Enacting Medication Administration as Nursing Practice in a Neonatal Intensive Care Unit: A Praxiographic Study

by

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B.S.N., Arizona State University, U.S.A. 1981
M.N., University of Alberta, 1988

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Abstract

The purpose of this research was to offer a description of the complexity of nurses' medication administration practices in relationships with technology. The clinical situations and circumstances in which nurses administer medications today are comprised of rapidly changing technological initiatives that are intended to support safe, efficient care. Nurses' medication administration practices are not immune to a rapidly changing technological health care environment. Research and literature has documented medication administration occurs in complex situations and nurses apply particular knowledge that supports decision-making and clinical practices for patient safety.

Praxiographic methodology was used to describe deeply embedded knowledge and values that shape and guide contemporary nursing practice. Lack of attention to knowledge and values that shape and guide nursing practice and care, may contribute to the risk that those practices may be lost as nurses retire in a rapidly changing healthcare environment. A highly technical Neonatal Intensive Care Unit (NICU) was the location for the study. Participants included twelve NICU nurses and a pharmacist.

The research findings included the significance of understanding NICU nurses' use of local and universal maps to navigate the complexity of medication administration. Furthermore, the research documented NICU nurses' medication administration practices as inseparable from technology. Further practice-based research is recommended to support the development of technologies that incorporate nurses' medication administration practices.

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Dedication

I dedicate my dissertation to the frontline nurses who navigate the complexity of health care systems to promote health and healing of individuals, families and communities. My dissertation is also dedicated to my colleagues, family, and friends who supported me during many challenging moments, as I completed my research and dissertation. And most importantly, I dedicate this dissertation to my brother whose life was cut short as I was writing the first draft of my dissertation.

Acknowledgement

I am extremely grateful to my supervisor, Dr. Mary Ellen Purkis for her encouragement and insightful guidance throughout my research. In particular, I am most thankful for her depth of knowledge and scholarly acumen with respect to the importance of practice-informed research for nursing practice. I would like to acknowledge my committee members, Dr. Karen L. Courtney and Dr. Karen MacKinnon for their consistent encouragement and scholarly insights.

Chapter One: Introduction

The purpose of this research was to gain an understanding of how nurses' medication administration was enacted in practice. The catalyst for my interest in researching nurses' medication administration practices was my practice as an on-call nurse educator. While on call over a weekend, I received a distraught call from a third-year nursing student who had made a medication error. The error happened during the night, on the student's first shift, within the parameters of a new practice education model in a Bachelor of Science Nursing (BSN) program. The new practice education model was a Collaborative Learning Unit (CLU) and the student was at the end of the third year of a four-year nursing program. In a CLU "students practice and learn on a nursing unit, each following an individual set rotation and choosing their learning assignment (and therefore the Registered Nurse with whom they partner), according to their learning plans" (Lougheed & Galloway Ford, 2005). Prior to the CLU practice experience, the student had been in an instructor supervised practice education model (an instructor is present on the unit with the student). Another change for the student was that she was working a 12-hour night shift. In the first three years of the BSN program prior to the medication error incident, the student had never completed a night shift.

In my reflection on this student's medication error, I could not help but ask if we, as nurse educators, might be contributing inadvertently to student medication errors. While nurse educators teach a check and balance system for medication safety, I contemplated, what might be missing about medication administration in the education of future registered nurses. My curiosity and experience shaped my doctoral research topic with an interest in medication administration as it is enacted in practice.

Medication Administration Research and Literature

Research and literature about medication administration have focused largely on error prevention without uncovering the thinking nurses employ in medication administration practices. Problem solving related to medication errors and patient safety is typically addressed by layering more human checks and balances with technology in hopes of decreasing errors (Carayon, et al., 2014; Chang & Mark, 2009; Fowler, Sohler, & Zarillo, 2009; Tregunno, Ginsburg, Clarke, & Norton, 2013). Finding causes to prevent errors is indeed very important, as medication errors continue to occur and result in patient safety concerns. However, noting that errors continue in more or less the same proportion despite many strategies to prevent errors raises concern (Chang & Mark, 2009; Lapkin, Levett-Jones, Chenoweth, & Johnson, 2016). And this concern raises questions such as; a) is the practice of medication administration adequately understood to support a comprehensive analysis of medication errors? b) What do nurses and educators know about how medication administration is enacted in practice? A further discussion of the medication administration literature is found in Chapter Two.

Technology and Medication Administration

The situations and circumstances in which nurses administer medications today are comprised of rapidly changing technological initiatives that are intended to support safe, efficient care. Nurses' medication administration practices are not immune to a rapidly changing technological health care environment. While electronic documentation of medication administration and patient care provides access to large amounts of health care data, it has not been free from challenges. Koppel, Wetterneck, Telles, and Karsh (2008) discovered 15 different types of workarounds to the bar code medication systems when nurses administered medications to patients. Similarly, research on electronic medication administration systems has uncovered

the potential for new errors (Alhanout, Bun, Retornaz, Chiche, & Columbini, 2017; Chang & Mark, 2009; Kushniruk, Triola, Borycki, Stein, & Kannry, 2005; Swartzberg, Ivanovic, Patel, & Burjonrappa, 2015).

The purpose of this research is to offer a description of the complexity of nurses' medication administration practices in relationships with technology. A highly technical Neonatal Intensive Care Unit (NICU) was the location for the study to answer the following question: How are NICU nurses' medication administration practices enacted in a highly technological environment with vulnerable preterm infants?

Methodology

In the interests of providing a description of how nurses' and technology enact medication administration, praxiography was chosen (Chapter Three). Praxiography focuses on the interaction of humans and technology in practice (Mol, 2002). As an interpretive method, praxiography focuses on the movements, actions, and involvements of human and non-human actors in practice without privileging one over the other. A praxiographic approach was used to collect data to describe NICU nurses' enactment of preterm infant medication administration. As medication administration is an integral part of NICU nurses' shift work responsibilities, descriptions of preterm infant care are also included in the research findings (Jennings, Sandelowski, & Mark, 2011).

Participant observation, practice documents, unstructured interviews, and historical nursing literature were data sources for my doctoral research. The participants in this study, for the most part, were experienced nurses who have witnessed medication administration changes occurring over years of practice and in some settings daily. Experienced NICU nurses were observed as they enacted medication administration in relationships with technology.

Observations recorded as field notes were cross checked with interview data for shared meaning about medication administration practices, between researcher and participants (Purkis, 1994).

Descriptions of experienced NICU nurses' medication administration practices, in relationships with present day health care technology are included in Chapters Six, Seven and Eight. NICU nurses' and technology's enactment of medication administration, are also discussed in Chapters Seven and Eight to answer the research question: How do NICU nurses enact medication administration in a highly technical environment with vulnerable preterm infants?

Focus on the Enactment of Practice to Inform Technology

The study also offers accounts of nurses' thinking regarding, and enactment of, medication administration practices. In order to inform the introduction of additional technologies, ostensibly to address and prevent errors, this study offers a practice-based account that describes interactions between current thinking practices of nurses and medication technologies currently in use.

To this day, nurses' work includes medication administration and it is the nurse who is the last professional passing the medication onto the person for whom it is intended. The potential exists for prevention of medication errors through understanding nurses' knowledge and enactment of medication administration practices. Furthermore, an understanding of the context of nurses' medication administration practices is needed to uncover how nursing knowledge is put into action in highly technical clinical settings (Purkis & Björnsdottir, 2006). This study provides a description of experienced NICU nurses' enactment of medication administration practices in relationships with present day health care technology.

Chapter Two: Literature Review

Historically, nurses have been the designated health professional for medication administration (Robinson Wolf, 1988). Contemporary and historical perspectives of medication administration are of importance for nursing practice, as this work contributes to knowledge development and professional identity among nurses (CNA, 2007). Nurses' medication administration practices continue to evolve since Robinson Wolf's seminal research in 1988.

In this chapter, I discuss scholarly literature and review web sites in order to gain an understanding of the popular and professional discussions about nurses and medication administration as contemporary and historical perspectives for this study. A literature search was conducted using PubMed, CINAHL, Google scholar and patient safety websites. Search terms included *medication administration*, *medication errors*, *nurses and medication administration*, and *nurses' thinking and medication administration*. The literature and the Institute for Safe Medication Practices Canada website (ISMP) presented in this chapter include documents published between the years 2000 and 2019. Landmark nursing literature on medication administration prior to the year 2000 is also included.

A critical reading of the descriptive, theoretical, and empirical literature selected illustrates particular patterns about the ways in which medication administration is portrayed, and how problems associated with medication administration are framed, including recommendations for resolving problems. For instance, most often, small technical fixes of one sort or another are recommended. These include educational programming or even *re*-programming of those individuals most involved in this activity, most often targeting nurses. As I will discuss in this chapter, such technical fixes are often in and of themselves, problematic and

fail to account fully for the very complex environment within which activities and errors of medication administration occur.

Introduction to Medication Administration Issues

Contemporary nursing medication administration literature and research place a strong emphasis on nurses' practice and medication errors. Nurses, by the nature of their work, are the main purveyors of patient care and therefore, closely connected to patient safety. Given patient safety concerns, error prevention gravitates towards approaches that control and predict nursing behaviours. These solutions are often stepwise approaches with mental reminders (Chang & Mark, 2009). One example of a mental reminder is the so-called *rights* of medication administration (i.e. a list of actions prescribed to be taken prior to administering a medication). These rights are described as involving anywhere from three to ten steps (Edwards & Axe, 2015; Macdonald, 2010; Robinson Wolf, 1988). It is notable that, in response to continually high rates of medication errors, more steps or reminders are added to the prescribed list of strategies for medication administration. A continual addition of steps reduces medication administration in status to a simple task that does not reflect the critical thinking and clinical reasoning required to administer medications safely in many nursing practice situations.

However, as literature demonstrates, medication administration occurs in complex situations and nurses apply particular knowledge that supports decision-making and clinical practices (Baker, 1997; Bucknall, et al., 2019; Carayon, et al., 2014; Edwards & Axe, 2015; Eisenhauer, et al., 2007; Garrett & Craig, 2009; Rohde & Domm, 2018; Smeulers, et al., 2014; Tamuz, Franchois, & Thomas, 2011; Tamuz & Thomas, 2006). Furthermore, research also documents examples of nurses' clinical practices, while performed in the patient's best interest, were understood as medication errors according to institutional policy (Baker, 1997; Bucknall, et

al., 2019; Rohde & Domm, 2018; Smeulers, et al., 2014). Medication administration, as I understand it, is a process that includes thinking beyond rules and procedures, such as the technical application of "rights" of medication administration.

