

The Impact of Computerized Provider Order Entry on Nursing Practice

by

Rosabella Vito
BNSc, Queens University, 2008

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of the Requirements for the Degree of

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Abstract

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The Institute of Medicine reported seven thousand deaths annually due to medication errors. It is estimated that two out of one hundred admissions experience a preventable adverse medication event resulting in an average cost of \$4,700 per admission, which is \$2.8 million dollars annually for a 700 bed hospital (Institute of Medicine, 1999). In Canada, medication related errors were identified as the most common adverse event (Canadian Institute for Health Information, 2007). A medication error is “any error that occurs during the process of history taking, ordering, dispensing, administering and surveillance of a medication regardless of whether harm occurred to the patient or if there was potential harm (Eslami, Abu Hanna, & de Keizer, 2007; Ong, 2007). Computerized provider order entry (CPOE) can play a vital role in the prevention of medication errors in the drug ordering stage. It was reported that the occurrence of Adverse Drug Events (ADE) was decreased by fifty-five percent with the addition of CPOE system (Berger & Kichak, 2004). However, the literature review on CPOE impact is heavily focused on the physicians’ perspective (Eslami et al., 2007; Reckmann, Westbrook, Koh, Lo, & Day, 2009;). Nurses play a significant role in the medication process, as traditionally, nurses are involved in all the medication process stages. Research on the impact of CPOE in the entire medication process is still lacking (Househ, Ahmad, Alshaikh, & Alsuweed, 2013). Understanding the perspective of nurses on the impact of CPOE in their work will increase awareness and understanding of CPOE use among health care professionals and health informaticians. This research adopts a grounded theory approach to explore the question of “how do nurses perceive the impact of CPOE on the medication process and on collaborative practice?” Ten participants were interviewed and out of the ten, eight participants were observed during a portion of their work. The information collected was

analyzed using a constant comparative method. Participants described that the CPOE supported legible order communication between care providers and departments. CPOE use removed the requirement to transcribe orders to the medication administration record, as well as, the necessity to fax the order sheet to the pharmacy. However, in the ordering stage the nurse is also involved in providing information for order decision-making. Nurses discuss probable medication orders in cases of urgent situations, or nursing assessments of the patient. In this decision-making, the information requirements of nurses involve not only the medication information, but also information about other orders such as diagnostics, laboratory, and patient care orders. Future CPOE design and CPOE implementations should consider including mobile devices, alerts, and workflow modeling with the nursing information needs.

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Dedication

I dedicate this thesis to my family and friends for supporting my aspirations through love, prayer, and dedication. I also dedicate this to my Lord and Saviour Jesus, for his faithfulness and unfailing love for which I am eternally grateful.

Chapter 1: Introduction

1.1 Introduction

Canada is one of the few countries in the world that provides access to most healthcare services with limited to no financial barriers. Canadian legislation and governing bodies are committed to protecting, promoting and restoring the well-being of the Canadian population which is among the healthiest in the world (Health Canada, 2011). However, despite these efforts distrust in the healthcare system is prevalent among Canadians. According to a recent Canadian survey in 2006, three out of every five Canadians surveyed thought it was likely that they would experience a serious medical error if they were treated in a Canadian hospital. This belief is not isolated to the general population, as sixty to seventy percent of health care managers, pharmacists, and nurses reported the same concern (Canadian Institute for Health Information, 2007). Both the general population and healthcare workers have a poor perception of healthcare quality. Quality, as defined by Accreditation Canada, is “the degree of excellence; the extent to which an organization meets clients needs and exceeds their expectations” (Canadian Patient Safety Institute, 2012). Clearly, the healthcare system fails to meet the expectations of the population to receive safe and quality healthcare.

Poor perception of healthcare safety echoes the evaluation from the Canadian Adverse Event Study. In 2000, researchers found that “out of the 2.5 million annual hospital admissions about 185 000 are associated with an adverse event and close to 70 000 of these were preventable” (Baker, Norton, Flintoft, Blais, Brown, Cox, Etchells, Ghali, Hebert, Majumdar, O’Beirne, Palacios-Derflingher, Reid, Sheps, Tamblyn, 2004). Medication errors were identified as the most common adverse event (Canadian Institute for Health Information, 2007). As a solution to reduce errors within the medication process, many major institutions and legislative bodies recommended the use of medication management information systems, such as Computerized Provider Order Entry (CPOE) (Berger & Kichak, 2004; Dwivedi, 2009; Metzger & Turisco, 2001; Shane, 2002).

Computerized Provider Order Entry (CPOE) play a valuable role in a systems approach to medication error. CPOE allows providers to enter orders and sends them to the appropriate hospital department (Ong, 2007). This eliminates unclear handwritten orders and facilitates rapid handling of orders by clinicians and departments. CPOE improves healthcare quality by increasing access to information and reducing variance and repetition in care management (Booz, Allen, Hamilton, 2005). Furthermore, CPOE provides standardized evidence based order sets that can also be integrated with clinician decision support systems to alert and aid clinician decision-making. Consequently, guiding providers to use more cost-effective therapies and to avoid adverse events (Aarts & Koppel, 2009; Shane, 2002). CPOE's use has decreased occurrences of adverse drug events and provided financial savings (Berger & Kichak, 2004; Dwivedi, 2009; Shane, 2002; Metzger & Turisco, 2001, Shojania et al, 2003). The adoption of CPOE in healthcare delivery does have positive outcomes. However, most of the evaluation was heavily focused on the drug prescription stage and the physicians' perspective (Reckmann, Westbrook, Koh, Lo, & Day, 2009; Eslami, Abu-Hanna, de Keizer, 2007; McKibbin, Lokker, Handler, Dolovich, Holbrook, O'Reilly, Tamblyn, Hemens, Basu, Troyan, Roshanov, 2011). There is limited research to address the effect of CPOE upon the medication process and failed to represent the perspectives of non-physician prescribers or other healthcare providers involved in the medication process (Househ, Ahmad, Alshaikh, & Alsuweed, 2013).

1.2 Statement of the problem

There is a lack of knowledge with regards to the use of CPOE upon the medication process and the impact of its use on other healthcare providers. Nurses have an important role in the medication process. They are involved in all stages especially in the administration of medications. Also, nurses play a unique role in medical error identification, interception, and recovery (Gaffney, Hatcher, & Milligan, 2016). Researchers have identified that nurses intercepted eighty-six percent of potential errors (Leape et al, 1995), and nurses are involved in medical error recovery on average: one error per week to one error per shift (Gaffney, Hatcher, & Milligan, 2016). Nurses have

an essential role in identifying potential medication errors. Therefore, an understanding of a nurses' perspective where CPOE is concerned will provide insights into how CPOE influences nursing practice and contributes to their knowledge of errors and patient safety.

1.3 Significance and Purpose of the study

Developing an understanding of the impact of CPOE upon nursing practice will help health informatics practitioners to understand how CPOE is utilized, what new errors may be introduced by CPOE, and may help standardize the definition of these errors. Such knowledge will also increase awareness and understanding of CPOE use among healthcare professionals. All of this information may be used to guide closed loop medication management design and implementation. Closed loop medication management is the automation of the medication process to support a seamless information transfer between the medication stages, from ordering to administration (Agrawal, 2009; Franklin, O'Grady, Donvai, Jacklin, Barber, 2007; Williams, 2005).

1.4 Research Objectives

Therefore the research objectives for this study are:

1. To understand the use of CPOE by nurses during the medication process
2. To identify the impact of CPOE on collaborative practice from the nursing perspective (nurse-physician and nurse-pharmacist interactions)

1.5 Research Questions

The purpose of this research is to describe the impact of implemented CPOE upon nursing practice. Specifically, the following research question will be answered:

How do nurses perceive the impact of CPOE on the medication process and collaborative practice?

In the next chapter, relevant information is presented to provide a background for the study. This chapter discusses the role of the nurse within the medication process, and the intended use of CPOE. This is followed by a review of the literature that identifies CPOE's impact upon healthcare. The literature review will establish the current state of the field and identify the gaps in the research.

Chapter 2: Review of the Literature

2.1 The Medication Process

Nurses are involved in all stages in the medication process. This process involves five dynamic stages: prescribing, transcribing, dispensing and compounding, administering, and the surveillance of medication effect (College of Registered Nurses of Nova Scotia (CRNNS), 2011; College & Association of Registered Nurses of Alberta (CARNA), 2007). *Prescribing* is a controlled act, in which authorized personnel, namely a physician or nurse practitioner, gives a medication order. Prescribers are expected to document their own medication orders. There are exceptions in the case of urgent or emergent situations where these orders may be verbally transmitted to licensed healthcare professionals such as registered nurses. *Transcription* involves the transferring of medication orders from an order form to a medication administration record (MAR) (CARNA, 2007). The MAR outlines the medication administration schedule for a patient and is used by nurses to document medications that have been administered. Registered nurses mostly transcribe medication orders. They are responsible for validating the accuracy and completeness of the transcribed orders before medication administration. In *dispensing*, medication orders are transmitted to Pharmacy for medication distribution, though nurses might be involved in this stage. The act of *medication dispensing and compounding* are considered restricted activities. The definition and authorization of these activities are different depending on the provincial legislature. In Alberta, the *Registered Nurses Profession Regulation* allows nurses to “dispense, compound, ... a Schedule 1 drug or Schedule 2 drug within the meaning of the Pharmaceutical Act” (CARNA, 2007). While, in Nova Scotia these activities are limited to Pharmacists. However, nurses are, allowed to “supply” medications, where medications are repackaged or provided to patients after they have been dispensed by pharmacy. For the purposes of discussion, the Government Organization Act definition of dispensing and compounding is used. Dispensing means “to provide a drug pursuant to a prescription for a person, but does not include the administration of a drug to a person” (CARNA, 2007). Compounding pertains to “mix(ing) together 2 or more ingredients, of which at least one is a drug, for the purposes

of dispensing a drug or drugs” (CARNA, 2007). Though, nurses are permitted to perform these restricted activities it is not to the same level as pharmacists. Whether or not a registered nurse engages in dispensing of medications, it is driven by patient-needs and guided by institutional policy (CARNA, 2007).

Medication *administration* is the act of giving medications to the patient through a specific route (CRNNS, 2011). Nurses engage in critical thinking as they assess the patient for the appropriateness of the medication; prepare medications with their knowledge of best practice; and obtain consent and educate patient about their medications. The nurses then follow the ‘10 rights’ of medication administration. This serves as a guideline for safe medication administration practice. Here the nurse ensures the right client, right medication, right route, right time, right dose, right reason/assessment, right education, right to refuse, right evaluation, right documentation are applied (College of Registered Nurses of Nova Scotia, 2011). These activities are followed by surveillance, where the nurse assesses the effectiveness of the administered drug and determines any experienced side effects by the patient. Application of these medication administration principles demands the full attention of nurses.

The whole medication process is highly cognitive and interactive. It involves collaboration among multiple healthcare providers and the patient (Cheek, 1997; Walrath & Rose, 2008; Makowsky, Schindel, Rosenthal, Campbell, Tsuyuki, & Madill, 2009). As well, communication exchange is an essential aspect of this process (Manias, 2009; Liu, Manias, Gerdtz, 2012). The complexity of the medication process and the high involvement of multiple providers make it prone to errors. It is a priority to mitigate these errors due to the obvious financial and patient mortality repercussions associated with poor medication processes. In the United States alone, seven thousand deaths are reported annually due to medication errors. Also, it is estimated that two out of one hundred admissions experience a preventable adverse medication event resulting in an average cost of \$4,700 per admission. This is approximately \$2.8 million dollars annually for a 700-bed hospital (Institute of Medicine, 1999). A safer healthcare system that includes a safe medication process will not only save lives but the financial resources

associated with treating adverse events can be allocated elsewhere if the number of adverse events is decreased.

2.2 Medication Errors

Medication errors may occur in any stage of the medication process where error can potentially harm or has led to patient harm (Eslami, Abu-Hanna, de Keizer, 2007; Ong, 2007). According to Bates and colleagues, fifty-six percent of medication errors occur during prescription, six percent in transcription, four percent during dispensing and thirty-four percent as part of administration (Bates, Cullen, Laird, et al, 1995). More recent studies showed similar distributions (Lisby, Nielsen, & Mainz, 2005; Muñoz, Perez, Lois, Gonzalez-Cobos, Antúnez, Aguilar, et al., 2009). In study by Lisby and colleagues, they detected medication errors of thirty-nine percent in prescription, fifty-six percent in transcription, four percent in dispensing, and forty-one percent in administration (Lisby, Nielsen, & Mainz, 2005). Medication administration errors are treated as the most serious form as these errors are less likely to be identified and are detected at the end of the process (Muñoz, Miguez, Pérez, Escribano, Garcia, & Saez, 2010).

Medication errors may be errors of commission, such as the administration of the wrong medication or prescribing the incorrect medication, or errors of omission, where a prescribed dose was not administered or missing prescription information (Committee on Quality of Health Care in America Institute of Medicine, 2000). Improper dosage and omission errors were the most common type of errors (Bohand, Simon, Perrier, Mullot, Lefevre, & Plotton, 2009; Lisby, Nielsen, & Mainz, 2005; Muñoz, et al., 2010). Current studies suggest that to prevent a medication error, strategies should target systems rather than individuals (Shojania, Kaushal, & Bates, 2003; Henriksen, Dayton, Keyes, Carayon, & Hughes, 2008). Committee on Quality of Health Care identified that approximately three out of four errors were caused by system failures during the medication process. Suboptimal drug knowledge dissemination, lack of patient information availability and failure of multidisciplinary communication are some of the identified breakdown in the

medication process (Committee on Quality of Health Care in America Institute of Medicine, 2000).

Automating the steps in the various stages of the medication process is seen to be pivotal to minimize failures within the medication process and to promote a truly closed looped system (Committee on Quality of Health Care in America Institute of Medicine, 2000; Microsoft, 2009). Various medication management information systems have been suggested to target different stages in the medication process. This includes the use of barcoding during medication administration (Simpson, 2005; Fowler, Sohler, Zarillo, 2009; Marini, Hasman, Huijter, & Dimassi, 2010); the use of point-of-care technologies that supports real-time documentation at the bedside (Simpson, 2005; Nelson, Evans, Samore & Gardner, 2005); and the adoption of computerized provider order entry (CPOE).

2.3 Computerized Provider Order Entry

The value of using computers in healthcare delivery has been identified since the early 1970s, it was viewed that physicians entering medical orders directly into the computer can contribute to quality (Stead & Sittig, 1994). The initial version of Computerized Provider Order Entry (CPOE) in the 1970s was originally designed as a cost saving strategy by limiting the choices in approved medication formularies (Aarts & Koppel, 2009). While, subsequent versions focused on standardization of orders with the use of order sets and order entry screens to improve legibility, to reduce order transmittal time, and to support centralization of orders (Ong, 2007). It quickly became evident that CPOE systems can offer other advantages for patient safety. This resulted in more advanced CPOE systems that incorporated elements of clinical decision support. Clinical decision support capabilities ranged from simple basic order edits and structured orders to rules-based alerts and surveillance (Metzger & Turisco, 2001). The degree of sophistication is dependent on the developer and the health organization. Currently, CPOE systems are developed by multiple commercial vendors, which may subsequently be customized to adopt the particular needs of a health organization. Other health

organizations may have developed their own ‘homegrown’ CPOE systems. CPOE may also be integrated in an electronic medical record, where order information is automatically translated into the electronic medication administration record. CPOE development is dynamic, with the current systems in continual work in progress and new emerging products are being developed (Metzger & Turisco, 2001).

Concurrent to the evolution of CPOE design is the changing definition of CPOE. Generally, CPOE is simply defined as an electronic system that allows order entry. Also, mostly referred to physician entry. However, as technology matures and clinical provider roles expand, CPOE is defined by design and its users. Naming conventions varied from computerized *physician* order entry to “provider” or “prescriber” order entry to encompass the intended users: physicians and/or non-physicians. CPOE may be integrated with other health information systems to transmit patient information and send orders to the appropriate hospital department, or simply a stand-alone system to minimize the misinterpretation of written orders. CPOE may generally be defined as any electronic system that collects and processes medical orders for the purpose of order communication and order execution, regardless of the naming convention. Though in actuality CPOE’s definition is reflected in the intended use of the system as expressed by CPOE functional design and by the work structure within the health organization. To properly account for the impact of CPOE, it is then imperative to describe the design of the CPOE in question and define its intended use. For the purposes of this study, CPOE refers to Computerized Provider Order Entry.

2.3.1 CPOE Intended Use

Studies evaluating the impact of CPOE showed some decline in adverse events. A fifty-five percent decrease in adverse events was attributed to the introduction of a CPOE system (Berger & Kichak, 2004). While, integrated CPOE systems showed financial saving benefits beyond medication safety. These systems’ ability to provide feedback regarding the appropriateness of diagnostic and laboratory interventions decreased the occurrence of unnecessary testing, resulting in cost savings. Tierney and colleagues

mentioned that CPOE integrated to a comprehensive electronic medical record has decreased admission costs by approximately thirteen percent (Tierney, Miller, Overhage, 1993). While, Evans et al noted that the addition of an antibiotic drug-dosing component in a CPOE system provided cost avoidance of one hundred thousand dollars per year.

