

Running Head: INTRODUCING TECHNOLOGY

Introducing Technology into an Acute Care, Multi-site Teaching Hospital

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Abstract

Objective

To investigate and describe how an acute care, multi-site teaching hospital implements a new technology called the Automated Medication Dispensing Cabinet (ADC) that will be used by nurses.

Design and methods

Qualitative, descriptive, single-case study method using the Ottawa Model of Research Use as a framework to guide data collection and analysis. The project was evaluated from the beginning, through the planning stages until a cabinet vendor was chosen.

Results

A multidisciplinary committee was created to implement the ADCs across the organization. Clinical nurses, the intended users, were not directly involved in the implementation; usability testing was not done; they were not prepared for all the needed training costs and no evaluation was planned.

Conclusions

An implementation framework was not used to guide the ADC project and several key areas surrounding implementation were missed. Recommendations were made to improve future implementation projects in health organizations.

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List of Abbreviations

ADCs	Automated Medication Dispensing Cabinets
AME	Assess, Monitor, Evaluate
CIO	Chief Information Officer
CPOE	Computerized Provider Order Entry
ED	Emergency Department
eMAR	Electronic Medication Administration Record
ICU	Intensive Care Unit
IM	Instant messaging
I-DPTS	Innovation–decision process teaching strategy
IS/IT	Information Systems/Information Technologies
KT	Knowledge translation
MAR	Medication Administration Record
OMRU	Ottawa Model of Research Use
OR	Operating Room
PARIHS	Promoting Action on Research Implementation in Health Services
RFP	Request for proposal

CHAPTER 1 - Introduction and Literature Review

The industrial revolution brought about changes at a rate never before seen in the field of health care (Barnard, 2002; Irvine, Elliott, Wallace, & Crombie, 2006). Throughout the 20th century, and up to the present time, scientists and researchers have continued to design and develop new tools to improve the way health care is delivered. Technology is present in every aspect of health care and advancements in technology are a way of life for the 21st century. Nurses represent the largest group of technology users in health care and, more than ever, nurses in hospitals and communities are being required to accept new roles and responsibilities associated with health technology (Barnard, 2002; Ting-Ting, 2004). Nurses are the link between these technologies and the patients/clients they serve (Barnard, 2002).

Much research has been completed over the last 25 years focusing on how technologies could and should be implemented in the clinical setting. Despite this considerable amount of research, there are still gaps in the literature as to how technology becomes successfully integrated into clinical practice (Francke, Smit, de Veer, & Mistiaen, 2008; Green & Seifert, 2005; Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004; Grol & Grimshaw, 2003). The implementation process is important because it will affect whether the technology is accepted or rejected (Anderson & Stafford, 2002). Nurses, as end users of technology, may feel resentment towards the innovation if they perceive they have not been involved in the design and implementation process or if they are improperly trained (Rogers, 2003; Timmons, 2003). Nurses may not have the option to outright reject a new innovation, which their organization implements, but nurses can find ways to resist or circumvent a technology they do not wish to use (Anderson & Stafford, 2002; Greiner & Knebel, 2003; Rogers, 2003; Timmons, 2003). Ultimately, nurses' support for the innovation is essential for successful implementation. This

study will focus on one organization that is implementing a new computerized medication storage and administration system called the Automated Medication Dispensing Cabinet (ADC). The goal of the study is to gain insight into the process of implementing a new technology and to observe how nurses are involved in the process.

Research Question

How does an acute care, multi-site teaching hospital implement new technology that will be used by nurses?

Literature Review

Moving research into practice – this is an area of study that researchers across multiple disciplines have looked at for decades. Many theories, models, and frameworks have been created to explain and guide the implementation of research into practice. Some of the terminology used to describe the implementation of research into practice includes but is not limited to: diffusion of innovation, dissemination, research utilization, knowledge translation, planned action, implementation research, quality improvement, research uptake, and change management (Campbell, 2010; Estabrooks, Thompson, Lovely, & Hofmeyer, 2006). Although there are areas of overlap in the terms listed to describe implementation, these terms are not synonyms for each other. Each refers to part or all of the process of moving research into practice.

In health care, moving research into practice is very important as clinicians rely on research to provide the best health care for their patients/clients. This health research comes in a wide variety of forms including research about: pharmaceuticals, organizational processes, clinical procedures, practice guidelines, technology and more. Moving research into practice can be challenging. Part of the problem is the volume of new research available (Rycroft-Malone &

Bucknall, 2010). Studying the process of moving research into practice is vital in order to identify, select and translate new research findings based on the needs of the organization. For the purpose of this thesis, the term "innovation" will be used to describe new knowledge, research, technology, etc. "Implementation" will be the active process by which the innovation is moved into clinical practice. Many theories and frameworks have been created in an attempt to facilitate the process of moving research into practice. The Ottawa Model of Research Use (OMRU) is the theoretical lens used for this case study.

Ottawa Model of Research Use.

The OMRU is an interdisciplinary framework developed by Logan and Graham in 1998. The purpose of the OMRU was to offer a practical and holistic approach to guide the implementation of evidence-based research into practice. The model was originally designed to be used by policy makers to increase the uptake of health research in the clinical setting and for researchers studying how health research is integrated into practice. (Logan & Graham, 1998). It is based on a number of assumptions: (a) the process of implementation takes place over time and it is not a unidirectional, sequential process; (b) patients/clients and their health outcomes are directly related to evidence-based practice and therefore they are important to the process; and (c) societal and external health-care environments do affect implementation and therefore must be considered in the process (Graham & Logan, 2004a; Graham et al., 2006; Rycroft-Malone & Bucknall, 2010).

Since its conception, the OMRU has been used by a wide range of professions studying research, policy and practice (Rycroft-Malone & Bucknall, 2010). The Ottawa Model of Research Use (OMRU) is considered "an interactive synergistic process of interconnected decisions and actions by different individuals related to each of the model's elements" (Graham

& Logan, 2004a, p. 93). The model is organized under three domains: assess, monitor and evaluate (AME). Within the assess domain, the three elements of innovation, potential adopters, and practice environment are assessed for barriers and supports of the implementation process. Once these are identified, the process moves to the monitor domain. Here, interventions are developed and implemented based upon the previously identified barriers and supports. The adoption process is monitored throughout. Once the project has been fully implemented, the last domain of the OMRU is the evaluation of the outcomes of the implementation project (see figure 1). Implementation is an active, interconnected, non-linear process, where each element is interconnected with the other elements within the model. This means that although the assessment of barriers and supports is completed before interventions are implemented, new situations may arise which requires new interventions to be created. (Kitson, 2009; Rogers, 2003; Rycroft-Malone, 2004). Although use of the model does not guarantee success, ensuring that adequate time and resources are put into each element of the model greatly increases the possibility of a successful outcome (Graham & Logan, 2004b; Logan & Graham, 1998; Rycroft-Malone & Bucknall, 2010).

Innovation.

According to the OMRU, the first element to be reviewed, under the assess domain, is the innovation. The development processes and the attributes of the innovation are assessed to identify barriers and supports of the implementation process. The innovation is the entity that is new to the people who will be using it. This innovation can be an idea, a practice, or an object (Rogers, 2003). The OMRU defines an innovation as "a practice guideline, a policy, procedure, or similar vehicle" (Rycroft-Malone & Bucknall, 2010, p. 88). As per the OMRU, the innovation should be informed by valid research when at all possible.

An innovation cannot be scrutinized in a vacuum. The attributes of the innovation that will be important to the implementation process will be the ones that inter-relate with the potential adopters and the practice environment. For example, if an organization wants to implement a new piece of machinery, the size of the machine matters only in relation to the space available in the environment and the opinion of the potential adopters. In the case of potential adopters, positive perceptions can increase the rate of adoption whereas negative perceptions can slow down or stop the adoption process all together (Greenhalgh et al., 2004; Logan & Graham, 1998; Rogers, 2003).

The perceptions of the innovation by the potential adopters can include: relative advantage, compatibility, complexity, observability, and trialability. Relative advantage is the degree to which the innovation is believed to be superior to the existing knowledge, research or technology. Compatibility and complexity relate to how well the innovation fits with the current values, past experiences and needs of the potential adopters and how difficult the innovation is to understand and use. Trialability refers to whether the innovation can be tested and experimented with before the potential adopters have to use it. Observability relates to how well the attributes of the innovation are discernible to others (Rogers, 2003). Examining the interactions between an innovation and its potential adopters is one way policy-makers can develop specific strategies designed to overcome barriers that are unique to an organization.

One example of an innovation is a new piece of technology. Technology is not a synonym for science but more the application of science. "Technology is the practical application of knowledge so that something entirely new can be done, or so that something can be done in a completely new way" (European Space Agency, 2009, p. 1). Barnard & Locsin

(2007) define technology by separating it into three levels: artefacts and resources, skills and knowledge, and technique.

The first, and most narrow level, is technology as a physical object (Barnard & Gerber, 1999). At this level, technology is just a neutral object (Barnard, 1997). The next level refers to technology as a form of knowledge where meaning is attached to an object. A stethoscope is just a piece of metal and rubber until a person uses it to listen to a patient's lung sounds or heart rhythms thus becoming a tool. Knowledge and skills for nurses also include practice standards, ethical decisions, and professional accountability (Barnard & Locsin, 2007). Without the knowledge and skills to use tools properly, tools can become useless or even dangerous. The third and most inclusive level is technology as a complex set of human activities labelled "technique." It is the most abstract of the three levels. Here technology is regarded from a political, economic, and human viewpoint. At this level, technology is no longer restricted to one individual who is using a piece of equipment in a responsible, ethical way; it is a way of viewing how that technology impacts society. In the same way that equipment helps to shape the hospital in which nurses work, techniques help organize the world around us. Examples include: economic models, time and motion studies, systems theory, and standardized nursing care plans (Barnard & Locsin, 2007).

The innovation that will be investigated in this study is a piece of technology called the Automated Medication Dispensing Cabinet (ADC). This technology includes the physical cabinets, the physical space around the cabinets, the process of creating policies and procedures related to the cabinets, and medication practices at the hospital that involve the cabinets.

ADCs are computer controlled storage units, located near the point of care, that allow medication to be stored, dispensed, controlled and tracked. (Institute for Safe Medication

Practices, 2008) These machines are similar to the automated teller machine used by banks. Each user (i.e. nurse, pharmacist) has a secure log-in that only she/he knows or has access to. This will be in the form of a password, swipe card, and/ or fingerprint. Each nurse will access the computer, select the patient and required medication from a list. For controlled substances, such as narcotics, the user will only have access to one medication at a time and the counting of narcotics by the nurse will be required as each drug is accessed. The computer will notify the user immediately when an error in count-back occurs. The computer will automatically record the withdrawal so signatures on paper will no longer be required and narcotic counts are done on an access basis so narcotic counts do not need to be performed at change of shift. Although other medications will be stored in the cabinets and do not require a signature by law, the inventory will still be monitored by the cabinet and the pharmacy notified when the stock is getting low (Cardinal Health, 2006; ISMP Canada, 2007; McKesson Corporation, 2006; Omnicell, 2002).

ADCs are designed to increase medication security, maintain electronic records of medication stocking and retrieval, facilitate on-time administration of first dose medication, decrease narcotic discrepancies, reduce costs by improving accuracy of pharmacy inventory, and reduce medication errors thereby increasing patient safety (ISMP Canada, 2007; McConnell, 1998; Miller, 1999; Paparella, 2006). Over the last 20 years, ADCs have been demonstrated to improve medication storage, distribution, and administration (Paparella, 2006; Wise, Bostrom, Crosier, White, & Caldwell, 1996). ADCs are designed to reduce many of the medication errors that occur when using traditional distribution methods. Medication errors, resulting from traditional narcotic delivery methods where handwritten medication orders are illegible or look-a-like drugs are stored in the same cabinet, have been reduced through the use of ADCs (Wilson, Reeves, & Crane, 1995). Although the use of ADCs has the potential to resolve many existing

problems with medication tracking and delivery, the use of this technology also has the potential to create new problems related specifically to the technology.

Many of the potential problems that arise from using the ADCs are a result of the cabinets being used in way the designers did not intend. For example, ADCs are designed to provide a double check before medication is dispensed. Pharmacy personnel enter the orders into the pharmacy computer and the nurse then double checks the order on the ADC screen before withdrawing the medication (ISMP Canada, 2007).

In Canada, fewer than 10% of hospital pharmacies are open 24 hours a day thus new medication prescriptions, that are created during pharmacy closures such as during the night shift, are not entered into the computer until the next day (Eli Lilly Canada, 2010). Nurses administering medications, under these circumstances, must choose from a generic list in the ADC instead of one unique to each patient. These nurses are the only ones verifying these overnight medication orders before administration takes place. This lack of a double check system in traditional narcotic storage scenarios can lead to the administration of an incorrect dosage or type of medication (ISMP Canada, 2007).

Another source of error that can occur is when drugs are placed in the incorrect drawer. This filling error can lead to the incorrect medication or dosage being given to the patient (Paparella, 2006). Nurses who withdraw medications for multiple patients in the same session may mix them up before distributing them which can lead to errors (ISMP Canada, 2007). When ADCs are used to hold stock medication as well as narcotics, nurses frustrated with waiting in line for an ADC might take out additional medications such as Tylenol and leave them on the counter for future use. This creates discrepancies in medication inventory and tracking.

Mechanical breakdowns and lack of technical support are also possibilities (Novek, Bettess, Burke, & Johnston, 2000).

There are a number of considerations for institutions that are purchasing new technology. They must be aware of any potential problems associated with the technology. They must ensure the technology suits the needs of the users at their particular institution. They must also develop policies and procedures to guide the use of the technology and to provide guidance on how to proceed when problems arise.

An individual or group using the OMRU to guide the implementation of a new technological innovation needs to assess the attributes of the innovation for barriers and supports as well as how the innovation and its attributes might affect the opinions and decisions of the potential adopters (users). Identifying these barriers and supports allows the implementers to create strategies to minimize negative responses and maximize positive ones (Greenhalgh et al., 2004; Logan & Graham, 1998; Rycroft-Malone & Bucknall, 2010). The innovation is only one of three elements under the assess domain of the OMRU.

Potential Adopters.

The second element under the assess domain is the potential adopters. The awareness, attitude, knowledge/skill, concerns and current practice of the potential adopters are assessed for barriers and supports for the implementation process. Potential adopters can be policy makers, practitioners, patients, or anyone else that will be using the innovation. The adopter characteristics add to the predictability of a successful or unsuccessful implementation process. This information can then be used to identify potential barriers and supports so the researcher can develop strategies to address these potential barriers and maximize supports (Logan & Graham, 1998; Rycroft-Malone & Bucknall, 2010).

Adoption of an innovation does not occur at the same time for everybody. Rogers (2003) has divided potential adopters into early adopters, early majority, late majority, and late adopters. According to Rogers, the number of individuals in each of these categories is normally distributed with the majority of adopters in the early majority and late majority categories. The rate of adoption depends on the characteristics of each individual. Characteristics which affect the rate of adoption include willingness to accept change and the social group to which the individual belongs within the organization. The awareness, attitude, and skill of nurses can also play a role in adoption success (Greenhalgh et al., 2004; Logan & Graham, 1998; Wejnert, 2002).

ADCs act like a vending machine for medications; they are basically a computer that opens and closes drawers. A nurse, without much experience with computers, may find the prospect of a new technology like the ADCs coming to her/his unit overwhelming; on the other hand, this same nurse might feel reassured if her/his group of friends on the unit is excited about the ADCs and offers to help her/him (Heart & Kalderon, 2011; Timmons, 2003). Nurses are at different comfort levels with computers and therefore implementation strategies need to be developed taking into consideration individual comfort levels (Bond, 2007; Ferlie, Gabbay, Fitzgerald, Locock, & Dopson, 2001). Optimally, organizations implementing new technology should determine the characteristics of adopters prior to implementation to minimize and address potential barriers (Atun, Kyratsis, Jelic, Rados-Malicbegovic, & Gurol-Urganci, 2007; Logan & Graham, 1998; Rogers, 2003; Rycroft-Malone, 2004).

Lessons can be learned from the implementation of other technologies where the primary users are nurses. Examples include electronic charting (e-charting) or e-MARS (medication administration records). Organizations need to involve nurses early in the planning stage; this is

just as important as choosing the correct technology for the job (Kirkley, 2004). Without nursing feedback and suggestions, aspects of the change or the innovation may be inconsistent with the values, norms or needs of the nurses trying to use the new technology which can lead to further difficulties with implementation (Berg, 2001; Kitson, 2009; Markham, 1998; Rogers, 2003). In addition to managing expectations, training, and communicating outcomes, organizations need to have at least one nursing champion who is active throughout the implementation process to provide peer support as well as to offer a clinical nursing perspective to the implementation group. Nursing champions can help to implement and sustain the new innovation beyond the initial introductory phase (Anderson & Stafford, 2002).

The potential adopters will be the link between the practice environment and the evidence based innovation. The need to assess this group for barriers and supports in order to develop transfer strategies is emphasized in the OMRU. A new innovation needs to meet the needs of potential adopters if its implementation is going to be successful. If nurses are going to accept and use new technology, the innovation not only needs to meet their needs but must also be compatible with their practice environment. The potential adopter is the second out of three elements under the assess domain of the OMRU.

Practice Environment.

The third and last element under the assess domain is the practice environment. The practice environment refers to the circumstances or external factors within the place where the innovation is going to be implemented. Patients, culture/social, structural, economic factors and uncontrolled events need to be assessed for barriers and supports to the implementation process just as potential adopters and the innovation were. Structural factors include: decision-making structure, rules, regulations, policies, physical structure of the setting, workload, current practice,

professional standards, and medico-legal issues (Rycroft-Malone & Bucknall, 2010).

Cultural/social factors refer to: local politics, personalities, leadership and peer opinion.

Patient/consumer and available economic resources are part of the practice environment and need to be considered.

Other factors may be identified depending on the unique environments of each institution. The practice environment affects the likelihood that potential adopters will actually adopt a new technology. For example, nurses are more willing to adopt/adapt to the use of a new technology if they believe it will increase patient safety and job satisfaction, especially if they have peer and manager support (Morriss, Abramowitz, Carmen, & Wallis, 2009). External factors can affect the implementation process in a positive or negative manner depending how they relate to the potential adopters and the innovation. By identifying these factors organizations can analyse them to determine how to enhance the positive aspects of the environment and counteract the negative aspects (Greenhalgh et al., 2004; Logan & Graham, 1998; Meyers, Sivakumar, & Nakata, 1999; Rycroft-Malone & Bucknall, 2010).

