Western&Graduate&PostdoctoralStudies

Electronic Thesis and Dissertation Repository

8-9-2016 12:00 AM

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

Maximillian D. Besworth
The University of Western Ontario

Supervisor
Dr. Lorie Donelle
The University of Western Ontario Joint Supervisor
Dr. Richard Booth
The University of Western Ontario

Graduate Program in Nursing
A thesis submitted in partial fulfillment of the requirements for the degree in Master of Science
© Maximillian D. Besworth 2016

Follow this and additional works at: https://ir.lib.uwo.ca/etd

Part of the Health Information Technology Commons, and the Nursing Commons

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.

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.

ACKNOWLEDGEMENTS

This dissertation is the result of a number of individuals I would like to personally acknowledge. I extend my deepest appreciation and gratitude to my thesis supervisors Dr. Lorie Donelle and Dr. Richard Booth for their valued support. Your expert feedback and guidance throughout this process has been invaluable. I would also like to acknowledge my advisory committee member Dr. Deborah Compeau for her respected mentorship and guidance throughout this process. In addition, the completion of this dissertation would not have been possible without the support of my graduate study colleagues and close friends who helped me navigate the demands of graduate education and make the most of my time away from my studies.

Finally, I want to extend a special and heartfelt thank you to my parents for always believing in me and encouraging me in all my endeavors. I thank you for passing on to me your sense of determination and appreciation for managing and enjoying my studies.

TABLE OF CONTENTS

LIST OF APPENDICES

Appendix A – BMJ Licensure Agreement – Permission to Reprint Figure

Appendix B – Semi-Structured Interview Guide

Appendix C – Western University Research Ethics Board - Ethics Approval Notice

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; Oroviogoicoechea, 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 (Oroviogoicoechea 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, &
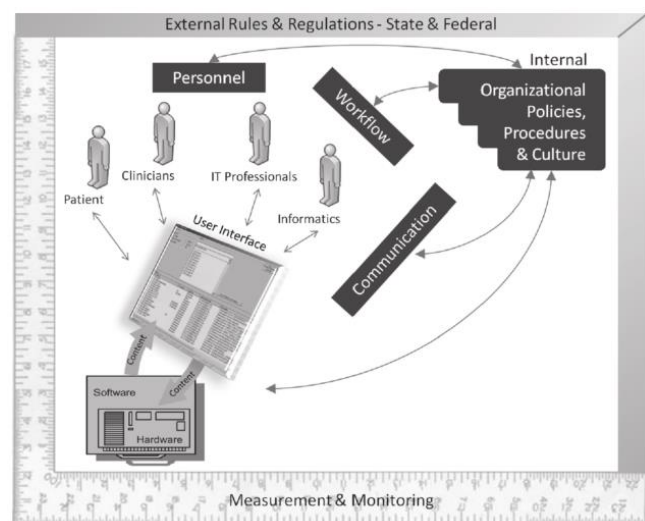

Figure 1. Illustration of the complex inter-relationship between the eight dimensions in Sittig and Singh's (2010) sociotechnical model. Reprinted with permission from British Medical Journal Publishing Groups Limited. Copyright 2010.

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 (Oroviogoicoechea 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.

References

Aarts, J., Peel, V., & Wright, G. (1998). Organizational issues in health informatics: A model approach. *International Journal of Medical Informatics*, *52*(1), 235–42. doi:10.1016/s1386-5056(98)00142-7

Amorim, M., & Miranda, F. (2015). An approach for the semantic interoperability of SNOMED: Improving quality of health records. In J. Machado & A. Abelha (Eds.), *Applying Business Intelligence to Clinical and Healthcare Organizations* (pp. 169–188). Hershey, PA: IGI Global.

Aretz, H. T. (2011). Some thoughts about creating healthcare professionals that match what societies need. *Medical Teacher*, *33*(8), 608–613. doi:10.3109/0142159X.2011.590389

Arvanitis, T. N. (2014). Semantic interoperability in healthcare. *Studies in Health Technology and Informatics*, *202*(1), 5–8. doi:10.3233/978-1-61499-423-7-5

Berg, M. (1999). Patient care information systems and health care work: A sociotechnical approach. *International Journal of Medical Informatics*, *55*(2), 87–101. doi:10.1016/S1386-5056(99)00011-8

Berg, M. (2001). Implementing information systems in health care organizations: Myths and challenges. *International Journal of Medical Informatics*, *64*(2-3), 143–156. doi:10.1016/S1386-5056(01)00200-3

Berg, M., Aarts, J., & van der Lei, J. (2003). ICT in health care: Sociotechnical approaches. *Methods of Information in Medicine*, *42*(4), 297–301. doi:10.1267/METH03040297

Bijker, W. E., & Law, J. (1992). *Shaping technology: Building society, studies in*

sociotechnical change. Cambridge, MA: MIT Press.

Booth, R., Andrusyszyn, M., Iwasiw, C., Donelle, L., & Compeau, D. (2015). Actor-network theory as a sociotechnical lens to explore the relationship of nurses and technology in practice: Methodological considerations for nursing research. *Nursing Inquiry*, *23*(2), 109–20. doi:10.1111/nin.12118

Canadian Institute for Health Information. (2013). *Nursing numbers still rising*. Retrieved from https://www.cihi.ca/en/spending-and-health-workforce/health-workforce/nursing-numbers-still-rising

Carayon, P., Schoofs Hundt, A., Karsh, B.-T., Gurses, A. P., Alvarado, C. J., Smith, M., & Flatley Brennan, P. (2006). Work system design for patient safety: The SEIPS model. *Quality & Safety in Health Care*, *15*(1), i50–i58. doi:10.1136/qshc.2005.015842

Coiera, E. (2003). Interaction design theory. *International Journal of Medical Informatics*, *69*(2-3), 205–22. doi:10.1016/S1386-5056(02)00106-5

Coiera, E. (2004). Four rules for the reinvention of health care. *British Medical Journal*, *328*(7449), 1197–1199. doi:10.1136/bmj.328.7449.1197

Courtney, K. L., Demiris, G., & Alexander, G. L. (2005). Information technology: Changing nursing processes at the point of care. *Nursing Administration Quarterly*, *29*(4), 315–322. Retrieved from www.lww.com/product/?0363-9568

Cresswell, K., Worth, A., & Sheikh, A. (2012). Comparative case study investigating sociotechnical processes of change in the context of a national electronic health record implementation. *Health Informatics Journal*, *18*(4), 251–70. doi:10.1177/1460458212445399

Gephart, S., Carrington, J. M., & Finley, B. (2015). A systematic review of nurses'

    experiences with unintended consequences when using the electronic health record.