This reduced inappropriate drug use and avoiding adverse events. Lastly, Brigham and Women's Hospital reported estimated savings of five to ten million dollars annually after CPOE adoption (Shojania et al., 2003). CPOE also proved to be a useful tool for quality measurement and its integration can improve coding and billing (Shojania et al., 2003).

The implications of CPOE adoption are promising though generally its adoption is still low. In 2009, researchers compared hospital wide CPOE adoption of seven countries. It showed that the Netherlands scored the highest, having adoption rates averaging at twenty percent. Followed by the United States at around fifteen percent. While Germany, Austria, Sweden, the United Kingdom, and France have less than ten percent adoption of hospital wide CPOE systems (Aarts & Koppel, 2009). A more recent study in Korea by Yoon and colleagues, reported 87% CPOE adoption in tertiary teaching and general hospitals (Yoon, Chang, Kang, Bae & Park, 2012). The reported low adoption rates from other countries may also be partly due to limited evaluated studies on CPOE, especially in Canada.

Although there is limited data on more recent CPOE adoption rates, it is possible that its usage has increased with increased electronic medical record adoption. In 2014, the Canadian national physician survey showed that physician usage of electronic medical records had tripled since 2007 (Collier, 2014). Alberta, British Columbia, and Ontario are the leading provinces with over 80% adoption, while New Brunswick had the lowest rate at 62%. The slow adoption of New Brunswick was attributed to not having EMR funding from the provincial government until 2013 (Collier, 2014). Financial funding is a common reason for slow adoption and it is possible that the rates will increase with the financial support (Yoon, et al., 2012; Collier, 2014). The United States has adopted this approach by enacting the Health Information Technology for Economic and Clinical Health (HITECH) Act in 2009. HITECH act supports the “meaningful use” of electronic health records (EHR) by the provision of incentive payments to eligible health

organizations or health care providers who can demonstrate meeting certain standards in EHR usage, including CPOE implementation, and report attaining clinical quality measures (Centers for Disease Control and Prevention, Office of Public Health Scientific Services (OPHSS), 2012; Centers for Medicare & Medicaid Services, 2010). The objectives of meaningful use are divided into three conceptual stages over several years. First stage objective was to capture and share data. Second stage objective was to improve clinical processes, and for the third stage the goal is to improve outcomes (Centers for Medicare & Medicaid Services, 2010). Meaningful use is a good reminder that CPOE adoption rates could not be the sole determinant of value, evaluation of improved clinical processes and patient outcomes are necessary.

In examining CPOE research studies the most studied medication stage is prescription. These studies showed a reduction in prescription error rates, but minimal changes in error severity (Reckmann, Westbrook, Koh, Lo, & Day, 2009). Reckmann and colleagues also mentioned that these evaluations are limited due to the modest sample sizes, and mostly conducted solely in the United States, representing “homegrown” CPOE systems developed by leading hospitals for use in the inpatient setting (Reckmann et al., 2009). In outpatient settings, the results do not provide adequate evidence that CPOE systems enhance safety and reduce costs due to the limited number of published research studies (Eslami, Abu-Hanna & de Keizer, 2007). Moreover, current studies had a limited description of the CPOE components, implementation process, settings, and the intended users. The description of these factors is important for this will help identify moderating and mediating factors in evaluating the impact of CPOE (McKibbon, Lokker, Handler, et al, 2011; Weir, Staggers, Laukert, 2012). An evaluation involving larger samples sizes and encompassing the impact of CPOE on the other medication stages is warranted. It should also consider the perspectives of other healthcare providers, such as nurses, in these stages. While nurses are involved in all throughout the medication process and play a significant role in preventing, intercepting, and recovering from medical errors (Gaffney, Hatcher, & Milligan, 2016), there are minimal research to understand the impact of CPOE in nursing work (Househ, Ahmad, Alshaikh, & Alsuweed, 2013). In Hasman and colleagues survey of physicians and nurses on CPOE satisfaction, they

found that generally both groups were positive about the use of CPOE and its impact on their workflow, efficiency, and medication safety, but researches also mentioned that both groups responses to other questions made it clear that there is a difference between what physicians and nurses need (Hasman, Khajouei, Jaspers, & Wierenga, 2011). Furthermore, they found that there is no direct relationship between user satisfaction and usability, for a CPOE system that may have a high user satisfaction might still contain usability issues and require improvements (Hasman, Khajouei, Jaspers, & Wierenga, 2011). More research on nursing experience using CPOE is warranted.

CPOE's adoption poses risks, as humans may make mistakes, computerized systems can also contribute to errors. CPOE may lead to some errors related to incorrectly selecting the wrong patient, wrong medication, or inappropriately selecting the administration schedule and route (Kushniruk, Triola, Borycki, Stein, & Kannry, 2005). CPOE may also give incorrect default medication dosing suggestions and the ability for free text allows physicians to bypass safety alerts within the systems which may lead to potentially incorrect orders (Kushniruk, et al., 2005; Shane, 2002; Shojania et al., 2003). Medication errors can also be a result of a poorly designed CPOE interface, for example fragmented screen design. This is seen in the initial analysis at the Brigham and Women's Hospital. The study showed an increase in potential adverse drug events related to the ordering screen structure of potassium chloride. The ordering screen design made it easy to mistakenly order large doses of intravenous potassium (Shojania et al., 2003). Some attributed these unintended consequences to a lack of integration. Pedersen et al found 25.7% of surveyed hospitals with electronic prescribing requires manual re-entry of medication orders into the pharmacy system the two systems are not integrated (Shojania et al., 2003). When these systems are not linked to the pharmacy system, the responsibility lies on the pharmacists to manually transcribe these orders. The manual reentering of these medication orders in decentralized CPOE systems increases the risk of an error (Shojania et al., 2003). The dichotomy of documented CPOE consequences may be attributed to the general impact of CPOE adoption, where CPOE influences user cognition and the healthcare socio-organizational work.

2.4 Cognitive Level

CPOE can influence the information processing activity of healthcare providers. Providers may become “screen-driven”, where they follow the system interface organization rather than the reasoning processes learned through their educational training (Borycki & Kushniruk, 2010). Also, Patel et al (2000) found that the electronic medical records influences the way physicians obtain, organize, and reason with knowledge. This is true for healthcare providers who become more accustomed to the CPOE systems. They are potentially more likely to accept system suggestions with minimal thought. As previously stated in the findings in the Brigham and Women’s Hospital, where the ordering screen structure of potassium chloride made it easy to mistakenly order large doses of intravenous potassium (Shojania et al., 2003). If the providers have followed the educational process and not solely depended on the screen, it is possible that the error may be prevented.

Aside from the interface design, the location of the computer also has a cognitive impact on the user. The inaccessibility of CPOE at point of care requires clinicians to remember pertinent patient information. For example, the physician has to walk to the computer station to input orders after assessing a patient. This extra activity of “walking” from point of care to a computer station has created an increase cognitive workload for physicians to recall patient information (Niazkhani, Pirnejad, van der Sijs, & Aarts, 2011). The studies on the cognitive impact of CPOE are mostly focused on physicians as the actors. Studies are lacking regarding the impact on the nurse’s cognition when entering verbal or telephone orders using CPOE, and its cognitive implications on relying CPOE for medication transcription and administration. The medication process is highly collaborative and involves many cognitively demanding tasks that this gap needs to be explored.

2.5 Socio-organizational Level

CPOE systems have improved the quality of orders in terms of standardization, audit trail, legibility, use of drug approval names and overall completeness with specification of key order information (Reckmann et al., 2009). However, it was also found that the CPOE has altered relationships among healthcare providers, contributed to workflow disruptions and that CPOE impact is dependent on the context in which CPOE is used.

2.5.1 Relational impact

There are opposing results on the impact of CPOE on relational dynamics of the health care team. Earlier studies on the physician-nurse collaboration revealed that the implementation of CPOE deteriorated communication between these healthcare providers. According to Pinejad and colleagues, the non-supportive features of CPOE impaired the synchronization and feedback mechanisms vital in the medication process (Pirnejad, Niazkhani, van der Sijs, Berg & Bal, 2008). In the study, the CPOE system allowed for remote-entry by physicians from their offices, and the prescription labels were printed upon order entry in the respective inpatient unit. In turn the nurses affixed the prescription labels to the paper administration records. This required the nurses to monitor the unit printer to be aware of new medication orders. Also, the physicians became unaware whether their instructions have been carried out. The CPOE system impaired the feedback mechanism and altered the synchronization between physicians and nurses during the medication process. Thus resulting in repeated phone calls between health professionals to notify and clarify the orders. In the CPOE environment interaction between health professionals is hindered. Most of the prescribing takes place behind the computer with less input and feedback from the nurses. Consequently, nurses are more dependent on the way physicians' prescribe with less opportunity to clarify orders (Van Doormaal et al, 2010). This change in direct mode of communication model (face-to-face) to indirect models (i.e. text pages and phone calls) increased the time required to clarify and validate orders and contributed to anxiety of nurses. These changes resulted in increased time demand for non-nursing activities, may have affected the quality of care

for patients (Tschannen, Talsma, Reinemeyer, Belt, & Schoville, 2011). These results are in contrast to the findings of the 2012 survey study by Ayatollahi and colleagues. Based on a Likert scale, nurses and physician were asked about their opinion on CPOE use. The researchers found that generally nurses had a more positive response compared to physicians in regards to the impact of CPOE on interorganizational workflow and their working relationship with physicians (Ayatollahi, Roozbehi, & Haghani, 2015). Although, this study is limited for it was only conducted in one hospital, the variances in results expose the need for more investigation of CPOE impact on the health care team relationships. Earlier studies reveal that communication is altered with CPOE implementation, however it may not be the most important basis for quality of communication. Communication quality may be affected by multiple factors. Pelayo et al compared the communication of nurses and physicians during the medication prescription and administration. They took into consideration both the organization of their work and the technological environment, CPOE versus paper. They identified that the organization of work has a significant impact on the physician-nurse communication within collaborative work. Also, that technology is limited to supporting all the communication activities because information needs are context dependent (Pelayo, Anceaux, Rogalski, Beuscart-Zephir, 2010). As exemplified in more urgent cases, communication requires higher interaction and exchange of information. The variances in the research results further suggest that more investigation is required to look at the impact of CPOE on the dynamics of the multi-disciplinary team. Also, further research at the contextual nature of their information needs.

2.5.2 Contextual impact

The impact of CPOE is influenced by the context in which it is used. Niazhani and colleagues identified three contextual elements:

- a) The task that CPOE is intended to support - whether the workload of nurses and physicians is depended on the process that CPOE is supporting. If the CPOE supported task is one of the core activities of that unit, then the impact of CPOE is greater.

- b) The extent of how information-intensive the task is – this determines the load required for information sharing while using CPOE
- c) The extent of how time-intensive (urgency) the task is – whether the CPOE design is able to support the urgency of the task.

Depending on these three contextual elements, the demand for CPOE use is variable. This means that in a medical unit that deals with a patient population who has multiple co-morbidities, and requires more complex medication therapy there would be a higher demand for CPOE use. Within this context, clinical end-users will also be dealing with more medications during order entry and medication administration thus have a higher information demand that needs to be supported in a timely manner.

2.5.3 Workflow impact

CPOE impact goes beyond the communication issues between physicians and nurses. It may alter the pacing, sequencing and dynamics of work patterns. Through enforcing rigid medication administration schedules or work processes that do not reflect reality of practice (Campbell, Guappone, Sittig, Dykstra, & Ash, 2008). These changes may have resulted in work-arounds and may have contributed to unintended consequences. The unintended consequences may be rooted to the poor articulation of clinical work. Therefore, unintended consequences introduced by CPOE may not be solely due to the technology itself. It may be due to the poor understanding of what CPOE supports taking into consideration the impact of CPOE on cognition, the socio-organizational nature of work and the context dependency of information utilization. It is possible that the CPOE may be well designed, but due to the poor understanding of the work (task) it is intending to support the potential benefits that are not realized. This then may introduce more unintended consequences than benefits.

2.6 Summary

Computerized Provider Order Entry has been around for three decades. It is deemed as an enabler to minimize adverse events in the medication process as recommended by major organizations and the US government. However, as there are reported benefits from its implementation the studies supporting these are limited with modest sample sizes, mostly focused on the prescription stage, and highlighting the perspectives of physicians. This portrays a protruded view of CPOE impact, as it vaguely represents the collaborative nature of the medication process. Furthermore, there is still more that is unknown regarding the unintended consequences of CPOE implementation upon nursing work. Therefore, an examination of CPOE's impact in the entire medication process is necessary. As nurses play a significant role in all these stages of medication administration, a study of the nursing perspective on CPOE use and its impact on nursing practice within the medication process is proposed.

Chapter 3: Research Methodology

3.1 Grounded Theory

A grounded theory approach is chosen to analyze the impact of CPOE in nursing practice. It is an emerging methodology in health informatics that can be used to gather data and develop ontologies (Cummings & Borycki, 2011), from which one can guide design and implementation of a closed loop system for the medication process. Using observational and interview tools to gather data, one can assess the cognitive and social-technical impacts of CPOE on nursing practice. The observations of nurses' interaction with CPOE in practice during the medication process gave data regarding the social-technological impact of CPOE. While the interviews, gave more insight into the cognitive aspects of CPOEs influence on nurses. An integrated approach with multiple methodologies was recommended (Borycki & Kushniruk, 2010). A semi-structured interview followed by observations was the approach selected for the study. The participants were asked to describe their experiences with CPOE and identified the impact of the technology on their work. The observations provided further insight into whether perceived impact is congruent with behavior.

Data analysis alone in grounded theory requires heavy time commitment to be immersed in the data (Cummings & Borycki, 2011). The descriptions and the emerging themes or concepts from this research may serve as a foundation for future quantitative studies. Also, it may contribute to the standardization of definitions and the nomenclature of new errors with CPOE introduction.

3.1.1 Participants

Participants were recruited through purposive sampling (see Appendix A and B for the recruitment materials). This type of sampling is chosen to gain an in-depth understanding of the impact of CPOE integration in nursing practice (Jackson & Verberg, 2007). The inclusion criteria was that participants must be practicing Registered Nurses with a

minimum of one-year of experience on a medical unit and has been working with the CPOE for at least a year.

3.1.2 Recruitment

An invitation letter was distributed through email by the Clinical Informatician Site leads to the managers of medical units in 3 acute care hospitals in the city (see [Appendix A](#) and [B](#)). The managers then forwarded the research invitation to their staff. Any interested participant sent their contact information to the researcher. Participants were given a gift card in appreciation of volunteering their time. The gift card value is approximately worth \$20 CAD, which is less than the hourly rate of the participants.

The researcher contacted interested individuals by telephone and/or email to explain the study purposes, procedures, and time commitment. At this point, the researcher obtained an initial verbal consent to proceed with the study (see [Appendix C](#)). After consent is obtained, an interview was set according to the availability of the participant and the researcher. The interviews mostly took place in a meeting room in the home acute care site of the participant or at the participant's preferred meeting place. On the interview day, prior to initiating the interview the study purpose, procedures, and time commitment were explained again and the participant questions were clarified. Then the participant was asked to sign an informed consent for the interview, for the audio recording during the interview, and the observational study (see [Appendix C](#)). After the interview, the schedule for the observational study was set with the participants depending on the days they are working. On the day of the observation, verbal consent to continue the study was obtained (see [Appendix C](#)). The recruitment process continued until data saturation occurred.

3.1.3 Setting

The study took place on the medical units of several tertiary hospitals in the city. The study is limited to medical departments as the patient population differs between medical units and surgical units. Patient population from the medical units tend to have more

indications for drug therapy since patients on these units are older and have multiple symptoms of disease. Indications for drug therapy increase with age as the prevalence of both somatic complaints and chronic diseases increases (Colley & Lucas, 1993). Even within the medical units among the tertiary hospitals there are variations in the patient population. Consequently, the study participants are asked to describe their workflow and the patient population they cater to.

3.2 Computerized Provider Order Entry (CPOE) description

The design of a CPOE may vary depending on the healthcare organization, and depending on its functionality the impact on nursing practice may vary. For this reason CPOE in the study setting is described. In this chosen research setting, a single CPOE system has been used in the 3 acute care sites for eight years at the time of the study (2006 to 2014). It is embedded in an existing Electronic Medical Record (EMR) designed by an outsourced vendor. CPOE is customized by the organization with standardized orders for some specialties and common orders. CPOE orders also allow for alteration, i.e. dosage and frequency. The orders entered into CPOE are automatically transcribed into the electronic Medication Record (eMAR). CPOE can be accessed on all computers on the unit, including the Computer on Wheels (COW) or recently changed in the summer 2011 to Wireless Carts (WI carts). The new changes in WI carts design are that they are lighter and are equipped with drawers where nurses may place the medications required for that shift. It would be difficult to dissociate the eMAR from the CPOE, since any changes in medication orders affect the eMAR where the nurses use both functionalities. This definition is clarified during the interview process with the participants to gain understanding how they perceive CPOE.