Nurses will have an opinion about a new innovation before it is ever introduced into the patient care unit. This opinion is formed from past experience, organizational support or current information provided by peers and the organization. An innovation that is introduced to a unit where the nurses have generally negative feelings toward the technology is less likely to be successful compared to a unit where the nurses have a more positive attitude; timely and positive motivation is key to successful change (Bushy & Kamphuis, 1989; Locock, Dopson, Chambers, & Gabbay, 2001; Rogers, 2003).

The long-term care facility, Riverview Health Centre in Winnipeg, introduced ADCs into its facility in 1997 (Novek et al., 2000). Administration and nurse managers believed that these

cabinets would reduce medication errors and improve the drug distribution process. The nurse managers were the trainers for the nurses on the units and the managers passed on their enthusiasm for the new technology and positively influenced the attitudes of the nurses in regards to the incoming technology (Novek et al., 2000). The nurses on the unit need to support change and the change process if the implementation of new technology is going to be successful (Kirkley, 2004; Locock et al., 2001).

Managers and trainers are not the only individuals that can influence the adoption of new technology. Other leaders within the organization will also express either positive or negative opinions. These opinion leaders can influence the beliefs and actions of potential adopters. Informal networks within organizations can support or hinder the introduction of a new technology based upon whether the group accepts the innovation as 'the norm' or not (Greenhalgh et al., 2004; Locock et al., 2001). Leaders within an organization also have an influential role because of their positions of authority. Nurses need to have support from nursing leadership if implementation is going to be successful (Vogelsmeier & Scott-Cawiezell, 2009).

The values of leaders within the organization must be congruent with the organizational values on which the innovation is based for successful adoption. Senior managers must be supportive of the change and committed to making it work (Gustafson et al., 2003; Kaluzny, McLaughlin, & Jaeger, 1993; Meyers et al., 1999). Ultimately it is a balancing act. The organization is affected by and changed in some way by the introduction of new technology, and the technology is also affected as it is adapted to meet the dynamics of the organization (Berg, 2001). Selecting a technology without consideration of the organizational context will decrease the likelihood of sustained adoption. For successful implementation to occur the organization

must be flexible enough to adapt to the new technological changes and the technology must meet the needs of the organization.

There are many factors in addition to the attributes of an innovation that can support or act as barriers to the implementation of new technology. The attitude toward, and perception of an innovation, can play a critical role in the success of a project. The leaders within an organization must support a project or those lower in the organization will never accept it. When the innovation fits with the needs of the organization, the organization adjusts to accept the new technology as a new way of doing business. Evaluating the practice environment, the third element in the assess domain of the OMRU, not only helps to ensure the innovation fits with the needs of the organization but works towards making the transition of using the new technology a success.

Interventions.

The second domain in the OMRU is the monitoring domain. There are two elements in this domain: interventions and adoption (see Figure 1). The first element, interventions, refers to activities that an organization undertakes to get the innovation to the potential adopters, encourage them to accept the change, and to provide them with the skills they require to use the new innovation. In the OMRU, interventions are divided into: barrier management strategies, implementation strategies, and follow-up strategies.

Barrier management involves considering the barriers identified in relation to the innovation, potential adopters, and practice environment and developing strategies to minimize or remove their potentially negative effects on the adoption process. Implementation strategies are focused on transferring the needed knowledge and skills to the potential adopters so they can use the innovation. Follow-up strategies are used to identify any problems during the

implementation and help the potential adopters sustain the adoption. The use of follow-up strategies will also help determine if the innovation is being used in the manner it was intended (Logan & Graham, 1998; Rycroft-Malone & Bucknall, 2010). Examples of implementation and follow-up strategies include: educational resources/workshops, use of opinion leaders, committee work, auditing, providing feedback, and identification of champions and super users, (Boaz, Baeza, & Fraser, 2011; Logan & Graham, 1998; Registered Nurses Association of Ontario, 2009; Timmons, 2003).

Interventions will vary between organizations and with different types of innovations because every situation is unique. A strategy that was successful in one situation may not work in another. Every intervention strategy must be uniquely tailored based on the assessment of barriers and supports of the innovation, potential adopters, and practice environment (Graham & Logan, 2004a; Graham & Logan, 2004b; Grimshaw et al., 2006; Rycroft-Malone & Bucknall, 2010). Multiple transfer strategies work better than a single one because no one strategy can adequately address all of the barriers in a project (Boaz et al., 2011; Campbell, 2010). In addition, strategies that are integrated with the process of care and involve end users tend to be more successful (Boaz et al., 2011). The approach is to develop ways to minimize the impact of barriers (barrier management) and facilitate positive change (Greenhalgh et al., 2004; Grimshaw et al., 2006; Logan & Graham, 1998).

Interventions are unique to every project and need to be designed based on the barriers identified in the assessment of the innovation, potential adopters and practice environment. Interventions are divided into three categories: barrier management strategies, implementation strategies, and follow-up strategies. Under each category, multiple strategies work better than

one single strategy to promote successful adoption of the innovation. The intervention strategy element is the first of two elements within the monitor domain of the OMRU.

Adoption.

The second element in the monitor domain is called the adoption element. Once the interventions have been developed, they are used to roll out the innovation to the organization. In the adoption element, actions based on the interventions are taken to move the potential adopters through the introduction of the innovation to sustained use of the innovation. The key to the adoption phase of the model is not only to be prepared with interventions, but also to define what constitutes success (Logan & Graham, 1998; Rogers, 2003; Rycroft-Malone & Bucknall, 2010). Aspects which could be considered when evaluating success include: which measurements should be used to evaluate outcomes, who will collect and monitor the data, and what will be the time frame for the evaluation?

The adoption phase is by no means a linear one; it is evolutionary and interactive. For example, a previously unidentified barrier might be discovered during the adoption phase requiring the project team develop different interventions to deal with the previously unidentified barrier. In addition, current interventions might not work as anticipated and may need to be modified. The cyclical nature of the OMRU means that users of the model need to continually reassess the innovation, its potential adopters and the practice environment throughout the intervention and adoption to determine the extent to which the innovation is being used. If implementers understand how the innovation is being used and/or changed over time, they can modify interventions to sustain the use of the innovation in the short and long term (Graham & Logan, 2004a; Logan & Graham, 1998; Rycroft-Malone & Bucknall, 2010). Although the adoption element is listed after the interventions in the monitor domain of the OMRU, the

organization implementing the project may move back and forth between the two elements as new barriers arise that were not previously identified.

Outcomes.

The final element of the OMRU, listed under the evaluation domain, is outcomes (see Figure 1). In evaluating the OMRU not only is it important to evaluate the process of implementing a new innovation but also the outcomes resulting from its implementation. Outcomes of importance include: patient/client health, practitioner, financial or system outcomes. The evaluation of the impact of innovation on the organization is the only way to determine its true value (Graham & Logan, 2004a; Logan & Graham, 1998; Rogers, 2003; Titler et al., 1994). Part of the evaluation process may include a study of the cost effectiveness of the process or identification of any unintended consequences of the process (Heathfield, Pitty, & Hanka, 1998). If nothing else, formal evaluation of a project will result in the identification of lessons learned for future projects within the organization.

In the case of the ADC project, outcomes that are important might be the impact of the cabinets on: medication error rates, accuracy of medication tracking, and the amount of time spent and stress experienced by nurses using the cabinets (as compared to the traditional approach to distributing medication). Other, valuable but unexpected outcomes might surface when implementation outcomes are investigated. Evaluating the outcomes of a project is the last element of the OMRU but not necessarily the end of the project. Evaluation might demonstrate a need to go back and readdress parts of the implementation process that were missed.

Steps for Using the OMRU.

The National Collaboration Centre for Methods and Tools outlined a six step approach to guide the implementation of a new public policy or program across multiple organizations using

the OMRU as guide (National Collaborating Centre for Methods and Tools, 2010). These same six steps can be applied to other implementation projects such as the ADC project.

Step 1: Set the Stage. Identify who has the authority to make the necessary changes, what resources will be required and who will be responsible for the implementation process.

Step 2: Specify the Innovation. Identify what the innovation is and what the implementation process will involve.

Step 3: Assess the Innovation, Potential Adopters and the Environment for Barriers and Facilitators. Identify barriers and facilitators to the implementation process and strategies ways to overcome barriers. This includes identifying gaps in current practice, perceptions, and attitudes of the potential adopters toward the innovation and recommending changes where needed.

Step 4: Select and Monitor the Knowledge Translation Strategies. Implement appropriate interventions which increase awareness/understanding of the innovation and include required training to use the innovation. Evaluate the knowledge translation strategies for effectiveness and employ supplementary interventions as required.

Step 5: Monitor Innovation Adoption. Evaluate the progression of the implementation, focusing on where the innovation has spread to and how practice has changed. Assess the effectiveness of the interventions and employ supplementary interventions if required.

Step 6: Evaluate Outcomes of the Innovation. Evaluate the impact of the process on patients, practitioners and systems to determine if the innovation achieved the desired change within the organization.

(National Collaborating Centre for Methods and Tools, 2010, p. 2-3)

While theoretical models are not used in the implementation of all new technologies, comparing an actual implementation process to that recommended within a theoretical framework will expand our knowledge of the process of implementing innovations for which nurses are the end-users.

Why the Ottawa Model of Research Use?

In the literature, there two types of implementation/knowledge translation theories. The classical theories describe how change occurs but are not specifically designed to guide change. The newer types of theories are called 'planned action theories'. These theories are also known as prescriptive theories because they explain, in steps, how planned change occurs (Graham, Tetroe, & KT Theories Group, 2010; Mosby, 2009). To meet the needs of this case study, there were several attributes in a theory that were required. (a) The theory (framework or model) had to be one that was defined as a planned action theory. (b) The theory had to be designed to be used by multiple levels of implementers from the individual to the organization. (c) The theory had to be well established with published evidence of use in other implementation projects.

After a review of the available theories (frameworks and models), the OMRU was chosen as the guiding framework for this case study. It was used to structure the literature review, code the data, and structure the results and discussion. Other theories that were considered included: Roger's Diffusion of Innovations, the Stetler Model of Research Utilization, Promoting Action on Research Implementation in Health Services (PARIHS), and Knowledge to Action Framework. While these theories have been used for the transfer of research of innovation into practice, they lack the attributes the investigator was looking for in a theory for this study.

Roger's Diffusion of Innovations is a model that describes the innovation-decision process. It is one of the earliest knowledge translation theories that still has significance today. It

postulates that in the process of innovation decision making, an individual moves through five stages: knowledge, persuasion, decision, implementation and confirmation (Rogers, 2003). This theory is considered a classical theory of change. Because the investigator was looking for a planned action theory, Roger's Diffusion of Innovations was not used for this case study.

The Stetler Model of Research Utilization was developed by Stetler and Marram in 1976 and later revised by Cheryl Stetler in 1994 and again in 2001. It was originally developed for baccalaureate nurses as a guide to help integrate research into practice. It has since been redeveloped and refocused for use by advanced practice nurses. The model's focus is "on a series of judgmental activities about the appropriateness, desirability, feasibility, and manner of using research findings in an individual's or group's practice" (Stetler, 2001, p. 272). The model is divided into five phases:

Phase I: Preparation (Purpose; Context; Sources of research evidence);

Phase II: Validation (Validation of evidence);

Phase III: Comparative Evaluation/Decision Making (Uses fit of setting; Feasibility;

Substantiating evidence and current practice to decide if the validated evidence should be used in the practice setting);

Phase IV: Translation/Application (Implementation process and operational details); and

Phase V: Evaluation (Pilot testing and formal testing of project after completion) (Sudsawad,

2007). The model is a planned action theory. Like the OMRU, this theory has a prescriptive

component to it, it is explanatory in nature, and facilitates a critical thinking approach. Where the

OMRU is designed to be used by individuals, teams, units, or organizations in multidisciplinary

settings, the Stetler Model is not designed to be used at the organizational level nor does it have a multidisciplinary focus (Rycroft-Malone & Bucknall, 2010).

The Promoting Action on Research Implementation in Health Services (PARIHS) framework was first developed by Kitson, Harvey and McCormack in 1998. It was "developed as a means of understanding the complexities involved in the successful implementation of evidence into practice" (Rycroft-Malone & Bucknall, 2010, p. 110). This multidimensional framework is more conceptual than process-oriented in nature. It is focused on the relationships among evidence, context and facilitation. Although the framework is designed to be used by a wide range of users, including multidisciplinary teams or organizations, the framework is not as prescriptive as the OMRU. The developers are still working to answer fundamental questions such as how do the three elements (evidence, context and facilitation) interact with each other and in the organization (Rycroft-Malone, 2004; Rycroft-Malone & Bucknall, 2010).

The last model, the Knowledge to Action framework, is unique compared to the other theories previously described. The authors, Graham and Tetroe (2006), based their framework on an analysis of 31 other planned action theories to help "make sense of the black box that is knowledge translation"(p18). In this framework the knowledge translation process is divided into two components: knowledge creation and action. Within each component are phases:

1. *Knowledge creation* (Knowledge inquiry; Knowledge synthesis; Knowledge tools/products)
2. *Action* (Identify problem/identify; Review; Select knowledge; Adapt knowledge to local context; Assess barriers to knowledge use; Select, tailor; Implement interventions; Monitor knowledge use; Evaluate outcomes; Sustain knowledge use) (Rycroft-Malone & Bucknall, 2010). The unique characteristic of this model is that it delineates two possible implementation processes. Process one: knowledge is created then the knowledge users focus on implementing the knowledge. Process two: the researchers and the knowledge users collaborate through both the research and action process (Graham et al., 2006; Rycroft-Malone & Bucknall, 2010).

The Knowledge to Action framework is similar to the OMRU in many ways. Both are descriptive and explanatory in nature, they both cover a wide base of possible users including individuals, teams, units or organizations and the user groups open to nurses as well as multidisciplinary groups. The OMRU was chosen for this case study over the Knowledge to Action framework because the OMRU has been in existence almost a decade longer. These extra years have given researchers and implementers alike a chance to use the model in a variety of practice settings to evaluate it and determine some of its strengths and weaknesses.

While there are other implementation theories and frameworks, those listed appeared to be most suitable in describing the process of implementing an innovation such as the ADCs. There is not one knowledge translation/implementation model that fits every situation in every organization. The only thing that is certain is that change is complex, dynamic, and inevitable. In healthcare, organizational structures transform, new technologies are developed, and patients/clients demand different modes of care. Organizations must embrace these changes and remain fluid if they are going to stay competitive in today's health market. It is important to study current implementation/knowledge translation processes to determine what works and what does not. Lessons learned are invaluable information where money flow is restricted but health and safety demands are high.

CHAPTER 2 – Methods

Design

A descriptive, single-case study method was used to describe the technology implementation process as it occurred at a multisite, tertiary care hospital (Zainal, 2007). Information was collected from multiple sources using multiple methods including: semi-structured interviews, reports, meeting minutes, surveys and observation of the meetings by the investigator.

A descriptive case study is a qualitative methodology which attempts to tell a story. It uses multiple sources of data to explore and describe complex situations or series of events. Case studies attempt to illuminate the "how" and "why" of a situation or phenomena. In some situations, case studies can be used to derive theories, but this case study used a theory that had already been developed to explore and explain the current situation (Baxter & Jack, 2008; Yin, 2009). The goal of the study was to understand how an acute care, multi-site teaching hospital implements new technology that will be used by nurses.

The Case

The case was based in an acute care, multi-site teaching hospital. This hospital was chosen for this study because it was beginning an initiative to introduce Automated Medication Dispensing Cabinets (ADCs) for narcotic and ward stock medication management in its inpatient units. Rarely is there an opportunity to study the implementation of new technology within a hospital on such a large scale, where nurses are one of the main users of the technology. The ADC project at the hospital began in 2008 but, due to delays, was not completed until 2012.

The case was bound by time, location, and the individuals that were involved in the ADC project. Data collection took place over a period of eight months. The original plan was to

complete data collection within three months, but due to ADC project delays, the data collection period for this study was extended to try and capture as much of the process as possible.

Data Sources

Data was collected from several sources and used in the analysis of the case. Some of the information was collected by the investigator and some of it was provided by the case institution. The data sources, who provided them, and when they were obtained are listed in Table 1.

Table 1 - Data Sources

Sources of data	Created and collected by	Period during which data was collected
Interviews	Primary investigator	Throughout
Surveys	ADC Committee	During vendor demonstrations
Meeting Minutes	ADC Committee	Throughout
Observational Notes	Primary investigator	Throughout
Medication Cycle Transformation Report	ADC Committee	Beginning
ADC Membership List	ADC Committee	Beginning

Interviews

The largest amount of data was collected through the interviews. Ten hospital employees from a variety of back grounds were interviewed over a span of four months. Interview participants included individuals from senior administration, pharmacy, information services/information technologies (IS/IT) and nursing. The positions of these individuals included vice president, manager, educator, analyst, and technician. The purpose of the interviews was to investigate: the changes to the narcotic control practices, why ADCs were chosen, how staff was to be prepared/introduced/trained/supported, details about the implementation process and evaluation processes for the project (see Appendix B). The interviews were audio recorded and conducted on hospital property at a time and location that was convenient to both the investigator and participant.

Sampling.

The investigator began by interviewing the senior vice president and chief operating officer. Written consents were provided by all participants before their interviews. Once the first interview was completed, the investigator asked the individual to recommend other persons within the organization that would have information about the ADC project. Based on the recommendations of this participant, the investigator purposively selected other individuals that were involved in the project and/or had information about the implementation process (Patton, 2002). By using this snowball technique, the investigator continued to work through the organizational chain interviewing key individuals that were part of the project and/or implementation process.

Data Collection.