Furthermore, the complexity of medication administration is reflected in health care costs that are impacted by errors. The World Health Organization (WHO, 2020) has documented medication errors as a leading cause of preventable patient harm. Therefore, exploring the complex practices of medication administration is timely and critical for patient safety and decreasing health care costs.

Costs of Medication Errors

In response to global and Canadian concerns for medication safety, the Canadian Patient Safety Institute (CPSI) is leading a *medication without harm* campaign to prevent medication errors (CPSI, 2018). Medication errors impact a) health outcomes, b) length of stay in a healthcare facility, c) readmission rates, and d) overall financial costs to Canada's healthcare system. "Preventable medication hospitalizations cost over $140 million CAD in direct and indirect healthcare expenditures, with lost productivity, including time off work, adding $12 million in costs.

Events associated with medication errors are among the most frequent of all harmful events possible in a hospital. Medication events captured in the *Measuring Patient Harm in Canadian Hospitals* report were attributed to 37% of patient harm incidents in the years 2014 – 2015 (Canadian Institute for Health Information (CIHI/CPSI), 2016). According to the WHO (2020), cost estimates for medications errors have been estimated at "US$ 42 billion annually, not counting lost wages, productivity and health costs" (p 8). The economic liability of medication errors requires professional and institutional collaboration for prevention.

A Focus on Medication Error and Perspectives of Error

Multiple definitions of medication errors. The variation in the literature on definition of errors and their causes points to the complexity of medication administration and the subsequent errors that can arise. The Institute for Safe Medication Practices Canada (2010) website refers to a medication error as a "medication incident" or "a mistake with medication, or a problem that could cause a mistake with medication" (Institute for Safe Medication Practices Canada, 2017). In a systematic review of error prevention literature, Raban and Westbrook (2014) were challenged when comparing research results due to researchers' different definitions of medication errors. Further research was recommended by Raban and Westbrook to better understand medication errors and the complex relationships in which they occur.

Definitions of medication errors.

Mistake in administration. Chang and Mark (2009), in their research, define a medication error conceptually as *a mistake in administration and not in the prescription of a medication*. This conceptualization sets a precedent that places limits on the definition of a medication error. In this study, the medication errors were classified as severe or non-severe errors. A *severe* error was defined as a patient requiring "increased nursing observation or technical monitoring; laboratory or radiographic testing; medical intervention, or transfer to another unit." (p. 73). In other words, a severe error resulted in additional costs for providing care to the patient. A *non-severe* error included any other error that did not fit the above criteria. Categorizing errors as severe or non-severe may also influence whether or not errors are reported. Similarly, reporting errors as severe or non-severe may not capture health professional priorities for patient safety, which includes other considerations such as the environment for care, communication, and the complexity of medications (Tregunno, et al., 2013).

Preventable or non-preventable. Edmondson (2004) refers to adverse drug events and classifies them as either preventable or non-preventable. For Edmonson, human error is considered a preventable ADE, whereas an unpredictable allergic reaction is considered a non-preventable ADE. However, technology (e.g., computerized medication systems) is not included in the description of ADE's or medication errors. Edmonson's definition also places limits on medication errors as those attributable to human action or inaction.

Nurses' definitions. Researchers have documented how nurses' clinical decision making about patient needs overrode institutional definitions of what constituted medication errors. In particular, based on patient status, nurses' decision making included purposefully administering medications late or withholding a medication. Many of these clinical decisions were later institutionally classified as an error. (Bucknall, et al., 2019; Rohde & Domm, 2018; Smeulers,et al., 2014). Institutional classification of medication errors creates visibility for such mistakes, but the sole focus on error at the delivery end, often heavily implicating nurses, renders the full process of medication administration invisible. A focus on the delivery end of the process of medication administration results in a limited understanding of how medication errors do or do not occur.

Classifications of Medication Errors

Prescribing errors. When a *pharmacist* discovered a prescribing error and followed up, it was classified as a "pharmacist's intervention" (Tamuz & Thomas, 2006, p. 929). Similarly, *physicians* reported prescribing error follow-up by pharmacists and nurses as a verification of a medication order, rather than as a correction of a physician's mistake. *Nurses* in the three hospitals studied did not keep track of their work of following up on prescribing errors, which unfortunately omits a critical piece of the medication administration data that could be helpful in

terms of institutional policies and ensuring adequate nursing staffing levels. The time nurses spent following up when they identified prescribing errors is not taken into consideration, nor is there a regular review of physician prescribing practices, so prescribing errors remain invisible as errors at an institutional level. *Pharmacists* did retain their intervention data but it was not tracked to discern patterns in physicians' prescribing practices (Tamuz & Thomas, 2006). As physicians only prescribe medications, they are connected with the process in a very different way than pharmacists and nurses who prepare or administer medications. Thus, physicians remain at arm's-length from institutionally sanctioned rule-based formulae for classifying medication errors.

Pharmacy errors: errors in preparation, labelling and distribution of medications. Tamuz and Thomas (2006) found nurses identified pharmacists as contributing to errors, as they often did not prepare (i.e., dispense) the medications on time. This resulted in a medication error due to late delivery and a violation of the rules nurses used for guiding medication administration practice. Nurses' thinking regarding how they do or do not assign error with respect to other professionals involved in medication administration requires exploration. Further research and discussion is also needed to uncover what *assigning error* means for identification and analysis of medication administration and errors.

Errors in administering medications: nursing perspectives. A central theme in the literature reviewed is the nurse's role in the prevention of errors (Anthony, Wiencek, Bauer, Daly, & Anthony, 2010; Colligan & Bass, 2012; Donze & Robinson Wolf, 2007; Freeman, McKee, Lee-Lehner, & Pesenecker, 2013; Flynn, Evanish, Fernald, Hutchinson, & Lefaiver, 2016; Hayes, Jackson, Davidson, & Power, 2015; Raban & Westbrook, 2014; Relihan, O'Brien,

O'Hara, & Silke, 2010; Ulrich, 2008). Most nurses understood medication errors as errors in administering medications.

Nursing continues to recommend the use of mental reminders or nursing rituals such as the *rights* of medication administration, to prevent medication errors (Robinson Wolf, 1988). As it becomes apparent that errors continue to happen despite the five plus "rights" equation of the present time, more rights are added to the formula. In 1988, Robinson Wolf spoke of three rights of medication administration. Wilson and DiVito-Thomas (2004) added a sixth right to the existing five rights, which was the right response. Harding and Petrick (2008) identify seven rights for nursing practice. A current Google Internet search uncovers references to as many as ten (10) rights of medication administration. A review of three Internet sites for the ten rights of administration, found the order in which the rights were listed and the terminology across sites differed (Ten Rights of Medication Administration, n.d.; Westmoreland County Community College).

Electronic medication administration record and data truncation errors. Cohen (2009), speaking as president of the Institute for Safe Medication Practices, stated that technology can create sources of error. One source of error for a computerized Medication Administration Record (MAR) is the truncation of data as there is a limit on the number of characters allowed per entry field. The resulting printed MAR used for medication administration may be incorrect due to missing data because of abbreviated formats in which the prescribed medication appears. This finding suggests that some electronic supports introduced into health care organizations, ostensibly to increase patient safety may, in fact produce the opposite effect. Cahill (2009), in her review of pediatric medication safety, also found computerized design system errors. Design-related errors consisted of "duplicate orders,

selection errors, keypad entry errors and application of order sets not appropriate to the patient" (p. 43). The complexity of medication errors is evident when design related errors are identified.

Electronic health record (EHR) features and errors. Bramble, et al. (2013) uncovered medication prescribers' and nurses' safety concerns related to electronic medication prescribing and patient documentation. Similarly, Kushniruk, et al. (2005) discovered that incorrect data entry was a concern related to the use of drop-down menus that could result in a wrong selection, such as an intravenous route of administration being selected when an oral route was intended. A copy and paste function in the EHR was identified as patient safety risk as inaccurate information entered into the system could be repeatedly propagated over subsequent patient encounters and medication order renewals. Bowman (2013) in her analysis identified that copy and paste functions of EHR's also contributed to inaccurate and outdated information. "Alert fatigue" was also documented as a potential risk for a medication error as it causes prescribers and nurses to ignore alerts. Important information may be omitted when an alert is ignored that was intended to prevent patient harm (Bramble, et al., 2013).

Consistent with existing research, Stockton and colleagues, (2017), found electronic reconciliation records with pre-populated data features contributed to the creation of medication errors. Chart reviews of 151 patients uncovered that twenty four percent of medication errors were related to using prepopulated electronic medication data. These authors advocate against reliance on an electronic system for medication reconciliation and call for a thorough review of a patient's medications by a pharmacist.

Computerized provider order entry (CPOE) errors. Switching from handwritten electronic medication orders was considered a solution to illegible prescriptions that impact patient safety. Despite the change to CPOE, researchers have discovered increases in medication

errors (Alhanout, et al., 2017; Swartzberg,et al., 2015). Swartzberg, and colleagues (2015) studied the introduction of CPOE using a pre and post research design to measure changes in prescribing errors. Research results found a significant increase in prescribing order mistakes post CPOE introduction. These researchers recommended that objective data analysis should accompany CPOE development to ensure that error reduction is achieved.

Alhanout and colleagues (2017), in their research, found missing features in a CPOE system contributed to pediatric prescribing errors. To prevent pediatric prescribing errors, they recommended better software design that includes mandatory patient characteristics such as bodyweight.

To summarize, medication administration complexity is apparent with the introduction of technology aimed to simplify and manage practice. Researchers consistently recommended that a continual assessment of electronic health records is needed to address usability and patient safety to prevent medication errors (Alhanout, et al., 2017; Bramble, et al., 2013; Kushniruk, et al., 2005; Stockton, et al., 2017; Swartzberg, et al., 2015).

Etiology of Medication Errors

Challenges to safe medication administration occur within complex care situations involving diverse populations. For instance, a large number of medications prescribed today are highly toxic and must be carefully administered as an exact dose to avoid negative complications for patients. Today's complex medication context does not lend itself to the simple "rules" approach that may have served nurses and their patients in earlier times.

Stewart and colleagues (2018) found that health professionals held divergent and similar perspectives on causes of medication errors. Pharmacists described causes as related to physicians' reliance on them to correct prescribing errors and reluctance to alter a prescription

for a colleague that was incorrect. Physicians identified health professional non-adherence to policy as a cause for medication errors, such as a pharmacist's not completing a required check list before dispensing a medication. Nurses identified a lack of recognition of their contributions to patient care as one cause for recorded medication errors. All health professionals identified inadequate staffing, high pressure patient care situations and the implementation of an electronic health record as contributors to medication errors in this context. Thus, researchers have repeatedly uncovered that health professionals' knowledge influences their explanations of the occurrence of medication errors. Furthermore, researchers found that practice situations also influenced health professionals' varied explanations of medication errors.