3.3 Procedure

The study used both interviews and observational methods at two separate instances for methodological triangulation. First, the participants were interviewed at their preferred meeting place for approximately 60 to 90 minutes. Prior to the semi-structured interview,

the researcher explained the study, answered any questions and obtained informed, voluntary written consent (see [Appendix C](#)). A questionnaire was given to obtain demographic information and to determine computer literacy level (see [Appendix D](#)). This was to gain insight into the participants' background and their experience in working with CPOE. After collecting all these data, the semi-structured interview commenced. The semi-structured interview entailed the researcher asking open-ended questions about the participant's CPOE use and CPOE's impact on their practice. Observations were conducted after the interview. Informed consent was obtained prior to the observational portion of the study. The timing of the observation was dependent on the participant's work schedule and availability. The participants were observed in their workplace while interacting with the CPOE system throughout the medication process. All participant behavior during this interaction with the CPOE was noted. No patient information and patient response were recorded. The participant was observed for approximately 2 hours during their work. Then followed by a 30-minute post-observation interview to clarify information collected during the observation. The total duration of the study was 4 hours.

3.3.1 Demographic data

The demographic data of the participants was collected to identify the characteristics of the sample population, which includes participant gender, age, nursing experience, and roles. This provided context in describing and understanding the impact of CPOE involving participants' work (Jackson, & Verberg, 2007). The demographic data collection tool is outlined in [Appendix D](#).

3.3.2 Computer Use

Many studies have been conducted where there has been an examination of the factors that contribute to low adoption among physicians. Studies have shown critical adoption factors include: technology integration; funding; satisfactory user interface; user attitude towards information systems; workflow impact; interoperability; technical support; and

expert support (Aarts & Koppel, 2009; Castillo, Martinez-Garcia & Pulido, 2010). Thus, identifying participants' level of computer literacy and participants' definition of the CPOE functionality provides understanding regarding the interaction between the participant and CPOE and gives context as to the impact of CPOE in their work. The participants were asked to describe their computer use, to rate their computer proficiency in a scale of 1 to 10, and to describe prior experience with health information technology (see [Appendix D](#)).

3.4 Data Collection

3.4.1 Semi-structured Interview

The semi-structured interviews were conducted prior to the observations in February to April 2014. This interview method was also used post-observation to confirm and further explore the themes and concepts identified during the observations. To initiate the interview, the participants were asked to describe the medication process in their current workplace and how they use the CPOE. It is important to gain insight in the context of use as previously mentioned in the literature by Niazhani and colleagues, the impact of CPOE upon nursing work is influenced by the task that CPOE is intended to support, the load of information sharing to accomplish the task and the time-intensiveness of the task (Niazkhani, Pirnejad, van der Sijs, & Aarts, 2011). Then, the participants were asked to describe the medication process using paper, and their perceived impact of using CPOE in their practice. Depending on the participant's response, further clarification questions were asked. A sample list of questions is outlined in [Appendix E](#). The interviews were recorded using an audio recorder with the participant's consent. The audio recordings were manually transcribed to a Microsoft Word document, which was stored in a password-protected laptop.

3.4.2 Observations

The interview gives insight into participants' work and the perceived impact of CPOE. However, this may have caused recall bias. Observational study of participants' behavior provides data triangulation. The participants were observed in their natural settings on the medical unit while interacting with the CPOE. Informed consent was gained prior to the start of the observation process. The aim was to observe how participants interacted with the CPOE, and to identify other factors that may influence their interaction with CPOE that the participants may not be aware of. The participants were observed for approximately 2 hours of their shift. Only the participants' interaction with the computer and the environment during the user-computer interaction were observed. Any nurse-patient interaction was excluded. For example, the activity was the nurse looked up scheduled medications to be administered at the bedside. She used the wireless medication cart to refer to the electronic medication administration record. Then poured the appropriate medications from the wireless cart drawers. Any interaction with the wireless medication cart and the nurse were noted, but how the patient responded to the use of the wireless medication cart in the room was excluded. Also, how the nurse administered the medication to the patient was excluded.

Field notes of participant behavior were taken during the shift using a data collection tool (refer to [Appendix F](#)). Any clarification regarding the participant's behavior occurred during shift breaks or after the shift (refer to [Appendix G](#)). This was to minimize the disruption to the natural setting. Notes were handwritten and then transcribed to a Microsoft Word document, which was stored on a password-protected laptop.

3.5 Ethical Considerations

Ethics approval from University of Victoria Human Research Ethics board and the Health Research Ethics Board of Alberta (HREBA) were obtained prior to the start of the

study (see [Appendix I](#)). Both written and verbal participant consent were gained prior to the start of the interview, observations, and post-observation interview.

The information sheet and the consent form were written at a grade 7 reading level. To ensure that the forms were at the grade 7 level, each paragraph was assessed using the readability scales: Flesch-Kincaid readability test, the Flesch-Kincaid Grade Level formula and the Gunning-Fox Index scale. These readability-scoring scales have been previously used in examining the readability of patient-informed consent forms for clinical trial research (Terblanche & Burgess, 2010). In the Terblanche and Burgess study, a web-based open-source project PHP Text Statistical tool was used to calculate the scores. The use of the web-based tool was reviewed and approved by the Health Research Ethics Committee of Stellenbosch University (Terblanche & Burgess, 2010). The tool is available from <http://www.readability-score.com>. The same tool was adopted to assess the readability of the information sheet and consent form for this study. The scores are listed in [Appendix H](#).

The Interview audio recordings and field notes were transcribed to the researcher's protected laptop. This information will be held for 5 years and destroyed. The paper field notes and audio recordings are stored in a locked filing cabinet that is stored in the researcher's office. The field notes will be disposed of in the organization's confidentiality bin. The audio recordings will be deleted.

Researcher removed herself from situations not part of the study, such as in the instance of patient deterioration (code 66, code blue). No patient interactions were recorded. Though, if a medication error is related to nurse-computer interaction, the researcher will further ask clarifying questions with regards to why that action happened from the participant's perspective, does he/she considered it as a medical error, and what are the steps taken after identifying the medical error. Researcher will preserve the participant's confidentiality. The identification and disclosure of the medical error is dependent on the participant.

3.6 Data Analysis

A Constant Comparative Method was adopted for this study, where the coding process is iterative and continuous. This included open coding, axial coding and selective coding (Cummings & Borycki, 2011). The coding process was conducted manually using a Microsoft word document and handwritten memos. Coded data from the observations were verified through the interviews conducted. On an ongoing basis, informants were asked to participate in member checks. For example in the interview process this was done through clarification and to confirmation of the meanings of their statements. Questions like “Could you describe what you mean by the previous statement” (Refer to [Appendix E](#)). During the observations, during breaks, after shifts or after detailed note taking of behavior, information (the interactions between CPOE and participant) was verified with the participant in question. Asking questions “why” to gain understanding why a certain behavior took place. For example, “yesterday, when you administered this medication, why did you act that way?” (Refer to [Appendix G](#)). An audit trail of all data collected was kept.

The findings of the semi-structured interviews and observations are discussed in the next chapter.

Chapter 4: Study Findings

4.1 Demographic Data

Ten registered nurses participated in the study. The majority of the participants were females (90%, n = 9), with only 1 male participant. Half of the participants were between the ages of 22 to 29 years of age (50%, n = 5), while 30% (n = 3) were between 40 to 49 years of age, and the remaining 20% (n = 2) were between 30 to 39 years of age. All of them were staff nurses with most of them having additional experience as a charge nurse (60%, n = 6), as a nurse educator (20%, n=2), and as a preceptor/buddy nurse (20%, n = 2). A preceptor or buddy nurse is a role whereby a staff nurse is paired with a student to oversee and guide the student with patient care for a period of time (Canadian Nurses Association (CNA), 2004). Generally, as a charge nurse, or preceptor/buddy nurse, or as an educator, a nurse has experience in supervising other nursing students/nurses' work. 40% (n = 4) of the participants have been working between 1 to 2 years, while 50% (n = 5) have been working between 3 to 10 years, and only 10% (n = 1) had greater than 10 years of nursing experience (See Table 1 for more detail).

Table 1 - Demographic Data

Participant Demographics	Frequency (%)
<i>Gender</i>	
Female	9 (90%)
Male	1 (10%)
<i>Age</i>	
22 – 29	5 (50%)
30 – 39	2 (20%)
40 – 49	3 (30%)
<i>Years of Registered Nursing</i>	
1 – 2 years	4 (40%)
3 – 10 years	5 (50%)
> 10 years	1 (10%)
<i>Nursing Experience/Roles</i>	
Staff Nurse	10 (100%)
Charge Nurse	6 (60%)
Preceptor/Buddy Nurse	2 (20%)
Nurse Educator	2 (20%)

At the beginning of the study, the intent was to only include participants with at least one-year experience and to have informants that have had differing experiences in using paper based medication processes and computerized order entry. Through the recruitment process, it was realized that participants working in the city are also likely to have done their student training in the city hospitals, the same sites where the electronic medical record with computerized order entry is used. As such, the previous assumption that a year or more experience would provide informants with differing years of experience was inappropriate. However, the inclusion criteria strictly based on a one year of experience is still kept. The limitation then is that the participants with only a year working experience may lack experience working strictly with a paper based medication process in an acute care setting.

4.2 Computer Use

Participants were asked to describe their computer use and to rate their computer proficiency on a scale of 1 to 10, with 10 being very proficient. All of the participants had experience in using a computer for email (100%, n=10). Most of them mentioned using a computer to use Microsoft Office (90%, n = 9) and the Internet/Social Media (80%, n = 8). This is outlined in Table 2:

Table 2 - Computer Use

Computer Use	Frequency (%)
Email	10 (100%)
Internet/Social Media	8 (80%)
MS Office	9 (90%)

Participants have experience in using a computer, and majority of the participants (90%, n = 9) rated their computer proficiency between 8 to 10 as shown in Table 3:

Table 3 - Self - Rated Computer Proficiency (1 to 10, 10 very proficient)

Self – Rated Computer Proficiency	Frequency (%)
1 – 7	1 (10%)
8 – 10	9 (90%)

Also, 70% (n = 7) of the participants had had previous experiences in using other health information technologies in advance of using the current system in the region (see Table 4 for more detail).

Table 4 - Previous Use of Other Health Information Technology (HIT)

Previous Use of Other HIT	Frequency (%)
No previous experience	3 (30%)
Had previous experience of using other systems (e.g. barcode system, clinical documentation only, view only)	7 (70%)

In summary, the majority of the participants rated themselves as proficient in using a computer. Participants used a computer in daily activities such as email, for internet/social media, and Microsoft Office. Some participants also had previous experience in using health information technology in their nursing practice.

4.3 Semi-structured Interview: Data

Ten interviews were conducted and transcribed. The transcripts were read first, and were read again to be analyzed using constant comparative method. The transcripts were read sentence by sentence and assigned codes. The codes were analyzed for attributes and developing relationships. Codes with similar attributes are placed into categories. Categories were reviewed further for emerging relationships and distinct attributes. In review, if there were similarities between the categories, these categories were refined into one theme (Cummings & Borycki, 2011). The participants were mainly asked to describe the medication process using the electronic medical record, to describe the medication process using paper charting, and to elaborate on these descriptions. The themes and categories for electronic medical record use are listed in the table below and appear in over 50% of participant interview data (see Table 5 below).

Table 5 – Interview: Electronic Medical Record Use (EMR)

Themes	Categories
Review Information	Orders Medications Communication
Paper Use	Organize Work
Logistics	Physical Resources
Order	Entry Communication
Medication Administration	Nurse Administered Record Schedule Documentation
Learning	Learning Curve/Computer Proficiency Training Support Motivation

Participants were asked to describe the medication process when using the electronic medical record (EMR). All the participants (100%, n = 10) mentioned that they use the (EMR) to review information, namely the orders (80%, n = 8), medications (60%, n = 6), and communication from other health care providers (60%, n = 6) when they start their work shift. They also mentioned that they write the patient history; medication information; pending blood work, diagnostic, and patient care orders from the electronic medical chart to paper (70%, n = 7). This approach was used (e.g. writing the medications to a medication list) to serve as a “to-do” list. The list reminded them of important orders and patient information, and to organize their patient workload.

Paper is still a necessary method for organizing work since logistics is a factor in getting access to the information nurses require during the medication process (80%, n=8). Logistics is the movement of physical resources and information resources to the point of care (Colins & Fabbe-Costes, 1993). This includes computer access, room space to maneuver the computer, and access to computers in isolation rooms. Physicians and nurses both require access to a computer. Physicians mostly enter orders, while nurses require access to administer medications at the bedside and to be notified of new and

changing orders. Nurses are the primary actors (60%, n=6) in the medication administration stage. Nurses (100%, n=10) need access to the electronic medication administration record (eMAR). The eMAR is where all the ordered medications for the patient are listed with the specific times the medications are to be taken (80%, n=8). Most of the participants (80%, n = 8) also described the presence of a learning curve when first learning to use the eMAR. Learning how to use an eMAR requires some level of computer proficiency. Training, support, and motivation help with the transition and utilization of an EMR.

4.3.1 Review Information

Nurses are involved in all stages in the medication process. This process involves five dynamic stages: prescribing, transcribing, dispensing and compounding, administering, and the surveillance of medication effects (College of Registered Nurses of Nova Scotia (CRNNS), 2011; College & Association of Registered Nurses of Alberta (CARNA), 2007). Throughout the medication process nurses use the nursing process, whereby nurses assess, plan, implement, and evaluate care (College of Nurses of Ontario (CNO), 2014). Assessment is where the nurse “incorporates critical inquiry and relational practice to conduct a client-focused assessment that emphasizes client input and the determinant of health” (College of Nurses of Ontario (CNO), 2014). This involves the ongoing collection and integration of patient information from various sources, such as the patient’s record, interviews, observations, and physical assessment, to plan and deliver care.

Participants describe reviewing information as an integral part in the assessment stage within the medication process. Reviewing information is the process of reading through the different components of a patient’s electronic medical record to identify pertinent information that will guide care, as such the medication process. All of the participants (100%, n = 10) mentioned using the electronic medical record to review information during their work shift. The information that was reviewed is outlined in the Table below:

Table 6 – Interview: EMR Use - Review Information

Theme	Categories	Percentage	Participants #
Review Information	Orders	80% (n=8)	0, 2, 4, 5, 6, 7, 8, 9
	Medications	70% (n=7)	0, 1, 2, 3, 4, 5, 8
	Communication	60% (n=6)	0, 1, 2, 4, 7, 9

The electronic medical record is subdivided into different tabs, such as the orders tab. The orders tab displays all the orders for the selected patient's chart. Orders include patient care orders (e.g. catheter insertion, dressing changes), medication orders, diagnostic, and blood work orders. The medications are also listed in the electronic medication administration record (eMAR). The eMAR contains the schedule of medications with fixed frequencies (e.g. at bedtime), and *pro pre nata* (PRN) medications, with time frames a medication could be given as needed by the patient (e.g. for nausea every 4 hours PRN). Communication is found in the documentation of patient information. Participants describe reviewing the orders (80%, n=8), medications (70%, n=7), and communication about the patient from other health care providers (60%, n=6). Reviewing this information allows the nurses to have an overview of what the patient requires in terms of patient care and to organize their work. Review Information may also include a verbal report from the previous nurse who highlights certain information from the previous shift to the oncoming nurse. Participants describe receiving reports and reviewing information at the beginning of their shift before seeing their patients in this statement:

“What we do is when we getting report we usually look at the eMAR [electronic medication administration record] you know finding out meds that we need to give at night, you know looking at the vitals. And once report is done, then we actually organize our time by looking at the computer first. Then we look at the patient...”
(Participant 1)

At the beginning of the shift and prior to seeing patients, time is taken to review information. Though the depth of how much information nurses' review is dependent on how much time nurses have as mentioned by a participant in this statement:

“...Umm, some days I have the luxury of actually sitting down in the computer, actually reading through their history, and umm looking a little bit more into their background, whereas other shifts all I have time for is to look through their orders, and then through their medications, and then through kinda just the basics what, who are they and what they are here for.” (Participant 0)

Time is a factor that influences how much information is reviewed in a shift. Orders, medications, and communication from other health care providers are routinely reviewed. If more time is available patient history and background are reviewed. The information is consumed based on what is relevant for that given shift. A participant described that, if

“... it [a medication] will not be given for my shift, it like qhs [bedtime medication] and so when I have eight patients, I don't really worry about what they took 16 hours ago, I worry about what I'm gonna be giving, mostly...” (Participant 5)

Nurses assess what is relevant for that given shift, so the history of medications that were previously given is not routinely reviewed. Typically orders, scheduled medications for that shift, and communication from other health care providers are the type of information that are reviewed. Orders give guidance on the care needs and pending diagnostics. While, electronic medication administration record (eMAR) gives an overview of what medications they have to administer. Communication from other health care providers are also important to them, especially in transfers of care, such as shift-to-shift and unit transfers. Participants review this when they are receiving a patient from a different inpatient unit:

“... well first I review their Inpatient, IP to IP, Inpatient to inpatient report. That's the nurse in the other unit or the emergency unit has written for that patient. It includes a quick history, it includes medications that they have prescribed, as well as what has been given, usually and how well they have done in the emergency department while they've been there...”(Participant 2)

Communication from other care providers informs the nurses about the medication process, especially in making decisions if certain medications need to be administered or

certain orders are required. This is discussed in more detail in the medication administration and orders section.

Reviewing information is a fundamental part of nurses' work. Nurses usually do this at the beginning of their shift to plan for care during their shift. Review information is part of the assessment stage within the medication process. However, reviewing information is not limited to medications only. They also review orders for patient care, pending diagnostics and blood work, and review written communication from other health care providers. Reviewing these orders, medications, and communication inform the nurse's decision-making with regards to the medication process.