The interviews were conducted over a four month period. Each interview lasted 8 to 47 minutes with an average length of 29 minutes. They were audio recorded and the participants were interviewed using a semi-structured interview guide developed by the investigator with prompts used as necessary (see Appendix B). Participants were encouraged to talk about their experiences with the ADC project as well as with previous health care technologies they have implemented or been involved with the implementation of. The interviewer took cues from each participant's story to explore the implementation process in greater depth. New participants were interviewed until data saturation was reached. One pilot interview was conducted to test and refine the interview guide before it was used for this project. The data obtained in that interview was not included in this project. The eight minute interview was included as part of the data, not because of what the interviewee said, but because of what he/she did not say. The individual was recommended by two other interviewees as an excellent person to interview because the

individual was a senior member in IS/IT department and also had an extensive nursing background. The interview was very short because the individual had no prior knowledge that the project existed.

Analysis.

The data was collected and analysed concurrently over the entire data collection period so that the emerging findings could be probed in subsequent interviews if necessary (Yin, 2009; Zucker, 2001). All audio recorded interviews were transcribed by either the investigator or a hired transcriber not affiliated with the case hospital. The electronic copies of the transcribed interviews were uploaded into Atlas TI, a computer program that assists with data management, coding, and storage of case study material including interview transcripts and project documents (Burnard, Gill, Stewart, Treasure, & Chadwick, 2008).

Initially, the investigator used inductive content analysis methods to classify sections of text under codes; these codes were not based upon any model or framework, but freely generated from the interview text (Burnard et al., 2008; Elo & Kyngas, 2008). Grouping the data into meaningful chunks allowed the researcher to organize and easily retrieve data without the loss of relationships between the parts. In some cases, more than one code was assigned to the same quote. Codes were added, modified, and discarded throughout the data collection and analysis periods based upon their relevance to the research question and the theoretical framework (Miles & Huberman, 1994). The primary investigator met with a second investigator on a regular basis to compare emerging codes. Once all the quotes were classified, the codes were compared to the themes dictated by the six elements of the OMRU (innovation, potential adopters, practice environment, interventions, adoption, and outcomes). This was done in two steps. First, the codes were superimposed over an existing diagram of the OMRU to create a visual picture of

how the codes and themes might connect. Next, the quotes were placed in a chart with their corresponding codes and the quotes were matched up to determine how they related to the themes in the OMRU (Creswell, 2007). Larger quotes were broken down into smaller segments until each quote matched up with only one theme. The quotes that included descriptions of the background of the project, but were not part of the implementation process, were grouped under an extra theme called “context of case study”. Once all quotes were linked with themes, it became apparent that none of the quotes corresponded with the adoption or evaluation elements in the OMRU. As a result, all quotes were categorized under five broader themes: context of case study, innovation, potential adaptors, practice environment, and interventions.

The results of the data analysis were not shared with the participants for validation after the analysis was completed. There is some argument that participant validation is important to increase rigour and reduce bias, but it also gives the chance for the participant to modify her/his answers based on information that was not available to them at the time of the interview (Burnard et al., 2008). The ADC project continued to progress as the interviews were being done. The project was not at the same point in time for the first interview as it was for the last. Since implementation is a process, potential modification of answers by the interviewee would have destroyed potentially valuable data.

Surveys

The vendors of the cabinets participated in two open houses, on different campuses of the multisite case hospital. Both sessions lasted four hours in length. These demonstrations were organized in a way that allowed staff to drop-in, interact with the display cabinets, speak to the vendor representatives and complete a survey regarding the different features of each cabinet. The vendor demonstrations were designed for nurses and pharmacy personnel to view and try the

actual cabinets, ask questions and provide feedback to the ADC committee. Clinical nurses were informally introduced to the concept of ADCs on their clinical units by their clinical managers and nurse educators shortly before the ADC vendor demonstrations but after the interview portion of the data collection was completed.

Sampling.

An invitation was sent from the ADC committee to all nurses and pharmacy personnel, through their respective managers and nurse educators, a couple of weeks before the cabinet demonstrations. On the day of the demonstrations, every person that entered the room was given an evaluation form and asked to complete it and drop it off in a box at the centre of the room. The evaluation forms from all individuals that completed all or some portion of the evaluation form were included in the analysis.

Data Collection.

Two different categories of evaluation forms were used by the ADC committee, one for the nurses and one for the pharmacy personnel. Each person was asked to rate all four of the cabinets on a variety of characteristics by checking either the agree box or the disagree box. At the bottom of the evaluation form, the participants were asked to choose which cabinet they preferred and provide any other comments. The investigator did not participate in the creation or collection of this data but was given a summary of the survey data once the collection was completed. The data obtained included quantitative counts and a qualitative summary of the comments (see Appendix A).

Analysis.

The surveys provided both qualitative and quantitative data. Descriptive analyses of the quantitative data were undertaken and data presented as frequencies (without confidence

intervals). Primarily, this data consisted of the count of how many participants agreed and disagreed with the statements in the evaluation forms. The comments on the evaluation form comprised the qualitative component of the evaluation of cabinets. This data was obtained at the very end of the data collection period, after all of the interviews has been coded and grouped into larger themes outlined in the OMRU. The qualitative portion of the survey results was thematically analyzed.

Meeting Minutes

Ten ADC committee meeting minutes were included as data in this case study. The meetings occurred between October 2008 and January 2010. Included with minutes was the attendance of who was present and absent for the meetings. Of those 10 meetings, the investigator was present at the last three as a guest.

Sampling and Data Collection.

The ADC committee minutes that were used were for meetings that ranged from the beginning of the project to the end of the data collection period. Copies of the minutes of the first seven meetings were provided to the investigator as historical data. The investigator was a direct observer at the last three meetings of this committee; these meetings occurred during the data collection period.

Analysis.

As with the survey results, the meeting minutes were made available to the investigator as the end of the data collection period. For each meeting minute document, the individuals that attended were divided into their respective departments (nursing, pharmacy, etc.) and counted. The content of the meeting minutes were thematically analyzed.

Other Data

Other data included the Medication Cycle Transformation Report and investigator notes. The Medication Cycle Transformation Report was a document prepared by a pharmacy-led taskforce and submitted to the hospital's senior management in 2008. The taskforce that drafted this report looked at best practices related to the medication cycle, in the literature and made 14 recommendations, in regards to patient safety, advanced information systems and technology, and opportunities for standardization (Case Study Institution, 2008). The report was provided to the investigator as background information for the ADC project.

Investigator notes were recorded directly after the interviews and ADC committee meetings were complete. They were recorded throughout the data collection period where appropriate. The ADC committee member list was only used to reference member names.

Analysis.

The Medication Cycle Transformation Report was reviewed by the investigator and excerpts from the report were used, with the quotes identified in the “context of case study” themes, to describe the background of the ADC project. The investigator notes were linked to specific sections of interview text in Atlas TI as memos. Those memos then became part of the data that was coded to aid in the analysis of the information provided in the interviews (Miles & Huberman, 1994; Yin, 2009). This Atlas TI database facilitated ready access to case study data during the research project (Darke, Shanks, & Broadbent, 1998; Elo & Kyngas, 2008; Miles & Huberman, 1994).

Language

Interviews were conducted in English by the investigator. Interviews were not offered in French as the investigator is not fluent enough to conduct the interviews in that language.

Interviews done by another person and then translated may have led to loss of language nuances and incorrect interpretation. Restricting the interviews to the English language did not result in excluding identified informants/interviewees from the interview process as all potential informants/interviewees spoke fluent English. All ADC committee meetings were held in English and documents/meeting minutes were only provided in English so there was no loss of data due to language translation.

Rigour

Yin's case study principles of data collection were used to ensure the rigour of this study. The framework included: construct validity, internal validity, external validity, and reliability (Yin, 2009). Construct validity refers to the extent that a research study actually measures what it says it measured (Denzin & Lincoln, 1994). In a case study, an investigator needs to identify what the specific concepts they want to investigate and what set of measurements they are going to use to collect the data. This ensures that the results of the study actually came from the data and are not subjective judgements of the investigator (Gibbert & Ruigrok, 2010; Yin, 2009).

For this study, the concept of implementation of technology, as defined by the OMRU, was used. The individual pieces of the OMRU became the framework under which the data was collected and analyzed. One of the strategies suggested to ensure construct validity is triangulation. This technique involves analysing different types of data to collaborate the evidence collected from the interviews. For this case study, multiple sources of data were collected including interviews, reports, surveys, meeting minutes and investigator notes. A second strategy is to maintain a clear chain of evidence so the study results can be reconstructed by an independent investigator (Gibbert & Ruigrok, 2010; Yin, 2009). A chain of evidence including paper documentation and electronic files was kept throughout the case study.

Construct validity applies mainly to the data collection process whereas internal validity is ensured in the design phase and applies to the data analysis phase. Internal validity refers to causal relationships between variables within in a study (Denzin & Lincoln, 1994). According to Yin (2009), internal validity is only at risk in causal or explanatory case studies because of the possibly of making inferences. In these cases, when event B cannot be directly observed, an investigator may infer, based on interview data, that event B was caused by earlier event A. The investigator must ensure all other possibilities are ruled out before making such an inference. Since this study is descriptive in nature and no causal inferences were made, internal validity was not explored further.

External validity or generalizability refers to the ability to generalize the results of this study to other populations, conditions, or theories (Gibbert & Ruigrok, 2010; Yin, 2009). There are two types of generalizability, one is statistical and the other is analytical. Statistical generalizability refers to conclusions based on observations being generalized to a population. Case studies do not allow for statistical generalizability (Lee, 2003). Instead, case studies are analytically generalizable; conclusions based on observations can be generalized to a theory (Eisenhardt, 1989; Yin, 2009). In this descriptive case study, the results were used to generalize to the OMRU.

The last criterion identified by Yin is reliability. This refers the ability for an investigator to repeat the same case study, with the same steps, and reach the same conclusions (Denzin & Lincoln, 1994; Yin, 2009). The most important thing about reliability is to have a transparent process and be able to replicate the results. This was achieved by the investigator in several ways. First, the date the data was created was recorded. This way, an auditor would be able to go back and see when all of the data was collected and in what order. Secondly, the database of

information was kept separate from any analysis performed by the investigator. That way none of the original data would be lost through the analysis process. Third, a case study protocol was used. Part of the case protocol included a semi-structured interview guide which was used during the interviews to ensure that the same open-ended questions were asked to each interviewee and no important data was missed. Finally, all face-to-face interviews were audio recorded and carefully transcribed. Whenever possible, large quotes were used when presenting the results to maintain the original meaning of the data (Gibbert & Ruigrok, 2010; Silverman, 2005; Yin, 2009).

Protection of Human Rights

Ethics approval for this case study was obtained from the case hospital's research ethics board and the University of Ottawa prior to beginning of data collection. The initial contact for the first interview was made by a third party to determine whether that person would be interested in participating in the study. After the first participant agreed to be interviewed, the investigator contacted that person and made arrangements. At the end of each interview, the participant was asked to recommend other individuals who might have information to contribute to the study.

Initial contacts for all participants were made by the persons who recommended them. Once the new participant agreed, the investigator contacted him/her to set up the interviews. Informed consent was obtained by giving the participants an information letter to read and answering any questions they had about the study before they sign a consent form (see Appendix C & D). Although the interviews were conducted in English, the invitation letter and consent form were offered in both English and French to ensure informed consent. Participants were free to withdraw from the study anytime without explanation or fear of consequences. Privacy,

anonymity and confidentiality of participants have been maintained during the data collection, analysis and reporting phases of the study. Codes were used to identify participants and the matching names will be kept locked in the Nursing Best Practice Research Unit at the University of Ottawa. Information collected in the interviews will not be shared with-hospital administration. Any specific reference to the hospital in this case study has been removed at the organization's request. This includes specific details about the hospital that may identify it.

CHAPTER 3 – Results

The data was collected from multiple sources over a period of six months from August 2009 to January 2010. Sources included audio recorded interviews, hospital documents, survey results and investigator notes. The interviews and investigator notes were analyzed and categorized into codes using AtlasTI. The codes were then grouped to larger themes based on the elements of the OMRU. The first four elements of the OMRU plus an extra theme labelled “context of case study” became the structure for the analysis and the reporting of the results. Other sources of data, including meeting minutes, survey comments, and hospital documents, were considered in the context of the five themes.

Data Sources

Ten interviews were completed by the investigator over a period of seven months (June to December 2009). Two participants were in senior administrative positions, two were from pharmacy (manager and technician), four from information services/information technologies (IS/IT) (manager and analyst), and two from nursing (manager and educator). No clinical nurses were interviewed. For all interviews, quotes and speech disfluencies that did not add to the meaning were removed for ease of reading (e.g. um, uh, you know, right, so, etc.)

The Medication Cycle Transformation Report was a document prepared by a pharmacy-led taskforce and submitted to senior management in 2008. The medication cycle was identified as an area of improvement during one of the hospital accreditation reviews. Of the 14 recommendations made by the taskforce, one was to implement a hybrid unit dose drug distribution system which included installation of the ADCs for narcotics and ward stock. All 14 recommendations from the Medication Cycle Transformation Report are listed in Appendix E.

The ADC committee meeting minutes covered the time period from October 2008 to January 2010. Ten sets of committee meeting minutes were included in the data analysis. The investigator attended three of the meetings as a guest; in addition to the official meeting minutes, provided by the scribe, notes taken at the meetings by the investigator were used as data. Seven of the meetings occurred before the data collection period started so the investigator treated the minutes of those meetings as historical data. The average attendance at these ten meetings was 12 members out of a possible 28. At each meeting, there was at least one representative from pharmacy, nursing and IS/IT. Other departments such as distribution, professional services, facilities and biomedical attended the meetings, as needed, based on the planned agenda topics. Over the 15 month period during which these 10 meetings were held, several members of the committee were replaced due to retirement or illness. The focus of the meetings was to update the group on the progress of the project. The majority of the committee work for the project was completed by smaller groups or individuals between committee meetings.

The survey results used for this study were collected during the vendor demonstrations that took place in November 2009. The surveys (one for nursing and one for pharmacy) were developed, distributed, collected and collated by the ADC committee. They consisted of a series of agree or disagree questions that clinical nurses and pharmacy personnel were asked to complete as they visited each of the four cabinet vendors. According to the ADC committee, the purpose of the surveys was to ascertain which cabinet the end users preferred based on the cabinet's characteristics. The investigator had no input into the survey questions or collection of the raw results. The investigator was only provided with a summary copy of the survey result details as listed in Appendix A. One-hundred and five surveys were completed by nurses; of

those only 36 included responses for all four vendors. Out of the 27 pharmacy surveys that were submitted, only 12 had responses for all the vendors.

The survey results were not particularly useful to the ADC committee in terms of selecting the ADC for purchase (Case Study Institution, 2009). The survey results provided only a small amount of information to the investigator in relation to answering the research question. There were several reasons for this. The questions were mainly agree/disagree (yes/no) which Cusick (2007) suggests are relatively meaningless unless accompanied by an explanation. In the ADC survey, there was no place for explanations for each individual choice, only a space for general comments at the end. The ADC surveys were not based on any type of standard usability questions. Usability is related to the product. Depending on a desired outcome, tasks need to be organized such that the outcome is reached effectively and efficiently to be usable (Brooke, 1998). Compounding the issue, some of the respondents to the survey had never seen an ADC before the demonstration but were asked questions about standards and usability. For example, nurses and pharmacists were asked if the touch screen lighting was acceptable but it was not made clear what it was to be acceptable for. The participants were not provided with any context for the questions. Over 95% of the participants answered that the lighting was acceptable for all four cabinets. This means there was no discernible difference between the touch screen lighting making the answer not useful. The number of responses to all the agree/disagree questions were fairly diverse and the average results were unremarkable.

The last source of data included in the analysis was notes made by the investigator throughout the data collection period. The investigator's thoughts and impressions were written down after the interviews or during committee meetings and later transferred into Atlas TI as memos. All of the data was categorized into five themes, four elements of the OMRU plus an

extra theme labelled “context of case study”. These five themes became the structure not only for the analysis of the data, but the reporting of the results as well.

Codes and Themes

The largest portion of the data collected was from the participant interviews and corresponding investigator notes. These interviews were transcribed, uploaded into AtlasTI and analyzed throughout the data collection period. Originally, quotes were categorized with codes freely generated by the investigator. Some quotes had multiple codes attached to them. Once the coding of the interviews and investigator notes was complete, the codes were compared to the six elements of the OMRU. It was discovered that all of the quotes, with the exception of a group of quotes which could be explained using a theme titled "context of case study", could be linked to at least one element of the OMRU. The first four elements of OMRU plus the extra theme became the five themes under which the quotes were categorized and the results reported upon (See Table 2).

Table 2 - Themes and related codes

<i>Themes</i>	<i>Codes</i>
Context of Case Study	<ul style="list-style-type: none"> • Research/Background • Merger/Discrepancy Between Campuses • Finances • Safety/Patient Care • Change Process/ Transformation • Standardization • Technology • Resources (people) • Leadership/Professional Practice • Support • Implementation/Roll out • Training/Education • Co-dependent/Multi-projects • Delays/Barriers/Challenges

<i>Themes con't</i>	<i>Codes con't</i>
Innovation	<ul style="list-style-type: none"> • Research/Background • Renovations/Physical Space • Security • Safety/Patient Care • Technology • Evidence-based/Best practice • Change Process/Transformation • Policy/Procedure/Process • Standardization • Workload/Duties/Flow • Tracking
Potential adopters	<ul style="list-style-type: none"> • Research/Background • Workload/Duties/Flow • Resistance • Staff Impact/Satisfaction • Training/Education • Technology
Practice Environment	<ul style="list-style-type: none"> • Federal Regulations/Accreditation • Merger/Discrepancy Between Campuses • Change Process/Transformation • Committees/Teams • Workload/Duties/Flow • Multidisciplinary/Interprofessional • Finances • Leadership/Professional Practice • Implementation/Roll out • Delays/Barriers/Challenges
Interventions	<ul style="list-style-type: none"> • Change Process/ Transformation • Resources (people) • Policy/Procedure/Process • Leadership/Professional Practice • Workload/Duties/Flow • Co-dependent/Multi-projects • Multidisciplinary/Interprofessional • Implementation/Roll out • Training/Education • Delays/Barriers/Challenges • Communication

Context of Case Study

According to the Medication Cycle Transformation Report, “the medication cycle is one of the most important hospital processes...At its best, the medication cycle has the power to heal; at its worst, it can cause harm and even death. A safe, effective medication cycle is fundamental to quality hospital care.” (Case Study Institution, 2008, p. 5). At the study hospital, nursing and pharmacy personal have been aware for years that there have been areas, related to medication delivery and patient safety, which required improvement.