    Nursing Administration Quarterly, *39*(4), 345–356.

    doi:10.1097/NAQ.0000000000000119

Giuse, D., & Kuhn, K. A. (2003). Health information systems challenges: The Heidelberg

    conference and the future. *International Journal of Medical Informatics*, *69*(2), 105–

    114. doi:10.1016/S1386-5056(02)00182-X

Harrison, M. I., Koppel, R., & Bar-Lev, S. (2007). Unintended consequences of

    information technologies in health care: An interactive sociotechnical analysis.

    Journal of the American Medical Informatics Association, *14*(5), 542–549.

    doi:10.1197/jamia.M2384

Health Metrics Network. (2008). *Framework and Standards for Country Health*

    Information Systems. *World Health Organization* (Vol. 2). doi:10.4018/978-1-

    60566-988-5

Henriksen, K., Kaye, R., & Morisseau, D. (1993). Industrial ergonomic factors in the

    radiation oncology therapy environment. In R. Nielson & K. Jorgensen (Eds.),

    Advances in Industrial Ergonomics and Safety V. Sweden: Taylor and Francis.

Hughes, R. (2008). Nurses at the "sharp end" of patient care the everydayness of errors.

    In R. Hughes (Ed.), *Patient Safety and Quality: An Evidence-Based Handbook for*

    Nurses (pp. 1–30). Rockville, MD: Agency for Healthcare Research and Quality.

Huston, C. (2013). The impact of emerging technology on nursing care: Warp speed

    ahead. *Online Journal of Issues in Nursing*, *18*(2), 1.

    doi:10.3912/OJIN.Vol18No02Man01

Irizarry, T., & Barton, A. J. (2013). A sociotechnical approach to successful electronic health record implementation. *Clinical Nurse Specialist*, *27*(6), 283–285. doi:10.1097/NUR.0b013e3182a872e3

Johnson, C. W. (2011). Identifying common problems in the acquisition and deployment of large-scale, safety-critical, software projects in the US and UK healthcare systems. *Safety Science*, *49*(5), 735–745. doi:10.1016/j.ssci.2010.12.003

Kabene, S. M., King, L., & Gibson, C. J. (2010). Technology and human resources management in health care. In M. Khosrow-Pour (Ed.), *Enterprise information systems concepts, methodologies, tools and applications*. Hershey, NY: Business Science Reference.

Kerr, M. P. (2002). A qualitative study of shift handover practice and function from a socio-technical perspective. *Journal of Advanced Nursing*, *37*(2), 125–134. doi:10.1046/j.1365-2648.2002.02066.x

Kirkley, D., & Rewick, D. (2003). Evaluating clinical information systems. *The Journal of Nursing Administration*, *33*(12), 643–651. doi:10.1097/00005110-200312000-00007

Koppel, R., Cohen, A., Abaluck, B., Localio, a R., Kimmel, S. E., & Strom, B. L. (2005). Role of computerized physician order entry systems in facilitating medication errors. *Journal of the American Medical Association*, *293*(10), 1197–1203. doi:10.1001/jama.293.10.1197

Leatt, P., Shea, C., Studer, M., & Wang, V. (2006). IT solutions for patient safety: Best practices for successful implementation in healthcare. *Healthcare Quarterly*, *9*(1), 94–104. Retrieved from www.longwoods.com/publications/healthcare-quarterly

Malato, L., & Kim, S. (2004). End-user perceptions of a computerized medication

system: Is there resistance to change? *Journal of Health and Human Services

Administration*, *27*(1), 34–55. Retrieved from http://www.spaef.com/jhhsa.php

Meeks, D. W., Takian, A., Sittig, D., Singh, H., & Barber, N. (2014). Exploring the

sociotechnical intersection of patient safety and electronic health record

implementation. *Journal of the American Medical Informatics Association*, *21*(1),

28–34. doi:10.1136/amiajnl-2013-001762

Menon, S., Smith, M. W., Sittig, D. F., Petersen, N. J., Hysong, S. J., Espadas, D., …

Singh, H. (2014). How context affects electronic health record-based test result

follow-up: A mixed-methods evaluation. *BMJ Open*, *4*(11), 1–9.

doi:10.1136/bmjopen-2014-005985

Mumford, E., & Weir, M. (1979). *Computer systems in work design: The ETHICS

method*. New York, NY: Wiley.