4.3.2 Paper Use

The medication process is a highly cognitive and interactive process. The three types of memory: sensory memory, working memory, and long-term memory are used throughout the medication process. Dr. Cooper discussed this modal model of memory. According to Cooper, the sensory memory is used to perceive incoming visual and auditory information, and this memory is only available for a few seconds. The working memory processes information fed by the senses to enable logical and creative thinking. Lastly, the long-term memory is the permanent knowledge and skills that are stored in the brain. Long-term memory is activated through consciousness, where working memory queries for specific information in the long-term memory (Cooper, 1998). In the medication process, the nurse processes the information that is received from reviewing the electronic medical record (visual), and the verbal report from the previous nurse (auditory). This constitutes the working memory. Working memory has a limited capacity to process information. It is limited to nine elements at once (Cooper, G., 1998). According to Dr. Cooper, writing down information using paper and pen alleviates the burden on the working memory, as it is a means to record elements in a permanent manner while the elements are being processed (Cooper, 1998). The importance of using

paper to decrease working memory is described in these statements made by the participants:

“..sometimes they want to know ‘when is the next time I can have pain meds?’ normally, I would know that on top of my head because I write it down on my notes..” (Participant 0)

“...if you took it [paper] away. I won’t have all of the things I need to do as a nurse on top of my head...”(Participant 8)

“The dose, the name, and the time. I still write because unless if it is a day shift where there is 16 meds. I am not going to write a list of 16, but at night it is easy to overlook or miss one, so by writing that is an active process that kind of umm helps me remember, because I’ve done something active. I remember better than just looking in passing, looking in passing is a passive umm activity. I can easily forget so I always write, so but then when I am going to give now I double check now the eMAR [electronic medical record].” (Participant 6)

Writing information on a piece of paper is a method used by 70% of participants to organize their work, as shown in the table below:

Table 7 – Interview: Paper Use with the Electronic Medical Record

Theme	Category	Percentage	Participants #
Paper Use	Organize Work	70% (n = 7)	0, 2, 3, 4, 5, 6, 8

Information is written down on a piece of paper to serve as a task list, and as a reminder of where nurses highlight important information. The following statements describe paper use:

“When I am reading through my patients in the computer I have one sheet of all my patients...And under medications I umm list the times, so if someone is due for a medication at 1600, 1700, and then 2200. I will be putting, you know, 16 with an empty box to check off, 17 with an empty box to check off. So as I have done the task and charted it then my box is checked off... Ahh so I can look at a very quick glance. ...I can look at a glance at what times my meds are due, versus having to go in to each eMAR and..”(Participant 3)

“And I have seen a lot of nurses they like to highlight in purple, yellow, orange and so forth, many colors.. or even write in red, blue, in green, so I do that too. That helps just to remember, like when you open the sheet at once you see red, ‘oh these are my orders’, you see blue ‘oh this are my medications’, so pretty much I am gonna itemize important orders that require me to do something or to execute a task... I have to highlight or make small notes on the side to help me remember, because the [EMR] sometimes get populated with so many orders... I just think that it is too much information at times, and then you have to sift through too much information to get what is applicable for your shift...” (Participant 6)

Participants use paper to help them organize their work by writing “small notes” of orders, medication times, and completed assessments. The “small notes” are highlighted or color-coded, and they are intended to be short (e.g. writing medication time with an empty checkbox). The intent is to help the nurse to remember that an action is required. Participants also described writing orders and/or assessments on paper before entering the information into the electronic medical record. The participants describe this in the following statements:

“Umm so I would add um their vital signs so I would write down what time I have taken them and I put them on that sheet because I don’t, umm the computers are mobile they can come into the rooms but I don’t find that is very convenient so I like to write things down with the time that I have done them and I enter them later on in the computer when I have time, so umm yea..” (Participant 4)

“You’d definitely write it down because it would take so long to navigate the system and get what you want...” (Participant 6)

Information is written down on a paper to help nurses remember and process the information that they have collected. Writing on paper decreases the load on the working memory by recording the information interim on paper, instead of carrying the information in their minds while navigating the electronic medical record.

4.3.3 Logistics

Logistics can be defined as the management of the flow of physical resources and information flow to where they are required (Colins & Fabbe-Costes, 1993). Medication

process, from prescribing to patient surveillance, requires the coordination of health care providers (e.g. physicians, pharmacists, and nurses), physical resources (e.g. medication supplies, computer devices), and information (e.g. medication order details, patient assessment) for the medication to reach the patient at the bedside. The participants (100%, n = 10) describe the medication process in the context of managing the physical resources to accomplish a task, as shown in the table below:

Table 8 –Interview: EMR Use - Logistics

Theme	Category	Percentage	Participants #
Logistics	Physical Resources	100% (n = 100)	0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Logistics involves the management of the medication supplies and computer devices. Participants describe managing the medication supply by checking that the medications they require are delivered from the pharmacy (60%, n = 6). Also, participants (70%, n = 7) mentioned that they prepare the medication supply for each of their patient for their shift. Medication supplies are provided to the unit from the pharmacy in a routine delivery schedule. If the medication is required right away (STAT), then the medications are brought separately. Medications are stored in the unit medication room in cassettes for each patient. On some units there are medication carts in each hallway, where the individual cassettes are stored. Also, there is the unit ward stock for commonly used medications, and the narcotic cupboard for controlled medications. The participants may transfer the medication supply to wireless computer carts to administer medications. Wireless computer carts, are interchangeably called as computer on wheels (COWs) or workstation on wheels (WOWs). Wireless carts are mobile and may have cassette drawers for medications. These drawers are locked and accessible with a code. Wireless computer carts could be used to enter orders or administer medications at the bedside. Nurses manage the medication supplies and the information required in the medication process.

4.3.4 Medication Supply

70% of the participants (n = 7) described preparing the medication supply for administration. Medication preparation is the gathering of the medications from the unit medication room or medication carts in the hallways. Some participants described transferring the medication supplies of their assigned patients to their wireless computer cart cassettes drawers. Alternatively for some units nurses have a wireless computer cart beside the medication carts in the hallways. The participants describe managing the medication supplied in the following statements:

“They [pharmacy] take the two existing boxes of cassettes and then they replace them with the full ones. It is up to us to take it from the orange cassettes [from the unit medication room] and to bring it out to our WOWs [wireless computer cart] and fill out our medication cassettes and we’re supposed to check if there are all there as well. And reorder anything that is in insufficient supply” (Participant 2)

“...so around 2 o’clock say for a day shift ‘cause we only have eight hour employees here, they go into the med room. They are supposed to dump all the excess meds so PRNs [as needed medications] that have not been given, extra doses for some reason into the pharmacy ‘out bin’ so there is not a chance extra medications may be given accidentally and then they are supposed to pick up the new evening cassettes dumped them in to the blue ones, return the blue cassettes to the WOWs [wireless computer carts]...” (Participant 9)

Participants transfer the medication supplies from the unit medication room to wireless computer carts, and at the end of their shift they return the excess to the medication room. Another participant describe working with medication carts in the hallway and a wireless computer cart. The participant takes the medication supplies from the medication carts, while referring to wireless computer cart for the list of medications in the electronic medication administration record (eMAR). This is described below:

“...Umm usually in front of the computer so I am at the computer and I have, umm I usually look at the list and kinda just give a general idea of what I am grabbing. And I pull out the meds kinda in their wrapping it one by one, so that is kinda my first check I put them all out and they are still in their wrapper and then I have them all out there with me. And then I do my second check, where I am I take them out of the wrapper, so I am looking at the screen and making sure it is the same one that I include in the cup, and then my third check is when I have my cup full and I have,

there's very rarely when where I do not recognize what this pill is for, because I just know them all so well so then I look at the computer screen and I sign it off as I look in the cup and make sure it's in the cup. So that is my third check.”
(Participant 5)

In preparing the medication supplies, nurses refer to the electronic medical record for the list of medications and then gather the corresponding medications from the medication cart or cassette. When the medications are gathered, then the medications are compared again to the medication list, to be removed from the sachet and poured to the cup. Once, all the medications are in the cup, the cup full of medications are compared with the medication list again and documented as done. This serves as a check, as indicated by the participant:

“...So what has been marked as given you know it has been opened, and its in the cup...” (Participant 6)

Participants prepare the medications that are required for their shift. They check if all the medication supply is available. If a medication is missing, 60% of the participants (60%, n = 6) call pharmacy or enter a refill order via electronic medical record, as described in these statements:

“...If we don't have them on ward stock, which we most likely don't. We have not a whole lot in our ward stock, then we fill out. Umm if it is a refill order, I fill it out then I call pharmacy to send it up as quickly as you can...They do runs, I think, one, two, three, four.. four times a day and it has to get caught between then or they can tube it up at our request...” (Participant 0)

The medications are supplied by the pharmacy and delivered to the unit. The nurses manage the medication that is required for the patient on the unit. If there are any missing medications nurses communicate to the pharmacy using a refill order or telephone call. Nurses oversee the medication supply required for their patients, and use the electronic medication administration record for the medication list. Nurses can manage the logistics of the medication process by using the wireless computer cart, allowing them to deliver medications right to the bedside.

4.3.5 Computer Devices

Participants (100%, n = 10) mentioned that the use of the electronic medical record depends on computer accessibility (e.g. on or off site), where the computer is located (e.g. close to patient room), and if there are any computers available. Participants also mentioned that a wireless cart that allows them to move the computer with them gives them portability, but whether they use the wireless computer cart is still determined by the space of the room or hallway, the wireless access, or if patient is in an isolation room. Logistics using the wireless computer device is reflected in the following participant statements:

“...umm the room space sometimes does not allow for it [wireless computer cart]. And so umm I bring the computer to the doors of the room, and then I’ll just walk to the patient to the computer to the patient to the computer and have it in close proximity to where I am working...Instead of trying to run around the unit trying to find a computer...Some nurses will choose to walk around the unit and leave the computer in one space. Me? Not so much...”(Participant 0)

“My experience is that it [wireless computer cart] has been unreliable. Umm if I am in a patient’s room, and I am about to dispense meds, I need my eMAR [electronic medication administration record] in front of me and I can’t spend 10 minutes rebooting my computer and you know moving it around the room” (Participant 3)

Participants may use the computer devices, but they are limited to the room space, the wireless reliability, and access to computer (e.g. isolation rooms, off site). Furthermore, participants describe slight changes to their practice in using the wireless carts. This is shown in the following statements:

“...So I have slightly changed my practice, in that I will draw up my meds in front of my computer, dispense them, come back to the computer so take the portability of the computer out of the situation just ‘cause it has been unreliable...”
(Participant 3)

“...Only thing is if you are in the room and orders are being put in, your interaction is more with the computer rather than the patient ‘cause you would bring the workstation on wheels inside the room, and you will be putting in orders and signing it of.” (Participant 1)

Nurses have to adjust their practice to manage the medication supplies and wireless computer device while interacting with the patient. Logistics is the management of the physical resources and information flow within the medication process (Colins & Fabbe-Costes, 1993). Logistics involves the delivery of medications and the accessibility of the computer to the point of care where information is required or to enter orders. Participants described wireless reliability, room space to maneuver the computer, and access to computers as logistical factors in managing the medication process.

4.3.6 Order

The Computerized Provider Order Entry (CPOE) in the electronic medical record is customized with standardized orders for specialties and common orders. CPOE also allows for alteration, e.g. dosage and frequency. The orders entered into CPOE are automatically transcribed into the electronic medication administration record (eMAR). CPOE can be accessed on all computers on the unit, including the computer on wheels (COW) or workstation on wheels (WOW). The orders available in the CPOE are not limited to medication orders. They also include diagnostic, blood work, patient care orders, and communication orders (e.g. refill orders, physician to nurse communication). *Prescribing* is a controlled act, in which authorized personnel, namely a physician or nurse practitioner, give a medication order. Prescribers are expected to document their own medication orders. There are exceptions in the case of urgent or emergent situations where these orders may be verbally transmitted to licensed healthcare professionals such as registered nurses (CARNA, 2007).

Orders are entered by physicians (100%, n = 100) and also entered by nurses (100%, n = 10) as indicated in the table below:

Table 9 - Interview: EMR Use - Orders

Theme	Category	Percentage	Participants #
Order	Entry	100% (n = 100)	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
	Communication	100% (n = 100)	0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Participants describe nurses entering orders for physicians due to time constraints. Also, depending on the type of order they may be entering orders under their own name or based on policy and procedures. The types of orders that nursing may enter include admission swabs, referrals to social worker or transition services, pharmacy refill orders as described by a participant:

“...umm almost 95 percent of the cases it will be physicians ordering the medications, or it will be the physician ordering and then I will put in the orders as per verbal conversation that we’ve had and it has actually been agreed between the two of us that yes indeed this patient can now have an increase in this med. And then the physician in turn will go and review the orders to make sure that yes the nurse did not put in the wrong medication...” (Participant 0)

Physicians enter most medication orders. However, nurses may also enter orders depending on the type (e.g. refill orders to refill medications that are missing) or when physicians are busy, not on site, and have no remote access. This is described in the following participant statement:

“...So I will be putting in I’ll put it in for them if they are busy like especially if it is a simple order like, give me something simple like heparin order or something ...Umm, When Im on nights? Probably, like when I put it in? that is probably like once a week, once every couple of weeks, probably. Yea like I did one over night and he is just not near a computer and I was talking to them on the phone...” (Participant 5)

Physicians mostly enter the medication orders, but given time constraints and limited access to a computer nurses enter the medication orders on behalf of the physician. As computerized order entry allows for order entry in any location with access to a computer, communication is a vital aspect of the ordering process. In instances where the ordering conversation happens via telephone, there is a need to clarify who would enter the order. This is shown in the following statements:

“I always offer first, I say ‘are you near a computer can you enter that order in?’ and umm and if they are not, then I say ‘okay then I can do it’ but I always put forward the option of them entering the orders first. That is something that we were

taught is that, is to be the physicians to be entering their own orders.” (Participant 3)

“Depends on who took it. If it is a verbal order, and I talked to the physician directly and he told me umm what to order then I usually put it on, but if it is over the telephone it depends... sometimes you have to clarify with the physician whether I should, I should enter it or not, or usually sometimes I ask the physician to enter it, to enter the order.” (Participant 8)

Computerized provider order entry allows for order entry anywhere in the hospital where a computer is available. Communication of who would enter the order is important, so that it is clear to both parties who will be entering the order.

Communication also happens to discuss a patient’s case prior to order entry. Participants (n=6) discussed that they may determine through the review of the patient chart, on patient assessment and/or patient history (e.g. missing home medications), or unexpected change in a patient’s condition, that a patient requires a medication order. Participants may choose to communicate verbally, telephone, paging system, or write in paper. There is a written list of nurse - physician communication. This is the chosen mode of communication when nurses cannot get a hold of the physician and/or the discussion can wait until physician rounds. Sometimes, physicians need further clarification on what is written on the paper communication and speak with the primary nurse directly. Physicians are the prescribers of the medication orders, however nurses also do assessment and are involved in determining if an order is required. This is described in the following statements:

“...Most of the discussion we have takes place through the nursing communication. There is a sheet in the paper chart where the physician looks through every day for any nursing comments. If I can’t get a hold of him during the evening or the night shifts then that is where they go on the day shifts, the physicians will always go looking through the charts... the paper charts, my apologies, and look through the charts, for these nursing notes and try to take them into account or they come to us and go ‘what do you need?’ or ‘describe this, because I don’t know what you are saying’ ... ” (Participant 0)

“...And we will write in there ‘family says patient has been receiving citalopram BID however milligrams. Umm and then next time the physician comes in, something like citalopram isn’t ahh umm, it’s not necessary to keep them alive for them to take it every day. If it is a cardiac medication, I would page the doctors and say ‘look there’s this cardiac medication and you don’t have it on the list, what you want to do about that?’” Something like citalopram, or calcium, or whatever that can wait until the next day so I just write it as a note. It depends on acuity.” (Participant 2)

“Pretty much most of the medications are ordered already by the physician. Unless if something that comes up unexpectedly. Lets say the patient is in pain and there is no pain medication ordered. You make a phone call...”(Participant 6)

Nurses may suggest that a medication order is required through their assessments and they communicate this to physicians. However, since physicians are the prescribers and mostly enter the orders directly into the electronic medical record it is important that nurses are aware of new or changed orders. Participants described that there are three ways that notification of new orders happens: print out, flags, or verbal communication. The following statements describe these:

“...there is a paper copy printed in the main desk but that is not the main way. You are given a flag comes up on your patient’s.. on your main page.. a little red flag that comes up under new orders. You have to double click on it and then you have to clear orders, that you have seen it. Umm on our unit those paper copies are not kept on file, those are...in general they are discarded” (Participant 3)

“Okay. Typically and how it should happen is that the physician enters in their order and then the nurses should have their flags on so they will get a notification that a new order has been entered...”(Participant 9)

“Okay. Umm that is another advantage of [EMR] over paper work, umm notifications it shows in the forms of flags that there is a new order. If it is a stat order then the flag is gonna be red to indicate that it is a stat order. That needs to be executed urgently, so that is an advantage over paper work, pretty much” (Participant 6)

Notifications of new or changed orders are important to nursing. The flags give a visual cue that an important order requires attention. It is up to the nurse to be turning on the flags and checking the flags, as indicated by these statements:

“No it is up to the nurse to be checking. On the computer to be checking their flags” (Participant 3)

“so orders pop-up and results pop-up throughout the shift and so I monitor those umm alerts throughout my shift to see if there is anything that changed or anything else I need to do for them” (Participant 4)

“...I also always make sure that I have my tabs, or like my flags marked so then usually at least once or twice my shift an order a flag is gonna come up thats gonna pop up with a new med or a new med that they’ve switched so then I [EMR] tells me that...” (Participant 5)

The disadvantage is that if the nurses do not remember to turn on their flags or if nurses do not have time to check their flags, as described by the participants:

“...And on the side, having to turn the flags on can sometimes be a problem ‘cause if nurses don’t turn on their flags with their order entry system they won’t know that there’s new orders ...”(Participant 9)

“...but as far as checking flags the recommendation is every hour or two to check for your new medication flags.. Does that happen? It depends on the practitioner, how busy they are? , what’s going on? What else is going on?. Maybe they heard about it because the physician mentioned it on his or her way out the door and it might have been instituted before the flags are there, or it might be one of those things where it is completely missed because there has been no communication. And they haven’t gotten back to their computer, and then it might be 3 or 4 hours out, yea.” (Participant 7)

There is a personal responsibility for nurses to turn on the flag, whereas before the physical presence of physicians gives them indirect notification:

“The only downside, with the written you are more aware of the change. With the electronic, the physician can be somewhere else entering orders and if we are not looking and updating the orders or the electronic MAR we can be missing something. Whereas with the paper charting, they have to physically be there...” (Participant 1)

Physicians and nurses both enter orders using the computerized provider order entry (CPOE). The physicians mostly enter the medication orders and nurses enter orders depending on the type of order or the circumstance (e.g. Physician is not on unit). CPOE enables the physician to be not physically present on the unit, thus communication is necessary to discuss if new orders are required, and who would enter the order. Also, notification of new and changed orders had changed from verbal communication to electronic flags. This changed nursing practice in a way that the nurses have to be personally reliable in accessing the computer to check these flags for new orders.