Certainly we’ve known for a number of years that there needed to be changes in the pharmacy process...You need to achieve five rights and a closed loop with medication. We knew there were huge gaps and that we had to start taking steps to get there. From our perspective, we just hadn’t gotten there yet because what we do is not decided by us. It’s directed from senior management. (Interview 30005, September 21, 2009, p1)

Originally, the different campuses were separate hospitals that merged into one large tertiary hospital. Even though these mergers took place more than a decade ago, practices still differed from campus to campus (Interview 10002, June 18, 2009). For example, at one site, medication was dispensed in bottles and delivered to the clinical units every seven days, while another campus used a single unit dose method distributed daily. Staff moving from campus to campus had to transition between these different practices increasing the risk of making errors (Interview 10001, June 2, 2009; Interview 10002, June 18, 2009). Although these inconsistencies were identified by nurses and pharmacists, there had not been enough money allocated in the budget to make the changes needed to improve medication delivery and consistency across campuses.

Now what we have is one corporate entity...and different drug delivery systems going on. If we want to progress on the e-health journey, we knew that was a critical issue to address. It's not a cheap undertaking to convert a hospital from a traditional drug to unit dose, and therefore for a number of years, while the concept had been on the table, the timing wasn't right relative to available funds. (Interview 10001, June 2, 2009, p1)

In the interviews, the senior management representatives explained how, over the past few years, the thinking pertaining to technology and health delivery has changed. Patient safety has become a national and provincial priority in Canada (Ontario Hospital Association, 2011). Changes to accreditation standards and federal narcotic regulations reflect these changes (Accreditation Canada, 201; Interview 10001, June 2, 2009). Information systems have increasingly become a driving force in health care technology today. Despite the recent cuts to health care spending, health care technology and eHealth are being seen as an investment for the future, rather than as a traditional expenditure (Interview 20009, October 30, 2009). Through health care technology, patient care can be made safer and more efficient. Safer and more efficient patient care means fewer negative outcomes and therefore future cost savings.

We're actually going to save money in the institution by not having people who have a drug reaction. They [patients with drug reactions] may have had a longer length of stay, or required a different set of drugs, or correct their problem or whatever the case may be. So we did modeling around that to say what will be the ultimate impact of this if we indeed improve patient safety. (Interview 10001, June 2, 2009, p7-8)

In 2007, a pharmacy taskforce was created to complete an internal review of all medication practices in the hospital. The main conclusions from the review indicated that medication practices across all hospital campuses were not standardized. There were different drug distribution models, pharmacists were not based out of all the clinical units, and some of the pharmacy technicians were not being used to their full scope of practice. Many of the processes were labour intensive, time consuming, and did not meet government standards (Case Study Institution, 2008). The taskforce compared the hospital's current practices with best practice literature as well as consulted companies in the private sector looking for ways to enhance patient safety while adopting the practices of lean management and fiscal savings for the future.

We did something a little unique. I asked them [pharmacy] to do a future state on their own; again multidisciplinary and as visionary as they can make it. But then I asked them to invite at least two...private sector companies who specialize in drug delivery, who have big market shares...And I asked them to have this company come and do an independent assessment, about what we were doing and whether they would organize it and run it this way if it was their business or would they do it differently. (Interview 10001, June 2, 2009, p12)

In 2008 the pharmacy taskforce presented 14 recommendations to senior management (see Appendix E). One recommendation, "Implement a hybrid unit dose drug distribution system across the hospital", specifically referred to installing ADCs for ward stock, controlled substances, remote areas and night cupboard services (Case Study Institution, 2008, p. 49). The report was strongly supported by senior management and direction was given to begin implementation of the pharmacy transformation recommendations.

The original time frame given for the completion of the ADC project was two years but due to changes in the organization and unforeseen circumstances, this time frame was extended. Just as the ADC project was scheduled to begin, there was a change in leadership of the IS/IT department and the new director reallocated some resources to other corporate initiatives leaving this project short of funds (Interview 20006, September 29, 2009). Since this project was heavily dependent on IS/IT involvement, the ADC project was delayed by almost one year until the IS/IT resources were released (Interview 30005, September 21, 2009).

Traditionally, in other IS/IT implementation projects, the project team trained the trainers, implemented the project, supported the initiative for two weeks post roll out, then moved on to another project. Long term support then became the responsibility of regular client support groups such as the IS/IT Help Desk and/or Nurse Educators. For technology that affects nursing, nurse educators have, in the past, taken on a large role when it comes to providing training and support (Interview 100010, November 6, 2009; Interview 10002, June 18, 2009).

Now, we haven't really started to have discussions with it [training] but I'm just going back on some other projects that we've had and some of the things that we've done, like a train the trainer approach. So, we would identify super users within each area and we'd try to get them involved as early in the project as possible so that they're familiar with the system that's being implemented or they are part of the discussion. They also would be involved in work flow and policy discussion and help them with their training. (Interview 20008, October 2, 2009, p3-4)

IS/IT is adopting a new model of training and support for the implementation of all corporate IS/IT initiatives. Under this new model, the plan is to create a training team with representation

from both the technical and clinical areas. This training team would provide training for all future IS/IT projects. Along with the nurse educators, there would be a support person assigned to each of the clinical areas who would be the contact person when technical issues arise. The rationale is that that one person would develop a personal relationship with the staff working on a clinical unit and therefore provide better service. Currently, there is a centralized IS/IT Help Desk where staff call if they require IS/IT support. Issues are logged and assistance is provided for basic problems (i.e. password resetting) or assigned to the appropriate group within the department.

We have a new IS/IT strategic plan and a new CIO [chief information officer]...His model has four components and it's called the stakeholder engagement model. We have a demand and analysis section so that's when a request comes in, a clinical analyst or business analyst ...identifies what their needs are, looks at the current state, decide what the future state could be, and then recommends whether this project should go ahead. That will go through to a project management office...then subsequently, a project is kicked off... When it's ready to be implemented, the trainers get involved. The trainers would be doing the same things I mentioned; develop the training package and do train the trainer. And ... after the actual implementation is done, we actually have a clinical support team. At this point, it's still undecided how many, but when we go broad...you would have to have a team member who is...like a buddy to that unit. (Interview 2006, September 29, 2009, p2-3)

At the end of the data collection period, the ADC committee had chosen a cabinet vendor and were negotiating with the vendor to see if an agreement on price and services could be reached

The first cabinets were tentatively scheduled to be implemented in early 2012 (ADC Meeting Minutes, January 18, 2012)

Evidence-based Innovation

The ADCs on the market today are all relatively similar. They all use a computer which controls a series of locked doors and/or drawers. Users must log in to gain access and all transactions are recorded electronically. This electronic signature replaces the traditional hand written signatures. Most of the individuals interviewed emphasized how computerization will help to streamline the drug process, ensure the security of the drugs and make drug delivery safer (Interview 20008, October 2, 2009; Interview 10002, June 18, 2009; Interview 20009, October 30, 2009; Email 100012, July 9, 2010; Interview 100010, November 6, 2009; Interview 20004, August 28, 2009; Interview 20007, September 29, 2009).

The cabinets improve patient care by providing security in two ways; the first is physical security of the drugs. According to federal regulations, narcotic drugs must be secured with two different locks (Canadian Legal Information Institute, 2010). One of the requirements the nursing representatives on the ADC committee put forward during the request for proposal (RFP) process was to ensure the future cabinets met this two lock regulation. Any medication cabinets the hospital purchases would need to meet these federal requirements (Interview 100010, November 6, 2009; Interview 20003, August 18, 2009). Only the ADCs that met this requirement were considered by the committee (Interview 30005, September 21, 2009; Interview 20008, October 2, 2009). The second form of security involves ensuring that the patients receive the correct medication. Drugs that are ordered and entered into the computer system by the pharmacy department will appear on the drug cabinet computer screen when a nurse logs in. The nurse can then compare those medications to their Medication Administration Record (MAR)

before removing the drugs from the cabinets (Interview 30005, September 21, 2009; Interview 20008, October 2, 2009). This double check (pharmacy enters the order into computer before a nurse removes the drug), is not available at night when the pharmacy department is closed. Some of the cabinets have an allergy alert feature that will alert the nurse if they try to take out a medication that the patient is flagged as allergic to.

Well, patient care is going to be made a lot better as a result of this [project].

You're going to get rid of that whole error problem. People will be getting the right medication which is a little important. (Interview 20009, October 30, 2009, p5)

Standardization of the ADCs across all the campuses will provide a consistent medication delivery process for staff that works on multiple campuses as well as increase staff confidence in safe medication delivery.

But we didn't invest in this [technology] because we thought there would be a return on investment. We actually did this on the pure basis of the fact that evidence out there demonstrates that these systems enhance patient safety in our environment. And again, if we're one corporate entity providing care, we live by a principle that the patient ... no matter where they interface with us, should receive the same level of care across our campuses. (Interview 10001, June 2, 2009, p8)

One of the other major benefits of using a computer is the ability to document electronically saving time for nursing and pharmacy staff, improve tracking, and reduce the volume of paper records stored by the hospital. Nurses will no longer have to spend time performing manual narcotic counts at shift change. Running tallies will be maintained by the computer when the medication is removed and, when a discrepancy occurs, the computer will be

able to identify who has accessed that medication. Electronic tracking of stock is the other major benefit of using computers. Much of the information previously tracked by hand in the past will now be computerized. When the stock in a cabinet reaches a minimum level, the computer will send an automatic refill message to the pharmacy department. These automatic refill messages drastically reduce the number of phone calls nurses must make to the pharmacy department to request missing narcotic drugs. This augmented drug tracking will allow for better drug management by the pharmacy department.

We have to fulfill requirements from the federal regulation that narcotics are signed out, there are witnesses, the waste and accounts are done on a regular basis, they're locked, et cetera et cetera. In a paper-based world, you can easily miss pieces of information. We have boxes and boxes and boxes of documents that we [the hospital] have to keep that pile up all over the place because again, it's the law. But also, if there's any issue, we have to be able to track them back. If you look at any of them [paper documents], there's going to be somewhere where there's a signature missing. There's a piece of information missing. Every time there's a discrepancy, the nurse-manager has to go back and try to make sense of all these sheets. So it's a bit of a mess to keep, especially at a hospital of our size...Going electronic was a way to get away from the paper. Because, now with computers and with technology, a lot of the information is automatically captured when you sign on to access the machine...Plus, from a nursing point of view, at the end of each shift, they have to go back to their box or their drawer...and count every single narcotic to make sure that there's none missing. So there's the time-consuming issue, there's documentation flaws and there's

storage issues for us...Going electronic will solve a lot of this because it will all of a sudden be captured electronically and the virtual world can capture a lot more data than the paper world. (Interview 20003, August 18, 2009, p1-2)

Individuals who have used the cabinets will also be tracked. Staff who repeatedly access drawers that contain medication not linked to their patients can be flagged in reports for follow-up. The monitoring of staff compliance with drug related policies and procedures can also be followed more easily with electronic documentation. Policies may be in effect, but if there is little compliance, they become irrelevant (Interview 20007, September 29, 2009).

The largest group of staff who will access the ADCs will be nurses working on the patient units. (Interview 10001, June 2, 2009). Consequently, nurses were invited to participate in two cabinet demonstration days. Although all the cabinets provide the same service, each company's cabinet had a slightly different design and features. The nurses who attended were asked their opinion regarding the various cabinets using a paper-based evaluation form. There were two significant findings from the evaluations. The first was the comments the nurses provided. Some comments were general, while others were specific to one cabinet or another, but all the comments could be divided into three main themes: the physical cabinet, functionality, and safety/security. These comments show that the nurses did not just walk around and look at the cabinets; they engaged the different vendors, watched the demos, tried the cabinets and asked questions. The second finding was the overall selection of which cabinet the nurses preferred. Some nurses were able to visit more than one vendor and collect enough information to make a decision on which cabinet they preferred (see appendix A). The ADC committee did take into consideration the nurses' and pharmacists' comments and preferences when choosing which company to purchase the ADCs from (ADC Meeting Minutes, January 18, 2010).

Potential Adopters

While the implementation of ADCs will have an impact on many disciplines, the largest group of end users will be the nurses. This is important from the ADC committee's point of view because nurses are important stakeholders and their perspectives are critical to the introduction and sustainability of the innovation.

We know it's key to keep everybody involved. We know it's key that the users...feel a level of accountability. It can't just be us [IS/IT] going in and implementing. It's like saying hey, this is great, you guys are going to love it, good luck! They have to be at the table and selling it to their own staff, because the reality is, we do walk away and go to the next project... They're the ones that are left there supporting it and making it successful...Nursing has to be the first line of support for the nursing staff up on those units. Otherwise, they're just going to think they've been left high and dry. We support, but the reality is, we've there for two weeks of being live then we're on to the ...the next project ... We need to have the right people through the process or it won't be successful.

(Interview 30005, September 21, 2009, p8)

The steering committee, who oversees all of the pharmacy transformation projects, recognized how important it was to have all the disciplinary groups represented on the ADC committee (Interview 10002, June 18, 2009; Interview 20009, October 30, 2009).

I am very proud of the leadership. I think they're doing a very good job. It's very systematic, it's detailed, and again it's multidisciplinary. It impacts a lot of people...It's not like a departmental project, it's a organizational wide project. It's got its complexities for sure and I think the team is doing a really great job ...not

only in the planning, but it's in the execution of this. They understand that this is a piece of the jigsaw puzzle and it's all got to fit together. (Interview 10001, June 2, 2009, p9)

In the case of nursing, clinical directors from all areas were asked to approach their teams and ask for clinical manager and nurse educator volunteers. Seven nurse volunteers started with the committee (ADC Meeting Minutes, January 5, 2010). When interviewed, these nurse leaders were very excited about the ADCs. The ability to track medications and run utilization reports from the cabinets was important to clinical managers. Some of the concerns about the technology included: a possible negative backlash from the clinical nurses, and nurses neglecting double checking the medication they are withdrawing assuming the cabinet is correct (Interview 20003, August 18, 2009; Interview 100010, November 6, 2009).

The nursing members of the ADC project committee were very engaged in developing a list of required cabinet attributes and ensured there was nursing representation at every meeting. The nursing members participated in the initial work of putting together questions for the request for proposals but opted out of reviewing the responses from the vendors. The nurses who were interviewed indicated that their input into the development of the proposal questions identified the legal requirements for the cabinets. In their opinion, reviewing the answers would have been a waste of time; either the cabinets met the requirements of the law or they did not.

Well, we're [nursing] not going to go through the nitty gritty, but when we went to the [RFP] exercise in the first place ...we were very much a part of that. So there is no point in having another ten people sit in a room to look at the same thing basically. Because if what we ask for is mandatory but it's not what the

company is giving us, then there is no point into even presenting us that company.

That's the way we looked at it. (Interview 20007, September 29, 2009, pg2)

Regardless, representatives from nursing were consulted at every step of the project. During vendor demonstrations, clinical nurses were invited to come and review all of the cabinets the hospital and offer their opinion as to which machine they preferred.

Practice Environment

The environment of this multi-site hospital presented the ADC committee with unique challenges. First was standardization between the different sites of the hospital. Each site was originally an independent hospital with its own unique way of doing business. Even though they had merged, the tendency has been to hold on to the unique practices from campus to campus. Second, was the multidisciplinary nature of the team and trying to meet timelines. The project leaders did not necessarily have any influence over members of the team making it challenging to complete work on time. Finally, the budget for the project was finite. Regardless of the potential increase to standardization and patient safety, the funds available for this project were limited. These challenges shaped the direction the project took and caused the project to extend past its original scheduled timeframe.

Many different hospitals were merged into one over a decade ago, but different processes for medication delivery were still being used at each campus during before the ADC project began (Interview 10001, June 2, 2009). The goal of the larger pharmacy transformation project was to standardize the medication delivery process across the organization.

There was no right or wrong. There was not a better campus or a worse campus. It was a function of this is what we came to the marriage with and we, the hospital,

have had so many other priorities to address, we haven't addressed this one yet.

And now we are ready, and we need to. (Interview 10001, June 2, 2009, p5)

The differences in the historical culture of each campus meant that the needs and desires of the staff varied by campus. As it is human nature to resist change so some resistance to the implementation of the new technology was expected. (Investigator notes from ADC Meeting, January 18, 2010).

Even though the larger medication transformation project began in the pharmacy department, many different groups became involved, each bringing their expertise (Case Study Institution, 2008). The committee for the ADC portion of the medication transformation project was formed from a wide range of multidisciplinary groups including pharmacy, IS/IT, professional services, facilities management, biomedical engineering, logistical services, and nursing (ADC project team list, August 2009).

It's just making sure that we have all the right people and don't forget some sort of peripheral players along the way...So they're[nursing] identifying from their preference where they think the cabinets will go, and they're going to provide that feedback to us. The next step then is facilities and IT is going to go out and take a look at it and say, no, that'll never work ...or yes, it will work...There's the facilities group, which in theory should be a front involvement, not a long term. There's also logistical services who will do the delivery and the stocking and things like that, that we have to make sure we're keeping involved in the process too. (Interview 30005, September 21, 2009, p6)

The two project leaders for the ADC project are from different departments within the hospital. One leader works in the pharmacy department and the other in the IS/IT department.

The pharmacy representatives bring the pharmaceutical and logistical expertise and IS/IT brings the technological expertise. Although both co-leaders approached the project in a systematic, detailed, multidisciplinary way, this dual leadership was not without its challenges

This project is much more outside of our [pharmacy's] realm of authority so we really have to work side by side with the other groups to make sure that we move ahead. It's challenging...especially with the delay. The fact that I'm responsible for getting this done but on the other hand, I have no control over when certain groups will be available. I have other groups that are waiting for us. (Interview 20003, August 18, 2009, p14)

Up to this point in the project, the biggest challenge with this multidisciplinary group has been to keep the members moving in the same direction. One interviewee described it as "the herding cat syndrome" (Interview 30005, September 21, 2009). When a person manages a group of employees, they can say "do this or else these consequences will happen." The leaders of the ADC committee have no direct managerial power over a majority of the ADC committee members and therefore can encourage individuals to meet certain timelines but cannot enforce them. Meeting project deadlines becomes increasingly difficult as more individuals and departments become involved.