Oroviogoicoechea, C., Elliott, B., & Watson, R. (2008). Review: Evaluating information

systems in nursing. *Journal of Clinical Nursing*, *17*(5), 567–575.

doi:10.1111/j.1365-2702.2007.01985.x

Pai, F.-Y., & Huang, K.-I. (2011). Applying the technology acceptance model to the

introduction of healthcare information systems. *Technological Forecasting and

Social Change*, *78*(4), 650–660. doi:10.1016/j.techfore.2010.11.007

Peute, L. W., Aarts, J., Bakker, P. J. M., & Jaspers, M. W. M. (2010). Anatomy of a

failure: A sociotechnical evaluation of a laboratory physician order entry system

implementation. *International Journal of Medical Informatics*, *79*(4), 58–70.

doi:10.1016/j.ijmedinf.2009.06.008

Pringle, D., & Nagle, L. (2009). Leadership for the information age: The time for action is now. *Nursing Leadership*, *22*(2), 5–6. Retrieved from www.longwoods.com/publications/nursing-leadership

Remus, S., & Kennedy, M. A. (2012). Innovation in transformative nursing leadership: Nursing informatics competencies and roles. *Nursing Leadership*, *25*(4), 14–26. doi:10.12927/cjnl.2012.23260

Remus, S., & Kennedy, M. A. (2015). Nursing documentation in digital solutions. In K. J. Hannah, P. Hussey, & M. A. Kennedy (Eds.), *Introduction to Nursing Informatics* (Fourth., pp. 145–176). Springer London.

Scott, J. T., Rundall, T. G., Vogt, T. M., & Hsu, J. (2005). Kaiser Permanente's experience of implementing an electronic medical record: A qualitative study. *British Medical Journal*, *331*(7528), 1313–1316. doi:10.1136/bmj.38638.497477.68

Singh, H., Ash, J. S., & Sittig, D. F. (2013). Safety assurance factors for electronic health record resilience (SAFER): Study protocol. *BMC Medical Informatics and Decision Making*, *13*(1), 46. doi:10.1186/1472-6947-13-46

Sittig, D. F., & Singh, H. (2010). A new sociotechnical model for studying health information technology in complex adaptive healthcare systems. *Quality & Safety in Health Care*, *19*(1), 68–74. doi:10.1136/qshc.2010.042085

Stein, M., & Deese, D. (2004). Information systems & technology: Addressing the next decade of nursing challenges. *Nursing Economics*, *22*(5), 273–279. Retrieved from http://www.nursingeconomics.net/

Studer, M. (2005). The effect of organizational factors on the effectiveness of EMR system implementation - What have we learned? *Healthcare Quarterly*, *8*(4), 92–98.

Retrieved from http://www.longwoods.com/publications/healthcare-quarterly

Takian, A., Sheikh, A., & Barber, N. (2014). Organizational learning in the
implementation and adoption of national electronic health records: Case studies of
two hospitals participating in the national programme for information technology in
England. *Health Informatics Journal*, *20*(3), 199–212.
doi:10.1177/1460458213493196

Taylor, S. P., Ledford, R., Palmer, V., & Abel, E. (2014). We need to talk: An
observational study of the impact of electronic medical record implementation on
hospital communication. *British Medical Journal*, *23*, 584–8. doi:10.1136/bmjqs-
2013-002436

Törnvall, E., Wilhelmsson, S., & Wahren, L. K. (2004). Electronic nursing
documentation in primary health care. *Scandinavian Journal of Caring Sciences*,
18(3), 310–317. doi:10.1111/j.1471-6712.2004.00282.x

Urquhart, C., Currell, R., Grant, M. J., & Hardiker, N. R. (2009). Nursing record systems:
Effects on nursing practice and healthcare outcomes. *The Cochrane Database of
Systematic Reviews*, *21*(1), 12–45. doi:10.1002/14651858.CD002099.pub2

Vincent, C., Taylor-Adams, S., & Stanhope, N. (1998). Framework for analysing risk and
safety in clinical medicine. *BMJ*, *316*(7138), 1154–1157.
doi:10.1136/bmj.316.7138.1154

Waneka, R., & Spetz, J. (2010). Hospital information technology systems' impact on
nurses and nursing care. *The Journal of Nursing Administration*, *40*(12), 509–514.
doi:10.1097/NNA.0b013e3181fc1a1c

World Health Organization. (2008). *Health information systems*. Retrieved from

http://www.who.int/healthinfo/statistics/en/

Yusof, M. M., Papazafeiropoulou, A., Paul, R. J., & Stergioulas, L. K. (2008).

Investigating evaluation frameworks for health information systems. *International*

Journal of Medical Informatics, *77*(6), 377–385. doi:10.1016/j.ijmedinf.2007.08.004

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 (Oroviogoicoechea 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 (Oroviogoicoechea 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; Oroviogoicoechea 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; Oroviogoicoechea 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 Oroviogoicoechea 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). Oroviogoicoechea 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 (Oroviogoicoechea 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 (Oroviogoicoechea 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 date 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.

References

Aarts, J., & Berg, M. (2004). A tale of two hospitals: A sociotechnical appraisal of the introduction of computerized physician order entry in two Dutch hospitals. *Studies in Health Technology and Informatics*, *107*(2), 999–1002. doi:10.3233/978-1-60750-949-3-999

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. doi:10.1016/0749-5978(91)90020-T

Almerud, S., Alapack, R. J., Fridlund, B., & Ekebergh, M. (2008). Beleaguered by technology: Care in technologically intense environments. *Nursing Philosophy*, *9*(1), 55–61. doi:10.1111/j.1466-769X.2007.00332.x

Alpay, L., & Russell, A. (2002). Information technology training in primary care: The nurses' voice. *Computers, Informatics, Nursing*, *20*(4), 136–142. Retrieved from www.cinjournal.com

Ammenwerth, E., Gräber, S., Herrmann, G., Bürkle, T., & König, J. (2003). Evaluation of health information systems - problems and challenges. *International Journal of Medical Informatics*, *71*(2-3), 125–135. doi:10.1016/S1386-5056(03)00131-X

Amorim, M., & Miranda, F. (2015). An approach for the semantic interoperability of SNOMED: Improving quality of health records. In J. Machado & A. Abelha (Eds.), *Applying Business Intelligence to Clinical and Healthcare Organizations* (pp. 169–188). Hershey, PA: IGI Global.

