in the nursing specific research literature exploring the impacts of HIS and its implementation within the nursing context (Gephart et al., 2015; Oroviogiochea, Elliott, & Watson, 2008; Pringle & Nagle, 2009). Nurses, representing the largest cohort of healthcare providers in Canada (Canadian Institute for Health Information, 2013), provide a critical link in the coordination of patient care across the health system. Due to nurses' central role in coordinating patient care, they are considered "key collectors, generators, and users of patient information" (Urquhart, Currell, Grant, & Hardiker, 2009, p. 2). As such, implementing HIS into environments where nurses work has the potential to alter nursing practice, through changes to work processes and flow; interdisciplinary communications; and the redefinition of various point-of-care activities (Coiera, 2004; Stein & Deese, 2004).

Since hospitals are a primary area of employment for many nurses, understanding the role of nurses and their interaction with health technology (including HIS) can have significant impacts on the role of the nurse and patient care (Oroviogiochea et al., 2008; Remus & Kennedy, 2015). Therefore, examining the interaction of *social* and *technical* factors that influence the implementation of HIS is argued to be necessary in

order to understand how HIS can impact nursing practice and education. To do this, the purpose of the study was to explore an interprofessional group of leaders' perceptions of social and technical factors which impacted an HIS implementation within an acute care hospital organization.

Theoretical Background

The Sociotechnical Approach

With roots in information systems theory (Bijker & Law, 1992; Mumford & Weir, 1979), a *sociotechnical* research approach allows researchers to deconstruct the relationships of, and between, humans and technology (Aarts, Peel, & Wright, 1998; Berg, 1999). Moreover, a sociotechnical approach to observing phenomena highlights the interrelation and coexistence of both *social* and *technology* elements in environments (Berg, Aarts, & van der Lei, 2003; Berg, 2001; Cresswell, Worth, & Sheikh, 2012; Meeks, Takian, Sittig, Singh, & Barber, 2014; Peute, Aarts, Bakker, & Jaspers, 2010). For instance, the use of clinical technology like HIS can influence human users in a variety of fashions; likewise, humans can exert influence over HIS through the way it is designed, implemented, and used. Therefore, using a sociotechnical approach to explore HIS implementation takes into consideration the various technical (e.g., features of the technology) and social elements (e.g., clinician workflow, care practices) that are active within a healthcare context (Berg et al., 2003; Berg, 2001).

In a review by Giuse and Kuhn (2003), the authors postulated that many of the failures of HIS implementation projects in clinical practice could be a direct consequence of primarily focusing on *technological* aspects of implementation, and minimizing the value and role of the related social factors. Other authors have also provided similar

observations related to the importance of examining both the social and technical elements of HIS implementation. *Technological* factors impacting various elements related to HIS implementation have been well documented in the literature, including (but not limited to): interface design (Coiera, 2003); information exchange between HIS (Arvanitis, 2014); and, data sharing and security (Meeks et al., 2014). Additionally, it has been reported that *social* factors impacted various elements related to HIS implementation including: management and leadership (Scott, Rundall, Vogt, & Hsu, 2005; Takian, Sheikh, & Barber, 2014); changes in communication patterns between healthcare providers (Taylor, Ledford, Palmer, & Abel, 2014); and the training and education of end-users and clinicians (Malato & Kim, 2004; Meeks et al., 2014; Törnvall, Wilhelmsson, & Wahren, 2004). These previous findings emphasize the need to consider HIS implementation as a socially contextualized process involving the exploration of both the people involved, and the technology itself.

Sittig & Singh's Eight-Dimensional Sociotechnical Framework

Sittig and Singh (2010) developed an eight-dimensional sociotechnical model to study health information technology at all phases of design, development, implementation, and evaluation (Figure 1). Informed by earlier sociotechnical models (Carayon et al., 2006; Harrison, Koppel, & Bar-Lev, 2007; Henriksen, Kaye, &

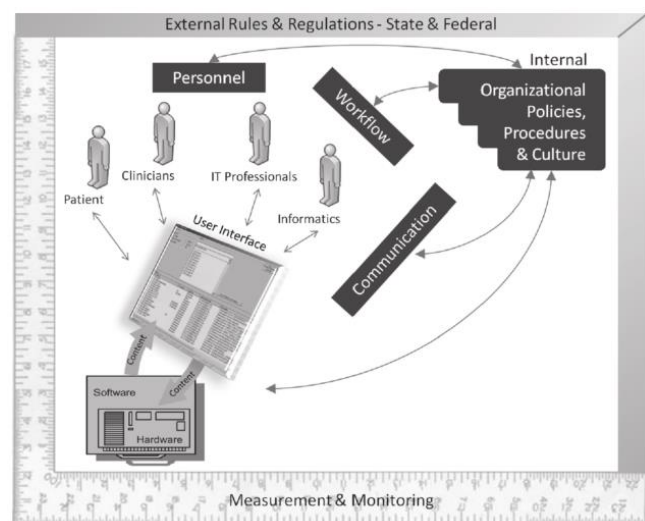


Figure 1. Illustration of the complex inter-relationship between the eight dimensions in Sittig and Singh's (2010) sociotechnical model. Reprinted with permission from British Medical Journal Publishing Groups Limited. Copyright 2010.

Morisseau, 1993; Vincent, Taylor-Adams, & Stanhope, 1998), Sittig and Singh (2010) provide a multidimensional framework by which any HIS can be both conceptualized and studied. To date, Sittig and Singh's (2010) framework has been operationalized in medical and information systems literature (Meeks et al., 2014; Menon et al., 2014; Singh, Ash, & Sittig, 2013) and was selected as the theoretical lens for this study due to the model's appreciation of both social and technical factors that influence HIS implementation.

Sittig and Singh's (2010) model is comprised of eight sociotechnical dimensions, representing interdependent domains of a digitally enabled healthcare system: *hardware and software; clinical content; human-computer interface; people; workflow and communication; internal organization policies, procedures, and culture; external rules, regulations, and pressures; and system measurement and monitoring* as found in Table 1.

Key Constructs	Construct definitions adapted from Sittig & Singh (2010)
Hardware and Software Computing Infrastructure	A technical dimension; comprised of the physical devices and software required to operate the HIS.
Clinical Content	Represents everything that can be entered, read, modified, or deleted by users.
Human-Computer Interface	Any aspects of the HIS that users can see, touch, or hear.
People	Accounts for the humans (e.g., healthcare providers, HIS developers, patients, training personnel) involved in the design, implementation, and use of HIS.
Workflow & Communication	Includes the necessary steps needed to provide patients with the care they need at the time they require it.
Internal Organizational Policies, Procedures, and Culture	Inclusive of the organizational structures, policies, and procedures that impact every other dimension of the model (i.e. budgetary allocation, IT policy & procedure).
External Rules, Regulations, and Pressures	The external forces that support or restrain the design, implementation, use, and evaluation of HIS.
System Measurement & Monitoring	Accounts for system measurement and monitoring addressing four key areas regarding the features and functions of HIS: (a) availability of features/functions for use; (b) determination of function use by clinicians; (c) system effectiveness on healthcare delivery and patient health; and (d) unintended consequences of the system.

Table 1. Sittig and Singh's (2010) sociotechnical model construct definitions.

Sittig and Singh's (2010) model does not assume that the eight dimensions are a linear, series of independent sequential steps; rather, the eight dimensions are viewed as interrelated entities that must be examined in relation to one another (Sittig & Singh, 2010).

One of the significant benefits of the sociotechnical model is that it can provide researchers with a lens from which to view and analyze the relationship between healthcare providers and HIS. Due to the model's sensitivity toward various social and technical factors in relation to HIS use, it can be used to deconstruct various processes and actions performed within clinical environments. For instance, the ordering and administration of a medication within an acute care environment requires a complex array of people (e.g., nurses, physicians, patients), clinical content (e.g., medication order), and other various workflow patterns between providers and patients (e.g., delivering and administering the medication). Similarly, administering a medication also requires other human-computer interface interactions (e.g., electronic medication administration record use), with all elements of the process being mediated by larger, external rules and regulations (e.g., College of Nurses of Ontario Medication Administration Practice Standard). Therefore, even in the simple act of administering a medication to a patient, there are a wide range of social and technical elements that take place, which are important for researchers to recognize and appreciate.

Sociotechnical Theory in Nursing and Leadership

Although research has shown sufficient support for the utilization of sociotechnical theory in the medical and information systems literature (Berg et al., 2003; Harrison et al., 2007), this perspective is underutilized to inform nursing practice and

education (Booth, Andrusyszyn, Iwasiw, Donelle, & Compeau, 2015; Kerr, 2002). To date, most of the research on the impact of HIS is physician or administration centric, neglecting the nursing role in HIS design and implementation (Waneka & Spetz, 2010)

Since HIS implementation is commonly a multidisciplinary endeavor, the unique information needs for nursing practice must be considered when designing and implementing these forms of clinical technology (Stein & Deese, 2004). The existing evidence indicates that nurses are commonly not consulted regarding the development or customization of the HIS until after implementation of the system (Oroviogicochea et al., 2008). Decisions regarding system selection, design modifications, and strategies to integrate a new HIS are often made by hospital management, and greatly impact the day-to-day activities of frontline staff expected to use the system (Kirkley & Rewick, 2003). It has also been noted that leadership's perceptions and attitudes towards HIS greatly impacts system performance (Health Metrics Network, 2008). Therefore, exploring how organizational leadership (e.g., executive level members, directors, and managers) both conceptualize and plan HIS implementation within clinical environments is an important direction for nursing research as this stakeholder group has the ability to directly influence various elements of an HIS and its subsequent impact on the nursing role (Kirkley & Rewick, 2003; Remus & Kennedy, 2012).