Tregunno, et al. (2013) found that for nurse educators, safe medication administration priorities were centred on the "environment of care", while physicians identified "personal responsibility for communication", and pharmacists concentrated on the "complexity of drugs" (p. 5). The causes identified by nurses, pharmacists and physicians (e.g., environment of care, personal responsibility for communication, and complexity of drugs) need to be incorporated into new guidelines that support safe administration of medications. Therefore, the complexity of patient safety, of which medication administration is one area of concern, is not easily reduced to a set of rules to be followed blindly. Instead, in order to prevent errors, medication administration protocols require interprofessional guidelines for care that incorporate the priorities of all health professionals and in depth pharmacological knowledge.

Samaranayake, Cheung, Chui and Cheung (2012) in their research documented inadequate computer interface between users and technology as the most common cause of medication errors. User and technology interface issues documented by Samaranayake and colleagues included incorrect data entry that resulted in errors in medication labels, prescriptions

and patient identification. Stultz and Nahata (2015) also reported inappropriate use of technology and insensitivity of Information Technology (IT), as common causes of medication errors in a pediatric institution (Stultz & Nahata, 2015). One example of IT insensitivity was dosage errors that were not prevented.

Boucher and Ho (2019) documented professional experience with a single incorrect computer key stroke that caused a serious error. These authors recommended prevention of medication errors and near misses through open health care team discussions to understand how they occurred.

Reporting of Medication Errors

To support learning and promote development of error reduction strategies, the Institute for Safe Medication Practices (ISMP) Canada employs a non-punitive philosophy and voluntary approach to reporting errors. It is apparent from the web site of ISMP Canada, that, in order to develop strategies for the prevention of medication errors, a comprehensive collection of information is needed, beyond numbers of errors. ISMP Canada encourages the reporting of near-miss medication errors as one source of information to support the development of strategies for the prevention of errors. Edmondson (2004) also focused on the group and organizational components that affect medication administration errors in her research. She suggested that organizations should reward individual and group behaviours that promote the reporting of medication errors in order to learn from mistakes and prevent error.

Williams, Sweeney and Britton (2014) investigated an established voluntary medication event reporting over a two year period in a neurology unit in a large tertiary hospital. Health care providers' voluntary reports of medication events were not consistent. Staff nurses reported the majority (93%) of medication events reviewed by the researchers, while physicians reported

14%. Williams and colleagues (2014) identified the notable differences between reporting were related to the heterogeneous nature of medication events. These authors contend that the heterogeneity of medication events in their research findings demonstrated challenges for prevention.

Professionals' Varying Perspectives on Medication Errors

Medication errors are perceived, defined, identified and reported differently depending on the practice setting and health care professional involved (Stewart, et al., 2018; Tamuz, et al., 2011; Tamuz & Thomas, 2006; Unal & Seren, 2016). Divergent professional perspectives on medication errors contribute to the complexity of medication administration. Tamuz and Thomas (2006) in a landmark study uncovered effects of differing disciplinary practices on definitions of medication errors. Nurses would report an error that pharmacists would not consider an error. For example, *nurses* using the five rights of medication administration would perceive a late medication as an error, whereas a pharmacist did not. *Pharmacists* in relation to medication tardiness used specialized knowledge, based on their understanding that the delay of the medication was not clinically significant for the patient and therefore should not be considered an error. In this example, the nurses drew on rule-based guidelines for medication administration; whereas pharmacists used therapeutic effects to classify a medication error. *Pharmacists* used specialized knowledge to inform their practice. Similarly, *nurses* drew on specialized knowledge of the organizational context of care to define late delivery as an error, grounded in knowing that if the drug is not given at the scheduled time it may get missed altogether.

In their research about a particular adverse drug event (ADE) Tamuz, Franchois and Thomas (2011), discovered that health professionals held divergent classifications of the error.

For instance, *nurses* and *pharmacists* took responsibility and sought practice changes prior to an institutional investigation. *Physicians* found no fault in the non-standard prescription written by a colleague, as it included a correct dose. *Pharmacists* and *nurses* identified the written order as confusing because it did not follow a standard format. Pharmacists and nurses also took responsibility for missing the error, in light of the confusing format of the written prescription. Physicians identified the ADE as a nursing and pharmacy error. A root cause analysis of the adverse drug event completed by the institution determined that the confusing format (non-standard format) of the prescription initiated the error. Follow up to the root cause analysis resulted in a requirement that all *physicians* comply with the standardized format for prescriptions.

Professional Classifications of Medication Error Vignettes

Not only did nurses, pharmacists, and physicians perceive medication errors differently, they also classified medication error vignettes differently (Tamuz & Thomas, 2006). Nurses were able to attribute error to pharmacists in a vignette with a pharmacist mistake. In contrast, nurses had difficulty attributing error to the physician when the vignette included a physician's mistake (Tamuz & Thomas, 2006). I can only surmise that an error is understood by nurses as directly related to preparation and actual administration of a medication to a patient. Prescribing errors are prevented when nurses and pharmacists use their knowledge and expertise to uncover or override physicians' prescribing mistakes and correct them before administration. This nursing practice of assuming responsibility for preventing medication errors renders physician prescribing errors invisible.

Interventions for the Prevention of Medication Errors

A literature search with the terms "medication error" and "patient safety" is replete with articles that cover a wide range of interventions to prevent errors. Strategies to prevent errors include: the promotion of computerized order entry for specialty areas such as the NICU, safe prescribing tips, scales to evaluate prescribing practices, and case studies that explicate situations in which errors occur (Donze & Robinson Wolf, 2007; Freund, 2008; Horns & Loper, 2002; Taylor, et al., 2009). Organizational strategies include a focus on the correction of human error and bar code technology to prevent medication errors (Fowler, et al., 2009).

Strategies designed to change nurses' behaviours (and thus minimize error incidents) include prevention of interruptions and distractions during medication administration (Anthony, et al., 2010; Colligan & Bass, 2012; Freeman, et al., 2013; Flynn, et al., 2016; Hayes, et al., 2015; Raban & Westbrook, 2014; Relihan, et al., 2010; Ulrich, 2008). Educational programs and training that focus on behaviour, were also strategies recommended to teach nurses how to handle interruptions during medication administration (Hayes, et al., 2015).

Clinical guidelines to prevent errors. Davis, Ware, McCann, Keogh, and Watson (2009) sought to measure how contextual influences related to socialization and work environment impacted medication administration. These researchers used a quantitative study with an exploratory descriptive design. These authors state that nurses are responsible for the "calculation, measurement and administration of medication" so "…If a medication error occurs it is often related to nursing error" (p. 1294). In this study, these researchers looked for relationships between nurses' access to information, level of experience, influence of colleagues and the impact of policies on nursing medication administration. Their aim was to better

understand nurses' adherence to following policies and clinical guidelines as a mechanism for the prevention of error.

Educational preparation and training to prevent errors. Problem solving related to medication errors and patient safety is typically addressed by layering more human checks and balances with technology and extra training of nurses in hopes of decreasing errors (Fowler, et al., 2009; Hayes, et al., 2015). For instance, Hayes and colleagues (2015) suggest extra preparation for nurses to handle interruptions during medication administration and further research that is solution-focused. Given that nurses administer routine and as-needed medications, these researchers, advocate for research that documents the effects of interruptions on scheduled and non-scheduled medication administration.

Blank, et al. (2011) designed an educational intervention for medication safety in response to the most frequently reported errors in American emergency departments. Using a pre and post-test design, this research showed improved medication knowledge of the nurse participants in the study. However, the knowledge increase did not translate into a significant change in practice as measured by a decrease in medication errors. Their research results raise the question as to how medication knowledge is translated or enacted in a high acuity specialty area, such as an emergency department.

Chang and Mark (2009) designed a six-month longitudinal study to respond to the relatively unchanged statistics of medication errors over the past ten years. The focus of the study was identifying factors associated with high rates of medication errors. They found a correlation between having a higher percentage of Baccalaureate (BSN) prepared nurses on the staff and lower rates of severe medication errors. From this study, the authors identified what they referred to as an optimal proportion of BSN prepared nurses needed to decrease medication

errors. The quantitative approach to Chang's and Mark's research most likely did not allow for an opportunity to question what it was specifically about the additional education that served to prevent medication errors. In other words, how do baccalaureate prepared nurses prevent errors? And what exactly does a BSN know and do to prevent medication errors? These authors recommended future research to include "a focus on the understanding of the mechanism of error development and the etiology of each type of error, non-severe and severe" (p. 75).

Prevention of interruptions and distractions. Reducing interruptions during medication administration is a well-known strategy for the prevention of medication errors. Flynn et al. (2016) provided training for nurse participants using evidence-based strategies for minimizing interruptions prior to data collection. Once nurses received the training, the research team observed nurses in practice. Research results demonstrated successful strategies to prevent avoidable interruptions during medication administration. However, the research team identified unavoidable interruptions in practice that were not preventable. The identification of unavoidable interruptions contributes to our understanding of the complexity of nurses' practice contexts in which medication administration occurs. Unavoidable interruptions are difficult to predict; thus, standardized prevention strategies may not address unavoidable interruptions that can cause medication errors.

Nurse researchers have uncovered distraction as a contributor to medication error for nursing students and staff (Robinson Wolf, Hicks, & Serembus, 2006). In cases of distraction, the literature overwhelmingly recommends the elimination of distractions as a method for reducing error. Pape et al. (2005) suggest a medication administration check list and signage as inexpensive steps to prevent distractions. Others have created no interruption zones using "red duct tape around all areas where medication is prepared" (Anthony, et al., 2010, p. 25). Colligan

and Bass (2012) suggest a framework for handling interruptions that nurses can follow for "prioritization of nursing activities" (p. 915).

Verweij, Smeulers, Maaskant and Vermeulen (2014) found that use of a tabard or vest with an inscription of "do not disturb" reduced the number of interruptions during medication rounds resulting in a reduction in the number of medication administration errors. Verweij and colleagues recommend further research on interventions to reduce medication administration errors. Flynn, and colleagues (2016) advocated for hourly patient rounds and education of patients and families to limit interruptions during medication administration.

Kliger (2010) also highlights distraction during the process of medication administration as one contributor to error and recommends the unit clerk serve as the point person to filter requests for the nurses' attention during medication rounds. However, this approach would assume that medication administration is a time-limited activity. Furthermore, this recommendation implies that the unit clerk has the knowledge needed to accurately prioritize requests for nursing attention.