4.3.7 Medication Administration

Medication administration is the act of giving medications to the patient through a specific route (CRNNS, 2011). Nurses engage in critical thinking as they assess the patient for the appropriateness of the medication; prepare medications with their knowledge of best practice; and obtain consent and educate patient about their medications. The nurses then follow the “10 rights” of medication administration. This serves as a guideline for safe medication administration practice. Here the nurse ensures the right client, right medication, right route, right time, right dose, right reason/assessment, right education, right to refuse, right evaluation, right documentation are applied (College of Registered Nurses of Nova Scotia, 2011). These activities are followed by surveillance, where the nurse assesses the effectiveness of the administered drug and determines any experienced side effects by the patient. Nurses are primarily responsible for medication administration. Nurses use the electronic medication administration record (eMAR) as the documentation for the list of medications, schedule, and medications administered. This is shown in the table below:

Table 10 - Interview: EMR Use - Medication Administration

Theme	Category	Percentage	Participants #
Medication Administration	Nurse Administered	60% (n=6)	0,1, 2, 3, 4, 5, 6, 7, 8, 9
	Record (eMAR)	100% (n = 10)	0,1, 2, 3, 4, 5, 6, 7, 8, 9
	Schedule	80% (n = 8)	0,1, 2, 3, 4, 6, 7, 9
	Documentation	60% (n = 6)	0, 4, 6, 7, 8, 9

Nurse Administered

Participants (60%, n = 6) mentioned that nurses manage medication administration based on the medication schedule and nursing judgment. Also, participants look at the medication record for possible medication options for the patient and evaluate the medication effectiveness or side effects. Participants described medication administration in the following statements:

“But something like baby aspirin that’s a morning medication if it says to give it to at two in the afternoon, I question ‘why is it given at two instead of eight?’ and sometimes there is a good reason for that, it’s been how they have been taking them at home and so it will have a different timing because of that’s what they are accustomed to...”(Participant 2)

“...So if there is anything that they need, any as needed medication for pain or nausea, I would umm access the as needed orders at that point and administer medications...” (Participant 4)

“Then nurses will decide if it’s appropriate to give it this time, they will go check the order on the patient order, the [EMR] system, they’ll verify using the eight right of medication administration and they will go to the patient’s room, give the medication, and mark as done in the eMAR.” (Participant 9)

Medication administration is determined by order and nursing judgment. Order gives direction for the schedule, but nurses use their judgment on the timing and how to best administer the medications.

Electronic Medication Administration Record (eMAR)

Participants (100%, n=10) mentioned that the electronic medication administration record (eMAR) contains all the ordered medications for the patient with the appropriate administration schedules indicated by the time cell and a designated colour. The time cell is the slotted time the medication is to be administered (e.g. 0800). The time trough is the time frame an as needed medication, *pro pre nata* (PRN), could be given to the patient. For example, a PRN medication can be administered every 4 hours, and the last administered dose was at 0800, so a time trough is displayed starting at 1200 onwards indicating that the as needed medication can be given at any of these times past 1200.

Colours also represent the time cell and trough. The scheduled time cells are yellow, while as needed time trough are purple. This colour scheme provides cueing, for example, the yellow cell is for scheduled medications, and red cell meant that the scheduled medication time has passed and medication was not signed for. The record has time columns, and the time frame of the record can be changed. Also, the medications are listed according to category and provide guidance. The electronic medication administration Record (eMAR) helps with organizing work. Participants' descriptions are reflected in these statements:

“And so, we are gonna give this medication at this time period, so 7 o'clock, it has a little yellow block and says we have to give it at 7 o'clock, so I have anywhere between 7 to 8 o'clock to give that. Kinda give that schedule in one day. And it also looks at medications that I can give on a as needed basis.. And so it can be anywhere from umm the last time it was given was 10 o'clock so I can give it from 11 o'clock onwards. Umm, kinda help me schedule my day and schedule my care. (Participant 0)

“..And then there are time columns eight, nine, ten. Actually you can change to actual or by the hour. I prefer by the hour, it gives you an idea about timing. Then it will tell you. It will have yellow inside the box that coordinates with the time and the medication for when you have to give it. So you can tell by color that you have medication to give at that time. If you are more than an hour late giving it, it will turn red. So you know that you are late given it, or something you have forgotten.” (Participant 2)

“Umm, and I can always expect that I'm going to see as needed medications at a certain spot and my scheduled at a certain spot, and that helps organize things instead of having to guess. And they are all alphabetical, so that helps. And umm I find too that some of the physicians will enter parameters, so if I am giving a blood pressure medication they would say withhold dose if systolic is less than 100. So I have some guidance there..” (Participant 4)

A refresh is used to update the eMAR with new information. This is described as follows:

“...And when you give, it will, if you refresh the page, it will make the trough starting again when it is next available..”(Participant 2)

“...It’s I check ‘em, pretty much, most of ‘em... half hour basis, when I’m not giving medications to make sure that they are, if there are any medications that have been changed or refreshed. Some times that happens, usually not often, but sometimes it can..”(Participant 0)

The electronic medication administration record (eMAR) is populated by the medication orders entered. eMAR is composed of time cells and a designated colour. The visual presentation of the medication list and the schedule helps the nurse to organize work. There are system-defined schedules, but nurses use their judgment in determining the timing and can reschedule the medications.

Schedule

The medication schedule is the timing of the administration (80%, n=8). The order, the nurse’s critical thinking, type of medication, and patient home routine determine the administration times. The schedule may also be changed based on patient condition, patient preference, and if the last medication is given late. This is described in the following statements:

“[EMR] usually determines it just as an automatic schedule and so when a physician says we are giving it BID, it automatically goes to eight in the morning and ten at night...that’s how it works. As a nurse I talk with my patient about when do you actually take this medication at home, trying to accommodate their schedule, especially if they’ve been here for a long time...and I can physically go into [EMR] and adjust the schedule to accommodate them. If I have give a medication late, I can reschedule tasks to make sure that there is an appropriate gap in between, so its given every four hours, I gave it a little late, so we have to wait a little more time...”(Participant 0)

“It’s... medication administration is supposed to be between half an hour before the time due and half an hour after the time due. So say an 8am med, they can give between 7:30 to 8:30...” (Participant 9)

The medication order determines the frequency of medication administration, and from this a schedule is automatically created in the eMAR. The schedules are not definitive, and is changed based on the nurses judgment and critical thinking.

Documentation

After the medication was administered, the participants mentioned that they document the administered medication in the eMAR (60%, n=6). Medication administration would at times require another nurse to check the medication prior to administration. This is documented in the eMAR as a co-signer. If the original provider did not sign the medication administration, another nurse may document this on behalf of the original provider. This is documented in the eMAR as “on behalf of another” and would require a signature from the original provider. This is described in this statement:

“...it is to sign medications so if I, umm our unit policy now is, umm if I am giving someone insulin whether it is a sliding scale insulin or a scheduled insulin dose then I need to second check that with another nurse umm and then they, I enter their name in, like when I’m sign the medications off, and they have to go in and acknowledged that I’ve signed them” (Participant 4)

Nurses work with other nurses in medication administration, and document this administration in the eMAR as co-signers. Medication administration document happens after a medication is given. However, participants also stated documenting prior to giving the actual medication to the patient. This serves as a check that the medication is poured into the cup. If documentation occurs in the eMAR prior to the time cell, there is an alert that is triggered indicating that this medication is not scheduled for this time. The user can overrule this alert. Participants describe that marking a medication has been poured into the cup help them remember that it was done. If there are any changes, e.g. patient refuses, then it is easier to edit the documentation. This is described in detail in the following statements:

“Yea, I usually mark it as done first umm before I go in the room, because I find, my personal thing is I am more likely to forget to mark it off than I am like ‘cause if the patient refuses the med I am going to remember that so I am not gonna forget to mark it as not done because that is out of the ordinary.” (Participant 5)

“Well, pretty much mark as done, and then if the patient refuses, usually as you take it out of the package and you put it in the medicine cup that is when you mark as done. And then when you get to the beside some patients will say ‘oh I don’t

want two Tylenol, I just wanted only one', you are gonna go back and adjust. Umm you can adjust the dosage, or you can if the patient say 'I don't want it anymore', so you can just go and say reset task, mark as not done, patient refused. You document it." (Participant 6)

"Yup, you can right click on the cell and click mark as done. Sometimes it gives you a message, 'are you sure you are gonna give this med?', usually its only if you have given it too soon...umm but you can mark as done anytime you want even if it's not the right time" (Participant 9)

Documentation could happen before a medication is actually ingested by the patient or after the patient has taken this medication. Documentation prior to administration is described as a "check" that a medication has been poured, and it helps with the participant's recall about the medication they gave.

4.3.8 Summary

CPOE is integrated in the electronic medical record (EMR) where the entered medication orders automatically generate a schedule and list of medications in the electronic medication administration record (eMAR). The electronic medical records also give access to results, documentation, and communication from other health care providers. Participants describe that in the medication process they review information in the electronic medical record, specifically the orders, medications, and communication. Pertinent information is highlighted, and listed as "small notes" on a piece of paper to remind them that a task is pending and to organize their work. In part, the paper supports the cognitive task of remembering to log into the electronic medical record to review the medication details in the eMAR. Furthermore, some participants mentioned documenting prior to administering the medication to remind them that the medication has been poured into the medicine cup. This action is described as "easier" as participants may forget to document after administration due to other competing tasks. Aside from remembering to administer medications, participants mentioned that they manage the medication supplies for their patient. In the beginning of the shift, participants may choose to gather all the required medication supplies for their patients from the unit medication room, and place

them in the cassette drawers of the wireless computer carts. This would allow the participants to have the medication supplies accessible while having the medication information they require in front of them at the point of care closer to the patient when administering medications. Also, the use of wireless computer carts would allow them to enter orders at the bedside in emergent patient situations. However, the use of the wireless computer carts is dependant on the room space, wireless availability, or if patient is in an isolation room. Nurses adjust their medication practices for both administration and ordering, depending on the available room space, medication supplies, computer devices, and patient condition. Nurses need to manage the medication information and physical resources while interacting with the patient.

4.4 Semi-structured Interview: Paper Chart Use

Ten participants were asked to describe their experience with paper based medication process. The interviews were transcribed and analyzed for themes and categories. In the ten interviews that were conducted, 8 participants (80%) had previous experience with paper charting in the medication process, while the other 2 participants (20%) had no previous experience. The 2 participants had their nursing training at sites that use the electronic medical record with computerized order entry. The results then only include the perspective of the 8 participants. Out of the 8 participants who had paper chart experience, 6 of the participants (75%, $n = 6$) used paper ordering sheets and paper medication administration records in varying settings (e.g. Critical Care Units or Intensive Care Units or General Medicine or Emergency Department or Long-term Care), and in other cities (e.g. Edmonton) or country (e.g. United States). There were 3 participants (37.5%, $n = 3$), who had experience in using a hybrid process, but the processes are different. 2 participants had the experience working with an electronic ordering system that produced a print out of the medication administration record. While the other participant had the experience working with paper ordering sheets and a barcode system. The barcode was used to document the administered medications. Furthermore, 2 participants (25%, $n = 2$) exclusively worked with a paper based or a

hybrid system when they were students. This meant that certain responsibilities these participants did not personally execute, such as transcription from order to medication administration record, and had to rely on their supervisors.

The 8 participants were asked to describe the medication process using paper chart. The themes and categories for paper chart use are listed in the table below and appear in over 50% (n=4) of participant interview data (see Table 8.0 below).

Table 11 - Interview: Paper Chart Use

Theme	Category	Percentage	Participants #
Order	Entry	100% (n = 8)	1, 2, 3, 4, 5, 6, 7, 9
	Communication	100% (n = 8)	1, 2, 3, 4, 5, 6, 7, 9
Medication Supply		87.5% (n = 7)	1, 2, 4, 5, 6, 7, 9
Medication Administration	Record	75% (n = 6)	1, 2,4,6,7,9

4.4.1 Order

Entry

In the paper chart process, order entry is the written account of orders prescribed by the authorized health care provider. In the interview, 8 participants (80%) had experience working in a paper based or hybrid based medication process. All 8 of the participants (100%, n = 8) described order entry as initiated by the physicians (see Table 12.0).

Table 12 - Interview: Paper Chart Use - Order Entry

Theme	Category	Percentage	Participants #
Order	Entry	100% (n = 8)	1, 2, 3, 4, 5, 6, 7, 9

7 out of 8 participants (87.5%) mentioned that physicians would write the orders in the paper order sheets. A participant described the order entry in the statement below:

“... ordering in the paper world, physician typically will go in see the patient, come back out, and write all their orders one after the other, hopefully in one single piece of paper. It was a triplicate, like a carbon copy type form.” (Participant 9)

The physicians wrote the orders in the order sheet. Even 1 participant, who worked with a hybrid process, described physicians writing on the paper order sheets which then the nurses would transcribe the order information to the electronic ordering system, or nurses would occasionally write in the order sheets when receiving telephone orders. The participants described these in the following statements:

“...write all the medications that the patient is to receive and then we [nurses] were to, they [physicians] always, they entered it like that. They didn't enter it automatically into the computer. At some point the nurses entered it into the computer on their behalf...Or occasionally the doctor will be on the phone and we will write on this page as well what order, and say 'per telephone with repeat' and our name on it because the doctor wasn't there to sign it, right?” (Participant 2)

“I think it was the same. I didn't see the nurses writing down as much, but then it was also in the ICU where the doctors are there and would come to see the patients so they would write down all the orders. But there is also, where they would be taking phone orders that was common.” (Participant 5)

Physicians are primarily responsible for the order entry, but nurses are still part of the process when a telephone order is required or transcribing the orders to the electronic ordering system so communication is key.

4.4.2 Communication

Table 13 – Interview: Paper Chart Use - Order Communication

Theme	Category	Percentage	Participants #
Order	Communication	100% (n = 8)	1, 2, 3, 4, 5, 6, 7, 9

Physicians and nurses work together in order entry. The physicians are the primary actors and wrote the orders. Nurses support the process through taking telephone orders, and entering in the electronic order system. Clear communication between physicians and nurses is important, especially for nurses to understand the orders. Participants described that it was a challenge to read the orders, as indicated in this statement:

“... I can remember several times like me, and my primary nurse, like obviously with I was a student, and I could not understand the writing and we work with my instructor...we have to go to the doctor ...like ‘hey, we cannot understand your writing so we don’t know what med[ication] that says...so you know like you’d ask five or six different nurses ‘do you know what this says?’ ...” (Participant 5)

“Again, the drawback being legibility. Physicians are notoriously bad writers, right? so it’s a lot easier to clarify an order if you can actually read it. Instead of going ‘umm I see you have ordered something here, I cannot for the li.. I think it begins with an L’, right? Whereas on computer its like ‘oh okay Lidocaine’.” (Participant 7)

The handwritten orders are some times not legible which causes the nurse to ask another nurses or the ordering physician to help clarify the order details. It is important to understand the order to be given properly as intended. Also, nurses are involved in transcribing this information to the medication administration record (MAR), so not only nurses needed to understand the order details they require to be notified that a new order has been written. A participant described this as:

“Doctors will just come and write the order and leave it in the chart. But if you [nurse] don’t cross check it and transfer, the order will be sitting in the chart and would never be executed.” (Participant 6)

Communication that there are new orders is important, even in the hybrid system where the physician would enter the order in the electronic ordering system and the medication administration record is printed out. A participant mentioned constantly checking the nursing desk to see if new orders were entered. This is shown in this statement:

“It was a pretty paper heavy system in that you would constantly have to go back to the nursing desk look in your mail slot and see if there’s any new orders, any new meds, any ahh, you know so, I just gave my 3 o’clock meds, do I need to look up my 4 o’clock med sheets. So you have to constantly go back to the nursing desk and see what’s there..”(Participant 3)

This participant had to constantly go to the nursing station to check if there is a new printout. Other participants who used solely paper-based process would go to the nursing

station to check if the paper chart flag for new orders was up. A flag is a visible indication for new orders in the paper chart. Physicians would pull this flag up when they have written new orders to let the nurses know that there are new orders. There is this visual cue that nurses need to pay attention to when looking at the charts in the nursing station. A participant described this as:

“...you [nurse] would have to use the paper charts a lot more and actually pay attention to the tabs. So there was, as far as I remember, there is a new order flag. And once a physician wrote in the patient order section of the chart. Then they [physicians] would flag that as a new tab or a new order, and the nursing staff would then go in and read the medication...” (Participant 4)

Orders need to be clearly stated and communicated to ensure that orders are timely executed. Other indications that there are new orders could come from the charge nurses who saw the physicians come by, or that the paper chart now has a flag up. Charge nurses then communicate this to the primary nurse. The participants have different perspectives on the notification approach used with paper charts, 1 participant mentioned that in paper chart you are “more aware of the change” since it requires physicians to be present on the unit. While another participant mentioned that during a busy shift, it may be difficult to keep on checking the flags at the nursing station.