Conclusion

To date, there is a considerable lack of research exploring the perceptions and decision-making processes of organizational leadership regarding HIS implementation and its impact on the nursing role. It is suggested that using a sociotechnical framework to help deconstruct the social and technical influences active during an HIS

implementation can help to generate deeper insights related to implementation and the nursing role. Further, critical examination of HIS implementation may also lead to more comprehensive understanding of the role nursing leadership plays in regards to the integration of HIS into acute care hospital environments.

In order to accomplish these goals, a study was conducted to explore the perceived impact of social and technical factors on HIS implementation. The objectives of this study were: (a) to explore a group of interprofessional leaders' perceptions of social and technical factors which impacted an HIS implementation within an acute care hospital organization; and, (b) to uncover how the various social and technical forces contributed to, or prevented, successful implementation of the HIS in relation to nursing practice and education.

This secondary analysis offers three contributions for those involved with HIS implementation and the nursing profession. Firstly, a review of published research literature allows for the integration of existing evidence regarding HIS implementation and nursing. Secondly, reconciling and reporting the findings from this study helps to identify sociotechnical factors impacting HIS implementation and clinical adoption from a nursing lens. Lastly, the consolidated evidence generated from this study provides a logical basis for recommendations for the nursing profession and development of clinical leadership in acute care settings.

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PART TWO
MANUSCRIPT

In North America, acute care hospitals are turning to *information and communication technologies* (ICT) to help restructure and optimize various elements of the delivery of healthcare (Andersson, Hallberg, & Timpka, 2003; Stein & Deese, 2004). Nurses, as the largest group of healthcare providers, are invariably affected by the introduction of such technologies (Waneka & Spetz, 2010). As such, understanding the role of nurses and their interaction with these technologies can have an impact on nursing processes and overall quality of care (Oroviogicochea et al., 2008; Poissant, Pereira, Tamblyn, & Kawasumi, 2005).

Health information systems (HIS) are one example of ICTs, and are defined as “any system that captures, stores, manages, or transmits information related to the health of individuals” (Amorim & Miranda, 2015, p. 170). Although many hospital organizations have realized benefits from implementing HIS (Chaudhry et al., 2006; Leape, Berwick, & Bates, 2015; Rahimi, Vimarlund, & Timpka, 2009), many are struggling to refine strategies to effectively implement HIS and operationalize their use (Nagle & Catford, 2008; Ontario Hospital Association, 2007, 2008).

In the context of HIS, implementation is one element of a series of phases (i.e., design, development, implementation, and evaluation) related to HIS integration (Kaufman et al., 2006). The implementation phase encompasses all processes involved in ensuring HIS operates in the healthcare environment, including installation, customization, systems integrations, user training, and optimization (Ovretveit, Scott, Rundall, Shortell, & Brommels, 2007). In general, individuals working in hospital

leadership roles (e.g., patient care managers, directors, executive level members, information technology coordinators) are called upon by their respective organizations to oversee this process. Hospital leaders often oversee the allocation of resources (both human and financial), identify other key stakeholder and leaders, establish reasonable goals, and communicate expectations to the staff using the HIS (Health Metrics Network, 2009).

Although nurses are the most numerous of healthcare providers (Canadian Institute for Health Information, 2013) and often the largest group of HIS users (Waneka & Spetz, 2010), nurses are often underrepresented in the implementation process (Oroviogioicochea et al., 2008). For example, decisions regarding system selection, design modifications, and strategies to integrate a new HIS are commonly made by hospital management, and greatly impact the day-to-day activities of frontline staff expected to use the system. As a result, exploring how individuals in leadership roles (e.g., patient care managers, directors, etc.) conceptualize and plan system implementation is important as they have the direct ability to influence how HIS are used (Kirkley & Rewick, 2003). Thus, any exploration of HIS used by nurses is highly informed by the decisions and actions conveyed by the organization's leadership team (Remus & Kennedy, 2012).

The current investigation is a secondary analysis of data collected in a 2014 study conducted at a large urban acute care hospital in Ontario, Canada. The primary study investigated the implementation, adoption, and use of a health information system (denoted by the pseudonym *Iris*) and employed the *Unified Theory of Acceptance and Use of Technology* (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003) and the *Theory*

of *Planned Behaviour* (TPB) (Ajzen, 1991) as the guiding frameworks for the research. The purpose of the primary research was to study the contextual features of the health care setting, which may influence the adoption and use of the HIS.

As part of the primary study, a specific HIS platform (*Iris*) was targeted for examination within the acute care hospital. Originally developed by a Canadian healthcare technology company, *Iris* functioned as a clinical decision support system, a category of HIS designed to gather, share, analyze, and use health-related data for decision-making surrounding patient flow throughout the hospital (Health Metrics Network, 2009; Sim et al., 2001). Through integration with third-party information management systems (i.e., Operating Room Patient Tracker, Emergency Department Information System, Bed Management System), *Iris* allowed healthcare organizations to track patients' progression as they moved through the hospital system. Additionally, *Iris* displayed key metrics including patients' length of stay, unit occupancy, organization-wide census, potential and confirmed discharges, and the number and location of alternative level of care (ALC) patients on a centralized dashboard in real time. The dashboard was a series of screens that displayed aggregated data that was made available on mobile devices including smartphones, as well as traditional on-site access on desktop and laptop computers. One of the main features of *Iris* was the real-time clinical reporting functionality of the system. As hospital staff and clinicians entered clinical data into various HIS across the hospital (e.g., Operating Room Patient Tracker, Emergency Department Information System, Bed Management System) all data were aggregated and displayed in real-time on the *Iris* dashboard. Instantaneous access to data of this nature

was intended to inform and support decision-making processes for hospital employees managing patient flow.

Guided by Sittig and Singh's (2010) sociotechnical framework, a secondary content analysis of the original study data was used to generate deeper understandings of the factors involved during HIS implementation to afford recommendations for nursing practice and education. This theoretical framework was selected due to its sensitivity toward the examination of HIS at all phases of design, development, implementation, and evaluation (Sittig & Singh, 2010). Subsequently, it was concluded that the model's dimensions accurately represent interdependent domains active in the *Iris* implementation: *hardware and software; clinical content; human-computer interface; people; workflow and communication; internal organization policies, procedures, and culture; external rules, regulations, and pressures; and, system measurement and monitoring.*

Review of Literature

A review of the research literature related to the HIS implementation within clinical environments was conducted using the Cumulative Index to Nursing and Allied Health Literature, Scopus, and PubMed databases. The search terms used to locate relevant literature included: *nursing, nurse leadership, health information system, implementation, acute care hospital, and sociotechnical*; these search terms were used individually and in combination. In addition to an extensive database search, the ancestry method (Conn et al., 2003) and hand searching of relevant journals and grey literature were conducted to identify pertinent articles in accordance with the following criteria: (a) written in English; and, (b) a focus on hospital-wide HIS implementation. Further

inclusion criteria included reports published between 2000 and 2015. Strudwick (2015) suggested that health technology literature originating prior to 2000 was significantly more diverse and less relevant for comparison purposes. Exclusion criteria included studies that lacked discernable research methods and unpublished manuscripts.

The initial literature search returned 1898 citation titles. Conducting an initial title review identified articles that warranted further screening, and reduced potentially relevant sources from 1898 to 315. In this process, the majority of articles were discarded as they focused on HIS in settings and contexts other than implementation in acute care hospitals. Abstracts were then examined with respect to the type of HIS being implemented, the setting/sample, methodology, and results. Following an in-depth abstract review of these 315 articles, 146 were considered relevant for further review. An in-depth read-through of each article resulted in 35 articles for inclusion in the final thesis.

This literature review findings are presented according to three major thematic areas identified in the literature: *Nursing and HIS*, *Nursing and HIS Implementation*, and *Nursing and Sociotechnical Research*.

Literature Review Findings

Nursing & Health Information Systems

Studies within nursing examining HIS have predominately focused on nurses' attitudes, satisfaction, and the relationship of nurses' characteristics (e.g., expertise, clinical experience, and age) with technology use (Dillon, Blankenship, & Crews, 2005). Cross-sectional survey methods were commonly used in this type of research, sometimes complemented with qualitative approaches including focus groups, observation, and

interviews. Several reviews exploring nursing research on inpatient hospitals' HIS have also been conducted to date (Ammenwerth, Gräber, Herrmann, Bürkle, & König, 2003; Oroviogicoechea et al., 2008; Timmons, 2003), providing insight into the implementation process from a nursing specific perspective.

Nurses' attitudes have been defined as a key factor for HIS acceptance and use (Dillon et al., 2005). Alpay and Russell (2002) examined nurses in primary care settings (N=128) and found that nurses were motivated to increase their knowledge and abilities regarding HIS. Several studies also suggested that nurses' attitudes regarding HIS use are favourable, as nurses believe HIS benefit patients (Thomas & Warm, 2009), enhance patient safety (Hyun, Johnson, Stetson, & Bakken, 2010; Thomas & Warm, 2009), and satisfy nursing information needs (Collins, Bakken, Cimino, & Currie, 2007; Hellesø & Lorensen, 2005; Thomas & Warm, 2009).

Although the nursing research literature has generally viewed HIS in a positive light, there were a handful of studies that outlined conflicting findings related to the value and role of HIS. Darbyshire (2004) explored nurses' experiences using HIS in their daily work and found nurses to be critical of systems; participants reported that the HIS was unable to reflect nursing practice or capture much of what they believed to be crucial nursing care. These findings are corroborated by several other studies, as nurses reported feeling conflicted using rigid systems unable to accommodate the caring practices of nursing care (Lee, 2005; Moody, Slocumb, Berg, & Jackson, 2004).