Andersson, A., Hallberg, N., & Timpka, T. (2003). A model for interpreting work and information management in process-oriented healthcare organisations. *International Journal of Medical Informatics*, *72*(1-3), 47–56. doi:10.1016/j.ijmedinf.2003.09.001

Ash, J. S., & Bates, D. W. (2005). Factors and forces affecting EHR system adoption: Report of a 2004 ACMI discussion. *Journal of the American Medical Informatics Association*, *12*(1), 8–12. doi:10.1197/jamia.M1684

Ash, J. S., Sittig, D. F., Dykstra, R. H., Guappone, K., Carpenter, J. D., & Seshadri, V. (2007). Categorizing the unintended sociotechnical consequences of computerized provider order entry. *International Journal of Medical Informatics*, *76*(1), 21–27. doi:10.1016/j.ijmedinf.2006.05.017

Ash, J. S., Sittig, D. F., Poon, E. G., Guappone, K., Campbell, E., & Dykstra, R. H. (2007). The extent and importance of unintended consequences related to computerized provider order entry. *Journal of the American Medical Informatics Association*, *14*(4), 415–423. doi:10.1197/jamia.M2373

Berg, M., Aarts, J., & van der Lei, J. (2003). ICT in health care: Sociotechnical approaches. *Methods of Information in Medicine*, *42*(4), 297–301. doi:10.1267/METH03040297

Booth, R., Andrusyszyn, M., Iwasiw, C., Donelle, L., & Compeau, D. (2015). Actor-network theory as a sociotechnical lens to explore the relationship of nurses and technology in practice: Methodological considerations for nursing research. *Nursing Inquiry*, *23*(2), 109–20. doi:10.1111/nin.12118

Campbell, E., Sittig, D. F., Ash, J. S., Guappone, K. P., & Dykstra, R. H. (2006). Types of unintended consequences related to computerized provider order entry. *Journal of the American Medical Informatics Association*, *13*(5), 547–556. doi:10.1197/jamia.M2042.Introduction

Canadian Institute for Health Information. (2013). *Nursing numbers still rising*. Retrieved

from https://www.cihi.ca/en/spending-and-health-workforce/health-workforce/nursing-numbers-still-rising

Chaudhry, B., Wang, J., Wu, S., Maglione, M., Mojica, W., Roth, E., … Shekelle, P. G. (2006). Systematic review: Impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine*, *144*(10), 742–752. doi:10.7326/0003-4819-144-10-200605160-00125

Collins, S., Bakken, S., Cimino, J. J., & Currie, L. (2007). A methodology for meeting context-specific information needs related to nursing orders. In *AMIA Annual Symposium Proceedings* (pp. 155–159).

Conn, V. S., Isaramalai, S., Rath, S., Jantarakupt, P., Wadhawan, R., & Dash, Y. (2003). Beyond MEDLINE for literature searches. *Journal of Nursing Scholarship*, *35*(2), 177–182. doi:10.1111/j.1547-5069.2003.00177.x

Cresswell, K., Worth, A., & Sheikh, A. (2010). Actor-Network Theory and its role in understanding the implementation of information technology developments in healthcare. *BMC Medical Informatics and Decision Making*, *10*(1), 67. doi:10.1186/1472-6947-10-67

Cresswell, K., Worth, A., & Sheikh, A. (2012). Comparative case study investigating sociotechnical processes of change in the context of a national electronic health record implementation. *Health Informatics Journal*, *18*(4), 251–70. doi:10.1177/1460458212445399

Damanpour, F., & Schneider, M. (2006). Phases of the adoption of innovation in organizations: Effects of environment, organization and top managers. *British Journal of Management*, *17*(3), 215–236. doi:10.1111/j.1467-8551.2006.00498.x

Darbyshire, P. (2004). "Rage against the machine?": Nurses' and midwives' experiences of using computerized patient information systems for clinical information. *Journal of Clinical Nursing*, *13*(1), 17–25. doi:10.1046/j.1365-2702.2003.00823.x

Debono, D. S., Greenfield, D., Travaglia, J. F., Long, J. C., Black, D., Johnson, J., & Braithwaite, J. (2013). Nurses' workarounds in acute healthcare settings: A scoping review. *BMC Health Services Research*, *13*, 175. doi:10.1186/1472-6963-13-175

Dienemann, J., & Van de Castle, B. (2003). The impact of healthcare informatics on the organization. *The Journal of Nursing Administration*, *33*(11), 557–562. doi:10.1097/00005110-200311000-00001

Dillon, T. W., Blankenship, R., & Crews, T. (2005). Nursing attitudes and images of electronic patient record systems. *Computers, Informatics, Nursing*, *23*(3), 139–145. doi:10.1097/00024665-200505000-00009

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107–115. doi:10.1111/j.1365-2648.2007.04569.x

Faber, M. G., & Getrouw, V. (2003). Design and introduction of an electronic patient record: How to involve users? *Methods of Information in Medicine*, *42*(4), 371–375. doi:10.1267/meth03040371

Gephart, S., Carrington, J. M., & Finley, B. (2015). A systematic review of nurses' experiences with unintended consequences when using the electronic health record. *Nursing Administration Quarterly*, *39*(4), 345–356. doi:10.1097/NAQ.0000000000000119

Graneheim, U. ., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education*

Today, *24*(2), 105–112. doi:10.1016/j.nedt.2003.10.001

Hall, W., & Irvine, V. (2009). E-communication among mothers of infants and toddlers in a community-based cohort: A content analysis. *Journal of Advanced Nursing*, *65*(1), 175–83. doi:10.1111/j.1365-2648.2008.04856.x

Harrison, M. I., Koppel, R., & Bar-Lev, S. (2007). Unintended consequences of information technologies in health care: An interactive sociotechnical analysis. *Journal of the American Medical Informatics Association*, *14*(5), 542–549. doi:10.1197/jamia.M2384

Health Metrics Network. (2009). *Guidance for the Health Information Systems Strategic Planning Process*. *World Health Organization* (Vol. 6). Retrieved from http://www.who.int/en/