Even though technological purchases are seen as investments instead of expenditures, cost may become the deciding factor as to which cabinet the hospital purchases. Regardless of the benefit to staff and patients, the ADCs must be affordable. If all of the cabinets available on the market are similar, then the cost may be the deciding factor in the hospital's decision to choose a particular vendor.

I would venture that they're probably all the same or quite close to each other. So it may be difficult to actually choose...It may end up being the cost that will decide which one we take. (Interview 20007, September 29, 2009, p2)

The ADC committee submitted their top two choices, but the final approval will come from the finance department.

Interventions

Although final approval for purchase was not received before data collection ended, the ADC committee did put forward its recommendations for the top two vendors and began to identify and develop strategies to address future potential barriers. Some of the potential barriers to implementation that were identified by the end of the data collection period included: training approximately 3500 nurses in a timely manner, training multigenerational nurses with different comfort levels in relation to technology and training nurses with different computer skill levels. Strategies for dealing with these training issues include the development of an IS/IT training team, multistage rollout and clear communication throughout the project.

The ADC committee has already begun to develop interventions to address possible training barriers. The majority of the end users will be nurses who work 24 hours a day, 7 days a week. This will make training the approximately 3500 nurses at the facility a challenge (Interview 100010, November 6, 2009). Training cannot take place too far in advance of the implementation or the nurses will forget what they have learned (Interview 100010, November 6, 2009). The nursing staff at the hospital is a multigenerational group. At one end of the spectrum are nurses who are just out of school and eager to learn new technologies; at the other end are nurses who are close to retirement and may find it difficult to adjust to the change of new technology (Interview 10002, June 18, 2009).

You've got those nurses who are ready to retire very soon. They've been used to doing things for a long time and they don't want to change. Then you get a lot of the younger nurses who are really on board with digitizing things and the technology behind it, so it's tough. You're running sort of parallel in a lot respects sometimes (Interview 20009, October 30, 2009, p13).

The nurses may also vary in their computer aptitude and skills. As with the introduction of much new technology, there tends to be a transition to new practice associated with it. Initially, the new cabinets may make medication retrieval times longer.

At the beginning, it's going to be difficult because there's going to be a learning curve. So they're [the nurses] going to be a little frustrated because it's going to take time, and they're going to have to be patient and until they actually know exactly what they're doing. (Interview 20007, September 29, 2009, p7)

The harder the cabinets are to use, the more challenging the implementation process will be. People with little or no familiarity with computers may require more training once the cabinets become activated (Interview 100010, November 6, 2009). Although no official training plans have been presented at the ADC committee meetings, the members and the larger organization have begun developing strategies to address training challenges.

The hospital is in the process of developing a new IS/IT services delivery model called The Stakeholder Engagement Model. The goal is to maximize the use of available resources and minimize the overloading of nurses with new IS/IT projects over the next few years. This model will improve the way IS/IT projects are researched, chosen, implemented, in addition to how training and long term user support are provided (Interview 20006, September 29, 2009). The ADC project has been chosen as the pilot for this new stakeholder engagement model. The

reason for bringing in a new service model was directly related to the large number of technological initiatives that are going to be introduced into the hospital over the next several years. By having a corporate training team, training becomes standardized and end users are less likely to be overwhelmed by too many projects at one time from multiple providers.

IS/IT really is changing the way they want to roll out new technology like this.

And they want to create a new training-education team within IS/IT. And so they've asked if we could be their guinea pig. It will be interesting but it doesn't exist yet...The first big roll out will be us. So there's a challenge there and make sure that this is not going to crash. And IS/IT, obviously, they're not clinical people so we need to have clinical people added to their group as well to make sure that it makes sense for the front line users. (Interview 20003, August 18, 2009, p8)

At the time data collection was complete, few details about this team were available although staff was being hired to work for this new IS/IT training group.

The plan consists of training to be done primarily through the IS/IT training group with the support of the ADC committee and ADC vendors. The ADC committee members have already begun to reflect on how training of the end users should proceed. Nursing is a practice-based profession therefore nurses like to learn through 'hands-on' activities (Interview 20007, September 29, 2009). This is a valuable piece of information to know when trying to develop training for the nurses. Users can become frustrated if the process is too complicated or too abstract (Interview 100010, November 6, 2009). As a result of these findings, the training group will need to find a method to achieve 'buy-in' from the nursing group.

There's thousands of nurses. So there has to be a huge coordinated effort to make sure we get everybody and we get everybody in a way that it doesn't kill them with all the initiatives coming along...It gives us an opportunity to align that training with other initiatives at the same time, so that we're not training a group of nurses on project X one month and then coming back the next month and going, okay, guess what, here's the next latest and greatest. We wanted to align those initiatives so they're well spread out apart as the people get trained, go live, get used to it and they're sort of stable before we do the next one. (Interview 30005, September 21, 2009, p2)

To combat the challenge of training all 3500 nurses in a timely manner, the implementation will most likely be rolled out in stages; this may be by campus first and then by unit. The hospital has a finite amount of resources that they can put into any one project (Interview 20003, August 18, 2009; Interview 20004, August 28, 2009). This multistage approach will result in nurses being divided into manageable groups. The training approaches used will have to be adjusted to meet the individual needs of each campus (Interview 10001, June 2, 2009; Interview 20004, August 28, 2009).

Communication is key to keeping the project moving forward (Interview 10001, June 2, 2009). During the interviews, senior management referred to the change management process and how the team leaders will ensure that everyone is aware of the progress of the project.

The first part though is all about the communication. How do you communicate what we [the committee] are doing? Why we're doing it? How it benefits our stakeholders? The patients? How it benefits the physicians who order the drug? How it benefits them as professionals and them as individuals? We've had to go

through that change process and explain to them. (Interview 10001, June 2, 2009 p4-5)

Throughout most of this ADC project, nurses were kept apprised of the project's progress through their managers and educators. The managers/educators received the information from the committee and then emailed their respective clinical groups. One of the greatest communication challenges that became apparent was keeping the right groups informed at the right times without overwhelming them. To further increase communication challenges, this project was not happening in isolation. Many other projects were occurring at the same time within the hospital.

Another big challenge is communication. And the problem we have right now is...we're a victim of our success. We have so many of them [projects] happening at once that we don't want to overburden everyone with tons of communication. But on the other hand, people need to know. Whether it's inside our [pharmacy] department, from a nursing point of view, or from the IS/IT point of view, so that we all know where we are at, where we are going and what's the end result that's expected. (Interview 20003, August 18, 2009, p13-14)

As new barriers are identified, the ADC committee will continue to develop strategies to overcome them.

Medication delivery is an integral part of patient care within the hospital. Standardization of the medication delivery process is important to improving staff satisfaction and increasing patient safety. The ADC project is one way the hospital is working toward these goals. Once a vendor has been approved, the next step in the ADC project will be to physically install the cabinets on the clinical units and train 3500 nurses who will be using these cabinets. Some

potential barriers have already been identified by the ADC committee. Strategies to overcome these potential barriers include piloting a corporate IS/IT training team and timely communication with all project stakeholders. As the project progresses, inevitably new problems/barriers will arise. The ADC committee will have to continually reflect on the evidence-based innovation, potential adopters and practice environment to ultimately succeed in the implementation process.

CHAPTER 4 – Discussion

Until recently, the medication processes and practices at the different campuses of the case hospital were inconsistent. Although a need to improve medication delivery had been identified as an issue for many years, funding to make changes was not available, even though healthcare technologies were seen by the institution as an investment for the future. Recently, patient safety has become a priority in Canada. As a result, hospitals across the country are being required to improve practices to meet the new patient safety standards issued by Accreditation Canada. In 2008, funding was made available and the pharmacy taskforce, commissioned by the administration of the case hospital, presented 14 recommendations to improve medication practices. One of the recommendations included installing Automated Medication Dispensing Cabinets (ADCs) for ward stock, controlled substances, remote areas and night cupboard services.

Although there are several different manufacturers of ADCs on the market, physically all of the ADCs provide the same functions (locked computer controlled drawers to store and track medication). The software which runs the ADCs is unique to each manufacturer creating different capabilities for each cabinet. Although ADCs have the ability to increase patient safety by reducing the number of traditional medication errors, the full potential of the cabinets may never be reached because of the differences in health care delivery in the USA and Canada; specifically, this case hospital does not employ 24 hour pharmacists which changes the way nurses interact with the cabinets during night shifts.

A multidisciplinary committee was created to implement the ADCs across the organization. Clinical nurses will be the single largest end users of the ADCs at the case hospital. Despite this, clinical nurses were not included on the project planning committee. The clinical

managers and nurse educators sitting on the committee were expected to represent the interests of the clinical nurse. While the managers and educators did attend all of the ADC committee meetings, they opted out of reviewing the RFPs. All communication regarding the project was transmitted from the managers and educators to the clinical nurses. Clinical nurses were invited to attend demonstrations by the different vendors of the ADCs, but only a small proportion of the nurses in the hospital were able to attend. Of those nurses that did attend, lack of time made it difficult for them to visit, evaluate, and provide feedback on all four of the cabinets.

Although the cabinets had not been introduced before this case study ended, some implementation challenges had already been identified by the committee. These included: the multidisciplinary nature of the committee, dual leadership challenges and meeting timelines, training 3500 nurses in a timely manner, intergenerational nurses who have different levels of comfort with computers, multiple campuses with non-standardized practices, and working within a finite budget. The ADC project is one of many IS/IT related projects that will be implemented at the hospital over the next few years. As a result, a new IS/IT training team is being created to deal with all these future projects. The ADC project will be the pilot project for this new training team. By the end of the data collection for this case study, a vendor was chosen to purchase the cabinets from but it was unknown whether a contract could be negotiated that would meet the needs of the organization while staying within the financial budget.

Implementing a new technology across a large and complex organization, such as the case hospital, is rarely straightforward. Every implementation situation is different and can therefore present its own unique challenges. James Emshoff (2008) described a useful analogy that outlines the challenges researchers have experienced when trying to implement new

innovations. In an ideal world we would “build it and they will come.” (Robinson, 1998).

According to Emshoff, the reality of implementation tends to look more like this:

Build it—and they will never know about it.

Build it—and they will hear about it but not understand what it is.

Build it—and they will not feel invited.

Build it—and they will want to come, but not know how to get there.

Build it—and they won't think the seats will fit if they do come.

Build it—and they will think they already have one.

Build it—and they will find it irrelevant to their needs or users.

Build it—and they will decide they should build their own.

Build it—and they won't be able to afford to come.

Build it—and they won't be able to read the map to get there.

Build it—and they will assign it to a committee to consider (and then forget about) it.

Build it—and they will come and rebuild it into something unrecognizable.

Build it—and they will come and love it! And ask you and your one assistant to build ten more just like it in surrounding communities. Now! (2008, p. 393-394)

Many of these challenges listed above can be linked to examples from this case study. For example, towards the beginning of the cabinet installation process, clinical units which did not have the cabinets but whose staff saw them in action had nurses wanting them installed on their units as soon as possible (Personal Communication, January 26, 2012).

The objective of the study was to investigate and describe how an acute care, multi-site, teaching hospital implements a new technology, in this case the Automated Medication Dispensing Cabinets (ADCs). The key recommendations arising from the findings of this study

include: the importance of using a framework or guide to structure the implementation project, assigning dedicated leaders for the project from start to finish, including end users on implementation committees, creating an organizational database to track which projects are being implemented where on what units, and evaluating all implementation projects and sharing lessons learned throughout the organization. The long term success of this implementation project is yet to be determined.

Comparing the ADC Project to the Literature

The goal of the ADC project was to introduce a new technology and change practice around medication administration in the hospital. A theoretical framework, to guide this implementation process, was not used by the ADC committee. Instead the project leaders used personal knowledge and experience from previous projects to guide the project. In many ways, the ADC project mirrored the implementation steps of the OMRU but there were some areas where the implementation steps outlined in the OMRU differed. (See table 3).

Table 3: Comparing the ADC Project to the Different Elements of the OMRU

OMRU Element	Similarities	Differences
Innovation	<ul style="list-style-type: none"> - new to end users. - informed by valid research. - investigated innovation attributes 	- practitioners currently working in clinical areas were absent from decision making process.
Potential Adopters	<ul style="list-style-type: none"> - used interdisciplinary project committee to investigate awareness, attitudes, intention, knowledge, skill and concern. 	- minimal involvement with one key stakeholder group (clinical nurses)
Practice Environment	<ul style="list-style-type: none"> - structural factors (standardization across campuses) - cultural/social factors (multidisciplinary committee) - economical consideration 	- minimal investigation into the impact of this technology on this organization's patient population.
<i>Interventions</i>	<i>Post study</i>	<i>Post study</i>
<i>Adoption</i>	<i>Post study</i>	<i>Post study</i>
<i>Outcomes</i>	<i>Post study</i>	<i>Post study</i>

Innovation.

The first element of OMRU is innovation. An innovation is "a change that constitutes something new to those who will use it. It is informed by research and is combined with the clinical judgement of the practitioner" (Rycroft-Malone & Bucknall, 2010, p. 88). The attributes of the innovation are evaluated based on how those attributes relate to the potential adopters and practice environment to identify possible facilitators and barriers. The developmental process of the innovation can also be important to the implementation (Logan & Graham, 1998; Rycroft-Malone & Bucknall, 2010).

The technology or innovation chosen for this project was the ADCs. Their purpose was to provide a secure storage area for medication, close to the point of care, where medication transactions could be tracked electronically (Cardinal Health, 2006; McKesson Corporation, 2006; Omnicell, 2002). These cabinets have been used for decades in the United States. There is ample research to demonstrate that ADCs improve medication storage and tracking, decrease costs associated with pharmacy discrepancies and improve patient safety by decreasing errors associated with manual medication administration processes (Institute for Safe Medication Practices, 2008; Pedersen, Schneider, & Scheckelhoff, 2009). The medication cycle transformation taskforce made 14 recommendations based on internal performance reviews, external best practice reviews, private sector partnerships, and external site visits (Case Study Institution, 2008). One of the recommendations was to install ADCs throughout the organization (see Appendix E). As per the recommendations in the OMRU, the attributes of the innovation (ADC's) were investigated by the ADC project team.

One of the areas the ADC project did not perform well was in usability testing. The International Organization for Standardization defines usability as "the extent to which a product

can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use” (International Organization for Standardization (ISO), 1998, p. 6). The purpose of usability testing is to match an activity, usually within a complex system, with the abilities and idiosyncrasies of the user and the work environment to maximize the chance of achieving the desired outcome (Cafazzo & St-Cy, 2012; Johnson, 2006). For example, the US Department of Veteran Affairs developed a research lab to investigate the usability of health information technologies to improve their health information system (Russ et al., 2012). It could be argued that some usability testing took place during the vendor demonstrations because clinical staff were able to perform tasks on the display ADCs. Usability testing involves systematic and validated tools, techniques and questions designed to evaluate the interactions between the product and the user (Brooke, 1998). Usability testing is not simply gathering opinions; the vendor demonstrations for the ADCs, which included questions primarily about opinions, cannot be considered sufficient usability testing.

Potential Adopters.

The second element of the OMRU is related to potential adopters. These are policy makers, practitioners, patients, or anyone else that will be using the innovation. When evaluating the potential adopters, is important to consider: (a) awareness of the specific practice innovation; (b) intention to adopt; and (c) concerns about the innovation (Rycroft-Malone & Bucknall, 2010, p. 90). Awareness, intention, and concerns can provide important information around facilitators and barriers to implementation (Rogers, 2003).

When developing new health care innovations, it is critical to involve clinical end users in the process because end users offer a unique perspective that non-clinical developers may not have considered. End users can better address their own needs and participation creates a sense

of user investment and ownership towards the innovation (Dredger et al., 2007; Høstgaard, Bertelsen, & Nohr, 2011). At the development stage, fundamental changes to a product or process can generally still be made. After development, large changes become progressively limited (Høstgaard et al., 2011). When implementing innovations that have already been developed, end user participation in the implementation process is also important. Involving end users can increase users' satisfaction and ease of use with the innovation, improve trust with the implementation process, increase the likelihood that the innovation and the work processes will match, and foster ownership to improve sustainability of the innovation. (Berg, 2001; Blakeney, Carleton, McCarthy, & Coakley, 2009; Kushniruk & Turner, 2011). For example, it is important to include clinical nurses in the process for creating clinical nursing training because these nurses are in the best position to indicate what information they need, what skills they are missing, and how training will best fit in with nursing work flow (de Veer, Fleuren, Bekkema, & Francke, 2011). Supportive opinion leaders and positive staff attitudes can go a long way to increasing the chance of success of an implementation project (Carlfjord, Lindberg, Bendtsen, Nilsen, & Andersson, 2010; Johnson, 2006).

The ADC project committee included representatives from all campuses, departments and disciplines that would be affected by the introduction of the ADCs. Representation included pharmacy management, pharmacy staff, clinical pharmacists, IS/IT management, IS/IT programmers, IS/IT analysts, clinical managers, nurse educators, and personnel from biomedical engineering, logistics and professional services. The only group affected by ADCs that was not included on the project committee was the clinical nurses. It was assumed that having clinical managers and nurse educators on the committee would be adequate to address the needs of the clinical nurses (Case Study Institution, 2008). Managers and educators do not have the same

daily clinical contact with patients and therefore clinical nurses experience situations of which their managers and educators might not be aware of (Personal Communication, June 28, 2012).

A Canadian example of the impact of failing to sufficiently engage clinical nurses in the implementation of a new innovation involved the adoption of clinical guidelines for pressure ulcers. The seven health care organizations making up a Canadian urban health region did not fully investigate all attributes of the clinical nurses when they implemented clinical guidelines around reducing pressure ulcers. The project team assumed that all staff would be comfortable using computers. This was not the case and significant amounts of basic computer training were required. The additional cost of replacing staff during training was not in the original budget and had to be absorbed by the individual clinical units (Clarke, Bradley, Whytock, Handfield, & Gundry, 2005). Had clinical nurses been part of the project team, they might have alerted the team to the issue earlier in the process.

Practice Environment.

The third element of the OMRU is the practice environment. This element involves investigating structural factors, cultural/social factors, patients/consumers, and economics. Examples include: rules, regulations, policies, physical space, workload, current practices, politics, leadership, peer opinion, and budget (Rycroft-Malone & Bucknall, 2010). Studying these factors in relation to potential adopters and the innovation helps to identify both facilitators and barriers to implementation.