Many researchers examining the use of HIS in nursing populations also possessed strong opinions related to the issue of user-friendliness of the system (Moody et al., 2004; Smith, Smith, Krugman, & Oman, 2005; Timmons, 2003). The main reasons for

dissatisfaction among nurses included: poor system navigability, slow system response, and inability to provide a comprehensive overview of patient progress (Cresswell, Worth, & Sheikh, 2010; Darbyshire, 2004; Moody et al., 2004; Smith et al., 2005; Timmons, 2003). Furthermore, several studies reported reduced clinician productivity resulting from the extra tasks, such as system navigation, entering orders, and processing reports generated by the HIS (Cresswell et al., 2012; Lapointe & Rivard, 2006; Scott et al., 2005). This increased time dedicated to administrative tasks was suggested to result in less time to focus on clinical activities (Ash & Bates, 2005; Cresswell et al., 2012; Takian, Sheikh, & Barber, 2012) and impacted communication patterns among providers, reducing face-to-face communication between nurses and physicians (Campbell, Sittig, Ash, Guappone, & Dykstra, 2006). Other studies echoed these findings, reporting workarounds (i.e., methods for overcoming a problem or limitation in a program or system) (Debono et al., 2013), when HIS could not accommodate clinician workflow (Campbell et al., 2006; Cresswell et al., 2012).

The relative advantages of eliminating paper-based clinical documentation and record systems in favour of an HIS were also reported by several authors (Aarts & Berg, 2004; Campbell et al., 2006). Switching to electronic provider order entry and clinical documentation was found to improve documentation legibility, support simultaneous and remote access to electronic health records, and allow for the integration of health information with other information sources (Alpay & Russell, 2002; Campbell et al., 2006). Despite positive findings, in several studies the transition from paper to electronic documentation was found to add stress to nurses' heavy daily workload and decreased their satisfaction with using HIS (Dienemann & Van de Castle, 2003; Dillon et al., 2005;

Hughes, 2003; Kirkley & Rewick, 2003; Smith et al., 2005; Van Der Meijden, Tange, Troost, & Hasman, 2003). Slow system response time, difficult system navigation, and limited availability of technical support emerged in the literature as key factors affecting the willingness of nurses to use HIS (Dienemann & Van de Castle, 2003; Hughes, 2003; Van Der Meijden et al., 2003).

Finally, several studies reported positive outcomes of HIS implementation when nurse leaders played an integral role in HIS design and implementation (Kirkley & Rewick, 2003; Oroviogicochea et al., 2008). Increased involvement of nursing leadership (executives, managers, and frontline nurses) in finding and implementing HIS has been linked to increased adoption by nurses and a reduction in the number of adverse drug events (Kirkley & Rewick, 2003). A review by Oroviogicochea et al (2008) aligned with these findings, suggesting that effective nursing leadership and involvement from nurses throughout design, development, and implementation is important to support effective implementation of HIS.

Nursing & Health Information System Implementation

Implementation refers to processes involved in ensuring an HIS is inserted into a healthcare environment, including all elements related to the installation, customization, testing, systems integration, user training, and optimization processes (Ovretveit et al., 2007). HIS implementation in acute care hospitals can span a significant continuum, lasting from months to years (Rahimi et al., 2009), with the majority of the difficulties encountered in the first six months (Kirkley, 2004). Regardless, in the implementation of any new clinical technology, a user learning curve is commonly experienced before

nurses are able to operate effectively (Dienemann & Van de Castle, 2003; Kirkley & Rewick, 2003; Kirkley, 2004; Lee, 2007).

A significant issue raised in the research literature exploring HIS implementation related to insufficient training of users, including nurses and other clinicians. It has been found that organizations sometimes underestimated the time and commitment required by staff members to adopt a new technology (Dienemann & Van de Castle, 2003).

Similarly, nurses have also reportedly found training to be inadequate and ineffective (Malato & Kim, 2004; Meeks et al., 2014; Törnvall et al., 2004). Takian and colleagues (2012) found that educational sessions often took place in formal education settings (e.g., classroom) and concentrated on how to operate the system, rather than focusing on the actual work practices or value of the HIS for clinical care. To maximize the benefits of training, educational sessions should be offered immediately following the technology implementation date (within days or weeks); nurses should also be re-trained to the HIS and offered additional information to ensure that the new system is being used appropriately (Dienemann & Van de Castle, 2003; Husting & Cintron, 2003). Several authors have also suggested that well-designed HIS-specific training programs are required to help nurses through the unsettling experience of clinical technology implementation (Husting & Cintron, 2003; Lee, 2005).

Engaging users in the implementation process was also found to impact subsequent adoption and use of HIS (Faber & Getrouw, 2003; Rahimi et al., 2009). In cases where implementation plans did not involve key stakeholders and users (e.g., nurses, patients, and the general public), clinicians tended to resent the system and resisted implementation (Ash et al., 2007; Cresswell et al., 2012; Lapointe & Rivard,

2005; Poon et al., 2004). Such resistance was also related to the involvement of clinicians in the initial design and implementation planning (Odhiambo-Otieno, 2005; Takian et al., 2012). Lack of adequate feedback to clinicians about leadership's decision making on HIS design and introduction also resulted in reduced efficiency of use (Ash et al., 2007), diminished interest and collaboration (Peute et al., 2010), and in some cases project downsizing and termination (Aarts & Berg, 2004; Lapointe & Rivard, 2005).

Finally, it was found that if nurses do not possess a firm grasp of the processes and functionality involved with using HIS, the subsequent implementation will be more difficult (Kirkley & Rewick, 2003; Waneka & Spetz, 2010). Several strategies have been proposed in the literature to facilitate the implementation process regarding the needs of nursing, many of which are best filled by nursing leadership (Kirkley & Rewick, 2003). Parker (2002) suggested setting expectations early in the design and implementation phases, and reinforcing them on a continual basis. Additionally, Parker (2002) suggested involving nurses in all stages of HIS design, implementation, and use, requesting and acting on feedback from nurses, and actively disseminating the goals and outcomes for the project to all users.

Nursing & Sociotechnical Research

Although research has shown sufficient support for the utilization of sociotechnical theory in medical and information systems literature (Berg et al., 2003; Harrison et al., 2007), this perspective is underutilized to inform nursing practice and education (Booth, Andrusyszyn, Iwasiw, Donelle, & Compeau, 2015; Kerr, 2002). Oroviogicoechea and colleagues (2008) conducted a review exploring nursing research on acute care hospitals' clinical information systems. In addition to a host of

recommendations, the authors concluded there is a need for nursing research to better explore the interrelationship of social and technical factors related to HIS implementation. It was also suggested that multi-method approaches including qualitative methodologies might provide more complete interpretations of phenomena involving people and technology within clinical environments (Oroviogiochea et al., 2008).

To date, most of the current research examining the impact of HIS in healthcare is either physician or administration centric, neglecting the nursing role in HIS design, implementation and outcomes (Waneka & Spetz, 2010). However, a substantial body of literature has emerged examining nurses' cognitive perceptions of interacting with technology (Oroviogiochea et al., 2008; Saranto & Kinnunen, 2009). Despite an increased awareness of nurse' interaction with HIS, the roles that technology and people fulfill within these clinical environments are commonly viewed as distinct and separate, instead of viewing both entities as mutually impacting toward one another (Almerud, Alapack, Fridlund, & Ekebergh, 2008a; Booth et al., 2015).

Although not within nursing, a number of studies in the medical and information systems literature have outlined support for Sittig and Singh's (2010) framework in studying HIS implementation (Meeks et al., 2014; Singh et al., 2013; Sittig & Ash, 2011). Similar to this study, Meeks et al.'s (2014) descriptive qualitative research applied Sittig and Singh's (2010) framework to explore the intersection of patient safety and HIS implementation and use. Meeks and colleagues (2014) suggest that sociotechnical models may be beneficial to help stakeholders understand HIS and suggest further research is warranted to gain an understanding of this phenomenon.

Summary of Literature Review

In summary, a number of studies have explored both the benefits and challenges of HIS implementation and use in both nursing and the larger healthcare system. The majority of reviewed studies used cross-sectional survey methods, occasionally complemented with qualitative approaches including focus groups or interviews. Additionally, reviewed studies exploring nursing and HIS were predominantly atheoretical in terms of conceptualization or instrument development.

Documented benefits of HIS implementation include enhanced patient safety, increased efficiency, improved documentation legibility, simultaneous and remote access to electronic health records, and the integration of health information (Alpay & Russell, 2002; Collins et al., 2007; Darbyshire, 2004; Thompson, 2005). Reported challenges include poor navigability, reduced productivity due to increased administrative tasks, increased workload, reduced nurse-physician communication, clinician generated workarounds, poorly addressed technical support requirements, and the inability of HIS to capture the nursing role (Campbell et al., 2006; Dienemann & Van de Castle, 2003; Dillon et al., 2005; Scott et al., 2005). In addition, the implementation strategy (Lawson-Body, Willoughby, Hoffner, & Longossa, 2014), degree of end-user involvement and training (Cresswell et al., 2010; Lapointe & Rivard, 2005; Lee, 2005), and impact of leadership (Kirkley & Rewick, 2003) were presented as key factors affecting HIS implementation. Finally, although the literature emphasized a need for nursing leaders to lead and advance transformative health change through HIS implementation (McCartney, 2004; Nickitas & Kerfoot, 2010; Remus & Kennedy, 2012), there are few reports exploring nursing leaders' roles in HIS design, implementation, and development.