Heaton, J. (1998). Secondary analysis of qualitative data. *Social Research Update*, (22). Retrieved from sru.soc.surrey.ac.uk/

Heaton, J. (2008). Secondary analysis of qualitative data: An overview. *Historical Social Research*, *33*(3), 33–45. Retrieved from http://www.gesis.org/en/hsr/hsr-home/

Hellesø, R., & Lorensen, M. (2005). Inter-organizational continuity of care and the electronic patient record: A concept development. *International Journal of Nursing Studies*, *42*(7), 807–822. doi:10.1016/j.ijnurstu.2004.07.005

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277–1288. doi:10.1177/1049732305276687

Hughes, R. A. (2003). Clinical practice in a computer world: Considering the issues. *Journal of Advanced Nursing*, *42*(4), 340–6. Retrieved from http://onlinelibrary.wiley.com/

Husting, P. M., & Cintron, L. (2003). Healthcare information systems: Education lessons learned. *Journal for Nurses in Staff Development*, *19*(5), 253–257.

Hyun, S., Johnson, S., Stetson, P., & Bakken, S. (2010). Development and evaluation of nursing user interface screens using multiple methods, *42*(6), 1004–1012. doi:10.1016/j.jbi.2009.05.005.Development

Irizarry, T., & Barton, A. J. (2013). A sociotechnical approach to successful electronic health record implementation. *Clinical Nurse Specialist*, *27*(6), 283–285. doi:10.1097/NUR.0b013e3182a872e3

Kaufman, D., Merrill, J., & Bakken, S. (2006). Applying an evaluation framework for health information system design, development, and implementation. *Nursing Research*, *55*(2), 37–42. Retrieved from http://www.nursingresearchonline.com/

Kennedy, M. A., & Hussey, P. (2015). Nursing Informatics. In K. Hannah, P. Hussey, M. Kennedy, & M. Ball (Eds.), *Inroduction to Nurisng Informatics* (pp. 11–35). New York, NY: Springer.

Kerr, M. P. (2002). A qualitative study of shift handover practice and function from a socio-technical perspective. *Journal of Advanced Nursing*, *37*(2), 125–134. doi:10.1046/j.1365-2648.2002.02066.x

Kirkley, D. (2004). Not whether, but when: Gaining buy-in for computerized clinical processes. *The Journal of Nursing Administration*, *34*(2), 55–58. doi:10.1097/00005110-200402000-00001

Kirkley, D., & Rewick, D. (2003). Evaluating clinical information systems. *The Journal of Nursing Administration*, *33*(12), 643–651. doi:10.1097/00005110-200312000-00007

Lapointe, L., & Rivard, S. (2005). Clinical information systems: Understanding and

    preventing their premature demise. *Healthcare Quarterly*, *8*(2), 92–100. Retrieved

    from www.longwoods.com/publications/healthcare-quarterly

Lapointe, L., & Rivard, S. (2006). Getting physicians to accept new information

    technology: Insights from case studies. *Canadian Medical Association Journal*,

    174(11), 1573–1578. doi:10.1503/cmaj.050281

Lau, F., Kuziemsky, C., Price, M., & Gardner, J. (2010). A review on systematic reviews

    of health information system studies. *Journal of the American Medical Informatics*

    Association, *17*(6), 637–645. doi:10.1136/jamia.2010.004838

Lawson-Body, A., Willoughby, L., Hoffner, E., & Longossa, K. (2014). Implementation

    factors influencing electronic medical records systems. *Issues in Information*

    Systems, *15*(1), 323–333. Retrieved from www.iacis.org/iis/iis.php

Leape, L. L., Berwick, D. M., & Bates, D. W. (2015). What practices will most improve

    safety? Evidence-based medicine meets patient safety. *Journal of the American*

    Medical Association, *288*(4), 501–507. doi:10.1001/jama.288.4.501

Leatt, P., Shea, C., Studer, M., & Wang, V. (2006). IT solutions for patient safety: Best

    practices for successful implementation in healthcare. *Healthcare Quarterly*, *9*(1),

    94–104. Retrieved from www.longwoods.com/publications/healthcare-quarterly

Lee, T. (2005). Nurses' concerns about using information systems: Analysis of comments

    on a computerized nursing care plan system in Taiwan. *Journal of Clinical Nursing*,

    14(3), 344–353. doi:10.1111/j.1365-2702.2004.01060.x

Lee, T. (2007). Nurses' experiences using a nursing information system. *Computers,*

    Informatics, Nursing, *25*(5), 294–300. doi:10.1097/01.NCN.0000289166.61863.0b

Lincoln, S. Y., & Guba, E. G. (1985). Naturalistic Inquiry. Thousand Oaks, CA: Sage.

Lopez, K. A., & Willis, D. G. (2004). Descriptive versus interpretive phenomenology: Their contributions to nursing knowledge. *Qualitative Health Research*, *14*(5), 726–735. doi:10.1177/1049732304263638

Malato, L., & Kim, S. (2004). End-user perceptions of a computerized medication system: Is there resistance to change? *Journal of Health and Human Services Administration*, *27*(1), 34–55. Retrieved from http://www.spaef.com/jhhsa.php

McCartney, P. R. (2004). Leadership in nursing informatics. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, *33*(3), 371–380. doi:10.1177/0884217504265094

Meeks, D. W., Takian, A., Sittig, D., Singh, H., & Barber, N. (2014). Exploring the sociotechnical intersection of patient safety and electronic health record implementation. *Journal of the American Medical Informatics Association*, *21*(1), 28–34. doi:10.1136/amiajnl-2013-001762

Menon, S., Smith, M. W., Sittig, D. F., Petersen, N. J., Hysong, S. J., Espadas, D., … Singh, H. (2014). How context affects electronic health record-based test result follow-up: A mixed-methods evaluation. *BMJ Open*, *4*(11), 1–9. doi:10.1136/bmjopen-2014-005985

Meyer, R., VanDeVelde-Coke, S., & Velji, K. (2012). Leadership for health system transformation: What's needed in Canada? *Nursing Leadership*, *24*(4), 21–30. doi:10.12927/cjnl.2012.22732

Moody, L. E., Slocumb, E., Berg, B., & Jackson, D. (2004). Electronic health records documentation in nursing: Nurses' perceptions, attitudes, and preferences.