"Innovative leaders, given the conceptual framework, innovation methods, and organizational support structures and systems can drive significant innovation and change within a healthcare system" (Blakeney et al., 2009, p. 8). The ADC committee investigated the practice environment to identify as many facilitators and barriers as possible. For example, they consulted

with the managers and educators on all the clinical units where the ADCs were to be installed to determine which cabinet location would work best for nursing workflow. The committee also recognized that current medication policies and practices would have to be revised in order to support the usage of ADCs in the facility. The plan for installing the cabinets, servicing them, restocking them and assisting with troubleshooting were all in place before the first cabinet arrived at the hospital. Support from senior management was positive and consistent throughout the implementation process (Personal Communication, June 28, 2012).

Interventions.

By the end of the data collection period for this study, the ADC committee had almost completed the 'access' phase of the implementation process as identified by the OMRU. They were in the process of obtaining final approval to purchase ADCs from their chosen vendor and had begun discussing how they were going to manage some of the potential barriers identified by the ADC committee. These potential barriers included: training approximately 3500 nurses in a timely manner, training multigenerational nurses with different comfort levels in relation to technology and training nurses with different computer skill levels. Strategies for managing these training issues included the development of an IS/IT training team, multistage rollout and clear communication throughout the project.

When it comes to implementing an innovation, there is no 'magic bullet' or 'one size fits all' intervention that will guarantee a successful implementation project (Davis, 2006). Much research had been done and is underway to determine which interventions work best in which situations (Grol, 2001). Multifaceted interventions, that combine different approaches, tend to deliver better results (Boaz et al., 2011).

In a study, completed by de Veer et al. (2011), the investigators created a questionnaire, based on an implementation framework by Fleuren (framework un-named), and distributed it to nurses working in a wide range of health organization across the Netherlands. The purpose was to determine what factors influenced the success or failure of an innovation process as perceived by nurses. Six hundred and eighty-five nurses responded to the questionnaire. Key findings included: (a) adequate training and coaching were considered facilitators; (b) attention to how the technology would fit into daily work routines was important to nurses; (c) pro-active visits to answer questions were seen as valuable; (d) train the trainer methods can be problematic as incorrect information can easily spread; (e) perceptions on the ease of use of the new technology improved if the innovation was supported post-implementation; (f) the risk of resistance to the new technology increased if nurses experienced unresolved problems or if their colleges did not support the technology; and (g) nurses felt it was important to be given the opportunity to provide feedback regarding the implementation process and the use/consequences of the new technology (de Veer et al., 2011). "Authoritative decisions (e.g. making the use of the technology compulsory) were reported to reduce the likelihood of success. If nursing staff felt they were or actually were included in the development or choice of new technology and in the design of the innovation strategy, the innovation process was perceived as more successful" (de Veer et al., 2011, p. 7)

Other potential barriers to implementation projects identified by nurses are: frustrating or deficient computer systems, learning that took longer than the training time available, lack of resources and lack of consistent leadership (Clarke et al., 2005). Factors external to the implementation project, such end user job stress, may accentuate immediate barriers to the project (Frank, Zhao, & Borman, 2004).

Adoption.

There is always the risk of the project failing when a new innovation is being implemented. Millions of dollars are lost each year, both in and out of the health care field, to failed implementation projects, especially ones related to computer projects. The London Ambulance Computer Aided Dispatch System cost the tax payer \$2.2 million and the system was never fully operational. The Taurus trading system cost the London Stock Exchange almost \$130 million and securities companies a further \$600 million for a semi-working product (Johnson, 2006). Implementation project may not fail outright, but they can be 'barely usable' (Lyytinen & Robey, 1999). End users may develop 'work-arounds' for technology or systems that do not work well (Johnson, 2006). This may lead to undesirable or dangerous consequences. Things like usability testing may have an associated cost up front to a project, but detection of those errors can be much less costly than correcting the impact of those errors gone unnoticed (Baylis, Kushniruk, & Borycki, 2012; Bias & Mayhew, 1994).

As previously stated, the data collection period for this case study did not include the actual adoption phase of the ADCs. In follow-up conversations with ADC committee members, it was discovered that the nurse training did not go as smoothly as planned (Personal Communication, June 28, 2012). The medication steering committee and the ADC committee did a lot of up front work to make sure they asked the right background questions, chose the correct the correct technology, prepared the clinical areas, set up the IS/IT interfaces, etc. What they did not spend a lot of time planning was how the implementation process would proceed once the background work was completed. Instead, the ADC committee took more of an ad hoc approach and dealt with issues as they arose (Personal Communication, June 28, 2012). Training the 3500 nurses was a good example of this lack of preparation specifically related to the reality

of nurses working on clinical units. With previous implementations, a "train the trainer" model was used. A sale representative would train the nurse educator and sometimes a certain percentage of the nurses and then the nurse educators trained the rest of the clinical nurses and any new nurses that were hired. This meant all training costs were either included in the vendor contract or absorbed by the clinical program. When the budget for the ADC project was set by the medication steering committee, no extra funding was included for training.

As the ADC project unfolded, it became the pilot project for the new IS/IT training team. Other parts of the organization, working on projects unrelated to medication transformation, had decided that since there were going to be increasingly complex IS/IT systems and tools implemented over the next 5-10 years, it would a good idea to have a training team within the IS/IT department. Once a contract was reached with an ADC vendor, the vendor recommended a two hour training session for every nurse. When the ADC committee went to the clinical programs and said you have to pay for two hours of training for all of your nurses, the programs refused. In the end it was decided that the clinical programs would pay for clinical education and the IT/IS department would pay for IS/IT related training. Since the details of how the training plan was going to work were never discussed in detail at the beginning of the ADC project, this unforeseen barrier was not planned for. In the end, the project ran over budget because of the cost of training the 3500 nurses. (Personal Communication, June 28, 2012).

Outcomes.

There is an important distinction between research and evaluation. Research adds knowledge to a field of study whereas evaluations provide stakeholders with information that will help them make a value judgement or decision (Fitzpatrick, Sanders, & Worthen, 2011). Evaluation builds capacity within an organization not only for future evaluation but for

evaluation utilization as well as organizational learning (Cousins, Goh, Clark, & Lee, 2004).

Evaluation findings can be used for:

- Demonstrating accountability
- Assisting in making a decision
- Bringing an issue to the attention of others (agenda setting)
- Helping stakeholders elaborate or refine their opinion
- Convincing of other to take action
- Exploring and investigating problems
- Involving stakeholders in program planning or policy develop
- Promoting understanding of issues
- Changing attitudes
- Changing the nature of dialogue or interaction among groups
- Influencing policy
- Introducing those involved to new ways of thinking (Fitzpatrick et al., 2011, p. 455)

Without a final evaluation, it is difficult to determine if the innovation has been adopted, is being used in the manner it was intended for and has provided the service it was purchased for. The goal of the evaluation component of an implementation such as the ADC project is to assess the effectiveness of the implementation interventions and evaluate the entire project to determine the impact of the innovation on the patients, practitioners, organization, and systems and to facilitate needed change. (Cousins et al., 2004; Fitzpatrick et al., 2011; Graham & Logan, 2004a; Logan & Graham, 1998; Rogers, 2003; Titler et al., 1994).

During the ADC project, budgets and timelines were monitored closely but there was no formative evaluation of interventions nor was there a final evaluation component built into the

process (Personal Communication, June 28, 2012). Without a final evaluation it is difficult to determine to what degree the ADC project was successful; success can be defined in many ways: effectiveness, efficiency, organizational attitudes and commitment, worker satisfaction, patient satisfaction and sustainability. (Berg, 2001; Ellis et al., 2007). Even if a final evaluation had been planned, the organization does not currently have the capacity to share that information with other departments or groups within the organization or even within the same department. (Personal Communication, June 28, 2012).

Study Strengths and Limitations

There are inherent strengths and limitations to this study as there are with all research. The strengths of the study included: a large multi-site hospital, multidisciplinary participants, and the use of a validated implementation framework. The potential limitations encountered in this study were: project delays, selection bias, researcher bias and framework bias.

Strengths.

The ADC project was an excellent case to study because it took place in a large, multi-site hospital, it involved a multidisciplinary implementation team and a validated implementation framework was used to guide the case study. Implementing a project at a multi-site facility highlighted a range of problems that would have not been an issue in a single site hospital. For example, there were different practices around medication delivery at the multiple sites that had to be synchronized before the ADCs could be implemented. Even holding committee meetings could be a challenge as the committee members were spread out over the multiple campuses and had to travel to the meeting site. Although having multiple sites for the project created implementation challenges for the ADC committee, this was a strength for the case study

because it highlighted aspects of implementation that may not have been part of a project that took place at a single site hospital.

For the same reason the multiple site aspect of the hospital made the case study stronger as did the multidisciplinary nature of the ADC project committee. It highlighted challenges to the project that would not have been an issue if a single department was responsible for the project. For example, the project lead was from pharmacy but had no managerial authority over the IS/IT, nursing or facilities individuals that were on the committee. When the ADC committee needed nurse managers to suggest possible locations for the cabinets or facilities to complete renovations to the nursing units, the project leader could request urgent action, but ultimately had no authority to move the other departments along. As with the multisite hospital, the multidisciplinary nature of the committee highlighted aspects of implementation that would never have been seen if the project was isolated to one department.

The last strength of the study was using the OMRU framework to guide data collection and to structure the results. The model was originally developed by Logan and Graham in 1998. Since its creation, it has gone through several revisions and has been used over the last 14 years to address clinical problems, inform practice, implement guidelines and guide doctoral studies (Rycroft-Malone, 2004; Rycroft-Malone & Bucknall, 2010). The framework has been validated in numerous research studies and the diversity of these studies suggests that the framework can be applied to many different kinds of implementation settings. This case study was made stronger by using an implementation framework validated by years of research.

Limitations.

The original intent, in designing this case study, was to observe the ADC project from beginning to end and follow it through all the steps outlined in the OMRU. Due to unforeseen

circumstances, the ADC project took five years to complete instead of two. As a result, the investigator only collected data during the planning stages of the project. There are large numbers of published articles about the outcome of implementation projects, but very few about the details of how a project is planned. This case study, as a result of the delayed timelines, is focused on the under-reported planning phase.

The individuals interviewed were chosen using a snowball method; this may have resulted in some selection bias. Although the investigator determined that data saturation was reached after 10 interviews, there is always the possibility that other individuals, who were not interviewed, may have had different information that would have contributed to the understanding of the case. Conversely, the snowball method is arguably the best way to identify interview subjects when the researcher lacks the inside knowledge to navigate through the possible candidates within the organization (Pan & Tan, 2011).

The investigator used the OMRU as a framework to guide data collection and to structure the results. Using this framework is considered a strength of the study but could have prevented the investigator from learning things that were not a part of the OMRU framework. As a result important data might have been missed. Using a different framework or no framework might have elicited different results. That being said, there is no one optimal framework. Each framework has different strengths and weaknesses depending on its intended audience, focus, etc. While the use of the OMRU may have narrowed the focus of the finding of this case to factors in the framework, it is more likely a broad range of implementation factors were scrutinized.

The size of the hospital and scope of the ADC project were definitely strengths of the case study. They created challenges to implementation that would never have been identified in a

smaller organization or a project that was confined to one department. Despite this, as with any research, there is the potential for bias. In this case, the investigator designed and executed the study in a fashion that would keep bias to a minimum. Using the OMRU as a guide for the study was both a strength and a potential limitation. The OMRU is a validated framework that has been used in research for 14 years. Using a framework to guide data collection ensures a researcher does not miss vital information but can also focus the data collection to the extent that information which was not related to the framework may have been missed.

Implications for Practice and Policy

Health organizations, such as this case hospital, are dynamic in nature. They function more like an organism than a machine (Kitson, 2009). So too must the implementation projects that take place within them. Implementation is a messy and complex process that is never exactly the same twice (Fitzgerald, Ferlie, Wood, & Hawkins, 2002; Van de Ven, Polley, Garud, & Venkataraman, 1999). Innovations cannot be simply disseminated into a health organization; they become assimilated where the organization is affected by the new innovation but the innovation is affected by the organizational dynamics as well (Atun et al., 2007; Berg, 2001; Francis & Perlin, 2006).

Based on the experience of the ADC project, the investigator suggests several recommendations for any health related organization that will be implementing multiple, complex, technological innovations. These recommendations include: (1) creation of an implementation policy that provides an organizational general structure and tools that could be used for any implementation projects, (2) finding ways to involve end users like clinical nurses on nursing related projects, (3) use of an internal scheduling system for all implementation projects within the organization to track which projects/programs are on which units at any given

time, and (4) creation of a mechanism for sharing the results of mandatory project evaluations to improve future projects. Once the data collection was completed for this case study, the investigator continued to informally follow the ADC project to its completion. Conversations with key individuals within the ADC project helped to reinforce the key recommendations of this study.

Implementation Policy.

"Failure is not an option" is a well known quote from the movie Apollo 13 (Howard, 1995). When implementing a new innovation, the goal is to complete the implementation project successfully. Standardization for implementation practices in organizations results in more consistent and efficient practices which can increase the chances of a successful implementation project (Tassey, 2000). Although there are examples of national and regional governments using implementation policies to improved or create new products, processes, or services, the investigator is unaware of any examples in the literature of individual health organizations formalizing implementation processes through the creation of organizational policies (Cowan & van de Paal, 2000; Huang, Amorim, Spinoglio, Gouveia, & Medina, 2004; Liu, Simon, Sun, & Cao, 2011).

There are implementation projects that have used implementation frameworks or models to guide the implementation project in health care settings. For example, Clarke et al. (2005) evaluated a two year project that used Roger`s theory on the diffusion of innovations to guide a implementation of a computer assisted clinical guidelines for the reduction of pressure ulcers across multiple organizations in a Health Region. The implementation project had varying degrees of success across the different organizations within the region but lessons learned from this project were used to create recommendations for other projects within the Health Region

(Clarke et al., 2005). In a second example, the OMRU was used to implement and evaluate a comprehensive pain management program for pediatric patients (Ellis et al., 2007). The program was implemented across the organization with positive results. Sustainability of the program over the long term was a concern so short term and long term recommendations were developed out of the project evaluation (Ellis et al., 2007). Without a framework, these projects might have missed key implementation steps. Without an evaluation of these projects, recommendations could not be made for sustainability and lessons learned for future projects.

The ADC committee, through its implementation activities over the duration of this project, identified gaps in their implementation process. Kitson (2009) hypothesised that knowledge translation can only occur with some sort of expert facilitation like a framework or model. In order to ensure future projects do not repeat the same mistakes, an organizational implementation policy needs be developed that addresses all aspects of the implementation process and clearly defines organizational expectations. The policy should include details about what an implementation process is, who should be involved, and what is expected at the end of the project in relation to evaluation. To ensure that no aspects of the implementation process are missed, the policy should include a tool, framework, and/or guide to assist organizational teams with their implementation project, especially for project leaders who are not as experienced in implementing new innovations.

In chapter one, the OMRU and the KTA were identified as frameworks that met the criteria for implementing innovation projects such as the ADC project. Some groups, such as the ADC committee, might find these frameworks challenging to use because of the complexity of the process and the lack specific details regarding individual elements. Estabrooks et al. (2006, p. 31) states that the OMRU requires "further development in incorporating the need for rapidly

changing clinical assessments and in the area of validated instruments supporting its elements and the relationships between them." A more practical solution for clinicians who are not experts in knowledge translation and implementing innovations might be a guide similar to the one produced by the RNAO for implementing best practice guidelines. This RNAO toolkit is specifically created to describe "a systematic, well-planned implementation process and is designed to assist nurses and other healthcare professionals to support evidence-informed clinical and management decision-making [related to the best practice guidelines developed by the RNAO]" (Registered Nurses Association of Ontario, 2012, p. 8). This toolkit could not be used in its present form as a general guide for implementation projects but it offers advantages, for clinicians, that theoretical models such as the OMRU do not. These advantages include: planning exercises, approaches and strategies, areas of caution, worksheets, case studies, scenarios, evaluation and sustainability tools (Registered Nurses Association of Ontario, 2012). All though the RNAO toolkit is based on the KTA framework, it provides a more practical approach for the clinical user.

Involve End Users.

Human factors engineering and participatory design methods clearly demonstrate the benefits of involving end users in innovation design and implementation projects (Cafazzo & St-Cy, 2012; Høstgaard et al., 2011; Johnson, 2006; Kastner et al., 2011; Russ et al., 2012). Some of the most common ways to involve end users include: membership on steering/advisory committees, membership on design teams, membership on problem-solving groups and consultation with individuals or groups (Damodaran, 1996, p. 366). Involving end users is essential, but not necessarily easy to accomplish (Berg, 2001; Dredger et al., 2007; Johnson,

2006; Sanoff, 2006). This is certainly the situation when it comes to involving clinical nurses on project teams or committees.

Nurses work in a very demanding and fluid environment. Traditionally, the case hospital has had difficulty eliciting nurses' participation on projects or committees that require face to face meetings during a standard Monday to Friday work week (Personal Communication, June 28, 2012). From years of working as a clinical nurse, the investigator hypothesises that rotating shifts (night and weekends) as well as the lack on monetary compensation for participation has resulted in less than optimal nursing participation on hospital committees that require the nurse to attend in person. A new area of research has been emerging over the past decade called 'distributed participator research.' This area of study looks at involving end users that are physically, temporally, or organizationally distributed (Lohmann, Ziegler, & Heim, 2008).

There are some potential risks of not including end users in the implementation process. One outpatient neurology clinic at a large teaching medical centre decided to implement a new computer document system for charting. The system was being used by a physician in another clinic and it worked well. The IT department was interested in expanding the document system into new areas. The administration felt that the implementation would improve efficiency and increase nurse involvement with the patients. The physicians and IT personnel worked closely to implement this new system into the clinic. Nurses were not included on the project team and nursing management felt the document system was being introduced to save the physicians more time by making the nurses do their work. In the end, the project failed because the project team did not understand the complexities of the clinic's environment and failed to involve one of the key stakeholder groups in the process (Statnikova, 2005).