It has also been suggested that further research is warranted to gain an understanding of how HIS implementation impacts the nursing role and subsequent nursing care processes. To date, no studies have used a sociotechnical exploration of experiences of hospital leadership and the HIS developers as a mechanism from which to generate ideas and recommendations to support nursing practice. Therefore, this secondary analysis was completed to examine the implementation of an HIS at a large acute care hospital to better understand the sociotechnical factors that contribute to, or prevent, successful implementation and use of HIS.

Research Questions

Two overarching research questions were asked of the data in order to generate recommendations for nursing practice and education: (a) *In what way do a group of interprofessional leaders perceive social and technical factors which impacted an HIS implementation within an acute care hospital organization;* (b) *How do these various social and technical forces contribute to, or prevent, successful implementation and use of the HIS?*

Methodology

Secondary Analysis

Secondary analysis of qualitative data “involves the use of existing data in order to pursue a research interest which is distinct from that of the original work” (Heaton, 1998, p. 1). Qualitative secondary analysis commonly applies new research questions to existing data, and is often used to generate new knowledge and provide support for existing theories or frameworks (Heaton, 2008). These data can include material such as interviews, questionnaires, field notes, and diaries (Thorne, 1994). There is a growing

interest in re-using qualitative data, as it reduces burden from recruiting additional participants and allows for the wider use of data from inaccessible respondents (Heaton, 1998).

Qualitative Content Analysis

A qualitative content analysis outlined by Hsieh and Shannon (2005) was used to guide this secondary analysis. Content analysis is defined as “a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns” (Hsieh & Shannon, 2005, p. 1278). Based on a naturalistic inquiry approach, this methodology aligns with the philosophy and art of nursing that strives to understand how individuals create meaning in their lives and how they interact with others and their environment (Lopez & Willis, 2004). Often used in nursing research and education, qualitative content analysis has been applied to a variety of data (Hall & Irvine, 2009; Söderberg & Lundman, 2001; Ziegert, Fridlund, & Lidell, 2007). This process has been advocated as being important to the nursing profession and the development of clinical practice (Elo & Kyngäs, 2008; Graneheim & Lundman, 2004).

While all methods of content analysis are used to interpret meaning from the context of data, there are three distinct approaches conventional, directed, or summative (Hsieh & Shannon, 2005). The major differences among the three approaches become evident in the development and utilization of codes for analysis. As an approach used to support or extend a theoretical framework or theory, this secondary analysis was conducted using a directed content analysis. This process involved applying a common

analytical framework to the data, using key constructs to inform initial codes (Hsieh & Shannon, 2005).

For the purpose of this content analysis, the data from the primary study included an interprofessional group of leaders and the HIS developer's perceptions of the implementation of a HIS system in an acute care environment. The purpose of this secondary content analysis was to generate a deeper, and multidimensional understanding of various sociotechnical factors that impact the implementation of a specific health information system, in order to generate recommendations for nursing practice and education. The proposed secondary analysis study was initiated following ethics approval from the Western University Research Ethics Board in February of 2015 (see Appendix C).

Data

An HIS, *Iris*, was implemented in a large, urban, teaching hospital organization in a phased approach (progressive integration of the HIS into a hospital, over a period time). This proposed implementation plan was intended to allow for progressive integration of the technical components of the HIS into clinician workflow and to facilitate more time to conduct a comprehensive staff education program. Data collection for the primary study occurred at two points in time; data were first collected prior to the implementation of *Iris* and at a second time period roughly four months after the initiation of the implementation (February and June of 2014, respectively). Data from the primary study included three anonymized focus group session notes with a broad range of hospital leadership (n=17) including patient care managers, patient flow manager, directors, and members of the executive team, as well as anonymized transcripts from individual

interviews with hospital staff and clinicians (n=10) working in leadership positions (including patient care managers, patient flow manager, directors of care, and members of the executive team). The HIS developers (including the Chief Executive Officer [CEO] and Director of Engineering and Product Development for the technology vendor) were also included in this data set. This cohort of hospital leadership was directly responsible for overseeing the HIS implementation as well as delivery of health services and allocation of hospital resources; therefore, these individuals were essential to ensuring high-quality patient care and the day-to-day operations of the HIS for care delivery. In addition, interviews conducted with the HIS developers provided insights regarding the development and implementation of *Iris* from an industry perspective.

Three key user groups were identified by hospital management to use *Iris*. *Patient care managers* were senior members of the management team, and these individuals had overall responsibility for the development, delivery and oversight of the related programming for patients under to a particular unit or service. Regarding patient flow, patient care managers were responsible for coordinating and approving inter-hospital discharges and admissions to and from their respective units. The *patient flow team* of the hospital was responsible for daily bed management/patient flow/discharge facilitation within the hospital organization. The *senior executive team* exercised leadership and management responsibility over all functions within their respective management portfolios ensuring services were designed to meet the needs of patients, clinicians, and staff.

Data Analysis

In total, five pages of focus group notes from three sessions, with seventeen participants in total, and seventy-nine pages of anonymized transcripts from ten individual interviews were analyzed. The analysis began using a directed content analysis approach, which involved applying a common analytical framework to the data and mapping key concepts or variables to predetermined theoretical codes (Hsieh & Shannon, 2005). In this process, data were analyzed using codes based on the eight dimensions represented in Sittig and Singh's (2010) sociotechnical framework: *hardware and software; clinical content; human-computer interface; people; workflow and communication; internal organization policies, procedures, and culture; external rules, regulations, and pressures; and system measurement and monitoring*. This analysis was performed iteratively and revealed sociotechnical factors identified as relevant to the implementation of *Iris*.

Approaches for Creating Quality Research

There are several criteria used for evaluating qualitative content analysis, the most common of which are those developed by Lincoln and Guba (1985). Lincoln and Guba (1985) suggest the concept of *trustworthiness*, the aim of which is “to support the argument that the inquiry's findings are worth paying attention to” (Elo & Kyngäs, 2008, p. 2). In addition, according to Morse et al.'s (2002) guidelines for establishing reliability and validity in qualitative research, relevant verification strategies include investigator responsiveness, methodological coherence, and an active analytical stance. When used appropriately, these strategies guide the researcher's direction and development of the study.

In alignment with recommendations by Morse and colleagues (2002), data were reviewed iteratively to explore the fit of the data with the central components of the sociotechnical framework identified by Sittig and Singh (2010). This ongoing analysis was used to consider all available possibilities and show a range of different conclusions related to the interpretation and analysis of the research data (Sandelowski, 2000). Methodological coherence was established by ensuring the research question aligned with the methods and data analysis processes.

An active analytical stance was maintained through a comprehensive literature review, and the use of an established and published theory (Meeks et al., 2014; Menon et al., 2014; Singh et al., 2013). In addition, direction and feedback throughout the analytic process was regularly provided to the researcher from thesis supervisors and advisors with expertise in health informatics and nursing. Finally, an audit of researcher's reflections was maintained throughout analysis, which was used as a means to assist resolution of analytical discrepancies regarding the fit of data to the coding scheme (Morse et al., 2002). Inconsistencies were thoroughly discussed in detail with thesis supervisors and advisors until consensus was achieved.

Findings and Interpretation

Findings are presented according to the eight dimensions of the sociotechnical framework (Sittig & Singh, 2010), and outline how the interdependent domains were represented in the data.

Hardware and Software Computing Infrastructure

The sociotechnical domain of hardware and software computing infrastructure accounts for the physical hardware and software required to run the HIS (e.g.,

desktop/laptop computers, smart phones, data storage) (Sittig & Singh, 2010). The implementation of *Iris* involved the integration of software only; no additional hardware (e.g., desktop or laptop computers, mobile devices) was allocated specifically for using *Iris*. In order to understand the intended benefits and outcomes of implementing *Iris*, it was important to first examine the state of existing information systems within the organization.

One of the biggest barriers for [the hospital] is the siloed nature of their organization like most. It happened to be pretty bad, and they've gone through a number of software purchases where they have bought systems to try and fix something, only to realize that there is no compliance or that it doesn't address the problem. So they have three or four different really expensive systems, one is an end of life, their bed management, housekeeping system, which they also use to do a lot of their patient flow. (Participant 009)

Implementing *Iris* was partially intended to reconcile issues with limited system interoperability, by collecting and displaying data from several systems gathering and tracking patient information (Participant 008). Although this goal was realized, several users reported issues in data accuracy stemming from perceived challenges with system interoperability between *Iris* and the bed management system: "I know there have been some glitches as far as where they are pulling their information from as it feeds through [the bed management system]" (Participant 003).

There were also predominantly negative reviews regarding the mobile functionality of *Iris*. Originally designed for a desktop environment, one user described *Iris* as being difficult to access and navigate on a mobile device (Participant 004).

Limited access to mobile devices for work purposes also made it less useful for several patient care managers and their teams, who spent much of their time out in the hospital and away from their desktop environment. One user stated, “Not all of my team are at their computers every day, nor do they have mobile devices” (Participant 002).

However, several users (Participant 001, 005) acknowledged the organizational efforts to improve system interoperability. Those who used *Iris* more frequently reported having adequate access to devices required to view the system, good system response time, and appreciated the collating of data from multiple systems in a centralized location: “Integration of systems, that’s been really helpful, you don’t have to login to multiple systems to get the info” (Participant 001).