Computers, Informatics, Nursing, *22*(6), 337–344. doi:10.1097/00024665-200411000-00009

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, *1*(2), 13–22. doi:10.1063/1.2011328

Nagle, L., & Catford, P. (2008). Toward a model of successful electronic health record adoption. *Healthcare Quarterly*, *11*(3), 84–91. Retrieved from http://www.longwoods.com/publications/healthcare-quarterly

Nagle, L. M. (2005). Focus on leaders: Dr . Lynn Nagle and the case for nursing informatics. *Nursing Leadership*, *18*(1), 16–18. doi:10.12927/cjnl.2005.17027

Nickitas, D. M., & Kerfoot, K. (2010). Nursing informatics: Why nurse leaders need to stay informed. *Nursing Economics*, *28*(3), 1–3. Retrieved from www.nursingeconomics.net/

Odhiambo-Otieno, G. W. (2005). Evaluation of existing district health management information systems: A case study of the district health systems in Kenya. *International Journal of Medical Informatics*, *74*(9), 733–744. doi:10.1016/j.ijmedinf.2005.05.007

Ontario Hospital Association. (2007). *Hospital report 2007: Acute care*. Toronto, ON. Retrieved from www.oha.org

Ontario Hospital Association. (2008). *Healthcare governance in volatile economic times: Don't waste a crisis*. Toronto, ON. Retrieved from www.oha.org

Oroviogoicoechea, C., Elliott, B., & Watson, R. (2008). Review: Evaluating information systems in nursing. *Journal of Clinical Nursing*, *17*(5), 567–575.

doi:10.1111/j.1365-2702.2007.01985.x

Ovretveit, J., Scott, T., Rundall, T. G., Shortell, S. M., & Brommels, M. (2007). Improving quality through effective implementation of information technology in healthcare. *International Journal for Quality in Health Care*, *19*(5), 259–266. doi:mzm031 [pii]\r10.1093/intqhc/mzm031

Parker, P. (2002). Solutions success. *Nursing Management*, *33*(February), 39–40. Retrieved from: http://journals.lww.com/nursingmanagement/pages/default.aspx

Peute, L. W., Aarts, J., Bakker, P. J. M., & Jaspers, M. W. M. (2010). Anatomy of a failure: A sociotechnical evaluation of a laboratory physician order entry system implementation. *International Journal of Medical Informatics*, *79*(4), 58–70. doi:10.1016/j.ijmedinf.2009.06.008

Poissant, L., Pereira, J., Tamblyn, R., & Kawasumi, Y. (2005). The impact of electronic health records on time efficiency of physicians and nurses: a systematic review. *Journal of the American Medical Association*, *12*(5), 505–516. doi:10.1197/jamia.M1700.j

Poon, E. G., Blumenthal, D., Jaggi, T., Honour, M. M., Bates, D. W., & Kaushal, R. (2004). Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Health Affairs*, *23*(4), 184–190. doi:10.1377/hlthaff.23.4.184

Pringle, D., & Nagle, L. (2009). Leadership for the information age: The time for action is now. *Nursing Leadership*, *22*(2), 5–6. Retrieved from www.longwoods.com/publications/nursing-leadership

Rahimi, B., Vimarlund, V., & Timpka, T. (2009). Health information system

implementation: A qualitative meta-analysis. *Journal of Medical Systems*, *33*, 359–
368. doi:10.1007/s10916-008-9198-9

Remus, S., & Kennedy, M. A. (2012). Innovation in transformative nursing leadership:
Nursing informatics competencies and roles. *Nursing Leadership*, *25*(4), 14–26.
doi:10.12927/cjnl.2012.23260

Sagtroglu, O., & Ozturan, M. (2006). Implementation difficulties of hospital information
systems. *Information Technology Journal*, *5*(5), 829–899.

Samoutis, G., Soteriades, E. S., Kounalakis, D. K., Zachariadou, T., Philalithis, A., &
Lionis, C. (2007). Implementation of an electronic medical record system in
previously computer-naive primary care centres: A pilot study from Cyprus.
Informatics in Primary Care, *15*(4), 207–216. Retrieved from
http://www.clininf.eu/journal.html

Sandelowski, M. (2000). Whatever happened to qualitative description? *Research in
Nursing & Health*, *23*(4), 334–340. doi:10.1002/1098-240x

Saranto, K., & Kinnunen, U.-M. (2009). Evaluating nursing documentation - research
designs and methods: Systematic review. *Journal of Advanced Nursing*, *65*(3), 464–
76. doi:10.1111/j.1365-2648.2008.04914.x

Scott, J. T., Rundall, T. G., Vogt, T. M., & Hsu, J. (2005). Kaiser Permanente's
experience of implementing an electronic medical record: A qualitative study.
British Medical Journal, *331*(7528), 1313–1316. doi:10.1136/bmj.38638.497477.68

Sim, I., Gorman, P., Greenes, R. A., Haynes, R. B., Kaplan, B., Lehmann, H., & Tang, P.
C. (2001). Clinical decision support systems for the practice of evidence-based
medicine. *Journal of the American Medical Informatics Association*, *8*(6), 527–534.

doi:10.1136/jamia.2001.0080527

Singh, H., Ash, J. S., & Sittig, D. F. (2013). Safety assurance factors for electronic health

record resilience (SAFER): Study protocol. *BMC Medical Informatics and Decision*