Communication between physicians and nurses at the order entry stage is important. Participants also mentioned that communication among nurses happens when action is taken on the order. This is exemplified in the participant’s statement:

“Nursing beside [the order] would either put done, req’d [requisitioned], umm pharmacy faxed, some sort of communication to indicate if it was given, if it was tended to, what the plan of action was...” (Participant 9)

A notation beside the order is made to indicate that action was taken on an order. This facilitates clear communication among nurses to not duplicate work. This also helps nurses verify that a certain order has been completed and acts as a “check”. This is described in the following statements:

“...they had like a triplicate, so we did the orders and the Charge nurse would sign, and then when we took over we would sign. Then we would fax a copy down to pharmacy, who would do the third check. Then we would get a list, not an electronic MAR, but just a MAR, medication administration record and that is what we would use to double check the orders during nights” (Participant 1)

“So every night, it was a night shift responsibility for eight patients, I go through each chart and I look through the last 24hrs worth of orders and make sure that they have either been put on MAR, they have been instituted, they are in the kardex or where ever they are supposed to be.” (Participant 7)

Communication of new orders with clear order details, and notification that it was acted on is important among nurses and physicians.

4.4.3 Medication Supply

Table 14 - Interview: Paper Chart Use - Medication Supply

Theme	Category	Percentage	Participants #
Medication Supply		87.5% (n = 7)	1, 2, 4, 5, 6, 7, 9

Majority of the participants 87.5% (n = 7) discussed managing the medication supply for medication administration (see Table 10.0). The participants stated that order sheets are faxed to the pharmacy, and the pharmacy sends the medication to the unit. A copy of the order sheet may be faxed while the rounds are progressing, as described in the following statement:

“...The orders as the rounds are progressing... the carbon copy is usually pulled right away and sent off to pharmacy. The turnaround for pharmacy then is about three or four hours, usually the night of. Then the charge nurses...turnaround is usually three, four hours.” (Participant 1)

The order entry and the transmission of the information to the pharmacy require a step from the nurse to fax the order sheet. Also, in preparation for medication administration, nurses use the medication administration record to gather the medication supplies from the cassettes.

“So when you take that cassette, there are a lot of medications. Some are for noon, some are for breakfast, some are for.. and then as you are taking and reading now the MAR[medication administration record], you are cross-checking and double checking is this the right medication?” (Participant 6)

Nurses are involved in managing the medication supplies in preparation for medication administration. Nurses fax the order sheet to send the order information to the pharmacy, and then the pharmacy sends the medications to the unit. The medications are compared with the medication administration record (MAR) to ensure nurses are gathering the correct medications for administration.

4.4.4 Medication Administration

Table 15 - Interview: Paper Chart Use - Medication Administration

Theme	Category	Percentage	Participants #
Medication Administration	Record	75% (n = 6)	1, 2,4,6,7,9

75% of the participants (n = 6) described the medication administration record (MAR), as the record of all the medications with the time the medication needs to be given (See Table 11.0). 83% of the participants (n = 5) worked with a paper medication administration record, while 1 participant worked with a barcode system to document the medication administered. The medication orders from the paper order sheet are manually transcribed into the record with the schedule by the nurse or by a unit clerk and then double-checked by a nurse. The medication administration record is used to verify the medication details before administration. This is described in the statements below:

“...I remember that you have to have the order here, and the medication administration record here, and then you have to check is it the right medication, right dosage, right amount, right frequency, right route with what is transcribed on the MAR, on the paper MAR, then you check, you make a check sign, that’s correct, that’s correct.” (Participant 6)

The medication administration record is the record of all ordered medications. This record is manually transcribed from the order sheets, so it is important that it is the

information is verified and correct. In the hybrid system, the electronic ordering system generated a printed medication administration record. The challenge in this is ensuring that the nurse has the most up to date medication administration record (MAR). As discussed earlier, if new orders are entered in the electronic ordering system a new MAR is generated and the nurse must go to the nursing station to check. In contrast, the barcode system provides a consolidated list at the bedside. As described by the participant in the following statement:

“Like with the barcode there is really no room for error there. The only way that it can get screwed up is if your patient’s umm, if you are scanning the patient, and you are scanning the med[ication] and if somehow the med[ication] is packaged wrong, like it is not the med that it said it is...like unless you somehow giving that medication, you know, if you take that the meds and give it to the patient before you scan it then obviously you just overrode the whole system but usually you would never do that because when you open it you break the barcode, and then there is no way to sign off your med, because you need the barcode to sign off the med you can’t just click and say you gave it. So to me it was pretty fool proof, you can’t just really screw up too much...”(Participant 5)

In using the barcode system for medication administration, the barcode on the medication sachet and the barcode on the patient are scanned. The medication information should match the patient’s medication list for the system to document the medication. Any discrepancies would require a system override. Unlike, the paper medication administration records that is dependant on the nurse to transcribe the medication schedule.

4.4.5 Summary

The participants had diverse experiences in using paper charting in the medication process. Some participants had experienced working with order sheets in prescribing stage and paper medication administration records in the administration stage. While, other participants had experience with working in a hybrid system, where the paper based process was either in the prescribing stage or the administration stage. Despite the various experiences, participants generally described that the paper based process required

rigorous communication. In the prescribing stage, nurses needed clear and legible orders written. If the orders were unclear, they would discuss with the ordering physicians or other nurses to clarify. Nurses also needed to be aware of when there are new or changed orders by going to the nursing station and checking if the paper chart flags are up or new printed medication administration records are available. Also, participants may know that there are new orders by being aware that physicians are physically on the unit. After receiving the orders, the orders need to be faxed to the pharmacy and transcribed to the paper medication administration record. This transcription stage also requires clear communication that an order has been acted on. Nurses would compare the order sheet and the medication administration sheet to verify that there are no medications that were missed. The paper based medication process requires manual work of translating the orders into the medication record with the schedule. Clear handwritten and verbal communication is key in this process, and also being aware of physical surroundings that a new orders flag is up or the physician is present to write new orders. Then again, the account of the paper-based medication process is grounded on the participants' ability to remember their experience. The descriptions may not be the full representation of the paper-based medication process.

4.5 Observations

Out of the ten participants who were interviewed, eight participants agreed to be observed. The participants were observed while they were working, and were asked clarifying questions after the observation period. Written memos taken during the observation were coded and analyzed. The table below displays any codes that appeared 50% of the time:

Table 16 - Observation: Electronic Medical Record Use (EMR)

Theme	Category	Percentage	Participants #
Documentation		62.5% (n = 5)	0, 1, 4, 5, 6
Review Alerts/Flags		100% (n = 8)	0, 1, 2, 3, 4, 5, 6, 7
Review Information	Medications (MAR)	100% (n = 8)	0, 1, 2, 3, 4, 5, 6, 7

Review Information	Orders	75% (n = 6)	1, 2, 3, 5, 6, 7
Review Information	Other	62.5% (n = 5)	2, 3, 4, 5, 7
Log off System		87.5% n = 7	0, 1, 2, 3, 4, 6, 7
Log Into System		100% (n = 8)	0, 1, 2, 3, 4, 5, 6, 7
Minimize System		62.5% (n = 5)	0, 2, 3, 5, 7
Reference		50% (n = 4)	0, 2, 5, 7
Logistics	Wireless cart	62.5% (n = 5)	0, 2, 3, 4, 7
Logistics	Medication Supply	62.5% (n = 5)	0, 2, 3, 6, 7
Medication Administration	Documentation	100% (n = 8)	0, 1, 2, 3, 4, 5, 6, 7
Medication Administration	Record	60% (n = 6)	1, 2, 3, 4, 5, 7
Paper Use	Organize Work	100% (n = 8)	0, 1, 2, 3, 4, 5, 6, 7
Travel		100% (n = 8)	0, 1, 2, 3, 4, 5, 6, 7

4.5.1 Documentation

Participants used the electronic medical record for documenting clinical assessments and document care.

4.5.2 Review Alerts/Flags

Participants used the electronic medical record to review alerts (e.g. Medication interaction) and for flags to notify them of new orders and/or change in orders. Participants turned on the flags at the beginning of their shifts, and would clear the flag after reviewing the orders.

4.5.3 Review Information - Medication Record

Participants used the electronic medication administration record to review the medications that needed to be given. Participants used colors in the record to cue them as to pertinent medications for that shift. For example, they looked at the “yellow solid box” for the scheduled meds, and any “red solid box” for any medications that is not signed off past and it is already past the scheduled time.

4.5.4 Review Information – Orders

Participants use the electronic medical record (EMR) to review various orders. At the beginning of the shift, participants scan the orders tab of the EMR for any medication orders, including the parameters for that medication; diagnostics orders; laboratory orders; and patient care orders. They would write down and highlight in their printed patient list any orders that were pertinent for their shift or that required attention. The time they spent in reviewing the orders depend on how much time they have as mentioned by the participant in this statement while being observed:

“I meant to do review the patient orders and info early, and I usually finish at 2315 but [I] started late and I am in charge and need to address patient issue..”
(Participant 6)

Participants would also review the orders tab again though out their shift to look at the details of new orders, or manage orders that were already executed by marking the order as complete or no longer required as discontinued.

4.5.5 Review Information - Others

Participants use of the electronic medical record to review patient list and review their information such as the diagnosis, patient’s history, previous assessments and care, results, and reports from previous shift or other units. This may be accompanied by a verbal report from the previous shift or another unit (e.g. patient being transferred from a different unit).

4.5.6 Computer Functions (Log off System, Log Into System, Minimize System)

Participants performed system functions to log into the system, log off the system, and minimize the system window. Participants usually log off from the system or minimize the window when they are walking away from the computer.

4.5.7 Reference

Participants use a reference link in the electronic medical record to search for medication information (e.g. drug information).

4.5.8 Logistics - Wireless Cart

Participants used the wireless cart to gather medications and to administer medications. They managed the wireless cart by placing the medication supplies into the cassette drawers in the cart, by cleaning the wireless cart, and recharging of battery. Some participants had the wireless carts parked in the hallway a few steps into their assigned patient rooms, while others moved the wireless carts with them up to the door of their assigned patient room.

4.5.9 Logistics - Medication Supply

Participants manage the medication supply for their patients. They gather the medication supplies required for medication administration. If the medication is missing from the cassette, they look for medication supply in the ward stock, or look for another medication supply from another patient's cassette, or enter a refill order.

4.5.10 Medication Administration Record - Documentation

Participants documented that medications are given post administration and a few documented pre-administration. Documentation is revised to mark as not done for medications that are left in the cup.

4.5.11 Electronic Medication Administration Record (eMAR)

Participants use the electronic medication administration record to prepare, administer and document medications. Participants refer to the colors of the medication administration record to cue them on what to give, e.g. yellow cell refers to scheduled

medications, and to organize their work by taking notes of the time medications need to be given. When it is time to give medications, they log into the system and refer back to the medication administration record. All the medications indicated for that particular time is then taken from the drawer and compare the details of the order with the medication sachet. The record was also used to look up at the last dose given for as needed medications (e.g. pain medications for the next scheduled dose). There is also clinical guidance (e.g. do not give with milk products). Participants has the option to reschedule the medication timing in the eMAR.

4.5.12 Paper Use – Organize work

The participants used paper to organize their work. The paper contained relevant information from the chart that was highlighted (e.g. medication times, vital sign frequencies), a list of tasks and reminders that are used for quick reminders.

4.5.13 Travel

Participants walked from one place to another (e.g. to enter patient's room; to grab weighing scale; to medication room). In travelling, participants mostly had their piece of paper where they had written notes on and would refer to their notes quite often.

4.5.14 Summary

At the beginning of each observation, participants generally are logged into the electronic medical record (EMR) reviewing information while writing and highlighting notes on their piece of paper. Participants would specifically look at the orders, electronic medication administration record, and report from the previous shift. At times, a nurse from the previous shift would come and discuss the patient case. Participants had relevant information in their piece of paper. They would refer to the paper to determine what is their next planned action. Most participants would go to the unit medication room and gather medication supplies and place the supplies onto the wireless computer cart cassette

drawers. Others would go to the medication room to only gather the medication supplies that are required at that given time for a patient. Participants had their own way of organizing their work, and used the wireless computer cart in different ways. Some had the wireless computer cart parked in one spot in the hallway of their assigned patients. Others moved the wireless computer cart closer to the door of their assigned patients, or inside the rooms. The access and use of the wireless computer carts may vary but all participants consistently had their piece of paper that they refer to. They would use the information in the piece of paper, and then would decide to log into the wireless computer cart or desktop computer to review information. Participants would look at existing information, and also look for new information (e.g. change in orders). Participants were constantly managing medication supplies, and new and existing information in the electronic medical record and verbal information from other nurses or physicians. Participants would do all this while travelling back and forth from one patient room to another, to nursing station and medication room.

Chapter 5: Discussion

5.1 Discussion

Implementation of CPOE and other health information technologies to achieve a close looped medication process is a strategic direction that many health organizations have set to accomplish. Although CPOE was introduced to address medication errors there may also be technology-induced errors or consequences of implementing technology in a highly dynamic environment such as health care. Nurses play a vital role in gaining understanding into this phenomenon. Nurses are involved in all stages of the medication process. This research study was conducted to answer the question of “how do nurses perceive the impact of CPOE on the medication process and collaborative practice?” Through the interviews and observations, the participants described the CPOE as the system used to enter medication, diagnostic, laboratory, patient care, and communication (e.g. refill orders) type orders. The medication, diagnostic, and laboratory orders are transmitted to the appropriate departments. The medication orders are processed and delivered to the unit based on the urgency (e.g. routine versus STAT) indicated by the medication order. Also, the medication orders automatically generate a schedule in the eMAR based on the frequency indicated in the order. The eMAR has a complete list of medications scheduled in a color-coded manner on the computer screen. The study showed that CPOE use has relational, contextual, cognitive, and workflow implications that in some instances lead to workarounds.

5.1.1 Relational Impact

Physicians mainly enter the medication orders using CPOE. Nurses at times may enter medication orders on behalf of physicians, when physicians are unable to access a computer, have limited time, or if an unexpected event happens to the patient that requires immediate attention. Nurses may also enter non-medication orders, e.g. communication order to pharmacy to refill the medication supply. CPOE is used to transfer medication information between departments, e.g. pharmacy and nursing unit.

Also, CPOE is used for order information sharing among health care professionals, e.g. pharmacist, nurses, and physicians. Participants mentioned that CPOE improved the legibility of the orders. Also, the automatic generation of a medication schedule and dynamic order transmission to pharmacy removed the requirement for nurses to transcribe and fax medication orders. Participants perceived that CPOE supported efficient medication information transfer between departments, and health care providers in the prescribing stage. In essence, CPOE had improved the legibility and clarity of a written order among departments and disciplines. However, the participants did not describe the prescription stage as an isolated action by physicians. The physicians are the primary actors in giving the medication orders but nurses contribute information that supports the decision-making of the physicians. Nurses assess the patients, and collate this information with communication from other health care providers or patients, and with information reviewed from the chart. Nurses use this information to discuss a patient's case with the physician prior to order entry. Nurses may discuss this verbally, via telephone, paging system, or write in a paper communication sheet. The chosen method of communication is dependent on the urgency of the patient health issue. The paper communication sheet is used when the discussion can wait for the physician rounds, if it requires immediate attention then nurses will phone or page the physician. The physicians would read the paper communication sheets as part of their rounds, and would speak with the nurse if further clarification were required.