Behavioural change. Finding causes of errors in order to prevent them is critical, as medication errors continue to occur and result in patient safety concerns. Stultz and Nahata, (2015) documented inappropriate use of IT as a contributor to the occurrence of preventable medication errors. These researchers recommend staff education to change behaviours to prevent inappropriate IT use that can contribute to medication errors. Inappropriate use was described as bypassing IT steps when prescribing, preparing and administering medications.

Chang and Mark (2009) investigated why errors continue in more or less the same proportion despite the many strategies designed to prevent these errors. Focusing on specific errors as the problem only appears to have the effect of spotlighting behavioral interventions to

address the problem. The result of such approaches is to add more tasks to an already busy, complex workplace – likely increasing the risk of error. Tasks are continually refined through the inclusion of more safeguards such as mental reminders or "memory templates" (Chang & Mark, 2009, p. 71).

Mental reminders: rights of medication administration to prevent errors. Tamuz and Thomas (2006) found in their research that nurses in three hospital settings practiced from a rule-based five rights of medication administration. However, the reporting mechanism for a violation of any of the rights was not reinforced by nurse managers, nor followed consistently by nursing staff. In this situation, it appears the five rights assisted nurses as a heuristic or guideline to prevent errors but did not assist with reporting deviations from the rules. These authors also uncovered practice situations in which nurses, who followed the rights, still made errors. The rule-based function of the rights of medication administration therefore is not always a guarantee for preventing errors.

Macdonald (2010) concluded that the five rights of medication administration are inadequate for present day practice. Medication administration, Macdonald contends, is a complex process and the rights do not address this complexity. Nurses have proposed a variety of additions to the rights in an attempt to address medication complexity and protect patient safety. However, depending on where a nurse might acquire information, it can be expected that there may be substantial variances in how a particular nurse practices medication administration.

Patient Safety Culture and Error Prevention

A review of the literature by Sammer, Lykens, Singh, Mains, and Lackan, (2010) identified the complexity of patient safety and the subcultures within which patients receive care. Senior leadership accountability was identified as the best indicator for the adoption of an

organizational culture of safety. Sammer and colleagues identified that one of the key institutional properties that support error prevention was a "just culture" or "the recognition of errors as system failures rather than individual failures and at the same time …holding individuals accountable for their actions" (p. 157). Recognition of the possibility of a system error in relation to medication administration allows for a focus on all aspects of medication administration, human and non-human, e.g. technology.

Work environment interventions. Davis, Ware, McCann, Keogh, and Watson (2009) highlight the influence that the work environment can exert on nursing practice. Implications for practice identified by these researchers include: "education of staff to promote universal understanding of, and adherence to medication policies, and an adequate staff mix of younger and experienced employees" (p. 1298). An adequate staff mix, these authors believe, will provide the support needed for newer employees. Davis, et al. (2009) identified one limitation of their research as the use of a self-report tool for data collection. These authors suggest that participant observation methods with opportunities to interview staff would enhance the data, generating a more robust study through which a better understanding of the practice situation and nurses' thinking in the clinical setting is developed. Participant observation would have enabled the researchers to follow up with nurses through questioning about what was witnessed in practice related to staffing mix and the work environment.

In an effort to include efficient strategies for prevention of medication errors, Kliger (2010) recommends using a change management strategy guided by the "Plan, Do, Study, Act" (PDSA) formula. The PDSA formula includes the engagement of frontline nurses and anyone involved in the issue at hand, in this case medication administration and the prevention of errors. Kliger promotes a strategy that is customized to the microsystem of a hospital unit as "culture,

attitude and flow processes" of each area of practice functions quite differently (p. 16). Kliger's strategies acknowledge the central role of nursing in medication administration and attempt to involve nurses in finding creative solutions.

Specialty areas and error prevention. The concern for patient safety and medication error prevention is very evident in specialty practice areas. For example, the Journal of Emergency Nursing includes a number of articles on medication error prevention and best practices for medication safety (Blank, et al., 2011; Paparella, 2016; Paparella & Mandrask, 2016). Paparella (2016) brings forward the Institute of Safe Medication Practice's best practices for hospitals, to support nurses' medication administration practices in emergency departments. Paparella's article summarizes best practices that respond to medication errors that lead to "patient injury or even death" (p. 161). Among recommended evidence-based best practices, is a patient weight in metric units upon admission to ensure accurate medication dosing. Using actual weight in metric units is designed to prevent estimations in emergency departments when medication dosing is weight based. Using estimated weights may impact the safety of care provided, as well as long-term patient outcomes. For instance, patients presenting with a cerebral vascular accident (CVA) receive medication that is weight-based for best results. When weight is estimated and not actual, patients with a CVA experience poorer outcomes (Barrow, Khan, Halse, Bentley, & Sharma, 2016).

Specialty practice areas may have a strong influence on nurses' thinking around medication administration. Davis, Keogh, Watson and McCann (2005) chose to study pediatric nurses' attitudes and opinions regarding adherence to institutional policies for medication administration. These authors employed a qualitative methodology to study this topic with the use of focus groups. Nurses who participated in the study reported the pressures of workload,

multiple patient needs, and ward culture as influencing adherence to medication policies. Findings from this research supported the argument that administration of medication in pediatric settings is a complex process related to workload, high acuity patients and ward culture.

Staffing mix to prevent errors. Firth, Anderson, Tseng and Fong (2012) studied the occurrence of medication errors and the staffing mix of Registered Nurses (RN) and Licensed Practical Nurses (LPN). When RN hours were increased and LPN hours decreased, medication errors decreased. However, when LPN hours were increased and RN hours were decreased the occurrence of medication errors increased. These authors suggest increasing RN hours as a strategy for preventing medication errors.

Härkänen and colleagues (2020) researched retrospectively, medication incident reports and found inadequate staffing as the most common reason identified for an error. These researchers recommend creation of an automated system that analyses incident reports in real time to address inadequate staffing.

Information technology to prevent medication errors. Researchers have documented IT has the potential to prevent medication errors (Shah, Lo, Babich, Tsao, & Bansback, 2016; Stultz & Nahata, 2015). Bar code medication administration (BCMA) systems have been developed to electronically to verify the correct patient with a drug to prevent administration errors at the bedside. Other IT features developed to prevent errors are Automated Dispensing Devices (ADD) and CPOE. Stultz and Nahata, (2015), in a retrospective study of medication errors, found 50.2% of errors were IT preventable. The research of Stultz and Nahata documented the importance of understanding why IT preventable errors still occur.

Davis et al. (2009) recommended "a dedicated computer terminal in the medication preparation area" (p. 1298) that would support nurses' practice. A dedicated computer terminal

to look up drug-related information and to check on procedures and policies for medication administration was recommended in a location that would be conducive to safe practice. In a previous study using qualitative methods, Davis et al. (2005) discovered computer terminal access was an issue for nurses relying on electronic systems for medication administration and information. For instance, familiarity with one computer model and its features does not assure facility with another. Nurse participants reported a need for computer literacy for successful medication administration. The importance of this research is evident in its ability to bring the complexity of medication administration to the forefront as the introduction of technology for medication administration in some situations has followed a cart-before-the-horse scenario. Technology for medication administration is meant to facilitate nurses' practice but nurses need to be confident using these technologies first (Piscotty, Kalisch, & Gracey-Thomas, 2015).

Nurses' thinking for error prevention. There is a continual search for another simple step, check list or practice to overcome medication errors. Yet as demonstrated in the work of sociologists, nurses, pharmacists, physicians and administrators, medication administration is a complex process that demands careful thought and a knowledge base to support decision making and safe clinical practices (Baker, 1997; Bucknall, et al., 2019; Carayon, et al., 2014; Edwards & Axe, 2015; Eisenhauer, et al., 2007; Garrett & Craig, 2009; Rohde & Domm, 2018; Smeulers, et al., 2014; Tamuz, et al., 2011; Tamuz & Thomas, 2006). Although this knowledge base is still underdeveloped, medication administration, as I understand it and based on my review of the literature, is a process that includes thinking beyond rules and procedures and the technical application of a "rights" approach to medication administration.

Through qualitative methods, Baker (1997) was able to unveil nurses' thinking with respect to medication error. In her research, Baker found there is considerable discussion by nurses' who use their knowledge to create "rules outside of rules" with respect to the classification of medication errors. Baker found that nurses used "situated and embodied logic" (p. 157) of the particular situation to create order amidst the complexity of the practice world. For instance, nurses "read between the lines of medication-order and administration sheets, and used "the medication round for gathering information for other purposes" (p. 156).

Baker's (1997) research documented situations in which the nurse's actions were in the best interest of the patient. Interestingly, some of these same actions were considered medication errors according to institutional policy. This research finding raises a very important consideration for nursing practice and education about how to support and legitimize independent decision-making around medication administration or practice that consists of "rules outside of rules" by nurses who are well equipped with "embodied and situated logic" and disciplinary knowledge. Independent decision-making allows nurses control over their practice, which is an important component of a healthy and effective work place (Shannon & French, 2005). Prevention of medication errors includes institutional recognition and legitimization for nurses' knowledge which enhances their ability to control their practice and respond to the complexity of practice situations.

Gibson (2001), in her discursive reading of literature about medication errors, found biomedical science, law and management were predominant frameworks used in the presentation of information. One of Gibson's guiding questions for her analysis was "What discourses are dominant in the literature and how do they shape nurses' role in medication error?" Her analysis of the literature and guiding frameworks used for medication errors pushes the reader to consider

nurses' knowledge and the clinical judgement that supports their thinking about medication administration. Gibson's analysis shows that policies and procedures for medication administration can be problematic when the context and thinking informing nurses' medication administration practices are not considered. She recommends that policies and procedures for medication administration practice take into consideration the complex clinical environment and honour nursing knowledge and skills that support patient safety.

Eisenhauer, Hurley and Dolan (2007) also studied nurses' thinking practices related to medication administration. Using semi-structured interviews, they were able to generate data rich with examples that provide accounts of the high level of knowledge and complexity of thinking needed for keeping patients safe during medication administration. One of the nurse participants reported checking recent lab work and heart rate, while also considering the uncertainty of how a patient might respond, before administering medications. In addition, the need for close monitoring of the patient response was also considered, with observations planned based on the time of administration and when the desired effect was expected. In one participant's account, noticing when the blood pressure peaked allowed for a rescheduling of the administration of the medication to provide a more therapeutic effect.