Making, *13*(1), 46. doi:10.1186/1472-6947-13-46

Sittig, D. F., & Ash, J. S. (2011). On the importance of using a multidimensional

sociotechnical model to study health information technology. *Annals of Family*

Medicine, *9*(5), 390–391. doi:10.1370/afm.1291

Sittig, D. F., & Singh, H. (2010). A new sociotechnical model for studying health

information technology in complex adaptive healthcare systems. *Quality & Safety in*

Health Care, *19*(1), 68–74. doi:10.1136/qshc.2010.042085

Smith, K., Smith, V., Krugman, M., & Oman, K. (2005). Evaluating the impact of

computerized clinical documentation. *Computers, Informatics, Nursing*, *23*(3), 132–

138. doi:10.1097/00024665-200505000-00008

Söderberg, S., & Lundman, B. (2001). Transitions experienced by women with

fibromyalgia. *Health Care for Women International*, *22*(7), 617–631.

doi:10.1080/073993301753235389

Stein, M., & Deese, D. (2004). Information systems & technology: Addressing the next

decade of nursing challenges. *Nursing Economics*, *22*(5), 273–279. Retrieved from

http://www.nursingeconomics.net/

Strudwick, G. (2015). Predicting nurses' use of healthcare technology using the

technology acceptance model. *Computers, Informatics, Nursing*, *33*(5), 189–198.

doi:10.1097/CIN.0000000000000142

Takian, A., Sheikh, A., & Barber, N. (2012). We are bitter, but we are better off: Case

study of the implementation of an electronic health record system into a mental health hospital in England. *BMC Health Services Research*, *12*(1), 484. doi:10.1186/1472-6963-12-484

Thomas, B., & Warm, D. (2009). Providing support for the information healthcare programme in Wales. *Nursing Standard*, *23*(26), 35–41. Retrieved from journals.rcni.com/journal/ns

Thompson, B. W. (2005). The transforming effect of handheld computers on nursing practice. *Nursing Administration Quarterly*, *29*(4), 308–314. doi:10.1097/00006216-200510000-00004

Thorne, S. (1994). Secondary analysis in qualitative research: Issues and implications. In J. M. Morse (Ed.), *Critical Issues in Qualitative Research Methods* (pp. 263–79). London: Sage.

Thorne, S. (1998). Pearls, pith, and provocation: Ethical and representational issues in qualitative secondary analysis. *Qualitative Health Research*, *8*(4), 547–555. doi:10.1177/104973239800800408

Timmons, S. (2003). Nurses resisting information technology. *Nursing Inquiry*, *10*(4), 257–269. doi:10.1046/j.1440-1800.2003.00177.x

Törnvall, E., Wilhelmsson, S., & Wahren, L. K. (2004). Electronic nursing documentation in primary health care. *Scandinavian Journal of Caring Sciences*, *18*(3), 310–317. doi:10.1111/j.1471-6712.2004.00282.x

Van Der Meijden, M. J., Tange, H. J., Troost, J., & Hasman, A. (2003). Determinants of success of inpatient clinical information systems: A literature review. *Journal of the American Medical Informatics Association*, *10*(3), 235–243.

doi:10.1197/jamia.M1094.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of
information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478.
Retrieved from http://www.misq.org

Waneka, R., & Spetz, J. (2010). Hospital information technology systems' impact on
nurses and nursing care. *The Journal of Nursing Administration*, *40*(12), 509–514.
doi:10.1097/NNA.0b013e3181fc1a1c

Ziegert, K., Fridlund, B., & Lidell, E. (2007). Professional support for next of kin of
patients receiving chronic haemodialysis treatment: A content analysis study of
nursing documentation. *Journal of Clinical Nursing*, *16*(2), 353–361.
doi:10.1111/j.1365-2702.2006.01597.x

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 (Oroviogoicoechea 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 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.

References

Ballard, E. C. (2006). Improving information management in ward nurses' practice.

    Nursing Standard, *20*(50), 43–8. doi:10.7748/ns2006.08.20.50.43.c4486

Booth, R. (2013). *Nurses' learning and conceptualization of technology used in practice*.

    University of Western Ontario Electronic Thesis and Dissertation Repository.

    Retrieved from http://ir.lib.uwo.ca/etd/1725/

Canadian Association of Schools of Nursing. (2014). *Nursing informatics: Entry-to-*

    practice competencies for registered nurses. Retrieved from

    http://www.casn.ca/2014/12/nursing-informatics-entry-practice-competencies-

    registered-nurses-2/

Darbyshire, P. (2004). "Rage against the machine?": Nurses' and midwives' experiences

    of using computerized patient information systems for clinical information. *Journal*

    of Clinical Nursing, *13*(1), 17–25. doi:10.1046/j.1365-2702.2003.00823.x

Health Metrics Network. (2008). *Framework and Standards for Country Health*

    Information Systems. *World Health Organization* (Vol. 2). doi:10.4018/978-1-

    60566-988-5

Kannry, J., Sengstack, P., Thyvalikakath, T. P., Poikonen, J., Middleton, B., Payne, T., &

    Lehmann, C. (2016). The chief clinical informatics officer (CCIO). *Applied Clinical*

    Informatics, *7*(1), 143–176. doi:10.4338/ACI-2015-12-R-0174

Knoedler, J. (2003). IT integration transforms the care continuum. *Nursing Management*,

    1(October), 8–10. doi:10.1097/00006247-200310002-00002

Lee, T. (2007). Nurses' experiences using a nursing information system. *Computers,*

    Informatics, Nursing, *25*(5), 294–300. doi:10.1097/01.NCN.0000289166.61863.0b

Meyer, R., VanDeVelde-Coke, S., & Velji, K. (2012). Leadership for health system

    transformation: What's needed in Canada? *Nursing Leadership*, *24*(4), 21–30.

    doi:10.12927/cjnl.2012.22732

Oroviogoicoechea, C., Elliott, B., & Watson, R. (2008). Review: Evaluating information

    systems in nursing. *Journal of Clinical Nursing*, *17*(5), 567–575.

    doi:10.1111/j.1365-2702.2007.01985.x

Parker, P. (2002). Solutions success. *Nursing Management*, *33*(February), 39–40.

    doi:10.1097/00006247-200202000-00014

Patterson, E. S., Cook, R. I., & Render, M. L. (2002). Improving patient safety by

    identifying side effects from introducing bar coding in medication administration.