Workflow and Communication

The workflow and communication dimension refers to the processes needed to ensure that patients receive timely care that they require (Sittig & Singh, 2010). When *Iris* was utilized as intended, several patient care managers and directors of care reported improved communication regarding patient flow by improving access to “transparent and timely information for the people that need to make decisions” (Participant 008). *Iris* was also seen to create an increased sense of accountability for the management of patient flow as discussed:

To have an understanding if you are taking care of the entire hospital or being [on call and responsible for admitting patients], knowing what’s happening in the [emergency department] as well as in the [operating room]. Because right now there are these virtual walls from unit to unit. (Participant 001)

Improved access to transparent information in real time was also perceived by one participant to enhance patient care through faster mobilization of resources:

I think that one of the benefits would maybe be able to get faster transfer times from the ED [Emergency Department] to the inpatient units (...). With respect to improving patient care, you're getting them in the right spot in a faster time in a nicer location or nicer setting. (Participant 004)

In addition, implementing *Iris* allowed hospital directors to identify inefficient work practices that were common prior to implementation of the HIS. In particular, one respondent commented on how the implementation of *Iris* created an organizational awareness of existing inefficient practices and data entry errors regarding patient flow:

So there are some workarounds that people do that no one knew, nor did they know that it actually impacts something else, up until we had this system that highlights all these inefficiencies or inaccuracy in terms of the work that we do every day and the time of the work that they do. (Participant 005)

For example, prior to *Iris*, the hospital organization had a process for tracking patients through the ED, whereby individual clinicians (nurses and physicians) and clerks were responsible for flagging each step in the patient journey (e.g., triaged, assessed by a physician, discharged to the unit) and manually inputting this data into the bed management system. However, this manual data entry was being done infrequently and sometimes improperly, resulting in less accurate recording of wait times. For example, if a clerk delayed inputting that a patient had been transferred to a unit from the ED, the measure of that same patient's time spent in the ED would be inappropriately amplified in the bed management system (Participant 009). Implementing *Iris* brought attention to

these inefficiencies and, as a result, these workflow processes were rectified in an effort to create consistent and accurate data for tracking patient flow.

Human-Computer Interface

The dimension of human-computer interface accounts for “aspects of the system that users can see, touch, or hear” (Sittig & Singh, 2010, p. 70). Findings from this study indicate that *Iris* provided users with an intuitive interface (computer screen view) that used colour coding. One participant (002) stated, “What I do like is the visual management with the colours, which makes it easily understood at a quick glance.” In addition, several users reported that interface navigation was intuitive, allowing for more efficient data access. The following comment reflects ease of system use: “You click on the area you want to see and you can drill down a little bit more. So the interface is pretty simple to use I don’t find it difficult” (Participant 001). These sentiments were echoed by another participant who stated, “[*Iris* is] visually simple, and it’s visually easy to look at and easy to navigate” (Participant 003).

There were mixed reports regarding the interface for mobile devices. “I don’t think that [*Iris*] is mobile friendly. I know that many of us are phasing into iPhones but currently we are using BlackBerries, and you really are just looking at [*Iris*] but really really small” (Participant 004). This was seen to impact adoption, as several users (Participants 001, 002, 004) preferred to access *Iris* from desktop computers, reducing remote access use of the tool. However, one user in particular found mobile navigation simple. “On my iPhone it’s good. Easy to navigate and I expand it as I need to” (Participant 006).

In this study, several respondents also reported parallel use of systems for accessing information. *Iris* was found to display information already included in the previously established bed management system as well as in an email sent from the patient flow and access team. However, one participant (002) described *Iris* as being more cumbersome to access relative to its HIS counterparts displaying similar information. As a result, this participant defaulted to interacting with a previously established system (patient access and flow email) with which she was comfortable, limiting her use of *Iris*:

We also receive an email three times a day from our patient access and flow group letting us know what our census is at (if we are in escalation, etc.) so maybe it's a habit. That is there in my hand, I don't have to go to a website or bookmark or whatever, so I probably read that email more than I go to [*Iris*]. (Participant 002)

People

The sociotechnical dimension of *people* refers to human involvement in all aspects of the design, development, implementation, and use of HIS, including how systems make users feel (Sittig & Singh, 2010). This dimension was highlighted through participants' reports regarding the impact of management and leadership on implementation and the importance of adequate training and communication.

Initially, respondents reported a strong organizational commitment to implementing *Iris*: “[Hospital leadership] understood that they needed change management and at the big kick off meeting they explained they had a number of users and were supported by senior management including the CEO” (Participant 008). However, the hospital experienced significant turnover in leadership soon after the

funding was allocated. “The person that bought the solution and made the decision to implement [Iris] was removed from the organization four weeks after we had our kick-off meeting” (Participant 008). As a result, oversight of the implementation of *Iris* was re-assigned to an existing director at the hospital, resulting in a cascade effect of increased workload for the individual in question, which delayed implementation efforts:

I think this is a big enough project and implementation that it really probably should have had a project manager assigned to it to manage all of this continual upgrading and troubleshooting. I don't think that any one director would have the time to do that themselves. (Participant 006)

Finally, the intensity of training, the timing, and the availability of support affected user perception of implementation. In general, lack of adequate feedback to clinicians about the decision making process regarding the design and introduction of *Iris* resulted in perceived reduced efficiency of use and diminished interest and collaboration as discussed by one participant:

I don't know that there's been great communication or understanding as to what phase we are in with the roll out. Because I know there have been some emails but some tabs don't work because they haven't been built yet, and I don't think we all understand what we can and can't do right now, so a lot of it is way finding on your own. (Participant 001)

This perceived lack of leadership exacerbated implementation challenges and encouraged indifference by two patient care managers (Participants 002, 003). These individuals felt *Iris* was unnecessary for their day-to-day work and that other leadership had not properly communicated if they were expected or required to use the HIS: “As it

stands today it's good information but it doesn't really impact my day-to-day work" (Participant 002). When one participant (003) was asked if she was required to use *Iris*, she responded, "No. I don't think so. I mean if it is someone will have to let me know and I'll pay more attention."

Clinical Content

The *clinical content* dimension accounts for everything that can be entered/created, read, modified, deleted, or stored by users on the HIS (Sittig & Singh, 2010).

Several participants described the way in which *Iris* was presented (as a read-only tool) to be a barrier to adoption and use. Considering *Iris* was used as an umbrella tool to capture patient information (instead of for data-entry), users initially failed to see the value in using *Iris* and defaulted to using systems with which they were familiar:

It makes a difference in how often people look at this tool. If you are using it all the time to move patients, it's open all the time. If you're only using this to get a snapshot [of the organization] and what else is coming or what you need to do next, then there is less perhaps drive to go and look at the tool. (Participant 008)

Moreover, issues with interoperability between the bed management system and *Iris* resulted in data inaccuracy early in implementation. In particular, several respondents reported finding discrepancies between the data displayed in *Iris* and other sources (bed management system, email, clinical staff), causing distrust of information displayed in *Iris*:

I have to say I'm still not sure of the data, so I look at it, it gives me information, but there have been enough times that the data has been wrong that I can't really rely on it at this stage in the game. (Participant 002)

Despite a number of negative findings, one participant (005) reported that *Iris* supported simultaneous and remote access to patient documentation, and allowed for the integration of health information from multiple sources into a centralized dashboard. The real-time nature of *Iris* was also reported as being helpful, providing users with a “quick overview; it's an umbrella system of what our organization looks like in terms of capacity across the organization” (Participant 005).

Internal Organizational Policies, Procedures, and Culture

The sociotechnical dimension accounts for the organization's internal structures, policies, and procedures that impact every other dimension of the model (i.e., budgetary allocation, IT policy & procedure) (Sittig & Singh, 2010).

As described by a member of the executive team that developed *Iris*, implementing the HIS resulted in increased organizational awareness about the importance of data mining to improve hospital operations and patient care:

Well I think there's been a bit of a culture change on the importance of using data to make decision-making, and I think there's a culture change that access and flow [of data] is the responsibility of many people in the organization not just one department that may have that title. (Participant 008)

The implementation strategy was also seen to be of importance. According to a member of the executive team that developed *Iris*, the implementation was planned for successive integration over four sequential phases. This process was intended for smooth

integration of the technical components into the workflow of patient care managers and directors and to facilitate more comprehensive staff education. However, delays in implementation resulted for a host of reasons, including issues with system interoperability and management turnover, altering the implementation plan and affecting adoption and use of *Iris* as indicated by a director of care and the developers of *Iris*:

I will say, and I know it's complicated, but I'm finding that this implementation is taking a fairly long period of time in that it kind of waxes and wanes in my memory. (Participant 002)

External Rules, Regulations, and Pressures

The sociotechnical domain of external rules, regulations, and pressures represents “the external forces that facilitate or place constraints on the design, development, implementation, use, and evaluation of HIS in the clinical setting” (Sittig & Singh, 2010, p. 71). The complex relationship between political, economic, and health care entities was found to impact implementation of *Iris*.

The initial purchasing decision for *Iris* was also intended to decrease ED wait times, a key metric used for both accreditation and funding allocation from the government:

So every hospital is working on a set of escalation policy protocols, workflow in terms of prioritizing ED [emergency department] vs. OR [operating room] vs. whatever, which are generally determined by the revenue stream. So in their case, ED admissions take the most priority because that's where the revenue comes from. (Participant 008)

In the beginning stages of implementation, there were also several other competing priorities from an organizational standpoint as described by one participant:

So it's totally understandable. So we're in the midst of rolling out the e-health record, we have a relatively new CEO [Chief Executive Officer], we have a number of senior leadership change; we just moved into a new wing; we're in perpetual escalation. Yeah there are a lot of things, people are looking at models of care, how we deliver nursing care to our patients, there is accreditations coming, yeah. There are many competing priorities, absolutely. (Participant 002)

Changes to the political and economic landscape inevitably affected the decision to purchase and implement the *Iris* HIS. For this hospital organization, the complexity of software and business models of the healthcare technology company prevented the hospital from using *Iris* to its full potential. Although *Iris* had the ability to function as a bed management system (with full capability to support data entry), the hospital organization decided to implement *Iris* as a read-only system (e.g., to view information on the dashboard and not for data entry) (Participant 008). This was the result of previous action taken by the organization to implement an interactive bed management system developed by a separate healthcare technology company. As a result, participants were required to use the bed management system for data entry instead of *Iris*, which impacted use of the HIS as described by one participant. "Right now we have another bed management system.... responsibility is oftentimes within the bed management system and not [*Iris*]" (Participant 005).