In the case of the ADC project, clinical nurses were not actively sought out to participate in the project; they were not invited because it had been too difficult to obtain clinical nurse participation in the past (Personal Communication, June 28, 2012). Project or committees meetings at this case hospital are typically held Monday to Friday between 0800 and 1600 hours. This is because these are the normal working hours for the majority of the members. Because non-clinical committee members are not working at the bedside, they can usually just step away from their regular duties to attend meetings. Clinical nurses would either have to come back to the hospital on their day off to attend a meeting (usually unpaid) or clinical managers would have to find replacement staff to cover the time the clinical nurse would be absent from the clinical unit for a meeting. Since both of these scenarios have financial implications for either the nurse or the clinical unit, nurses at this organization tend not to participate in committee work (Personal Communication, June 28, 2012). There is only one corporate committee in the organization, relating to clinical practice which two clinical nurses from each unit are paid four hours a month to participate in. The funding for this committee is provided by external sources and despite this only 50% of clinical units have nursing representatives who attend regularly. This is a higher committee participation rate than one normally sees in this organization for any of the unpaid committees (Personal Communication, Nov 5, 2012).

The investigator recommends the case organizations expand beyond the traditional meeting structure and explore different ways to engage nurses. There are a number of ways organizations could increase the participation of clinical nurses who are working rotating shifts. The following could be considered:

1. Identifying a group of nurses that rotate attending meetings and provide a summary to the rest of the group. That way one nurse will not be overly burdened with having to attend every meeting.
2. Using teleconferencing as a way for nurses to participate without having to physically attend the meetings. Teleconferencing is already a popular meeting tool used by the hospital. If nurses are not working or are at a different campus, they could dial into the meeting and still participate in the discussion.
3. Using video conferencing as a way for nurses to participate without having to physically attend the meetings. With the introduction of the World Wide Web, video conferencing has become increasingly popular. Each site has a microphone, video camera, and projection screen. Computer presentations can also be shared this way. Currently at the case hospital, only a small number of rooms are set up for video conferencing. The hospital could expand this service by adding inexpensive microphone/video camera combinations to individual computers on clinical units which would allow clinical nurses to video conference in and still be close to their patients (Marotta, 2006).
4. Using instant messaging (IM) programs as a form of communication. IM programs allow participants to type messages to each other in real time. The advantage of such programs is that less sophisticated equipment is needed. All a participant needs is a computer, smart phone, or tablet and a connection to the internet. Web casts frequently integrate an IM feature. Web casting is when the person who is presenting the topic is at a location with a microphone and video camera. Their presentation is recorded and streamed (sent out) over the internet to participants. Participants who

have a computer and access to the internet watch the presentation in real time. If the participants have a question, they can type it into an IM box and the presenter can read it and respond.

5. Using other collaboration tools when the work can be completed without the entire group membership present at the same time. With the use of computers, electronic, or virtual, meeting spaces can be created where members can communicate, share ideas, work on documents and projects and more. These virtual interactions can take place in real time or asynchronously. There are many different computer programs available that allow collaboration at a distance, many at no cost. Some examples include wikis, forums, white boards, knowledge management systems, application sharing programs, etc. (Lohmann et al., 2008)
6. Obtain funding (internally or externally) to pay nurses to participate in committee work.

The current system for engaging clinical nurses in implementation projects is far from optimal. The use of technology such as conferencing tools, instant messaging programs or electronic collaboration tools is one way that may make it easier for nurses who work rotating shifts to participate. Using these techniques will not guarantee greater participation by clinical nurses, but organizations need to be creative and get nurses involved.

Project Coordination.

Increases in nurse workload and stress are directly linked to decreases in positive patient outcomes (Hughes, 2008; Lacey et al., 2007). Nursing workloads may increase when implementation projects are added to daily work because learning new technologies, systems, and other innovation take time and effort (Berg, 2001; Statnikova, 2005). Multiple

implementation projects can create chaos for a clinical unit with a busy patient population. In the case hospital there is currently no centralized method for coordinating implementation projects across the organization. This means that one clinical unit could have five implementation projects all occurring at the same time while another unit has none (Personal Communication, April 17, 2012). The investigator recommends that an electronic solution be created where project leaders can book implementation projects on clinical units. This way, different groups would be able to determine whether a unit is busy with other projects before scheduling their own implementation process. The University of Trent IT department is currently using a web page to list all current active IT projects and delivery dates to the rest of the university (University of Trent, 2012). Organizations could use an internal web page to house a list of clinical units and implementation projects. Anyone in the organization would have to log new implementation projects here so staff on clinical units would not be overwhelmed with too many projects at the same time.

Sharing of Evaluation and Feedback.

If implementation of new innovations was an easy and straight forward process, there would not be 30 plus years of research in this area. Implementation is difficult and each organization is different (Fitzgerald et al., 2002; Van de Ven et al., 1999). That is why sharing lessons learned from one project can inform future implementation projects, potentially save costs and improve the chances for future implementation successes (de Veer et al., 2011; Greenhalgh et al., 2004; Statnikova, 2005). Currently, very few projects within the organization are formally evaluated and if they are, there is no way to communicate that information to the rest of the organization (Personal Communication, June 28, 2012). Within the implementation policy, there should be requirements and instructions for how to complete a formal evaluation at

the end of each project (Fitzpatrick et al., 2011). This evaluation process should be mandatory and the results available in a location where other members of the organization can access it (e.g. internal web site or computer server). Each organization is different and therefore has its own set of unique strengths, facilitators and barriers in relation to the implementation of new technologies. Too many times resources for projects at large organizations are front loaded. Much time and many resources are spent planning and implementing projects but organizations often do not insist on mandatory evaluations of these projects (Cousins et al., 2004; Fitzpatrick et al., 2011). Consequently, the organization never knows how well or poorly the project went and what lessons were learned. In a time where budgets are being reduced, information that has the potential to save future time and money should be shared within the organization.

Every project has its positive points and areas for improvement. In the ADC project, many things went well. Despite all the project delays and training difficulties, the cabinets were finally installed and are functioning. The recommendations for health organizations implementing innovations included: creating an organizational policy for implementation, using creative way to involve end users in implementation projects, organizing implementation projects within the organization to reduce projects conflicting with each other, and evaluating implementation projects and sharing the lessons learned with other departments and groups within the organization.

Future Areas of Study

In attempting to answer the research question, other questions were raised about how future projects could and should be carried out. Future areas of study include: innovative ways to involve clinical users in implementation projects, the standardization of guides and frameworks

in implementation projects in the form of new policy, the impact of evaluation on projects and repeating of the study using different frameworks.

Authors that write about implementation frameworks and guides have state consistently that involving end users in the implementation process is key to a successful project (Hunt, Sproat, & Kitzmiller, 2004; Kramer & Schmalenberg, 2008; Rogers, 2003; The Standish Group, 1995). Clinical nurses were the majority of end users in the ADC project but their contribution to this project was limited. At the case organization, clinical nurses are rarely involved in project committees because of the difficulties associated with having them participate. The lack of clinical nurse participation in this case raises some interesting questions. How well do clinical managers and nurse educators represent the interests of the clinical nurse on committees? Will the use of computers and technology (wiki, e-forums, collaboration software) work in improving the involvement of clinical nurses and facilitate more participation by them? Are there other innovative ways to involve end users that work shifts over the period of 24 hours, 7 days a week? Is it the lack of technological expertise or perception of the lack of technological expertise from clinical nurses a reason why nurses do not seek to participate in more implementation projects? Is the benefit of having clinical nurses more involved in implementation project worth the effort of changing the current project format to accommodate them?

Another area of interest arising from this case study is the role of frameworks and guidelines in implementation projects. The case organization does not have a formal guide for implementing projects. Each department and project team implements projects based upon knowledge and past experience. How would the outcomes of implementation projects change if organizations had an implementation policy based on a standard framework or guidelines for all implementation projects? Is it feasible to implement such a policy? If a standard guideline were

to be implemented, standardized evaluations would need to be part of the policy. Currently, at the case organization, evaluation of implementation projects is not standard practice. If the requirement for an evaluation were to be included in the policy, how would success be measured? How would the results be shared? Are the results useful within the organization? Outside the organization?

The theoretical framework used to guide the analysis of this case study has the potential to cause bias, in that it may have shaped what the researcher observed and how these observations were interpreted. Even so, there is an abundance of research in the literature on implementation projects that are analyzed using implementation frameworks, whether the project used a framework as a guide or not. What there is little literature on is implementation policy at the organizational level. Hospitals constantly adopt new technologies and the study could be repeated at the same institution studying the adoption of another similar technology for which nurses will be the end users but determining whether adding an organizational policy change, that includes an implementation framework, will improve the end result of the project. As the use of technology in hospitals increases, there will be many opportunities to study the impact of technology on nursing and how nursing has an impact on the technology.

Good research has the potential to raise just as many questions as it answers. The original intent of this study was to describe the implementation process of the ADCs from beginning to end. Because of project delays, only the planning stages of the project were studied. This disadvantage turned into an advantage because it provided an opportunity for a detailed look into the planning stages of an implementation project in a health organization. All questions cannot be answered in one research study but this case study is an excellent illustration of how the implementation of new technologies that will be used by nurses occurs in large tertiary hospitals.

Conclusions

The purpose of this case study was to investigate and describe how an acute care, multi-site teaching hospital implements new technology that will be used by nurses. The ADC project was part of a larger medication transformation project aimed at closing the medication delivery loop to increase efficiency and improve patient safety. Although the project team was multidisciplinary in nature and an effort was made to involve all key stakeholders in the implementation process, nursing was not as engaged in the process as some of the other disciplines. The ADC project committee missed some key elements of implementation identified in the literature that could ultimately affect the success and sustainability of the project over time. Recommendations have been made to improve future implementation projects by creating an organizational implementation policy which includes: project evaluations, involvement of end users, scheduling system for implementation projects and methods for sharing evaluation results.

Technology is not going away. It is changing more rapidly with each passing every year. This project was one of many multisite, multidisciplinary, IS/IT related projects that will be implemented at the case hospital over the next decade. As budgets tighten and the public pushes for safer, more affordable health care, hospital administrators are going to have to be strategic about choosing and implementing technology that is going to meet the needs of the organization in an affordable manner.

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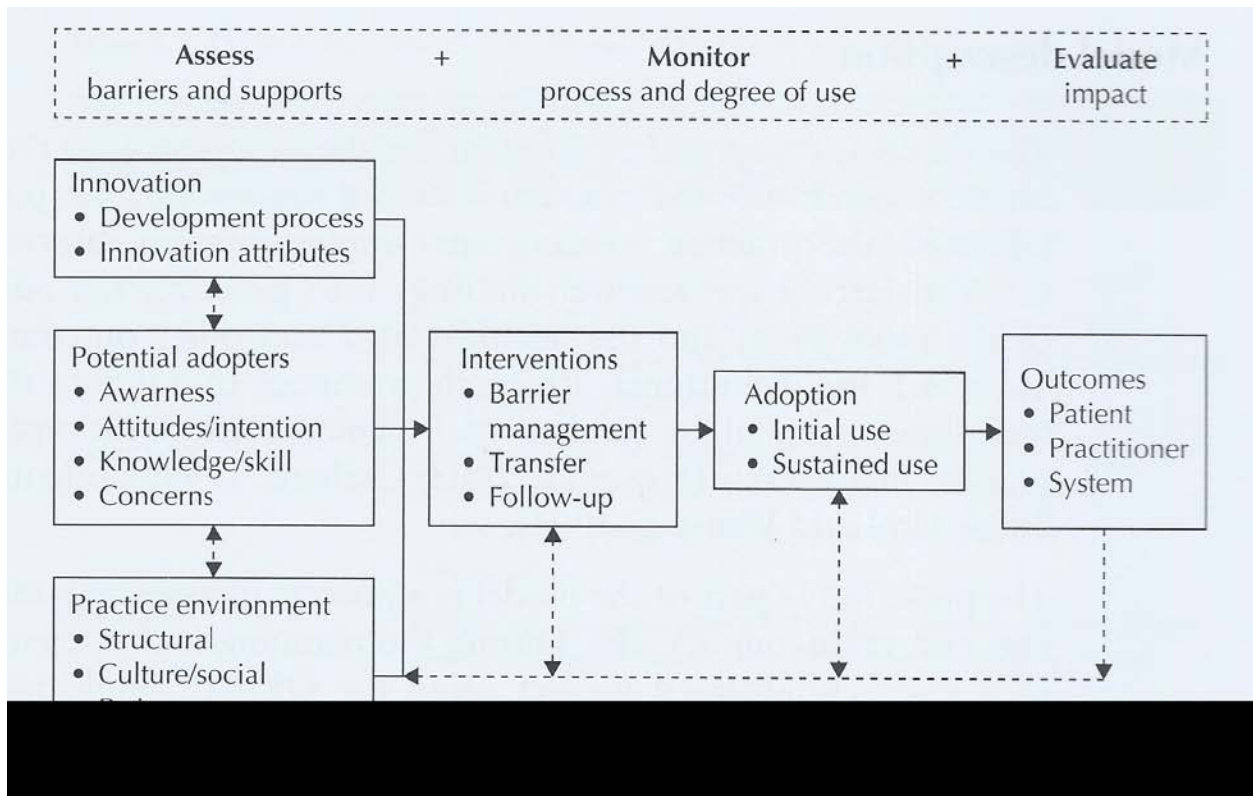
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Figure 1 – Ottawa Model of Research Use



(Adapted from Graham and Logan, 2004 and printed with permission in Rycroft-Malone & Bucknall, 2010, p. 87)

Appendix A – Results of Demo Surveys

Questionnaire and Results - Nursing

<i>Vendor Code</i>	W		X		Y		Z	
<i>Agree (+) Disagree (-)</i>	+	-	+	-	+	-	+	-
Simple log on	57	3	65	2	69	1	52	
Simple log off	57	1	59	1	64		51	
Simple password change	52	1	46	4	45		41	3
Touch Screen display is acceptable	59	2	66	3	66	3	50	1
Touch Screen height is acceptable	62		64	4	62	4	50	1
Touch Screen dimensions are acceptable	61	2	68	2	64	4	47	1
Touch Screen lighting is acceptable	60	3	68		64	1	48	2
Touch screen is easy to use	60	4	61	5	64	3	45	4
Workspace available is adequate	41	19	52	13	41	22	34	19
Location / size of Return Bin is adequate	42	11	55	9	42	3	42	5
Simple Global Search for patients from other areas	52	4	45	8	50	3	36	7
Simple Product Search to find products in another cabinet	48	3	45	6	46	4	34	4
Simple Patient look up for those assigned to a specific cabinet (limited patient list)	49	4	51		51	4	39	3
Patient Allergy Information is available	55		55	3	62	2	45	2
Patient Profile easy to read/interpret	54	3	53	3	56	3	43	1
Medications available in cabinet easy to identify on patient profile	49	1	47	3	59	3	43	2
Medication can be easily dispensed from patient profile	57	2	54	5	60	1	40	2
Medication NOT displayed on a patient profile can be easily dispensed	44	4	46	4	57	3	36	3
Nurse can easily request / obtain multiple products simultaneously	50	5	49	2	58	3	38	6
Medication location identified making retrieval simple	57	2	53	6	61	2	42	3
Medication pockets easily opened	56		63	1	64		44	3
Pharmacy notification when an item is 'Out of Stock' and needs to be replenished is simple	44	3	48	5	53	1	39	3
Simple acceptance of override messages	53	2	46	4	48	3	40	3
Simple process to return unused meds	52	5	42	4	60	2	40	4
Simple process to record wastage	45	3	43	2	42	3	34	5
Discrepancy resolution procedure is acceptable	40	1	31	2	43		29	6
Manual Patient admit process is acceptable	37	2	25	4	30	6	25	7
Allergy Information can be entered manually	34	8	17	15	18	14	14	17
Nurses able to record pt data (i.e. vitals) when prompted	36	6	14	10	18	12	12	17
Drawer / Pocket accessibility during downtime is adequate	43	4	26	1	41	3	23	4

Total surveys received = **105**

of those surveys, total # completed for all four vendors = **36**

Which Cabinet do you prefer? (# of votes)

W - 14

X - 18

Y - 17

Z - 5

*Comments:***For all Cabinets:**

- Would like to see these systems in place for all medications (x4).
- Would like computerized daily MAR and medication profiles.
- Biometrics issue.
- Limited use of matrix drawers to prevent errors.
- Nurses float a lot so need access to multiple cabinets.
- Linked to hospital sign on?
- Would like bariatric option/dose.
- Need for fridge dispensing.

For Vendor W:

- Font size needs to be larger (x3).
- Drawers are harder to manipulate in downtime.
- Drawers are too small.
- Inadequate work space.
- Drawers are too low (x2).
- Allergy information does not stand out.
- Don't like display.
- Needs allergy alert (x2).
- + Very intuitive.
- + Easy logon.
- + Quick access of drugs.
- + User friendly (x6).
- + Clearest screen.
- + Like alerts for med dispensed and time between doses (x3).
- + Good size.
- + Medication info.

For Vendor X:

- Too bulky (x6).
- Limited capabilities.
- Drawers are too low (x2).
- Patient profile too busy.
- Screen is too high.
- Too complicated (x3).
- + Screen height is adjustable.
- + Limits need for 2nd RN to check (x2).
- + Quick sign on and access to drugs (x2).
- + Large screen.
- + Dispenser allows for less chance of mistake to occur (x3).

For Vendor Y:

- Too complicated (x3).
- Have to touch hard on screen.
- Drawers are too low.
- Screen is too low.
- Screen is too small (2).
- Many steps for each process.
- + Like option of remote access feature (x13).
- + Drug information available (x4).
- + Lights embedded in cabinet to facilitate easier location of meds (x3).
- + User friendly.
- + Good security features.

For Vendor Z:

- Limited capabilities.
- Needs larger workspace.
- Drawers are too low.
- Return bin too small.
- Screen needs to be brighter.
- Not easy to use.
- Does not meet nursing needs.
- Wastage process is complicated.
- Keyboard is too high.
- Trailing zeros.
- + Like training module.
- + Simple (x3) and fast access.
- + Good allergy display.
- + Workspace is too large.