In presenting their results, Eisenhauer and colleagues state "the safe administration of medications is more than a technical mechanical process" as they discovered "situations requiring judgment in dosage, timing, or selection of specific medications indicated the most explicit data about participants' use of critical thinking and clinical judgment" (2007, p. 86). Their analysis also demonstrated nurses' critical thinking about the patient's current health state and both observation and interpretation of these observations before and after the administration of medications. Therefore, for the nurse participants of Eisenhauer and colleagues' study,

medication administration is a process that includes the application of both general and specific knowledge. The complexity of practice required that nurses move beyond general knowledge to incorporate knowledge specific to patient assessments and evaluation of the particular situation. These nurse participants provide an example of sensitively aligning knowledge for medication administration in ways that support safe and competent patient care.

Hoyles, Noss and Pozzi (2001) conducted an interesting study on nurses' mathematical reasoning and medication administration. These researchers were interested in exploring nurses' proportional reasoning for drug dosage calculations. Despite being taught a formula in their nursing education, Hoyles and colleagues found nurses did not consistently use this formula and yet remained error free. Nurses were able to use their preferred math skills, which may or may not correspond to what was taught in nursing school, to arrive at a correct dose and/or concentration of a prescribed medication. Hoyle and colleagues, mathematical research identifies the diversity of thinking and reasoning found in nurses' practices of medication administration. This same diversity is important to not overlook as it supports safe medication administration. Similarly, a push for a homogenous practice may lend itself to the creation of errors given nurses' diversity in application of math rules for medication administration.

Summary and Gap Analysis: Occupational, Organizational and Professional Complexity

de Ruiter, Liaschenko and Angus, (2016), identified that the evolution of healthcare technology (IT) with a switch from paper to electronic documentation, has been a significant development. These authors contend that the introduction of IT has impacted the organization of clinical work. An impact on clinical work organization that has not included the input of clinician, patient and family input to achieve a more balanced integration of IT to support health,

healing and care. Thus, de Ruiter and colleagues suggest prevention of unintended consequences of IT, requires clinician input.

Tamuz and Thomas (2006), used aviation safety studies as a guide to design research to study patient safety, in particular, medication errors in three hospitals. These authors found aviation safety mechanisms were not necessarily applicable in a health care setting due to the different context in which hospitals operate. The hospital comprises a number of units separated by function (e.g., nursing, pharmacy), and were therefore, different from the single unit of the airplane cockpit. Most useful from this research is the investigators' recognition of the organizational complexity of hospital personnel functions and their respective lines of authority. Physicians, who are not hospital employees and yet have legal and professional responsibility for patient care, further compound organizational complexity and ambiguity (Tamuz & Thomas, 2006).

Tamuz and Thomas (2006) suggest that their research results do not recommend the adoption of standardized definitions used by "Patient Safety Organizations or other reporting depositories" (p. 938). In their research of medication errors, these authors have uncovered what Law (2003) refers to as "messiness", since medication administration practices lack clear definition, and a "disciplined lack of clarity may be what is needed" (p. 3). For example, nurses' practices of medication administration include the context of the clinical setting and the knowledge nurses use to support decisions. Baker's (1997) research included nurses' accounts of clinical practices that deviate from institutional rules in order to meet specific health needs of patients.

Healthcare institutions are characterized by occupational, organizational and professional complexity, which precludes following a neat and tidy package for patient safety. Thus, Tamuz

and Thomas recommend further research be undertaken to give consideration to the entire process of medication administration and all of its complexities, including healthcare personnel characteristics, professional and procedural controls, and environmental and institutional factors.

The literature presented provides insight into the varied approaches that have been used to study the topic of medication errors. Perhaps the most interesting aspect of this literature has to do with what it says about a) the sundry and complex issues related to the delivery of health care, and, b) how everyday practices confound so many of the very pragmatic strategies suggested by much of the research reviewed. Furthermore, it is evident through the multiple perspectives expressed in the literature that complexity is an inevitable element of medication administration. Various professionals, who hold multiple practices and perspectives, are often separated administratively by hospital units and professional standards and regulations, which further compound the complexity of medication administration. However, the actual practice of medication administration was not consistently studied in the research literature I reviewed. To add to the research for medication error prevention a larger body of practice-based research is needed.

Summary

The literature presented in this chapter addresses a) different frameworks (i.e., biomedical, institutional and nursing) used for medication administration practices, b) safety issues and a focus on error prevention, and c) the consequences of a lack of understanding of clinical settings and nursing knowledge. Different professional groups have different perspectives on medication administration and error. Understanding varied perspectives and intervention research are important for achieving patient safety. However, at the same time such differences further contribute to the complexity of practice, due to a lack of consideration of

clinical settings and multiple healthcare professionals involved in medication administration. A standardized approach to prevent medication errors that does not address the complexity of medication administration is documented in this literature. Standardization then reinforces rules and adherence to these rules over nurses' complex patient safety practices.

Tamuz and Thomas (2006), in their research, raise the importance of recognizing the uniqueness of the clinical settings and the importance of describing institutional, legal and professional standards and regulations for medication administration practices. Therefore, it follows that medication administration is not solely a nursing practice/action; rather, the practice of medication administration is an accomplishment relying on various health professionals, technology, and institutional policies and procedures. Thus, strategies that are used to direct nurses' behaviours to prevent errors do not capture the complexity of medication administration. Research is needed to describe medication administration practices in such a way that the research captures nursing knowledge and practices that prevent errors.

More recently, recognition of the need for multidisciplinary attention to safe medication administration is present in health professional literature: a "drug's journey is more than what happens at the bedside" (Edwards & Axe, 2015, p. 398). A drug's journey begins with the chemical preparation, and continues with prescription, assessment, administration and evaluation of a medication intended for a patient. Edwards and Axe recommend not only a focus on nurses and medication administration, but also including attention with respect to all the professionals who play a role in the drug's journey to the patient.

Nurses are the professionals who connect to various links in a long chain of events around medication administration, including the final link between medications and patients. Thus, nurses play a pivotal role in preventing errors. My research was designed to move beyond

the focus on nurses' behaviours and errors (Kondro, 2008) to unravel the chain of events that comprise medication administration practices. Similarly, my research was designed to describe complex clinical settings and nursing knowledge inherent in medication administration practices.

Literature on nursing and medication administration focuses on error prevention as a straightforward process that can be guided by steps and technology. A review of medication error prevention literature includes strategies that signal distractions and interruptions contribute to errors, which speak to the complexity of the situations and circumstances of nurses' practice. However, the actual complexity remains opaque and thus technological and institutional prevention strategies may not address all situations and circumstances of medication errors. Given there are different descriptions, attitudes, perceptions and practices with respect to error identification and response, an understanding of medication administration in highly technical settings with vulnerable patients is timely given the need to prevent medication errors. Similarly there are various practices for error prevention including the spectrum of medication rights.

My research was intended to move beyond the focus on human behavior and medication error prevention to describe how nurses' medication administration practices are accomplished in a highly technical environment with vulnerable patients. I chose a neonatal intensive care unit (NICU) to conduct my research to answer the following research question: ***How are nurses' medication administration practices enacted in the highly technological environment of the NICU with vulnerable neonates as patients?***

Chapter Three: Praxiography: An Overview

An overview of praxiography is presented in this chapter. Praxiography as a practice-based research methodology was chosen to investigate medication administration to add to error prevent research.

Medication errors are a significant contemporary health care concern. To address the concern new technologies are being developed for nurses' medication administration practices to protect patient safety. However, the benefits that new applications offer are accompanied by unintended consequences (Koppel, et al., 2008). As demonstrated in the work of sociologists, nurses, pharmacists, physicians and administrators, medication administration is a complex process that demands careful thought and a to-be-developed knowledge base to support decision making and safe clinical practices (Bucknall, et al., 2019; Carayon, et al., 2014; Edwards & Axe, 2015; Eisenhauer, et al., 2007; Tamuz, et al., 2011).

A strong focus on medication error prevention is an appropriate and required professional response to ensure patient safety. However, a predominant focus on error prevention strategies can overshadow the complex reality of practice in which medication administration is enacted. My research was designed to describe what I have come to understand as the complexity of present-day practices of medication administration. To study the complexity of medication administration practices, I am asking the following broad question: ***How do nurses enact medication administration in a highly technical environment with vulnerable patients?*** In my research, my unit of analysis was a highly technical neonatal intensive care unit (NICU) where vulnerable preterm infants are cared for by registered nurses.

This chapter provides an overview of praxiography, an interpretive research method developed by Annemarie Mol (2002). As an interpretive method, praxiography follows practices

such as medication administration as they are enacted. Reflexive field notes are used to record observations and the researcher's interpretation. Interviews are used to cross check researchers' interpretations of practice observations with participants to ensure shared meaning. Praxiography is "the study of practice" (Mol, 2002, p. 31). Studying Practice, Mol contends, is never losing sight of anything and in doing so, ensures that practices such as medication administration "must not be isolated from the practice in which it is enacted" (p. 33). Practice is not considered a singular way of doing practice but rather, practice is considered multiple as it materializes in relationships with human and non-human actors as it is enacted. Praxiography as a research method recognizes practice as complex and does not guide the researcher to normalize the complexity or document a singular practice.

Praxiography and Enactment of Practice

As a method, praxiography does not seek to identify power structures or social constructions influencing health care practices. Rather, as a method it focuses on how a practice is enacted. The word enactment is deliberatively chosen to convey that activities take place as practice proceeds (Mol, 2002). Studying practice is challenging and praxiography requires a researcher to move beyond pre-determined expectations of how practice unfolds. Power and institutional structures that influence medication administration and the culture in which it occurs are worthy of study. However, my interest was to gain an understanding of how medication administration is enacted by nurses who co-exist with technology to enact medication administration and patient care.

Praxiography, Mol contends, is an ontological inquiry that maps out practice by describing "knowledge primarily in activities, events, procedures, buildings and instruments" (2002 p 32). As an interpretive method, praxiography seeks to describe knowledge incorporated

in daily events and activities that is not found in written texts. In my research, I sought to describe knowledge practices as they are enacted in the everyday medication administration activities of nurses in a highly technical environment with vulnerable patients.

Praxiography: A Focus on Praxis

As in ethnography, praxiography includes describing and recording and writing about a phenomenon (graphy). However, the focus of praxiography is on praxis, rather than culture (ethno) (Mol, 2002). Praxis, gives focus to "how knowledge is manipulated in practice," and requires an "investigation into clinical procedures and apparatus" of practice (Mol, p 16). Studying praxis includes a focus on knowledge practices that are considered carriers of implicit and explicit knowledge (Mol, 2002). Following practice as it is being enacted is the primary strategy of praxiography. Thus, observation in practice is the primary data collection method.