System Measurement and Monitoring

The system measurement and monitoring domain refers to the measurement and monitoring of four key issues related to HIS implementation: (a) availability of features and functions for use; (b) determination of function use by clinicians; (c) system effectiveness on health care delivery and patient health; and, (d) unintended consequences of the system (Sittig & Singh, 2010). In general, users reported a number of qualified positive outcomes related to the implementation of *Iris*, including reduction in ED wait times, fewer bed management meetings, and a change in culture, appreciative toward the use of data to support hospital operations and patient care.

As described by one participant (009), *Iris* was partially intended to help the organization meet performance based funding targets, which links funding allocation with accountability standards for patient outcome. Prior to the implementation of *Iris* the hospital organization had substandard ED wait times -- a key metric used for both accreditation and funding allocation from the government. The implementation of *Iris* represented a response of the hospital organization to healthcare policy that rewards performance based on key metrics (e.g. ED wait times). As described by one participant (008), *Iris* was suggested to be an effective mechanism from which to capture and report the salient data related to patient flow and outcomes. “[The hospital] is rewarded on pay-for-performance, which includes length of stay. And I think our tool enables them to collect the data that they need to manage today and be able to do something about it” (Participant 008).

Summary of Key Findings

All components of the sociotechnical framework were found to be present in the participants’ interaction and use of *Iris*. The significance of these key findings is

discussed in three ways: (a) the impact of HIS functionality and integration with other systems; (b) the influence of turnover in project leadership; and, (c) the ability of *Iris* to impact hospital operations and nursing care.

The strength of *Iris* was its ability to aggregate data from multiple internal sources (inclusive of the bed management system, emergency department information system, operating room tracker, and census data) to create an overall picture of patient census and flow throughout the organization. As a result, several participants reported improved communication among organizational leaders through enhanced access to information in addition to more timely and transparent data. Several participants also qualified that *Iris* was easy to use for its intended purpose, largely due to its intuitive interface navigation.

However, a preponderance of negative views dominated participants' experience of the implementation process. In particular, effective implementation and use of *Iris* was restricted by the read-only functionality of the system. Although the information displayed by *Iris* provided an overview of the organizational status in real-time, users were not able to interact with the system beyond viewing the aggregated data that was provided to them. As a result, users defaulted to using familiar interactive systems required for data entry, often containing information duplicated in *Iris*. Additionally, although mobile device compatible, *Iris* was originally designed for a desktop environment and smartphone functionality and navigability were reported as being limited. *Iris* was therefore much less useful for patient care managers and their teams, who spent much of their time out in the hospital and away from their desktop environment.

Although initially there was a strong organizational commitment to implementing *Iris* with backing from executive level members, significant turnover in leadership compounded issues with implementation. This perceived lack of leadership exacerbated implementation challenges and encouraged disinterest from clinicians and other users regarding the implementation of *Iris*. Furthermore, participants described feedback as being limited regarding the implementation process, and were unsure of the intended purpose and goals of implementing *Iris*. A lack of ongoing communication from leadership prevented widespread recognition and use of the system, underscoring the need for knowledgeable and dedicated leadership.

Finally, there was consensus among numerous participants (Participants 002, 003, 007) that in its current form, *Iris* was underused and unable to provide real benefits to individuals or the organization. In addition, there was very little evidence to support *Iris* directly impacting the quality of patient care. Although it was mentioned that *Iris* provided a mechanism by which to measure organizational goals for patient movement throughout the hospital, no participants mentioned improvements in patient experience, health outcomes, or patient safety. However, this is consistent with the goals of the organization, whose original intentions were to decrease ED wait times and improve organizational transparency related to pressures faced by each department in terms of patient flow.

Discussion

This secondary analysis explored the implementation of a HIS in a large urban acute care hospital from the perspective of hospital leadership and the developers of the system. The purpose of this study was to: (a) explore a group of interprofessional

leaders' perceptions of social and technical factors which impacted an HIS implementation within an acute care hospital organization; and, (b) uncover how the various social and technical forces contributed to, or prevented, successful implementation of the HIS in relation to nursing practice and education. Using a directed content approach, Sittig and Singh's (2010) sociotechnical framework was used as a theoretical framework to obtain an understanding of participants' perceptions regarding HIS implementation and use.

The findings from this study offer a multidimensional outlook as to how an urban acute care hospital implemented and used an innovative health information system (*Iris*). Findings demonstrate that *Iris* was successful in supporting simultaneous and remote access to patient documentation, and allowed for the integration of health information from multiple sources into a centralized dashboard. The real-time nature of *Iris* was also reported as a benefit, providing users with an up-to-date summary of organization-wide capacity and patient flow, facilitating communication between managers and directors of care.

Early in HIS implementation, workload for users including hospital leaders and frontline staff clinicians and staff can increase, reflecting the increased administrative work (processing reports, entering orders, system navigation) associated with a new HIS (Cresswell et al., 2012). As a read-only tool, the effort required to use *Iris* was minimal. However, several participants indicated they were required to access multiple internal systems to access and compare similar data, thereby increasing their workload. This finding is consistent with previous studies of HIS implementation, whereby parallel use

of multiple systems for patient care (e.g., paper-based and electronic records) resulted in increased workload for clinicians (Campbell et al., 2006; Samoutis et al., 2007).

Moreover, issues with interoperability among several existing internal systems resulted in data inaccuracy early in implementation, causing distrust of information displayed in *Iris*. For example, in order to ascertain data regarding the census of a particular unit, managers would often reference both *Iris* and the bed management system, often finding discrepancies between the two. This finding was supported by previous studies that indicate data inaccuracy issues can result from the use of numerous HIS that are unable to communicate directly with one another (Poon et al., 2004; Sagtroglu & Ozturan, 2006).

The design of *Iris* also featured an intuitive interface for accessing information regarding patient census and flow. Despite being a relatively user-friendly system, participants failed to see the value in using *Iris* to support their everyday practice and felt leadership had not properly communicated if they were expected or required to use *Iris*. As a result, participants defaulted to using other systems with which they were comfortable. These findings complement other published literature examining HIS implementation, where clinicians typically adopt workarounds to accommodate mandatory use of the system being implemented (Debono et al., 2013). It seems clear that even the most advanced health technology will “fail in the absence of clear appreciation of the needs, perceptions and experiences of end-users” (Darbyshire, 2004, p. 23).

Throughout the implementation of *Iris*, the hospital organization also experienced significant turnover in management responsible for the strategic implementation of *Iris*.

As a result, participants reported feeling uninformed regarding the purpose and expectations for using *Iris*. These findings are consistent with those from several studies, where implementation may be jeopardized by a perceived lack of leadership (Scott et al., 2005; Takian et al., 2014). In order to mitigate the impact of unanticipated change in leadership during HIS implementation, hospital organizations should consider establishing formal succession plans and an interprofessional team to oversee implementation. This collaborative approach may be more flexible in adapting to unanticipated leadership changes during implementation. The literature is clear that effective HIS implementation requires knowledgeable, experienced, and insightful leadership, and continued commitment of top management to designing and implementing the HIS (Damanpour & Schneider, 2006; Scott et al., 2005).

The findings of this secondary analysis also provide support for the use of Sittig and Singh's (2010) sociotechnical framework to describe the experiences of participants implementing HIS in an urban acute care hospital. Studies of HIS implementation often employ prospective designs (Lau, Kuziemsky, Price, & Gardner, 2010), evaluating key metrics related to hospital efficiencies, medication ordering and administration, and hospital operations pre- and post-implementation. However, HIS implementation as practice transformation assumes human and technology changes over time (Berg et al., 2003). In order to reap the benefits of clinical technology, HIS should not be seen as merely the automation of existing clinical processes. Rather, implementing HIS represents an opportunity to redesign healthcare delivery, and appreciation of a shift in organizational culture that leverages technology to enhance organizational efficiencies. Therefore, as technology and human processes evolve over time, it may be pertinent to

undertake research that appreciates a sociotechnical perspective exploring HIS as occurring in a complex clinical setting.

Implications and Recommendations

Implications

Drawing on this cumulative evidence, there are several implications derived from this study that, at a minimum, should be taken into consideration by the nursing profession within the context of an interprofessional leadership team regarding HIS implementation.

Although the provision of care is commonly understood within a multi-disciplinary context, design and implementation of HIS is often physician and administrative centric, with minimal or no input from nurses (Gephart et al., 2015; Waneka & Spetz, 2010). At a minimum, successful implementation of HIS requires nurses to fully understand the interrelated social, technical, and environmental factors involved (Sittig & Singh, 2010; Waneka & Spetz, 2010). However, nurses at both the front-line and leadership levels are well-suited to drive HIS initiatives through clinical ownership and broad participation from the design stage (Meyer, VanDeVelde-Coke, & Velji, 2012).