Questionnaire and Results - Pharmacy

<i>Vendor Code</i>	W		X		Y		Z	
<i>Agree (+) Disagree (-)</i>	+	-	+	-	+	-	+	-
Simple log on	12	2	13	3	12		14	
Simple log off	12	1	12		10		12	
Simple password change	11	1	10		8		11	
Touch Screen display is acceptable	11	3	14	2	12	2	17	1
Touch Screen height is acceptable	15	2	13	3	11	3	17	
Touch Screen dimensions are acceptable	15	1	14	2	10	3	17	
Touch Screen lighting is acceptable	16		16		10	2	15	1
Touch screen is easy to use	13	1	14	1	11	2	15	
Scanner is accessible / easy to use	12		11	1	10	1	13	1
Medication location identified making retrieval simple	10	3	10	4	12	1	11	3
Medication pockets easily opened	12	1	10	5	7	4	13	
Pharmacy restock report easy to read	9	1	6	1	6	1	7	1
Restocking process is acceptable	8	1	7	2	9		12	
Products can easily added / removal for 'temporary use'	13		7	1	8	1	9	1
Report for Return Bin contents is easy to read	7	2	9		7	1	6	2
Location/Size of Return Bin is adequate	9	1	8	3	8	1	9	1
Process to empty return bin is simple	8	1	6	1	9	1	9	1
Inventory / Stock functions easy to use	12		6		8	1	9	
Lot / Expiry tracking available	8	2	8		8	1	10	
Notification for expired products is available	13		7	1	8	1	9	1
Removal process for expired / recalled products is adequate	9	1	5	2	8	1	8	1
Discrepancy resolution procedure is acceptable	13		5	1	10	1	10	
Drawer/Pocket accessibility during downtime is adequate	8	2	4	2	9	1	6	2

Total surveys received = **27**

of those surveys, total # completed for all four vendors = **12**

Which Cabinet do you prefer? (# of votes)

W - 1

X - 3

Y - 5

Z - 4

*Comments:***For Vendor W:**

- Concern of battery power only being 2 minutes.
- Don't like print of medications on profile (x2).
- Allergy on override an issue due to no warning.
- Previous experience with drawer failures at another site.
- Too low of workstation.
- Dark unit.

For Vendor X:

- Machine is larger than others (x2).
- Do not like how drawers are indentified.
- Keyboard height.
- + Like dispenser.
- + Area for info on high risk/alert meds.
- + Nice format visually.
- + Easy to use (x2).

For Vendor Y:

- Only allows for expiry tracking not lot.
- Screen is small (x3).
- + Convenient system.
- + Like default information on screen.
- + Drug info option (Gold standard website).
- + Like option of remote access feature (x2).
- + Durable drawers.

For Vendor Z:

- Keyboard height.
- Not as appealing visually (x2).
- + Organized concept.

Appendix B – Semi-Structured Interview Guide

1. What do you know about changing the narcotic control practices at the hospital?

Describe why you think changes are necessary.

Prompts:

- How did you become involved in this change process?
- How was knowledge about this topic obtained? Who are the ‘experts’?
- Where there safety/security issues which this change is trying to address?

2. Why was Automated Medication dispensing cabinets chosen as a part of this change?

Prompts:

- What attributes of ADCs were considered important?
- How were you involved in the decision making process? Please describe.
- What issues in medication control/administration does this technology address?
- How will hospital and nursing policies/processes change as a result of the introduction of these cabinets?

3. What factors/issues needed to be considered when developing strategies to prepare the staff about the upcoming upgrade?

Prompts:

- Who will be affected by the introduction of ADCs?
- How is the hospital environment taken into consideration?
- What are some of the perceived barriers that the project might face?
- What are some of the supports/strengths the project could use?
- Are there differences in awareness, attitudes, knowledge/skill, concerns, or current practice around medication control/administration?

4. How will the staff be introduced, trained and supported through the implementation process?

Prompts:

- Who will be responsible for training?
- What kind of support does the company supplying the technology provide?
- How was this training regiment developed? Where techniques taken from other facilities that have undergone similar upgrades? Describe.

5. How do you think the implementation of ADCs will affect staff and patient care within the organization?

Prompts:

- How will ADCs impact the job of nurse within the organization? Other interdisciplinary groups?
- Who will be responsible for modifying policy and procedures regarding medication administration? How will nursing be involved in that process?

6. What do you think about how the implementation of the ADCs is being undertaken?

Prompts:

- What part of the process do you like/dislike?
- What barriers need to be addressed/overcome?

7. What kind on-going evaluation does the organization have planned for the project?

Prompts:

- Is there a formative evaluation process? Describe
- When will the project be re-evaluated?
- What criteria will be used to determine if the implementation was a success?
- Are there plans to expand the use of this technology in the hospital? (e.g. other units, storage of all stock medication)

8. Do you have any other comments /concerns/opinions about the ADC project?

Appendix C - Information Sheet and Consent Form (English)**Information Sheet****Introducing Technology into an Acute Care, Multi-site Teaching Hospital***Background of Study*

This research study is being conducted by Pamela Tkach, Registered Nurse, as part of her MScN degree in Nursing at the University of Ottawa. The goal is to describe how The Hospital implements Automated Medication Dispensing Cabinets (ADCs) for the storage and retrieval of narcotics.

Purpose and Design

The research will be conducted using case study method. Data will be collected from observations on the nursing units, hospital documentation, and interviews with individuals involved in the project. The goal of this study is to describe how the hospital is implementing this ADC project in the hope that two years later, when the project rollout is complete, researchers can look at the outcomes and use this data to see why the project worked out the way it did.

Study Procedures

Approximately 15 interviews will be conducted on hospital property at a time convenient for you. Participants for these interviews will be selected using a purposeful sampling method. The interviews will be conducted in English and audio taped.

Length of Study

Data will be collected over a three month period. The interviews will be semi structured and last 30-60 minutes. They will be located on hospital property at a time and location convenient for both you and the researcher.

Possible Side Effects

Discussing your opinions and experiences may make you feel uncomfortable. You are free to not answer any question and may stop the interview at any time.

Benefits of the Study

Your participation may help nursing researchers better understand how new technology becomes integrated into a hospital setting.

Withdrawal from the Study

You may withdraw from the study at any time and you may choose to have any audiotapes/transcripts destroyed. You may also choose to not answer any questions without consequence.

Cost

You will not be paid to participate in this study.

Confidentiality

No personal health information will be collected for this study. All information will be kept confidential unless release is required by law. It will not be shared with hospital management or administration unless release is required by law. The researcher will identify you by a number and all information leaving the Hospital or the University of Ottawa will be coded so you will not be identifiable. No identifying information will be revealed in the study results and only anonymous information will be published. The study data will be kept for 15 years and then destroyed. The Hospital Research Ethics Board and Health Research Institute may review your research study records for audit purposes.

Voluntary Participation

You are under no obligation to participate in the study and you may choose to participate or withdraw at any time without providing the researcher with a reason. Any information you share will not be given to your manager or the hospital. If you have any questions about the study, you may contact the researcher or her supervisor.

Researcher – **PAMELA TKACH**, RN, BScN

School of Nursing, Faculty of Health Sciences, University of Ottawa

Supervisor – **KIRSTEN WOODEND**, RN, BScN, MSc, PhD

Associate Professor, School of Nursing, Faculty of Health Sciences, University of Ottawa

If you have any questions regarding the ethical conduct of this study, you may contact the Chairman of the Hospital Research Ethics Board



Consent Form

I have read the two page information letter with consent form and have had an opportunity to ask the researcher any questions I had about the study.

My questions and/or concerns have been answered to my satisfaction and I agree to participate in this study. If I decide at a later stage in the study that I would like to withdraw my consent, I may do so at any time.

A signed copy of the Information Sheet will be provided to me.

If I have any questions about the study, I may contact the researcher or his supervisor.

Participant's Name _____ Date: _____
(print):

Participant's Signature: _____

Researcher's Name _____ Date: _____
(print):

Researcher's Signature: _____

Appendix D - Information Sheet and Consent Form (French)**Lettre d'information****Introduction de la technologie dans les unités de soins aigus d'un Hôpital d'enseignement multi-sites***Contexte de l'étude*

Ce projet d'étude est mené par Pamela Tkach, infirmière autorisée, dans le cadre de son programme de maîtrise en sciences infirmières à l'Université d'Ottawa. Le but de la recherche est de décrire comment L'Hôpital met en service les cabinets de distribution de narcotiques automatisés (CDNA) dans le cadre du stockage et de la récupération de narcotiques.

Objectif et devis de recherche

La méthode utilisée dans cette recherche sera l'étude de cas. Les données seront recueillies à partir d'observations effectuées au sein des unités de soins infirmiers et dans le cadre d'études documentaires et d'entrevues avec des personnes recrutées pour le projet. L'objectif de l'étude est de décrire la façon dont l'hôpital introduira de la technologie en soins aigus, dans l'espoir que deux ans plus tard, lorsque le processus sera complété, les chercheurs pourront examiner les conséquences et utiliser les données de cette étude dans d'éventuelles évaluations de programmes.

Procédures

Environ 15 entrevues seront effectuées sur le site de l'hôpital. L'échantillon sera dit de convenance. Les entretiens seront menés en anglais et les données enregistrées sur des cassettes audio.

Durée de l'étude

Les données seront recueillies sur une période de trois mois. Les entrevues dureront de 30 à 60 minutes et auront lieu sur le site de l'hôpital, dans un lieu et à une heure de votre choix.

Inconvénients et risques

Il se pourrait que le fait de parler de votre expérience vous rende inconfortable. Si cela se produisait, vous ne seriez pas tenu de répondre à toutes les questions et pourriez demander à mettre fin à l'entrevue à n'importe quel moment.

Avantages

Vous pourriez ne pas tirer avantage de votre participation à cette étude par contre, les résultats permettront aux chercheurs en sciences infirmières de mieux comprendre la façon dont la nouvelle technologie est intégrée en milieu hospitalier.

Retrait de l'étude

Vous pourrez également demander à être retiré de l'étude de recherche à n'importe quel moment et demander à ce que tout enregistrement et transcription de document soit détruit, sans aucune conséquence sur votre emploi.

Honoraires

Aucun honoraire n'est prévu pour votre participation à cette étude.

Confidentialité

Aucune information personnelle concernant la santé ne sera recueillie dans cette étude. Toutes les informations seront tenues confidentielles dans les limites prévues par la loi. Afin de préserver votre identité et la confidentialité de ces renseignements, vous ne serez identifié que par un numéro de code. Si vous acceptez de participer à cette étude, votre nom ne paraîtra dans aucun document écrit ou présentation. Les données du projet seront conservées pendant 15 ans par le chercheur responsable du projet de recherche. Après cette période, le dossier de recherche vous concernant sera détruit. Les Conseils d'éthique en recherches de L'Hôpital et l'Institut de recherche de L'Hôpital pourraient éventuellement accéder à votre dossier de recherche, uniquement à des fins de vérifications.

Participation volontaire

Vous n'avez aucune obligation à participer à ce projet d'étude. Vous pouvez choisir de participer ou de vous retirer à tout moment sans fournir de raison au chercheur. Aucune information que vous soumettez ne sera communiquée à votre gestionnaire ou à l'hôpital. Si vous avez des questions à propos de cette étude, vous pouvez joindre l'étudiante chercheuse ou sa superviseure.

L'étudiante-chercheuse – **PAMELA TKACH**, inf. aut., B.Sc.Inf.

École des Sciences infirmières, Faculté des sciences de la santé, Université d'Ottawa,

Superviseure – **KIRSTEN WOODEND**, inf. aut., B.Sc.Inf., M.Sc.Inf., PhD

Professeure associée, École des Sciences infirmières, Faculté de sciences de la santé, Université d'Ottawa

Pour toutes questions ou préoccupations concernant cette étude, veuillez communiquer avec le président des Conseils d'éthique en recherches de L'Hôpital.



Formulaire de consentement

J'ai lu les deux pages de la lettre d'information qui m'a été fournie avec le formulaire de consentement et j'ai eu l'occasion de poser toutes mes questions à propos de l'étude au chercheur.

Je déclare avoir reçu des réponses satisfaisantes à mes questions et/ou préoccupations et j'accepte de participer à cette étude. Si je le décide, il me sera possible de me retirer de l'étude à n'importe quel moment.

Un exemplaire signé de la lettre d'information me sera remis.

Si j'ai des questions à propos de l'étude, je peux communiquer avec le chercheur ou son superviseur.

Nom du participant _____ Date : _____
(en caractères d'imprimerie) :

Signature du
participant : _____

Nom du chercheur _____ Date : _____
(en caractères d'imprimerie) :

Signature du
chercheur : _____

Appendix E – Case Institution Recommendations

Recommendations from the Medication Cycle Transformation Report

Recommendation: Convert Campus B and Campus C to service based pharmacist coverage with technician order entry.

- With the introduction of CPOE technicians and pharmacists will no longer perform order entry. However, it will be several years before CPOE is fully operational. The implementation strategy should consider the timeline for CPOE.

Recommendation: Implement advanced technician roles at Campus B.

- Transfer 1 team leader to Campus B with consolidation of Campus A.
- Convert Campus B research/computer support pharmacist to a computer support technician 3.
- Transfer research technician support to Campus B with Neurosciences consolidation.
- Establish a service agreement with Campus C for increased research technician support.
- Provide after hours pharmacy research services at Campus B.
- Establish a corporate call schedule for after-hours pharmacy research services.

Recommendation: Transfer medication supply management and transportation responsibilities from the Logistical Services Department to the Pharmacy Department at Campus B and Campus C.

- Align transfer with conversion of Campus B to unit dose drug distribution model.
- Improve use of pneumatic tube at Campus B. Night cupboard – use pneumatic tube for requisitions.

Recommendation: Consolidate the drug information service to the Regional Drug Information Service located at Campus A.

- Maintain adequate drug information references at Campus B.

Recommendation: Consolidate the majority of Campus A's activity to Campus B.

- Transfer Campus A's routine dose preparation and batch preparation to Campus B.
- Maintain Campus A's facilities in Campus A's Main Pharmacy for first doses.
- Maintain Campus A's facilities in Campus C, Oncology Satellite, Perinatal Satellite and ICU
- Satellite Pharmacies as these represent specialized services with specific requirements.
- Extend regular Campus A's operating hours at Campus B by 5 hours.
- Invest in both an automated syringe filler and a TPN compounder for Campus B to improve productivity.
- Transfer 2 FTE technicians from Campus A to Campus B.
- Reduce 1 FTE technicians corresponding with increased efficiency.
- Establish a transportation system to transport IVs from Campus B to Campus A.

Recommendation: Increase the proportion of syringes and IVs prepared by the Pharmacy Department, specifically for the Intensive Care Units, Emergency Departments and Operating Rooms.

- Transfer preparation of first dose IVs in Campus A ICU and ED to the new ICU Satellite Pharmacy, corresponding with Satellite operating hours and ED relocation.
- Transfer preparation of first dose IVs in Campus B ICU to the planned ICU Satellite Pharmacy, corresponding with the ICU expansion and Satellite operating hours.
- Prepare routine IV doses for the corporate ICUs and EDs (admitted patients) at Campus B in the consolidated A facility. Transport doses to the appropriate location using existing transportation network.
- Batch produce commonly used IV doses for the EDs, ORs and ICUs in Campus B consolidated Campus A's facility. Store doses as ward stock for first dose administration in areas without access to a Satellite Pharmacy.

Recommendation: Implement medication reconciliation at admission, as per the Medication Reconciliation Task Force plan. Develop a plan and implement medication reconciliation at discharge and transfer points.

- Implement medication reconciliation in the Surgical Pre-Admission Units, using existing nursing staff.
- Implement medication reconciliation in the Emergency Departments using 3 pharmacy technicians per campus.
- Develop and implement a plan for implementing medication reconciliation at discharge and transfer points.

Recommendation: Establish a strong performance management system. Convert Campus B and Campus C to a centralized drug budget and expenditure model and implement case costing.

- Transfer unit level drug budgets and expenditures to the Pharmacy Department.
- Explore opportunities to provide Clinical Managers at all Campuses with drug expenditure profiles for their units, within a case costing model.
- Proceed with implementation at the beginning of the fiscal year.
- Proceed with implementation prior to converting Campus B to unit dose distribution.
- Roll out case costing at Campus B post conversion to unit dose distribution.
- Reallocate the 1 FTE financial technician at Campus B to other duties.

Recommendation: Repatriate Campus D's Pharmacy activity to Campus A Main Pharmacy.

- Transfer 1.1 FTEs from the Campus D Pharmacy to Campus A Main Pharmacy to support the transferred activity.
- Install 3 automated dispensing units in Campus D to provide timely access to first dose and after hours medications.

Recommendation: Implement a hybrid unit dose drug distribution system across the...Hospital.

- Implement a centralized drug distribution model for scheduled first doses.
- Install unit dose compatible locking medication carts on Campus B and Campus C inpatient units.
- Install automated dispensing cabinets for ward stock, controlled substances, remote areas and night cupboard service.
- Phase cabinet installation, focusing first on the ICUs, EDs, ORs and high narcotic use areas. Follow with cabinet installation for all remaining inpatient units.

Recommendation: Implement a semi-automated unit dose drug distribution system at Campus B and Campus C.

- Install an automated drug packager in Campus B Main Pharmacy for process efficiency and risk mitigation.
- Fill unit dose carts just in time. Cease updating unit dose carts after fill is complete to reduce errors.
- Use the automated packagers at the Campus B and Campus A for dispensing first doses.
- Install 4 picking stations in Campus B Main Pharmacy.
- Export Campus A bar coding system to Campus B.

Recommendation: Centralize pharmaceutical materials management to Campus A. Centralize narcotics management to Campus A.

- Install an inventory carousel at both Campus A and Campus B for improved inventory control.
- Increase the number of inventory turns corporately from 13.7 turns annually to 15.4 turns annually.
- Achieve inventory labour efficiencies equivalent to 1.3 FTE.
- Install narcotic management software for improved narcotic control, tracking and documentation.
- Achieve pharmacy narcotic labour efficiencies equivalent to 0.4 FTE.
- Avoid \$340K of nursing time spent documenting, counting and resolving narcotic discrepancies.

Recommendation: Consider the implementation strategies for both CPOE and eMAR.

- Consider first implementing CPOE for chemotherapy orders.
- Consider implementing cMAR in advance of eMAR.

Recommendation: Implement a closed loop medication delivery system using bar code technology.

- Implement closed loop medication delivery following unit dose distribution, CPOE and eMAR.
- Develop an implementation plan that considers technology requirements, changes to Pharmacy and Nursing workflow and information management opportunities.