Through a focus on practices as they are enacted, a praxiographer includes technology as a practice and not a tool to carry out practice. Technology when not viewed as a tool can be studied as a practice that coincides with nurses' medication administration. Therefore, inclusion of technology as practice generated the following question: ***How do NICU nurses' and technology enact medication administration practices in a highly technical environment with vulnerable preterm infants?***

Actor-Network Theory as a Theoretical Perspective integral to Praxiography

Praxiography, as a research strategy moves beyond the usual person or group-centred approach of ethnography and integrates Actor Network Theory (ANT). This allows praxiography to include an explanation of all possible actors/actants (human and non-human, animate, inanimate) taking part in the achievement of the practice under investigation. Describing

medication administration, as enacted through practices of nurses, pharmacists, documents and computers, offers a view of what occurs in changing situations and circumstances in practice.

Actor-Network Theory is a theoretical perspective that supports praxiographic research as it considers the inseparability of humans and technology. ANT guides a researcher to trace and reveal the activities of human and non-human actors connected with human-technology accomplishments (Latour, 2005; Rutland & Aylett, 2008). ANT does not separate humans and non-humans when tracing activities (Nimmo, 2011). Rather, praxiography includes humans and non-humans without privileging one over the other.

In my research, non-human actors included electronic medication administration records and computerized systems for medication orders, and medication processing, storage, and inventory. Human actors in this study included nurses, pharmacists, and medication prescribers (physicians, nurse practitioners and physician's assistant); all of whom interface with non-human actors in the enactment of medication administration. ANT facilitated an unraveling of contentious issues or points of tension related to medication administration.

Actor and actants in actor network theory. To be an *actor* in ANT represents ongoing dynamic conduct through continual development of enabling relations between human subjects and non-human objects (Rutland & Aylett, 2008). Actors, through their relationship with other human and non-human actors, become *actants* in Actor-Network Theory. Actants are able to act, as a product of a relationship with other actors. It is through the working with actors/actants in an actor-network that actants gain the capacity for action or agency. Thus, in my research, drawing from this approach, both nurses *and* the Pyxis dispensing machine are understood, and treated for analytic purposes, as actants. The way in which each responds and then acts in relation to one another must be carefully examined. Therefore, I recorded observations of nurses accessing

Pyxis dispensing machines in order to trace relationships with other health professionals and technologies that create networks enabling the accomplishment of medication administration.

The network in actor network theory. A network, according to Latour, implies that "a point-to-point connection is being established, which is physically traceable and thus can be recorded empirically" (2005, p. 132). In an actor-network of medication administration, nurses are human actors and become actants as a result of their relationship with other actors, both human and non-human (Latour, 2005). When medication administration is explored through an actor-network lens, the nurse becomes not the originating source of action in practice but instead, is understood to have the *capacity* for action *in relation* to other actors in the network. Therefore, medication administration is not solely a nursing practice/action but instead the practice of medication administration is treated as an accomplishment relying on interconnected and interdependent actors in a network.

A Level Playing Ground

Actor-Network Theory offers a theoretical perspective that pushes beyond the tendency to privilege principles over practices (Mol, 2002). A level playing ground is of essence when planning a praxiographic study guided by ANT, where all actors, human and non-human, are considered inseparable and symmetrical (Latour, 2005; Nimmo, 2011). For example, the Pyxis Medication Dispensing Unit determines when a medication is released in relation to the keying in of a code by a nurse with a specific request. Neither actor in the above example is subordinate to the other when praxiography is the chosen research method. Both are given due consideration as having agency in the practices as observed. Thus, the human and non-human and the social and technological are understood as mutually enacted in medication administration (Latour, 2005).

As a theoretical perspective, Actor-Network Theory offered the following questions to describe NICU nurses' medication administration practices in a highly technical environment with vulnerable preterm infants: Who are actors/actants in the practice of medication administration? What are the human and non-human relationships enabling the administration of medication; and, what are the actor-network connections in the practice of medication administration? For example, how is the medication administration record a non-human actor connected to the nurse, pharmacist, as human actors in the practice of medication administration actor-network? And another example, how does that medication record, a non-human actor as a member of the actor-network, *act* to influence practices of medication administration?

Complexity and the Description of Practice

My research interest was to enhance existing professional and academic literature focusing on medication error prevention, shifting attention to studying the moment-to-moment reality of practice. Praxiography guides a study of medication administration while it is being enacted by technology and nurses. As discussed in chapter two, extant literature acknowledges medication administration complexity and the challenge to eliminate drug errors. Praxiography recognizes practice is complex and does not guide the researcher to normalize the complexity of NICU nurses' daily practices with technology and vulnerable patients. Actor Network Theory, as theoretical perspective integral to praxiography, pushes for a flattening, rather than a hierarchical ordering of practices, to trace medication administration. This perspective supports my research interest and question: ***How do NICU nurses and technology enact medication administration with vulnerable preterm infants?***

Praxiography as a Strategy for Documenting Knowledge Practices

'Knowledge and practice are considered to be intimately linked and praxiography as a research strategy, provides empirical access points to conduct practice research" (Bueger, 2014 p 386). Through observations of practices, a praxiographer seeks to uncover *implicit* or what Mol (2002) refers to as "knowledge about practice" (p 159). Praxiographic research focuses on implicit knowledge or knowledge that is not readily verbalized nor found in written texts (Bueger, 2014; Mol, 2002). Explicit knowledge, such as rules and standards, is found in written texts but depends on the enactment of practice for meaning (Bueger, 2014; Mol, 2002). Interviews, practice specific documents and literature offer *explicit* knowledge about practice or what Mol refers to as "knowledge in practice" (p 159). For example, the literature I reviewed revealed differences in how medication errors were defined in practice related to health professionals' explicit knowledge (Stewart, et al., 2018; Tamuz, et al., 2011; Tamuz & Thomas, 2006; Unal & Seren, 2016).

Research Strategies and Data Collection

Praxiography includes a number of strategies for data collection with practice observations as the primary strategy (Bueger, 2014; Mol, 2002). Location and daily activity descriptions, expert interviews, and present and past document analysis are further complementary strategies of data collection (Bueger, 2014).

Location and Daily Activities in Which Practice is Situated

Praxiographic data collection includes a description of the location and daily activities in which practice is situated and enacted. The location for my research was a highly technical Neonatal Intensive Care Unit in which medication administration practices are enacted.

Therefore, my data include a description of daily activities and a diagram of the NICU in which I conducted my research.

A focus on a location also includes descriptions of the sites and structures in which a practice is situated and enacted. I observed NICU nurses and technology in three distinct sites that are connected to medication administration for vulnerable preterm infants (Chapter Seven). Observations in these three distinct sites provided data on how each site ordered medication administration practices.

Participant observation. Participant Observation is the primary and preferred method of data collection to gain direct access to actions that maintain a practice (Bueger, 2014; Mol, 2002). Medication administration is a component of NICU nurses' daily practice activities and responsibilities. Participant observation allows for the direct recording of practice activities and bodily movements that do not require speech. For example, I observed and recorded activities and bodily movements of NICU nurses between a preterm infant's room and the medication room. Activities and bodily movements of pharmacists and nurses in the three centres of activity were also observed and recorded. Participant observations of practice activities and bodily movements were recorded as detailed field notes. Practice observations afforded the collection of data about NICU nurses' and technology's situated participation in medication administration practices.

Participant interviews. In praxiography, participant interviews are also an important method of data collection to explicate background knowledge and cross check observation data (Purkis, 1994). This includes reconstructing the interviewee's detailed everyday practices and their evaluative standards. Interviewees are asked to describe activities that are part of everyday practice to clarify their implicit knowledge. A researcher also asks interviewees about observed

practices to co-create an interpretation of practices. The data collected through participant interviews includes detailed first hand descriptions of activities, bodily movements, and co-created meaning of an interviewee's practice. Data generated through interviews gives participants a voice while honouring their knowledge.

Praxiographic interviews rely on experts who have been participating in the practice on a daily basis over an extended period of time. For the purpose of my research, the selected participants were NICU nurses with a minimum of five years of experience. These same nurses described both their present and past medication administration practices during observations and in interviews.

Documents. Analysis of documents is another data collection strategy in praxiography that can include hints about practices and implicit knowledge. Documents include texts written about practices and manuals and handbooks that guide practice. All of these documents provide data about knowledge that informs practice. Practitioners also produce documents, such as nursing literature, to describe their practices. Literature includes the manner in which practices have been carried out and provides interpretations of the underlying background knowledge. Chapter Five on historical medication administration practices has been included in this dissertation as it contributes to nurses' background knowledge and evolution of medication administration practices.

Visual documentation also contributes to a praxiographic data collection. In my research, I have included photographs and diagrams as examples of the designs of situations and settings in which medication administration practices are enacted. Visual documentation, related to the bodily activities of a practice, supports a researcher's written description of a practice (Bueger, 2014).

This chapter has provided an overview of praxiography, a qualitative method to study practice. Practice observation as the primary strategy for data collection, affords the researcher empirical entrance points to describe knowledge practices connected to medication administration. A praxiographer records and takes note, of the activities and techniques that make practice "visible, audible, tangible, and knowledgeable" (Mol, 2002, p. 33). Praxiography, as Mol suggests, includes engaging in practice theory driven research that requires a distinct methodology with similarities to ethnography in order to describe, record, and write about a phenomenon (graphy). However, the focus of praxiography is on praxis (practice) and not culture (ethno).

Chapter Four includes a further discussion of my research process. Descriptions of the process of gaining entry to the neonatal intensive care unit, participant selection and data interpretation are presented in chapter four.

Chapter Four: Research Process

In this chapter I describe the research process. I chose the research methodology and setting to add to nursing research that has documented nurses' practices experience and knowledge.

Nurse scholars have written about the differences between nursing practice as experienced and practice as taught (Dieklemann, 1995; Ironside, 2003), the telling of stories as a culturally supported way of sharing knowledge (Street, 1992), the differences between knowing that and knowing how (Tanner, 2006), nurses' intuition and clinical decision making (Benner & Tanner, 1987) and the bedside nurse as an empiricist (Maeve, 1994). Research about medication administration, in keeping with this tradition of nursing scholarship requires a methodology that is practice-based in its approach. Praxiography fits my purpose, since, as Mol (2002) states, it combines Actor-Network Theory and ethnography for a comprehensive explanation of practice; in this study that of NICU nurses' medication administration practices. A detailed description of Praxiography and Actor-Network Theory was presented in Chapter Three.