    Journal of the American Medical Informatics Association, *9*(5), 540–553.

    doi:10.1197/jamia.M1061

Pringle, D., & Nagle, L. (2009). Leadership for the information age: The time for action

    is now. *Nursing Leadership*, *22*(2), 5–6. Retrieved from

    www.longwoods.com/publications/nursing-leadership

Sittig, D. F., & Singh, H. (2010). A new sociotechnical model for studying health

    information technology in complex adaptive healthcare systems. *Quality & Safety in*

    Health Care, *19*(1), 68–74. doi:10.1136/qshc.2010.042085

Stein, M., & Deese, D. (2004). Information systems & technology: Addressing the next

    decade of nursing challenges. *Nursing Economics*, *22*(5), 273–279. Retrieved from

    http://www.nursingeconomics.net/

Stevenson, J. E., Nilsson, G. C., Petersson, G. I., & Johansson, P. E. (2010). Nurses'

    experience of using electronic patient records in everyday practice in acute/inpatient

ward settings: A literature review. *Health Informatics Journal*, *16*(1), 63–72. doi:10.1177/1460458209345901

Swenty, C. L., & Titzer, J. L. (2014). A sense of urgency: Integrating technology and informatics in advance practice nursing education. *Journal for Nurse Practitioners*, *10*(10), 57–67. doi:10.1016/j.nurpra.2014.07.034

Tierney, W. M. (2001). Improving clinical decisions and outcomes with information: A review. *International Journal of Medical Informatics*, *62*(1), 1–9. doi:S1386-5056(01)00127-7 [pii]

Waneka, R., & Spetz, J. (2010). Hospital information technology systems' impact on nurses and nursing care. *The Journal of Nursing Administration*, *40*(12), 509–514. doi:10.1097/NNA.0b013e3181fc1a1c

Westra, B. L., Delaney, C. W., Konicek, D., & Keenan, G. (2008). Nursing standards to support the electronic health record. *Nursing Outlook*, *56*(5). doi:10.1016/j.outlook.2008.06.005

Westra, B. L., Subramanian, A., Hart, C. M., Matney, S. a, Wilson, P. S., Huff, S. M., … Delaney, C. W. (2010). Achieving "meaningful use" of electronic health records through the integration of the nursing management minimum data set. *The Journal of Nursing Administration*, *40*(7-8), 336–43. doi:10.1097/NNA.0b013e3181e93994

Appendix A

BMJ Licensure Agreement: Permission to Reprint Figure

This Agreement between Maximillian Besworth ("You") and BMJ Publishing Group Ltd. ("BMJ Publishing Group Ltd.") consists of your license details and the terms and conditions provided by BMJ Publishing Group Ltd. and Copyright Clearance Center.

License Number	3850300187853
License date	Apr 15, 2016
Licensed Content Publisher	BMJ Publishing Group Ltd.
Licensed Content Publication	BMJ Quality and Safety
Licensed Content Title	A new sociotechnical model for studying health information technology in complex adaptive healthcare systems
Licensed Content Author	Dean F Sittig, Hardeep Singh
Licensed Content Date	Oct 1, 2010
Licensed Content Volume Number	19
Licensed Content Issue Number	Suppl 3
Volume number	19
Issue number	Suppl 3
Type of Use	Dissertation/Thesis
Requestor type	Individual
Format	Electronic
Portion	Figure/table/extract
Number of figure/table/extracts	1
Descriptionof figure/table/extracts	Figure 1. Illustration of the complex inter-relationship between the eight dimensions of the sociotechnical model.
Will you be translating?	No
Circulation/distribution	1
Title of your thesis / dissertation	HIS Implementation in an Acute-Care Environment: A sociotechnical content analysis

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?	● Experience o How long have you worked at the hospital organization? o How long have you worked in your current position? o 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?	● What do you particularly like about it? o Why do you like that? o Can you give me an example? ● Is there anything that you particularly dislike about it? o Why do you dislike that? o 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?	● 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) o 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?

4. So tell me about how you use Iris now?	• Are you required to use Iris? If so, by whom?
	• I have here a list of the different ways that people might use Iris.
	    o Management of unit-specific patient flow
	    o Management of Program-specific patient flow
	    o Monitoring of patient flow while ON CALL
	    o To gain an understanding of patient flow organization-wide
	    o Review of number of ALC patients within organization
	    o Review of number of isolation cases within organization
	    o General information only
	    o I have not used it at all / I don't expect to use it at all
	    o 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.
	    o 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?

5. Do you sometimes experience that it is difficult to use Iris? If so, what is the typical reason for	• 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?	● Benefits on your job? o 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	● 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

██████████████████

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 ██████

      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

██████████████████

Ethics Officer, Office of Research Ethics
1393 Western Road, Support Services Building, Room 5150
London, ON Canada N6A 3K7

██████████████████

CURRICULUM VITAE

MAXIMILLIAN DAVID BESWORTH

Education: Western University
                    London, Ontario, Canada
                    Bachelor of Science in Nursing (BScN)
                    2009-2013 Graduated with Honors

Work Experience: Registered Nurse
                    St Joseph's Health Care
                    London, Ontario, Canada
                    2015-2016

                    Teaching Assistant
                    Arthur Labatt Family School of Nursing
                    Western University
                    London, Ontario, Canada
                    2013-2016

                    Research Assistant
                    Richard Ivey School of Business
                    Western University
                    London, Ontario, Canada
                    2013-2015