Furthermore, the findings of this study allude to the importance of leadership in managing the transition of implementing HIS in acute care hospitals. HIS implementation is enhanced when members of the leadership team (e.g., managers, directors, etc.) are committed to the implementation, knowledgeable regarding the social and technical factors that affect HIS, and include members of their clinical teams (e.g., nurses, physicians, allied health) in the design and implementation process. As suggested

by several authors (Meyer, VanDeVelde-Coke, & Velji, 2012; Nagle, 2005; Pringle & Nagle, 2009), nursing leaders are well-suited to contribute to the leadership team that informs the nature and scope of information, supporting innovation and executive decision-making regarding HIS (Remus & Kennedy, 2012). Nursing leaders bring an in-depth understanding of the nursing staff's needs and concerns (e.g., patient care, nursing workflow, and nurse job satisfaction) and an ability to critically examine how the technology will enhance the way nurses do their jobs (Kirkley & Rewick, 2003). As such, having nursing leaders represent the nursing perspective throughout HIS design, implementation, and optimization allows for these concerns to be addressed (Stein & Deese, 2004). Health organizations seeking to build a sustainable HIS infrastructure should involve nursing leadership to target nurses' abilities and opportunities for engaging in HIS design, implementation, and optimization (Waneka & Spetz, 2010).

This study also provides some insight into the benefits of studying HIS from a sociotechnical perspective. Exploring the social and technical factors impacting HIS over the short and long term can help provide insight into some strategies to improve further implementation efforts. It will also be imperative that research in nursing continues to examine interpretations of nurses' interwoven relationship with technology, for use in patient care.

Directions for Future Research

The final implication derived from the findings of this study is the need to continue HIS implementation research in nursing. Nursing is ever evolving, and it will be important to examine on an ongoing basis how HIS supports, or inhibits elements of nursing care. Utilizing both qualitative and quantitative methods to evaluate

implementation of HIS in contexts where nurses operate will be helpful for sustainable adoption and use of all forms of clinical technology (Ammenwerth et al., 2003; Van Der Meijden et al., 2003). When evaluating HIS, the data from multiple sources can complement each other to provide a more comprehensive picture. Feedback related to HIS implementation also needs to be timely, ongoing, and reflect the complex adaptive environment in which the HIS is being implemented (Irizarry & Barton, 2013).

The use of sociotechnical interpretations of HIS implementation offers a number of fruitful directions for future research. It would be pertinent to explore how different implementation strategies and processes impact HIS adoption and use by nurses. Since the implementation of HIS is a nuanced and complex process, the development of strategies related to the type of organization, staff education and communication, and changes to clinician workflow must be generated. Examining the influence of these factors on HIS implementation and their relative outcomes may provide increased insight regarding best practice for organizational implementation of HIS and other clinical technology.

Secondly, acknowledging and celebrating the unique contribution nursing can make to the redesign of healthcare through technological innovation needs to be further explored. It has been noted that nursing is currently underrepresented in terms of HIS design, implementation, and evaluation despite the increasing impact of technological innovation on nursing practice and patient care (Kennedy & Hussey, 2015).

Reconsidering certain models of HIS implementation in light of the study findings, or increased sensitivity to the nuances of nursing practice is recommended.

Lastly, it is important to better understand how HIS invariably affects the provision of nursing care and patient outcomes. Often, studies of HIS implementation employ prospective methods examining patient outcomes including safety, adverse events, and satisfaction pre-post implementation (Chaudhry et al., 2006; Leatt et al., 2006). A more comprehensive exploration of the patient experience of HIS implementation and their perceptions of care would be a valuable addition to the nursing research literature surrounding HIS.

Limitations

This study has several limitations. Although a comprehensive search was performed, only English articles in scientific journals were included in the literature review; literature published in other languages were not reviewed. As well, this study only examined HIS in a large urban acute care hospital. This process excluded HIS used in community and outpatient health care settings; their inclusion may have led to different findings. However, the acute care setting has had the greatest number of HIS implementations relative to other health care settings (Lau et al., 2010; Rahimi et al., 2009). This highlights important opportunities for future research related to nursing leadership within an interprofessional team among other health care settings.

In addition, it was important to attend to the unique challenges regarding the fit between the nature of the data and the secondary research questions with the design of the primary research (Heaton, 2008; Thorne, 1998). Due to the secondary nature of this study, all data was anonymized and devoid of participant identifying information. As a result, it was not possible to identify linkages between participants' responses and their role within the hospital organization. Furthermore, data from the primary study included

notes from focus group sessions. This process of note taking inferred a degree of interpretation by the primary researchers, which may have influenced secondary findings. Finally, findings from this study are interpretive and non-generalizable to other populations and settings.

Conclusion

As with any health technology, HIS influences the environments in which they are introduced in many different ways, and often more deeply than is expected (Nagle & Catford, 2008). In general, all components of the sociotechnical model were found to influence the implementation, and subsequent use of *Iris* according to three broad areas: (a) the impact of HIS functionality and integration with other systems; (b) the influence of turnover in project leadership; and, (c) the ability of *Iris* to impact hospital operations and nursing care.

Although there was some qualitative evidence of the benefits derived from use of the *Iris* HIS, the majority of findings of this study indicated that there were significant challenges related to the process and complexion of the *Iris* implementation. In light of the concerns identified in this study, it is imperative that researchers conduct ongoing evaluation of future implementation efforts. Though it is often found that issues encountered throughout HIS implementation are mostly unanticipated and contextual in nature, elucidating these issues may be helpful to enhance new implementation efforts and sensitize HIS design towards the nursing role. More work is needed to achieve success in ways that can be replicated and sustained over time.

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PART THREE

IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSIONS

Summary of Key Findings

The overall aim of this study was to explore how sociotechnical factors contribute to, or prevent, successful implementation and use of HIS in order to generate recommendations for nursing practice and education. In this study, a secondary analysis was completed using data from focus groups (n=17) and individual interviews (n=10) conducted with a group of interprofessional hospital leaders (i.e., managers, directors, and members of the executive team) and the HIS developers in Ontario, Canada in 2014. In the original study, participants were asked to share their perceptions regarding the implementation and use of a HIS used to facilitate patient flow, given the pseudonym *Iris*.

Sittig and Singh's (2010) sociotechnical model was used as a guiding framework to identify the perceived facilitators and barriers of implementing *Iris* in an urban acute care environment in Ontario, Canada. All components of Sittig and Singh's (2010) sociotechnical model were discovered to impact the participants' ability to engage in implementing the HIS, ultimately impacting use by hospital leadership. Several perceived benefits of implementing *Iris* emerged in the data including increased organizational transparency regarding patient flow and improved communication among leadership responsible for coordinating patient flow. However, while participants were optimistic regarding the potential of the HIS, there were a number of reported challenges. Problems with inaccurate data, duplication of information across several HIS, and

significant turnover in leadership during implementation ultimately compromised the ability of the organization to implement the system effectively.

Implications for Nursing Leadership, Education, & Practice

The findings of the study lend support toward using the sociotechnical model as a conceptual lens from which to explore the complexities of HIS implementation and its impact upon the nursing role. Some practical implications for nursing leadership, practice, and education are provided below.

Nursing Leadership

The findings of this study reinforce the importance of leadership in managing the transition of integrating HIS in acute care organizations. Healthcare is widely accepted as a multi-disciplinary field, where coordinated care is provided by teams (Tierney, 2001). As a result, hospital organizations may benefit from establishing multi-disciplinary leadership teams that provide ongoing oversight and coordination of HIS implementation. Captured by the sociotechnical dimension *people*, these individuals play a key role in the designing and implementing HIS. A collaborative approach to implementation may also be more flexible in adapting to unexpected changes in leadership, preventing disruptions in the implementation process when one leader or champion needs to be replaced.

As outlined by Meyer et al. (2012), nursing leaders are well suited to contribute to the leadership team that is responsible for decision-making regarding HIS design, implementation, and use. Through partnership with HIS developers and other key stakeholders within a hospital organization, nursing leaders can advocate for changes in technical system components of the *human-computer interface* (e.g., desktop and mobile

computer screen view) to better accommodate clinician workflow. Nursing leaders can also advocate for the specific needs of the nursing profession and nursing-related concerns (e.g., patient care, nursing workflow, and nurse job satisfaction), which are sometimes overlooked by traditional healthcare system models (Ballard, 2006; Stein & Deese, 2004). As a result, health organizations seeking to build a sustainable HIS infrastructure should involve nursing leadership to target nurses' abilities and opportunities for engaging in HIS design, implementation, and use (Waneka & Spetz, 2010).

It will also important to identify and support nursing leaders that oversee, support, and manage the utilization of HIS. Often, nursing informatics leadership roles (e.g. chief nursing informatics officer, chief nursing officer, nursing informatics specialist) are defined in title, responsibility, and scope of practice by local organizations (Kannry et al., 2016). As a result, there is a need for researchers to better delineate the knowledge, education, skillsets, and operational scope of nursing informatics leadership to support the design and integration of HIS.

Nursing leaders should also be called upon to provide their teams with technical skills and cultural support for HIS integration (Lee, 2007). This may include the physical manipulation and cognitive skills to use HIS to enhance nursing processes of care, along with establishing reasonable expectations for use. Engaging nursing leaders in the design and development of HIS may also create awareness about the use of clinical information systems as catalysts for redesigning healthcare delivery rather than simply the automation of existing processes.

Nursing Practice

In Canada, it has been noted that nursing as a profession has been “slow to adapt the skills, knowledge, and competencies required to implement and lead technologic innovation in a changing health system environment” (Booth, 2013, p. 1). As the largest group of healthcare workers, nurses provide around the clock care and play a pivotal role in documentation and patient safety (Stevenson, Nilsson, Petersson, & Johansson, 2010). However, nursing involvement in the design and implementation of HIS is often underrepresented (Oroviogioicoechea et al., 2008). At a minimum, it is critical that HIS are user-friendly and designed for the purpose of supporting everyday practice (Stevenson et al., 2010). Nurses are well suited to support and drive HIS initiatives, with expertise that can be leveraged at all stages of design and implementation.