The purpose of this chapter is to explain the research process employed to uncover nurses' contemporary practices of medication administration in relationships with technology. My research question was: ***How do NICU nurses and technology enact medication administration with vulnerable preterm infants?***

Research Process

Ethical and operational approval.

Gaining entry to data collection site. Ethical approval was received from the University of Victoria (14-339) and was also accepted by the research site. Ethical approval was granted for

observation and interviews of neonatal intensive care nurses in a twenty three bed unit. Ethical approval included observations of NICU nurses in practice.

Research setting. The research site was chosen for the study because the neonatal intensive care unit (NICU) employs the latest medication administration technology and has individual patient rooms. The patient rooms have a large glass window, which allows visibility from outside of the room. The glass window allowed for observations outside of the room and away from the nurse to prevent any distractions. The NICU was specifically designed for preterm infants. All nurses I observed in practice as part of this research project cared for preterm infants. NICU nurses would also care for full term infants with blood glucose instability and possible meconium aspiration if the postpartum nurses were not able to provide the required monitoring. I did not observe NICU nurses caring for any full term infants during data collection. My observations of NICU nurses occurred during care and medication administration for preterm infants. All data presented in this dissertation refers to NICU nurses' care and medication administration practices for preterm infants.

As a nurse educator based on Vancouver Island, I have taught on many hospital units and this created a potential conflict as I am well known to the nurses. Many of the hospital units in the Vancouver Island area did not offer individual patient rooms or the latest technology with respect to medication administration. With individual patient rooms, I was able to not add myself as another body to a multiple patient room. Individual patient rooms prevented interruptions that can occur with a larger number of people occupying the same space. NICU nurses were able to focus on one infant at a time without interruption and this provided an opportunity for them to explain what they were doing as they administered medications. A

benefit that I observed was the NICU nurses were able to focus on one infant during medication administration without interruption from other patients in the room.

Access to the research setting was initiated through a long term colleague who worked in that hospital. She had previously served as a guest lecturer for a pharmacology class I had taught. I had no role in the evaluation of this individual in relation to her employment or registration. All other nurses who agreed to take part in the study were recruited through purposeful and snowballing sampling. I had no previous experience in working with these nurses and had no authority to evaluate their professional performance.

Another important consideration for the research setting selection included the presence of a supportive nurse educator. The hospital ethical approval required an employee to sponsor the research. With the partnership and support of the nurse educator, together we completed all of the steps required by the hospital for ethical approval prior to the initiation of data collection.

Participant selection. Once ethical approval was obtained, the NICU nurse educator solicited participants for the study and referred interested NICU nurses to the researcher. The purpose of the research was explained to interested NICU nurses and written consent (Appendices A & B) was obtained from all participants. Purposeful sampling (Morse, 1991) was employed initially to select participants who were experienced nurses and had worked for at least 5 years in a NICU. Snowball sampling was also used as participants were asked to refer experienced colleagues for participation in the research. The selection criteria for participants was deliberate in order to secure the participation of nurses who were experienced in practice and had worked through transformations of medication administration practices, including the introduction of technology to replace paper documentation. The only exclusion criterion for

participation in the research was nurses with no NICU experience and no experience with both paper and electronic documentation.

The sample size for my research was limited to those who consented to be observed in practice. Therefore, my sample size was determined by nurses and a pharmacist who agreed to be observed in practice.

Participants. Twelve neonatal intensive care unit (NICU) nurses participated in this study. Eleven participants had more than 15 years of experience and one participant had five years of experience. All participants held a Bachelor of Nursing degree. The nurses were considered experts in the practice setting, as they were able describe their experience and practice in detail. Upon the recommendation of the NICU nurse manager, the NICU pharmacist was approached and this person also consented to participate in the study. All nurses identified as female and the pharmacist as male.

Data collection process. Data collection included participant observation, unstructured interviewing, and the collection of NICU nurses' paper documents used in practice. Observations in practice were followed up with interviews. Field notes were written during and immediately following observations of NICU nurses in practice.

Praxiographic data collection. Praxiographic data collection includes participant observation, document analysis and interviews. In praxiography, "participant observation is the preferred and primary method of data collection as it allows for direct access to the body movements and actions that perpetuate practice" (Bueger, 2014, p. 399).

Participant observation. I observed twelve neonatal nurses in practice. Observations were recorded through detailed field notes and follow up interviews were undertaken to gain

greater depth of understanding about the observed practice. Together, these observations and interviews about observed practice constitute the observation data.

Observations in the NICU occurred during 12-hour day and night shifts. Each observation session lasted from four to six consecutive hours. I observed the beginning and end of a 12-hour shift to observe a participant receiving and delivering a shift handover report. On the recommendation of the nurse manager, I also observed and interviewed a pharmacist in practice for a total of two hours.

Praxiographic methods require a researcher to record possible actions and interactions of participants (Mol, 2002). To fully capture participants' actions and interactions, I took continuous unstructured notes during and immediately following an observation. For example, my field notes included what I noticed in the practice environment, such as:

1. placement of a computer monitor,
2. nurse's interactions with the Pyxis medication dispenser to remove medications,
3. nurse's interactions with the computer for dual verification of medications,
4. the number of times a nurse clicked on different icons on the Electronic Charting system to input not only medications but also patient assessments,
5. the number of steps a nurse took between a patient room and the medication room.
6. the number of times a NICU nurse moved a computer mouse to navigate the electronic medication administration record (EMAR) and electronic health record (EHR) of a preterm infant.

The field notes included descriptions of the way nurses engaged in practice from the start of the shift to the end of a shift, with observations of shift handovers. I also observed and recorded nurses' medication administration practices. The recording of NICU nurses' actions,

spoken words and how objects were utilized in practice were included in field notes. For example, my field notes described a) actions of NICU nurses with a bar code scanner used for medication verification, b) nurses' data entry into a computer and c) nurses' written notes on a paper document. During observations, NICU nurses often described their actions for the preparation of a medication for administration and care of a preterm infant. Observational data illuminated how NICU nurses and technology enacted preterm infant care and medication administration. Observation provided an opportunity to ask nurses questions about how practices of medication administration are enacted.

Documents. Paper documentation used by NICU nurses in practice also contributed to data collection for analysis (Appendices C, E, F, & G). Documents such as shift handover report sheets, infant feeding records, and emergency medication weight-based guidelines were reviewed. Data collected from documents provided hints about practices and implicit knowledge that could be cross checked in an interview (Purkis, 1994). For example, NICU nurses were observed writing on the paper documents that they used in practice. Interviews afforded an opportunity to clarify the meaning of documents NICU nurses used in practice. Standardized NICU medication administration documents, contributed to data collection. Visual documentation also contributed to data collection and analysis. Photographs of the Pyxis in the medication room and a diagram of the NICU floor plan are included in the data chapters. No humans were present in any of the photographs. Consent for photographs of the medication room was given by the nurse manager. Diagrams were free sketch drawings of the unit layout and identified the location of the medication rooms. Visual documentation was included to support my written descriptions of NICU nurses' medication administration practices.

Interviews. Twenty unstructured interviews with ten of the participants were conducted and all participants provided information on issues of importance during observations in practice. As described above, twelve participants were NICU nurses and one was a pharmacist. The participants provided a variety of perspectives and experiences to describe nurses' medication administration practices.

Unstructured interviews were used to allow participants to largely determine the direction of the interview, thereby giving expression to issues of importance to them. Frequent clarification was sought during the interviews to ensure "shared meaning" between the researcher and participant (Spradley, 1979). All participants were interviewed at least once with follow up interviews as questions developed from the original interview and observations in practice.

Interviews were conducted to explicate background knowledge and cross check observation data (Purkis, 1994). NICU nurses were asked to describe activities that are part of their everyday practice to clarify their implicit knowledge. Observation questions were asked to gather detailed first hand descriptions and to illuminate the meaning of NICU nurses' practice activities during preterm infant care and medication administration.

Interviews ranged from 30 to 60 minutes in length. Interviews were audio-recorded in all but five cases in response to participants' discomfort with audio recording. For the five non-audio interviews, I took notes and reviewed the interview notes with the participant for accuracy of meaning. All audio-recorded interviews were transcribed verbatim by the researcher and a paid transcriptionist.

Follow-up interviews were conducted with participants following repeated participant observations in the NICU. Questions posed in follow-up interviews were directly related to the field notes I had written post observation. Interviews following observations were conducted to

clarify my observations and ask questions I was unable to ask while observing practice. Additionally, follow up interviews were conducted as questions arose when interview transcripts were reviewed. The following open-ended questions were used to begin interviews with participants.

1. Please tell me about your medication administration experiences with preterm infants.
2. Please tell me about your experience with technology and preterm infant care and medication administration.

Historically, interpretive results have been defended as warrantable and a research strategy determines the validity of a study (Plowright, 2011). Reliability and validity of my study is discussed in the following sections.

Reliability

Reliability of a study refers to the replicability and consistency of the research (Le Compte & Goetz, 1982). As praxiography uses ethnographic approaches that include individualistic techniques for collecting data, and for this reason it is difficult to establish reliability (Robertson & Boyle, 1984). However, Le Compte and Goetz (1982) aver that "delineation of the physical, social and interpersonal contexts within which data are gathered enhances the replicability of ethnographic studies (p. 39). Thus, the replicability of the results refers to the agreement between descriptions of NICU nurses' medication administration practices in a highly technical environment and other observers. To increase reliability of the study the researcher used the following strategies. First, the researcher kept field notes of practice observations that included descriptions of the practice settings NICU nurses' preterm infant care and medication administration activities. Second, questions that were recorded as field notes during observations were posed to participants during interviews. Third, tape recordings and verbatim transcriptions

of the interviews enhanced the reliability of the results because preterm infant medication administration practices and care could be confirmed by other researchers. Excerpts of verbatim accounts can be found in Chapters Six, Seven and Eight. These excerpts are used to illustrate and substantiate the analysis. Finally, this dissertation includes details of a NICU nurses' shift activities and medication administration practices in three distinct locations of the research setting.

Praxiography as a research method provides "empirical access points" to describe practice (Bueger, 2014 p. 383) and not to "privilege" one practice over the other (Mol, 2006). There is a recognition that praxiography is a method intended to describe what happens when a practice such as medication administration is enacted in a particular setting and surrounding circumstances.

The intention of my research was to avoid generalization across practice settings. Instead, I chose to describe practices of medication administration as a participant observer and from descriptions provided by nurse participants during interviews. My research intended to give voice to that which, does not appear in the literature that focuses on human behaviour and medication error prevention (Anthony, et al., 2010; Colligan & Bass, 2012; Freeman, et al., 2013; Relihan, et al., 2010).