Physicians may choose to enter the orders directly into the system, or in discussion with the nurse and ask the nurse to enter the order. If the physician decides to enter the order directly, with or without direct communication with the nurse, the nurse needs to be aware of the new order that has been entered into the system. In the study, the participants described that there are three ways that new orders are communicated: print out, flags, or verbal communication. CPOE is integrated in the electronic medical record, which is designed to display a "flag", and generates a print out when new orders are entered. The "flags" give a visual cue and are the main method of notification. Consequently, nurses are responsible to be logging on to the system or refreshing the screen, and checking the flags. This is similar to the paper based medication processes

where nurses are made aware of new orders when the flag is up on the paper chart. In both processes, it is the nurse's responsibility to check the flag. The difference is that in the paper based process, physicians need to be physically present to write the orders or verbally dictate the medication orders to a nurse. The physical presence of physicians may give indirect notification that a new order may have been given. While with the verbally dictated order, another nurse or charge nurse is involved and they communicate to the primary nurse that there is a new order. The disadvantage in the electronic medical record is that if the nurses do not remember to turn on their flags or if nurses do not have time to check their flags, then they may not be aware of the new order.

The use of CPOE altered the communication between the nurses and the physicians. The communication patterns changed from direct communication (face-to-face) to indirect methods of communication (e.g. paper communication, paging system, phone calls). New orders are notified via flags, and the information input from nurses is written, although the chosen modality of communication may vary depending on the urgency of the situation. Generally, nurses have to frequently check the "flags" in the EMR for new orders. The finding is similar with the outcomes from two separate studies by Pinejad and colleagues (Pirnejad, et al, 2008) and Van Doormaal and colleagues (Van Doormaal et al, 2010). They mentioned that the implementation of CPOE impaired the feedback mechanism and altered the synchronization between physicians and nurses during the medication process. The prescription took place behind the computer with the nurses more dependent on the way physicians' prescribe and less opportunity to clarify orders (Van Doormaal et al, 2010). Legible and clear medication orders are required to prevent errors. However, this is not the only factor to minimize errors, these new orders need to be communicated in a timely manner for administration. A missed notification may result in an error of omission (e.g. new drug not being given) or in an error of commission (e.g. discontinued medication being given). Also, in the prescription stage the input of nurses are necessary. Nurses carry information from their assessments, patient interaction, and review of information that help inform medication ordering, such as changing patient conditions or patient's home medications. In both cases, there is a sense that in using

CPOE nurses and physicians need to be more aware what type of information requires immediate feedback and direct communication (e.g. changed dose to start today, changing patient condition) or what could wait (e.g. routine, changed the medication to start tomorrow, home medications need be ordered) and use indirect communication.

5.1.2 Contextual Impact

Nurses use the medication information (drug, dose, frequency, route, time) from the ordering provider (physicians) to plan for care and ensure that it is safely administered to the patient. However, nurses' information requirements for medication administration are not limited to the medication information. They also require information about other orders, such as diagnostics, blood work, patient care orders, and communication from other health care providers. This order and communication information inform how nurses organize their work, and influences their decision making with regards to the medication process. Decisions that nurses make could be related to rescheduling the medication to fit the patient's condition and care needs (e.g. home routine). It could also be that nurses suggest a medication order to the physician or give the patient a PRN medication based on their assessments, and review of the information. The CPOE provides a structured method to enter orders. Then the EMR contains this order information and other patient information. The amount of information that nurses' process is influenced by how much time they have. Nurses mainly review the orders, medications, and communication from other health care providers that are relevant to their work shift. Nurses require information for all of the patients that they are assigned to. They tend to look at information over several patients and through the period of their shift. They need to administer the medications for their entire patient assignment within the schedule. The eMAR is organized per patient, and not several patients in one screen. The information need of nurses to remember which patient requires what at a certain time is not supported by the eMAR. Nurses then tend to write "small notes".

5.1.3 Cognitive Impact

Nurses write “small notes” of relevant information in a piece of paper to help them organize their work. The “small notes” help with remembering the key information, and prioritize what needs to be done. Nurses still log into the electronic medical record to review the details they require for the medication administration, but the “small notes” serve as their task list for their patient assignment and recall what medications need to be given at a certain time. It also serves as a quick note for any assessments that they have done. These small notes are referred throughout the work shift as the nurse travel quite frequently at a given shift. Potter and colleagues in their study determined that nurses apparently have high cognitive loads (Potter, et. Al., 2005). They found that nurses process new information and access previous information to make decisions while providing patient care. Though, their study were based on a small nonrandomized sample, it is still a source of a probable explanation as to why nurses still require paper as it is similar to the description of the participants in the study. Nurses describe that the paper is a necessary artifact as it supports their work and their memory to manage their patient assignment. Nurses also mentioned that they slightly modified how they organized their work to help remember that a medication has been poured. This is discussed in the next paragraph.

5.1.4 Workflow Impact

The recommended workflow is that documentation of administered medications is done after the patient takes these medications. However, some nurses in the study mentioned that they do document or “sign off” medications as they pour the medication in the medication cup. They described this as a “check” that the medication has been poured. It helps them remember that the medication is already poured, and that there is no need to go back again to the computer to sign the medications as given. If the patient did not take a medication, the nurses described that they are able to determine which medications are those based on the color and shape, and mark as not signed off.

5.2 Contributions to Health Informatics Practice

In developing and implementing CPOE with an integrated eMAR it is important to determine the relational dynamics of information, contextual information needs of each provider, the cognitive load of using the information, and the possible workflow changes that will result as to accommodate these factors.

Participants in the study described the relational dynamics of information in the medication process as cyclic. The initiator of the medication information is the physician, and others, such as the nurse, would contribute information to inform the initiator's decision. Also, the receiver of that medication information is the nurse. In designing and implementing CPOE, the cyclic relational dynamics in the prescription stage must be considered. Clinical decision support within CPOE can be developed using this cyclic relational dynamics, where on ordering the information that nurses provide, such as documentation of assessments, is readily available on ordering. Also, considering that nurses frequently travel throughout their shift, they may not be able to place this information in the electronic medical record in a timely manner. There is also a consideration that administered medication information may be entered prior to actual administration. Discussion with the health care professionals when implementing CPOE to establish clear guidelines on communication and usage is necessary, especially on how synchronization and feedback mechanisms can be preserved with CPOE use. The guidelines can support consistent feedback mechanisms for information that needs immediate attention, such as nurse communicating to the physician about a patient's changing condition, and the physician communicating to the nurse new STAT medication orders have been entered. Assumption that the most recent information is available in the electronic medical record and that this information is reviewed in a timely manner may lead to errors. Direct communication between physician and nurses are still necessary.

Contextual information needs of providers are determining the type of information that is required, and how it should be presented. Nurse's information need is based on seeing patient medication information for all their assigned patients and over their shift period. The eMAR displays the medication information per patient. Nurses require a method to manage information for group of patients, and a means to organize this information.

Nurses may benefit from a summary screen with the commonly reviewed and pertinent information: medications, orders, and communication from other health care providers. Also, a summary screen that enables the nurses to organize the information based on the relevancy of the information for their given shift would help them in organizing their work. The technical solution needs to be mobile, which allows nurses to easily carry the device with them as they travel from patient to patient. Another consideration is the use of vibration or smart technology, such as a smartwatch, that would alert nurses that there are new orders, change in the orders, or remind them of pending tasks, without logging into the EMR to view the alert. It is necessary to consider in designing technical solutions for nurses that the solution would support the cognitive load of nurses and the organization of their work.

5.3 Contribution to Education

This thesis attempted to contribute to education by expanding the knowledge on change management, and workflow modeling in CPOE implementations. Understanding the work of nurses within the medication process and nurses perceptions on CPOE will help target the areas that would facilitate CPOE adoption. Change agents may highlight the CPOE functions that support the nurses' work, such as color-based schemas in eMAR, and order legibility. Also model the workflow that allows nurses to look at their patient assignment information over their shift period, with alerts or reminders for pertinent information.

5.4 Future Research

For future research, a study on mobile devices, such as smartwatch or iPads, in the medication process is worth considering since nurses travel frequently during their shift and require a means to manage the information for several patients. A mobile device may address the workflow needs of nurses that were not met by the wireless carts. Further exploration on the cognitive load of nurses while using CPOE and eMAR on these

wireless carts and mobile devices would give insight to why paper is still used. Looking at the patient perspective on having a wireless cart or mobile device at the bedside. Whether the introduction of these technologies alter the relational dynamics between patient and health care professionals. It is also valuable to explore the frequency and types of errors intercepted by nurses using CPOE, and how nurses use health information technology in medical error recovery.

5.5 Limitations

The qualitative study was informant-driven, which provided insight into the experience of using CPOE in nursing practice. The semi-structured interview allowed the participants to express how they think that CPOE had an impact on their practice. While, the observations of their practice shed light as to how they interacted with CPOE in the actual work context. Through this, one gained a view of the cognitive and behavioral responses to the CPOE integration in nursing practice. The limitation of the study is it focused on the medical nurses' perspective. Excluding other nurses' perspectives from other departments, namely surgery, emergency, and intensive care, limits the transferability of the study findings. However, the study needs to be limited to the medical perspective, as each unit or setting has its own unique socio-organizational culture (i.e. workflow). Thus inclusion of other settings will increase the scope of the research. For example, surgical units do have a tendency to have a fast turnover compared to internal medical units. As a result, the usage of the CPOE may vary depending on their workflow. Another limitation is that the participants are limited to a Registered Nurses' (RN) perspective. As such registered practical nurses (RPN) or Licensed Practical nurses (LPN) are excluded in this study. In the city of the study, there are increasing numbers of Licensed Practical nurses in acute care with their scope of practice being gradually extended to accommodate the increasing demands of acute care settings. It would be valuable in comparing the perspectives of LPNs with RNs. Also, to look at the perspective of physicians and pharmacists during the prescription stage and if from their experience the synchronization and feedback mechanism have changed with

CPOE use. The study is based on participants' memory that maybe prone to recall bias. It is worth exploring a true pre- and post- CPOE implementation, where the experiences are current and not based solely on memory. Also, the majority of the participants was female in there twenties, and most likely has completed their student training in the city hospitals where the same CPOE has been in use since 2006. The limitation is that the participants do not represent the male nursing perspective, and that the participants with only a year working experience may lack experience working strictly with a paper based medication process in an acute care setting. Furthermore, most of the participants rated themselves as highly computer proficient and mentioned using computer systems in their daily lives. They may be more familiar with technology, and may have higher expectations of the effect of the system on their workflow, efficiency, and ease of use of technology (Hasman, Khajouei, Jaspers, & Wierenga, 2011).

In qualitative research, one needs to pay attention to reflexivity, as personal experience may have an influence on the conceptualization of the study, and have an impact on data collection and analysis stages. As the sole researcher and a RN who practiced on a surgical unit for four years and worked with CPOE as an advance user I needed to be aware of the probable bias that may be present. Though methodological triangulation is employed through interviews, observations, and post interviews, having another researcher with a non-nursing background conducting the study would have increased credibility of the study.

5.6 Conclusion

From the nursing perspective, the use of CPOE with an integrated eMAR has relational, contextual, cognitive, and workflow implications that at some instances lead to workarounds. In developing a closed loop medication system, information relational dynamics and considering what other information contributes to the decision of a medication order and medication administration is necessary. The other information consideration could include orders, medications, and communication from other health

care professionals. Furthermore, nurses require a means to organize this information for multiple patients and over the period of their shift. This will support their cognitive load and workflow since they travel frequently throughout their shift. This study is limited to the perspectives of registered nurses working in medical units. Also, may have a degree of bias due to the limitation that one researcher conducted the qualitative analysis.

Further research on the physicians, pharmacists, other nurses and the synchronization and feedback mechanisms through out the medication process are necessary. It also is valuable to conduct a pre- and post- CPOE implementation study rather than based on memory. Further research will provide deeper insights on how CPOE is utilized and of the errors that are introduced due to workarounds, and will help in standardizing the definitions of these errors. All are necessary to guide closed loop management design and implementation.

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Appendix A: Email Scripts

Email Script to Site Directors

Subject: Support for Research Study

Dear [Insert Site Director's/Program Director's name],
I previously contacted you asking for approval to conduct a research study entitled "Computerized Physician Order Entry (CPOE) Impact on Nursing" on the medical units of your site.

The study has been approved by the Community Research Ethics Board of Alberta and assigned Protocol Number: 1321. Also, approved by the University of Victoria Human Research Ethics board and assigned Protocol Number: 14-007. Please see attachments for the Approval Letter and Certificate.

As the research study involves semi-structured interview (approximately 60 to 90 minutes), observation (approximately 2 hours during a shift), and followed by a post observation interview (30 minutes) support of the unit managers is essential for participant recruitment and for the observational study to take place.

I would greatly appreciate if you could ask the support of your Medical unit managers. Below this email is a support letter template.

Thank you again for supporting Continued Education through this endeavor,
Sincerely,

Email Script to Unit Managers

Subject: Support for Research Study

Dear Managers,

A research study entitled “Computerized Physician Order Entry (CPOE) Impact on Nursing Practice” is being conducted by Rosabella Vito. She is a graduate student in the Department of Health Information Science at the University of Victoria, and part of the SCM Clinical Operations Support Team. The purpose of this research is to look at how CPOE is used in nursing work. This will help give insight to

We are asking for your support to conduct the study on your units in the month of March; and to invite your staff to participate in the study.

The research study involves:

- a) Semi-structured pre-observation interview (approximately 60 to 90 minutes)
- b) Observation (approximately 2 hours during a shift)
- c) Post observation interview (30 minutes)

The total time commitment is 4 hours, but the study is planned to be in segments. The pre-observation interview (60 to 90 minutes) will be conducted outside the participant’s work hours (during their time off). While the observation and post-interview will be conducted during a portion of the participant’s work shift. The time interval is indicated by when your staffs are likely to be involved in the medication process (e.g. medication administration, ordering, etc).

Scheduling of the study is dependent on the availability of the participant and when they are on shift. However, your assistance is valuable in scheduling the optimal times for the observational study to take place on your unit. Rosabella Vito will email you directly to verify whether the time/date that works for the participant also works with your Unit’s schedule.

Please forward the invitation letter to your staff (see attachment) and ask interested staff to respond by March 7th, 2014.

If you have further questions about the study, please email the researcher, Rosabella Vito, at [email]

Sincerely,

Appendix B: Participant Invitation Letter



Participant Invitation Letter

Title of Study: Computerized Physician Order Entry Impact (CPOE) on Nursing Practice

You are invited to join a study called "Computerized Physician Order Entry (CPOE) impact on nursing practice". The researcher is Rosabella Vito. She is a graduate student from University of Victoria and who currently works with the SCM Clinical Operations Support Team at Alberta Health Services.

Purpose

The study wants to know how CPOE is used in nursing work. It looks at how the CPOE is used to enter orders. It also looks at how CPOE is used to give medications. This study does not look at job performance. It looks at computer-nurse interaction.

What is involved?

If you volunteer to join this research, the total time of the study is 4 hours. It starts with an interview for 60 to 90 minutes during time off work. You can choose to be interviewed in person or over the phone.

You will be asked how you use the CPOE in your work. Then we will arrange a time to observe you for 2 hours during your work at your unit. The time and date will be arranged according to your availability and the unit's schedule. The observation is to look at your interaction with the computer.

After the observation, you will be asked more questions for 30 minutes. This is to ask you more questions to understand what you did while using CPOE. The interview is audio recorded. Also, field notes will be taken during the observation. The information collected will be reviewed for themes on the impact of CPOE on your work.

Importance

This will help to know what is the impact of using CPOE in nursing work. This can help other people to understand CPOE use. Also, help with CPOE design in healthcare.

Consent

You must decide to be part of this study on your own. You should not join if you do not want to. Your decision will not have any effect on your employment status. If you choose to be part of the study, you may leave anytime without giving any reasons why. Also, there are no consequences when you decide to leave. If you decide to leave, your information will be deleted unless you allow it to be part of the study. At any given point, if you decide to withdraw from the study, you will still be compensated for your time.

Risks

There are minimal known risks when you join the study. It is possible that you may feel uneasy while being observed. The researcher will observe from a non-high traffic area and avoid entering patient rooms. Also, the researcher will minimize distractions while you are actively working. The researcher will write notes for clarification and wait until you are on break or have a downtime to ask the questions. Remember this is not a job evaluation. Also, if you feel uneasy you may reschedule or opt out of the study with no consequences.

The focus of the observation is nurse-computer interaction. There may be possible instance of incidental finding, (e.g. medication error). In that circumstance the researcher is ethically responsible to ask clarifying questions and possibly note the event to the attention of your manager. This circumstance is a safety-learning incident and does not reflect job performance. AHS adopts a just and safe culture for incident reporting.

Compensation

You will receive a \$20 gift card for joining the study. The gift is not intended to force you to join the study. It is wrong to provide unnecessary payment or incentives to research participants. If you will not join if there is no gift, then you should decline. Also, at any given point you decide to withdraw from the study the gift card will still be given.

Appendix C: Participant Consent Form



Participant Consent Form

Computerized Physician Order Entry Impact (CPOE) on Nursing Practice

You are invited to join a study called “Computerized Physician Order Entry (CPOE) Impact on Nursing Practice”. The researcher is Rosabella Vito. She is a graduate student from University of Victoria in Health Information Science and currently works with the SCM Clinical Operations Support Team at Alberta Health Services, Calgary.

This study is for the completion of the Masters in Health Informatics degree requirements of Rosabella Vito. Also, the study is under the supervision of Tracey Schneider, Principal Investigator; Elizabeth Borycki, Associate Professor; and Andre Kushniruk, professor.

You may contact the researcher or the supervisory committee if you have any questions:

Purpose and Objectives

The study wants to know how CPOE is used in nursing work. This can help other people to understand CPOE use and its impact. Also, may help with CPOE design in healthcare.