In order to reap the benefits of HIS for nursing practice, it will be important to identify linkages between HIS use and health outcomes through *system measurement and monitoring* (Sittig & Singh, 2010). Often, data from HIS are collected and presented without the necessary synthesis or analysis required for management of day-to-day operations or long-term planning (Health Metrics Network, 2008). Leveraging HIS to improve health system functioning requires a commitment to collating and analysing data generated by HIS, disseminating the resulting information to key stakeholders and users, and using the generated knowledge to inform practice. Gaining a better understanding of how data from HIS impacts nursing practice and health outcomes and sharing this knowledge with users may foster increased engagement by nurses and positively impact development and implementation (Waneka & Spetz, 2010).

Nursing Education

As demonstrated in this study, HIS users, including nurses, need to have the motivation and abilities to effectively use HIS and understand the implementation process. Developing these skills requires nurses to understand what HIS are, to engage in HIS use for different purposes in various clinical contexts, and consider how HIS impacts nursing practice. This brings to light the foundational and ongoing educational needs that may be required in order for nurses to leverage outcomes of HIS use at work.

Pringle and Nagle (2009) suggested continued education to achieve broad integration of nursing informatics competencies into the nursing perspective. In Canada, the Canadian Association of Schools of Nursing (CASN) (2014) developed a list of nursing informatics competencies that “all registered nurses should possess upon graduating from an undergraduate nursing program in Canada” (p. 1). The specific objectives of the project include: (a) promoting a national dialogue among nurse educators, informatics experts, and nursing students on integrating nursing informatics into entry-to-practice competencies; (b) increasing the capacity of Canadian nurse educators to teach nursing informatics; and (c) engaging nursing’s key stakeholders in developing nursing informatics outcome-based objectives for undergraduate nursing curricula (Canadian Association of Schools of Nursing, 2014). These entry-to-practice nursing informatics competencies represent a fundamental step towards adequately preparing the nursing workforce of tomorrow.

It has also been suggested that strategic integration of informatics competencies into graduate nursing programs may better prepare nurses entering the workforce in advanced practice positions (Swenty & Titzer, 2014). With advanced knowledge of terminology associated with HIS and a working knowledge of how various HIS are

designed and operate, advanced practice nurses would be well positioned to work alongside hospital leadership and HIS developers to design and implement HIS.

Supporting the learning needs of practicing nurses will also be critical moving forward as technology advances. Opportunities for continued learning should be offered by hospital organizations, providing ongoing educational sessions and on-site training to ensure new HIS is being used effectively. To assist with ongoing education in the current workforce, a super user strategy has also been recommended that leverages nurses with computer skills to assist with implementation and help solve user problems (Knoedler, 2003; Patterson, Cook, & Render, 2002). Organizations implementing a new HIS should consider similar strategies to help nurses adjust to the inherent changes in workflow and to help with ongoing evaluation of system requirements to support nursing practice (Parker, 2002).

Recommendations for Further Research

This study exploring the context of HIS implementation in Canada warrants further exploration to explore the challenges, needs, and strategies to improve HIS implementation efforts. Further evaluation measures must be undertaken to more fully understand the use of technology like HIS and the impact on adoption and effective use of these innovations to optimize the delivery of health services and improve patient care. In this sense, it will also be important to gain a better understanding of how HIS directly impacts nursing practice and patient outcomes. These questions may be answered by seeking out the experiences of patients, students, nurses, and hospital leadership working in varied practice settings.

Evaluating the impact of HIS on nurses' processes of data collection and information use as well as collaboration within the interprofessional healthcare team would be a valuable contribution to the research literature. The variations in HIS implementation and use across different hospitals, wards, and healthcare providers could also provide insight into the unique needs of different regions and clinical areas. Finally, an examination of how nurses can inform HIS design to best support the needs of the profession across multiple settings is indicated for future studies.

The use of sociotechnical interpretations of HIS implementation offers a number of fruitful directions for this type of research. Sittig and Singh's (2010) theoretical framework outlines factors that influence HIS including design, development, use, implementation, and evaluation. In doing so, the framework offers a tangible blueprint for developing, implementing, and evaluating the effectiveness of implementation efforts. More specifically, the framework provides a cohesive and systematic approach to evaluating the extent to which organizational implementation strategies influence patient care delivery goals. This may be of particular interest for nursing researchers seeking to monitor or evaluate the effectiveness of implementation efforts, as well as the quality assurance and performance of their health care units and nursing staff.

Conclusion

In summary, this study provides new insights for implementing HIS in an acute care organization by exploring this process through a sociotechnical lens offered by Sittig and Singh (2010). All components of the sociotechnical framework affected the participants' ability to engage in implementing the HIS, illuminating the potential value of attending to the relationship between social and technical relationships.

The findings of this study provide an understanding of participant's experiences that may increase awareness and reinforce the need to strengthen collaboration between nurses and hospital leadership and involve nurses in the initial design and implementation stages of HIS. Findings of this study also offer some practical implications for nursing leadership, education, and practice. Recommendations for additional research are also provided for further investigation of HIS implementation and nurses' engagement in HIS design, implementation, and evaluation.

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Appendix A

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Appendix B

Semi-Structured Interview Guide

Interview Question	Probes – Check to see if these are covered in the person’s answer. If not, ask.
1. Can you tell me a bit about your job?	<ul style="list-style-type: none"> ● Experience <ul style="list-style-type: none"> ○ How long have you worked at the hospital organization? ○ How long have you worked in your current position? ○ How have you used similar systems in the course of your work/education in the past?
2. What do you think of the Iris system?	<ul style="list-style-type: none"> ● What do you particularly like about it? <ul style="list-style-type: none"> ○ Why do you like that? ○ Can you give me an example? ● Is there anything that you particularly dislike about it? <ul style="list-style-type: none"> ○ Why do you dislike that? ○ Can you give me an example? ● How useful do you find Iris to be in doing your job? (i.e. Productivity, Effectiveness, Improved patient care) ● Do you think the advantages of Iris will outweigh the disadvantages? ● How easy is Iris to use? ● Are you satisfied with the information presented in Iris? Is it accurate, up-to-date, complete, relevant to your job, easy to read? ● Are you satisfied with the Iris system? Does it do what you need it to do, provide satisfactory response time, does not crash, satisfactory login?
3. Do you think other people in the hospital feel the same way about Iris that you do?	<ul style="list-style-type: none"> ● Are there people who particularly like/don’t like it? Why do you think that is? ● Who influences you most in your day to day work? (i.e. Supervisors, Peers, Patients, Senior Management, Physicians) <ul style="list-style-type: none"> ○ How do these people feel about you using Iris? ● Have you seen other people using Iris? If so, who? Did iris appear useful for them? What (if anything) did you learn from seeing others use it?

<p>4. So tell me about how you use Iris now?</p>	<ul style="list-style-type: none"> ● Are you required to use Iris? If so, by whom? ● I have here a list of the different ways that people might use Iris. <ul style="list-style-type: none"> ○ Management of unit-specific patient flow ○ Management of Program-specific patient flow ○ Monitoring of patient flow while ON CALL ○ To gain an understanding of patient flow organization-wide ○ Review of number of ALC patients within organization ○ Review of number of isolation cases within organization ○ General information only ○ I have not used it at all / I don't expect to use it at all ○ Others, please list below ● Can you have a look at this list (hand over a sheet with the activity questions) and tell me which (if any) you currently do using Iris. <ul style="list-style-type: none"> ○ How do you normally complete these tasks (if not with Iris)? ● How do you typically interact with Iris? (Desktop, Tablet, Phone, Blackberry, iPhone, Android) ● When do you use Iris? ● Where? ● How often? ● How has Iris altered the way you do your job? ● Do you see your use of Iris changing in the future? ● For tasks they use – do you see yourself using Iris more for these tasks? ● Do you think you would stop doing some of these? ● For tasks that they don't use - do you think you would ever use Iris for this task? ● What would make you want to use it more? ● Do you prefer Iris or other sources to provide the information? Why?
<p>5. Do you sometimes experience that it is difficult to use Iris? If so, what is the typical reason for</p>	<ul style="list-style-type: none"> ● Are you satisfied with the support you have received? ● Do you have the equipment (i.e. computer, table, PDA) you need to use Iris?

this?	
6. What do you think the benefits of using Iris have been?	<ul style="list-style-type: none"> ● Benefits on your job? <ul style="list-style-type: none"> ○ To what degree are you satisfied with your overall use of Iris? Please explain. ● Benefits on other employees? ● Benefits to the hospital in general? ● Benefits to patients? ● What do you think the benefits of using Iris will be?
7. Think-Aloud Protocol	<ul style="list-style-type: none"> ● I have Iris open here, would you be able to take me through step-by-step and describe in detail what information you would typically look at on Iris?

1. Age: What is your current age?

20 TO 29

30 TO 39

40 TO 49

50 TO 59 5

60 OR OLDER

2. Role: Which category best describes your job? (Circle only one number)

1 Senior Leader (President, Vice President)

2 Director - Clinical

3 Director - Support Services

4 Patient Care Manager

5 Supervisor

6 Other

Appendix C

Approval From Office of Research Ethics

February 4th, 2015

[REDACTED]

Re: HSREB L1 106280 - Letter of Research Ethics Board Review exemption
Factors Influencing the Implementation of a Health Information System in a Complex Acute Care Environment

Dear [REDACTED]

Thank you for submitting the above mentioned study to the Western University Office of Research Ethics (ORE). As per our discussion, this project aims to analyse secondary de-identified data.

As per Chapter 2, Article 2.4 of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS-2, 2010), the ORE does not require a formal application since this study falls outside of the scope of the ORE and "relies exclusively on secondary use of anonymous information" that will be provided by a lead researcher.

Please retain this letter for your records and do not hesitate to contact me if you have any further questions

Thank you

[REDACTED]

Ethics Officer, Office of Research Ethics
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[REDACTED]

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