Participants Selection

You are being asked to participate in this study because you are a Registered Nurse who has a minimum one-year experience on a medical unit.

What is involved?

If you volunteer to join this research, the total time of the study is 4 hours. It starts with an interview for 60 to 90 minutes during your time off work. You can choose to be interviewed in person or over the phone. You will be asked how you use the CPOE in your work. Then we will arrange a time to observe you for 2 hours during your work at your unit. The time and date will be arranged according to your availability and the unit’s schedule. The researcher will contact the unit manager to double check if your availability works for the unit schedule.

The observation is to look at your interaction with the computer. This study does not look at job performance. It only looks at nurse-computer interaction.

After the observation, you will be asked more questions for 30 minutes. This is to ask you more questions to understand what you did while using CPOE. The interview is audio recorded. Also, field notes will be taken during the observation. The information collected will be reviewed for themes on the impact of CPOE on your work.

Inconvenience

Joining this study maybe inconvenient to you. The time commitment is 4 hours. Also, having the researcher during your shift may hinder your work. Please advise the researcher if you would want to opt out of the study at any given point.

Risks

There are minimal known risks when you join the study. It is possible that you may feel uneasy while being observed. The researcher will observe from a non-high traffic area and avoid entering patient rooms. Also, the researcher will minimize distractions while you are actively working. The researcher will write notes and wait until you are on break or have a downtime to ask the questions. Remember this is not a job evaluation. Also, if you feel uneasy you may reschedule or opt out of the study with no consequences.

The focus of the observation is nurse-computer interaction. There may be possible event of incidental finding, (e.g. medication error). In that event, the researcher is ethically responsible to ask questions. It is possible that the event is brought to the attention of your manager. That is a safety learning incident, it does not reflect job performance. AHS adopts a just and safe culture for incident reporting.

Benefits

The study will help other people understand the impact of CPOE on nursing work. Also, help with future CPOE design.

Compensation

You will receive a \$20 gift card for joining the study. The gift is not intended to force you to join the study. It is wrong to provide unnecessary payment or incentives to research participants. If you will not join if there is no gift, then you should decline. Also, at any given point you decide to withdraw from the study the gift card will still be given.

Participation

You must decide to be part of this study on your own. You should not join if you do not want to. Your decision will not have any effect on your employment status. If you choose to be part of the study, you may leave anytime without giving any reasons why. Also, there are no consequences when you decide to leave. If you decide to leave, your information will be deleted unless you allow it to be part of the study. At any given point, if you decide to withdraw from the study, you will still be compensated for your time.

Ongoing Consent

The research will ask you for your verbal consent throughout the study. This is to make sure that you have the opportunity to still opt out.

Privacy

The study results will not name your identity. A code is used for your information. However, your MANAGER AND colleagues may know that you joined the study. This is due to SCHEDULING OF the observation during your work. They may know you joined the study, but they will not be able to connect it with the study results. Your identity will remain unknown in the result study.

Results

The results will be shared with others. Results will be published and presented through thesis, article(s), summary for the participants, and presentation to ahs managers.

Information

All the data from this study will be kept for 5 years then destroyed. All the data will be stored in a safe location in Alberta health services, Calgary that will protect your information. After 5 years your data will be completely

destroyed. All computer files and voice recordings will be erased. Also, all paper documents will be shredded. Only the primary investigator, researcher and research committee will have direct access to your information.

Contacts

You may directly contact the researcher, Rosabella Vito. You can reach her a

Also, may contact the Research Committee as listed in the next page.

To raise your concerns about the study the University of Victoria Human Research Ethics Office at 250-472-4545 or ethics@uvic.ca. Also, the Community Research Ethics Board of Alberta (CREBA) at 780-423-5727 or health@albertainnovates.ca

Your signature below shows that you agreed to join the study. You understand the terms of the study. Also, you had the opportunity to ask your questions to the researcher

Name of Participant

Signature

Date

Appendix D: Questionnaire: Demographic Info & Computer Use



British Columbia • Canada

Questionnaire: Demographic Info & Computer Use

Title of Study: Computerized Physician Order Entry Impact (CPOE) on Nursing Practice

Demographic Information

Name: _____ Gender: _____ Age: _____
 Preferred Method of contact (e.g. email, phone, etc.) _____
 Availability for Interview (Please indicate Date/Time): _____
 Availability for Observational Study (*Please indicate Date/time you are working*): _____

Nursing Experience

Years (e.g. 1999-2003)	Care Level (e.g. Acute Medicine)	Roles & Responsibilities (e.g. Staff nurse, Charge nurse, etc)

Computer Use

Please describe your computer use (e.g. email, MS office, etc)

How would you rate your computer proficiency in a scale of 1 to 10, 10 very proficient? _____

Why?

Have you used health information technology before for your nursing work (e.g. electronic medical records)?

Yes No

If yes, please describe the system and what/how you used it?

How long did you use them (months, years, etc.)?

Appendix E: Semi-Structured Interview Questions

Introduction of Interviewer

During the interview, I would like to discuss the following topics: your nursing experience, your computer use and your thoughts on the impact of CPOE in your practice. With these topics in mind

Nursing Experience (Current)

Main Questions	Additional Questions	Clarifying Questions
Can you describe your current work environment?	<ul style="list-style-type: none"> • What is the patient population your current work caters to? • How would you describe their acuity? 	<ul style="list-style-type: none"> • Can you expand a little on this?
Can you tell me about the roles and responsibilities that you have taken in your current job?		<ul style="list-style-type: none"> • Can you tell me anything else?
Describe the medication process, from ordering to medication administration in your current workplace	<ul style="list-style-type: none"> • Who are the participants? • How are they interacting? • What are the nursing roles in the medication process? In the ordering, transcription, dispensing, and administration? 	<ul style="list-style-type: none"> • Can you give me some examples?

Nursing Experience (Past)

Did you work with the paper method in your nursing career?	<ul style="list-style-type: none"> • If so, when? How long? 	<ul style="list-style-type: none"> • Can you expand a little on this?
Can you describe your current work environment?	<ul style="list-style-type: none"> • What is the patient population your current work caters to? • How would you describe their acuity? 	<ul style="list-style-type: none"> • Can you tell me anything else?
Can you tell me about the roles and responsibilities	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Can you give me some examples?

that you have taken in that time?		
Describe the medication process, from ordering to medication administration when using the paper method?	<ul style="list-style-type: none"> • Who are the participants? • How are they interacting? • What are the nursing roles in the medication process? In the ordering, transcription, dispensing, and administration? 	

Computer Use

Describe the Computer Physician Order Entry you use	<ul style="list-style-type: none"> • What functions can it do? • Describe its design 	<ul style="list-style-type: none"> • Can you expand a little on this? • Can you tell me anything else? • Can you give me some examples?
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Impact on Nursing Practice

What are the factors that help you accomplish your tasks (within the medication process)?	<ul style="list-style-type: none"> • With the CPOE? • With the paper method? 	<ul style="list-style-type: none"> • Can you expand a little on this? • Can you tell me anything else? • Can you give me some examples?
What are the factors that hinder you to accomplish your task?	<ul style="list-style-type: none"> • With the CPOE? • With the paper method? 	
How would you evaluate the change from paper to CPOE?	<ul style="list-style-type: none"> • What are the changes? • What is the impact on nursing practice? Other healthcare providers? • What is the change in the medication process? 	
In your opinion, what is you're the preferred	<ul style="list-style-type: none"> • Why? 	

method?		
How would you evaluate the impact on safety of using CPOE?	<ul style="list-style-type: none"> • In your experience, which safety problems bother people the most? • In your opinion, what are the most worrisome safety problems in your area? • How do you think these concerns can be mitigated? • How did you learn about these problems? • Why is this considered a problem? • Under what circumstances does the problem arise? • What is the scope of the problem? • Which places are most affected by the problem, when does it usually occur and who are the main players? • Have you noticed any changes in the situation over the past few years? • Which safety problems give rise to complaints? • How do you explain the problem? 	
How would you evaluate the impact on safety of using paper?	<ul style="list-style-type: none"> • In your experience, which safety problems bother people the most? • In your opinion, what are the most worrisome safety problems in your area? • How do you think these concerns can be mitigated? 	

	<ul style="list-style-type: none"> • How did you learn about these problems? • Why is this considered a problem? • Under what circumstances does the problem arise? • What is the scope of the problem? • Which places are most affected <p>by the problem, when does it usually occur and who are the main players?</p> <ul style="list-style-type: none"> • Have you noticed any changes in the situation over the past few years? • Which safety problems give rise to complaints? How do you explain the problem? 	
<p>In your opinion, how satisfied are nurses with CPOE?</p>	<ul style="list-style-type: none"> • From your experience, did it improve your nursing practice? Why? 	<ul style="list-style-type: none"> •

Conclusion of the Interview

<ul style="list-style-type: none"> • Are there any other thoughts on CPOE use that we have not discussed and that you find impacted nursing practice? Your own practice? OR • Do you want to add anything on the impact of CPOE in nursing practice? Your own practice? 	<ul style="list-style-type: none"> • 	
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Appendix G: Clarification Questions

Post-Observation Clarification Questions (Sample)

<ul style="list-style-type: none">• Can you describe how CPOE support your decision-making? And the (given action/activity)?
<ul style="list-style-type: none">• What did you find easier during (a given action/activity)?
<ul style="list-style-type: none">• What did you find difficult with its using during (a given action/activity)? Was it easier from before? Cognitively taxing?
<ul style="list-style-type: none">• Why did you act that way during (a given activity)?

Appendix H: Readability Scores

Consent Form: Reading Ease	
Readability Formula	Score
Flesch-Kincaid Reading Ease	61.8
Consent Form: Grade level	
Readability Formula	Grade
Flesch-Kincaid Grade Level	7.7

Information Sheet: Reading Ease	
Readability Formula	Score
Flesch-Kincaid Reading Ease	65.4
Information Sheet: Grade level	
Readability Formula	Grade
Flesch-Kincaid Grade Level	7.1

Appendix I: Ethics Approvals

CREBA

Community Research Ethics Board of Alberta

Protocol Number: 1321

Name of Principal Investigator: Tracey Schneider, Director, Community Research Ethics Board of Alberta (CREBA)

Name of Co-Principal Investigator: Rosabella Vito, Chair, Community Research Ethics Board of Alberta

Project Title: CPOE Impact on Nursing Practice

The Community Research Ethics Board of Alberta has reviewed the protocol involved in this project. The scientific design is found to be both sound and ethical within the limitations of research involving human subjects.

Approval by the CREBA does not encompass authorization to access the patients, staff, or resources of any regional or provincial health authority or other local health care institutions for the purposes of this project. Enquiries regarding institutional approval requirements should be directed to the appropriate person in each jurisdiction.

Responsibility for monitoring the implementation of the project is primarily that of the institution or facility the research is affiliated with. Concerns arising from monitoring should be reported to CREBA.

Date of CREBA review meeting:

September 20, 2013

Approval granted as of:

November 28, 2013

Documents reviewed and approved:

- Request for review application and full proposal received September 3, 2013
- Completed ARECCI Ethics Screening Tool
- Invitation letter, participant consent form, demographic information & computer use questionnaire, sample semi-structured interview plan (pre-observation), observation template, and sample clarifying questions (post-observation)
- Budget
- Curriculum Vitae
- Letter of response received November 21, 2013 in reply to CREBA's letter of request dated October 2, 2013

Conditions for Approval:

- Appropriate consent is obtained from all participants in this project.

Please accept the Board's best wishes for success in your project.

Sincerely,

☺

Maeve O'Brien
Chair, Community Research Ethics Board of Alberta

This approval is valid for one year until November 28, 2014



Protocol Number: 1321

Name of Principal Investigator: Tracey Schneider, D

Name of Co-Principal Investigator: Rosabella Vito, Clinical Informatics, Alberta Health Services

Project Title: CPOE Impact on Nursing Practice

The HREBA - CHC has reviewed the protocol involved in this project. The scientific design is found to be both sound and ethical within the limitations of research involving human subjects.

Approval by the CHC does not encompass authorization to access the patients, staff, or resources of any regional or provincial health authority or other local health care institutions for the purposes of this project. Enquiries regarding institutional approval requirements should be directed to the appropriate person in each jurisdiction.

Responsibility for monitoring the implementation of the project is primarily that of the institution or facility the research is affiliated with. Concerns arising from monitoring should be reported to the CHC.

Date of CREBA review meeting:
September 20, 2013

Approval granted as of:
November 28, 2013
February 10, 2014 (amendment request)
November 18, 2014 (renewal request)
November 8, 2015 (renewal)

Documents reviewed and approved:

- Request for review application and full proposal received September 3, 2013
- Completed ARECCI Ethics Screening Tool
- Invitation letter, participant consent form, demographic information & computer use questionnaire, sample semi-structured interview plan (pre-observation), observation template, and sample clarifying questions (post-observation)
- Budget
- Curriculum Vitae
- Letter of response received November 21, 2013 in reply to CREBA's letter of request dated October 2, 2013
- Amendment request to modify the proposed methodology, information letter and informed consent form received February 6, 2014
- Annual progress report form with renewal request received November 14, 2014
- Annual progress report form with renewal request received October 21, 2015

Conditions for Approval:

- Appropriate consent is obtained from all participants in this project.

Please accept the Board's best wishes for success in your project.

Sincerely,

Chair, HREBA – Community Health Committee


This approval is valid for one year until November 8, 2016



University
of Victoria

Human Research Ethics Board
Office of Research Services
Administrative Services Building
PO Box 1700 STN CSC
Victoria British Columbia V8W 2Y2 Canada
Tel 250-472-4545, Fax 250-721-8960
ethics@uvic.ca www.research.uvic.ca

Certificate of Approval

PRINCIPAL INVESTIGATOR: Rosabella Vito	ETHICS PROTOCOL NUMBER 14-007
UVic STATUS: Master's Student	Minimal Risk - Delegated
UVic DEPARTMENT: HEIS	ORIGINAL APPROVAL DATE: 04-Feb-14
SUPERVISOR: Dr. Elizabeth Borycki	APPROVED ON: 04-Feb-14
	APPROVAL EXPIRY DATE: 03-Feb-15
PROJECT TITLE: CPOE Impact on Nursing Practice	
RESEARCH TEAM MEMBER Co-principal Investigator/Committee Member: Tracey Schneider ([redacted]); Committee Member: Andre Kushniruk (UVic)	
DECLARED PROJECT FUNDING: None	
CONDITIONS OF APPROVAL	
This Certificate of Approval is valid for the above term provided there is no change in the protocol.	
<p>Modifications To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.</p> <p>Renewals Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.</p> <p>Project Closures When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.</p>	
Certification	
This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.	
<div style="text-align: center;">  Associate Vice-President Research Operations </div>	


Certificate Issued On: 04-Feb-14

14-007 Vito, Rosabella



Human Research Ethics Board
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Certificate of Renewed Approval

PRINCIPAL INVESTIGATOR: Rosabella Vito	ETHICS PROTOCOL NUMBER 14-007
UVic STATUS: Master's Student	Minimal Risk - Delegated
UVic DEPARTMENT: HEIS	ORIGINAL APPROVAL DATE: 04-Feb-14
SUPERVISOR: Dr. Elizabeth Borycki	RENEWED ON: 28-Jan-15
	APPROVAL EXPIRY DATE: 03-Feb-16
PROJECT TITLE: CPOE Impact on Nursing Practice	
RESEARCH TEAM MEMBERS Co-principal Investigator/Committee Member: Tracey Schneider (Committee Member: Andre Kushniruk (UVic)	
DECLARED PROJECT FUNDING: None	
CONDITIONS OF APPROVAL	
<p>This Certificate of Approval is valid for the above term provided there is no change in the protocol.</p> <p>Modifications To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.</p> <p>Renewals Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.</p> <p>Project Closures When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.</p>	
Certification	
<p>This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.</p>  <p>Associate Vice-President Research Operations</p>	

14-007 Vito, Rosabella

Certificate Issued On: 28-Jan-15



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 Administrative Services Building Rm B202 PO Box 1700 STN CSC Victoria BC V8W 2Y2 Canada
 T 250-472-4545 | F 250-721-8960 | uvic.ca/research | ethics@uvic.ca

Certificate of Renewed Approval

PRINCIPAL INVESTIGATOR: Rosabella Vito	ETHICS PROTOCOL NUMBER 14-007 Minimal Risk - Delegated
UVic STATUS: Master's Student	ORIGINAL APPROVAL DATE: 04-Feb-14
UVic DEPARTMENT: HEIS	RENEWED ON: 15-Jan-16
SUPERVISOR: Dr. Elizabeth Borycki	APPROVAL EXPIRY DATE: 03-Feb-17
PROJECT TITLE: CPOE Impact on Nursing Practice	
RESEARCH TEAM MEMBER Co-principal Investigator/Committee Member: Tracey Schneider (Committee Member: Andre Kushniruk (UVic))	
DECLARED PROJECT FUNDING: None	
CONDITIONS OF APPROVAL	
<p>This Certificate of Approval is valid for the above term provided there is no change in the protocol.</p> <p>Modifications To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.</p> <p>Renewals Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.</p> <p>Project Closures When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.</p>	
Certification	
<p>This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.</p> <p style="text-align: right;">Dr. Tracey Schneider Associate Vice-President Research Operations</p>	

Certificate Issued On: 15-Jan-16

14-007 Vito, Rosabella