Mol (2002) contends the "Praxiographic 'is' is not a universal is, it is a local 'is' and requires a spatial specification" (p 54). A local "is" focuses on what happens in specific circumstances and situations of practice, rather than a universal "is" that focuses on what should happen in all practice situations. The value of my analysis lies in a "local specification" and detailed descriptions of a highly complex activity in relation to supporting the health of very vulnerable preterm infants. My analysis is not the universal "is", reliant on tasks and "rote"

rehearsals of medication administration, such as remembering the rights of medication administration or the no interruption zones to prevent medication errors (Kliger, 2010; Verweij, et al., 2014; Wilson & DiVito-Thomas, 2004). Instead my analysis describes, the what and where of local practices of medication administration.

Validity

Unique to praxiography is the intensive and descriptive collection of empirical data (Mol, 2002). It is this method of data collection, which contributes to the validity of praxiographic research (Mol, 2002). Other factors contributing to validity of the research include the inductive approach of the unstructured interview (Morse, 1991) and participants' responses reported in their own words. From the interviews, I was able to confirm participant's meanings by probing responses. Probing allowed participants to clarify responses, which otherwise might have remained vague or ambiguous. Interviews were transcribed verbatim for analysis.

Other measures and techniques I employed to support validity were:

1. A continual checking of my observations and note taking during and immediately following an observation.
2. A continual checking of my interview data
3. Cross-checking observation in interviews with participants to refine understandings of observations
4. Cross-checking observation and interview data to illustrate commonality between the two.
5. Discussing my initial analysis with my supervisor and other nursing colleagues
6. Continuous review of the literature to look for commonalities and differences with my own data and analysis.

7. Retention of all my notes, which contributed to the data analysis.

Data Analysis

Data analysis was conducted concurrently with data collection. Interview and document data were used to cross check practice observations (Purkis, 1994) Cross checking of interview and documents was not used to derive generalizations, but rather to investigate these surface similarities within the specific situations observed to discern the differences between actants. Discernment of differences between actants within specific situations illuminates how each contributes to the apparent "complexity" of medication administration practices. Uncovering differences may illustrate why efforts to standardize practices usually fail. Similarly, cross-comparison contributed to descriptions of multiple practices of medication administration.

Praxiographic analysis. Praxiographic analysis describes and traces what happens in practice, to uncover how practice is enacted and what gives it meaning. NICU nurses' practices of medication administration were described and traced through participant observation, field notes, documents and interviews. Analysis un-brackets practices to describe how they are enacted in the complex networks within which they are enacted (Mol, 2002). By un-bracketing practices, analysis acknowledges the unstable nature of practice and describes how actors manage and navigate changing situations and circumstances. Praxiographic analysis focuses on responses to changing situations and circumstances and includes divergent perspectives. Therefore, analysis does not seek to document a uniform practice of medication administration, rather analysis documents varied and divergent practices.

In my research, the mapping of medication administration practices included descriptions of responses to what may be considered a habitual practice, to include input beyond normative responses to predetermined situations. Descriptions of NICU nurses' assessments of infants and

pre-packaged medications before administration are included in the data collected. Analysis for this research was completed through mapping medication administration practices as they were enacted. Mapping included close attention to how NICU nurses and technology enact medication administration in different situations and circumstances. Analysis included describing the organizing practices of NICU nurses and technologies as medication administration was enacted (Mol, 2002).

Mol's (2002) concept of "modes of ordering (p. 69)," and the associated analytic devices of mapping and a horizontal lens were utilized to document the complexity of NICU nurses' medication administration practices. Modes of ordering are "ways of handling problems, and framing concerns" when practice is enacted (Mol, 2010 p.264). Analysis included describing technologies', pharmacist's and NICU nurses' modes of ordering of medication administration. A horizontal lens affords a mapping of NICU nurses' medication administration practices that "co-exist" within and between situations and arrangements in which medication administration practices are enacted.

Mapping requires a horizontal lens on a health care practice, and moves away from a vertical or hierarchical focus. A horizontal perspective of practice allows for what is otherwise invisible, as nothing is hidden by subordination. In a horizontal view, no single actor is considered more important than another. To "map out" NICU nurses' medication administration practices, I observed the actions and involvements of human and non-human actors without privileging one above the other. By not privileging one actor over the other, the subject-object divide becomes irreducible and technology and human actors are understood to be inseparable (Latour, 2005). Technology is not viewed as a separate object or tool for the subject of medication administration, instead, technology is presented as an integral part of NICU nurses'

practices. Neither the technology nor a NICU nurse is assumed to perform medication administration independently. Analysis is focused on the inseparability of technology and NICU nurses' practice.

A NICU nurse and technology, through a relationship in a network that is traceable by observing actions over time, create medication administration practices for the safety and wellbeing of a preterm infant. A dichotomous view or separation of subject and object does not allow for an understanding of the effects of technology and NICU nurses on one another. When neither actor is privileged over the other a researcher seeks to describe how each actor is connected and affects one another within a network.

Latour (2005) defines a network as a "description of where all actors do something and don't just sit there transporting without transforming effects" (p128). Actors in my research such as technology and humans are mediators and neither are intermediaries, nor tools that NICU nurses use for medication administration.

Technology as symmetrical. Technology, (e.g. computer, EMAR, Pyxis and bar code scanner) is viewed as a symmetrical actor with a capacity for action in relation to other actors in the network. As a symmetrical actor, technology is of equal importance for medication administration as a pharmacist and nurse. Technology as a mediator in NICU nurses' medication administration practices network may "translate, transform, modify and distort" meaning. If viewed as an intermediary, technology "transports meaning without transformation" (p.39) and in doing so places medication administration as the sole responsibility of NICU nurses, giving no consideration for technology's capacity for action (Latour, 2005, p.39). With an intermediary designation for technology, error prevention focuses on human behaviour and excludes a computer, bar code scanner and Pyxis as potential source of errors. The effects of technology on

safety go unnoticed without strong theoretical approaches to practice (Latour, 2005; Mol, 2002,). A strong theoretical approach requires a horizontal lens to interpret medication administration practices. A horizontal lens reveals technology as a mediator rather than an intermediary in NICU nurses' preterm medication practices. Technology, when considered as a mediator, is a contributor to efforts to improve medication administration safety.

Summary

In summary, this chapter described the research process for the study. The research setting, participant characteristics, data collection and analysis were discussed. Praxiographic analysis takes a radical shift away from clinically controlled trials intended to document best health care practices to "map out" the reality of practice (Mol, 2002 p.7). A "mapping out of practice" uncovered how medication administration within a network of human and non-human actors was enacted to protect vulnerable preterm infants. My analysis was not focused on institutional constructions or various perspectives of medication administration practice. Rather, my analysis is centred on NICU nurses' and technologies' enactment of medication administration and described the organizing that occurs as it is enacted in different settings and circumstances.

In Chapters Six through Eight of this dissertation, as I "mapped out" NICU nurses' practices, the complexity of preterm infant medication administration and how it was enacted was illuminated. Nursing research that analyzed adverse drug events documented the complexity of medication administration and human factors that contribute to errors (Carayon, et al., 2014). My analysis explored a broader panorama, beyond human factors and medication errors, to map out how NICU nurses, pharmacists and technologies enacted preterm infant medication administration practices. This analysis included the inseparability of NICU nurses and

technology, and uncovered practices that are enacted to protect vulnerable preterm infants. In Chapter Five, I present the historical context of nurses' medication administration practices. The purpose of chapter, is to discuss the evolution of nurses' knowledge and practice that has contributed to safe medication administration practices. Following, Chapter Five, I discuss the research findings in Chapters Six, Seven and Eight.

Chapter Five: Historical Practices

History: Nursing Practices and Medication Administration

This chapter provides a historical context for my research about NICU nurses' present day medication administration practices. The purpose of this chapter is to draw on, literature and the author's practice experiences to document the development of safe medication administration practices that evolved from nurses' practice knowledge and actions.

The discussion that follows includes an overview of medication administration practices that nurses developed and enacted in relation to practice settings and circumstances. Nurses designed and redesigned medication administration practices as they negotiated the introduction of new technologies and health professionals into their work environments.

Foucault (1970/1994) in discussing the role of history on human science posits, "History constitutes, a favourable environment, which is both privileged and dangerous…it offers a background…it determines the chronological and geographical boundaries in which… knowledge can be recognized as having validity" (p. 371). Therefore, acknowledgement of the historical influences on nursing's medication administration practices is of significance for an understanding of how nursing practice has been shaped and evolved over time. One such influence on nurses' medication administration practices is the "*Rights of Medication Administration"* as an accepted set of rules for checking drug and patient information prior to the administration of a medication. An historical account of practices of medication administration contributes to an understanding of how nurses have taken up and been situated into contemporary relationships with technology and health professionals.

What Medication Administration Was

As nurses moved into the domain of medication administration their practice centred on patient safety. Historically, nurses' practices of medication administration included, three checks called rights prior to medication administration (Robinson Wolf, 1988). Citing Groff (1896), Robinson Wolf stated that the practice of three rights of medication administration dated back to 1896. For patient safety, prior to medication administration three checks sought confirmation that:

1. the right medication was given
2. to the right patient
3. at the right time

Robinson Wolf (1988) described medication administration as one of many nursing rituals in her research. Accounts of nurses' practices of medication administration documented by Robinson Wolf included a "high priority, highly visible, and time consuming practice… and regarded medication administration as a serious trust, shared with physicians" (p 63). By the time of Robinson Wolf's research in the late 1980's, nurses had assumed responsibility for transcribing orders, preparing, dispensing, and administering medications. Nurses' goals for care included protection of the patient from harm, while promoting the healing effects of medications.

Hospital Setting Roles and Responsibilities: Nurses and Hospital Staff. Other hospital staff (e.g. ward clerk or unit clerk) also played a role in transcribing and processing of physician's medication orders. Nurses' maintained the overall responsibility for medication administration verifying the unit clerk's transcription and processing work. Robinson Wolf's (1988) research referred to many paper documents used to record nurses' function of medication administration and an "ethnocentric language" (p. 64) used to communicate with colleagues and

physicians about medications, their administration (such as QID for the administration of a drug four times a day) and their effects. It is argued by Robinson Wolf that the purpose of the "language" was to reduce the time needed for medication discussion concerns and serve as a recording style for patient records. Robinson Wolf's research presents nurses as the gatekeepers of patient safety with respect to medication administration who used paper documents and "ethnocentric language" to maintain order and prevent mistakes.

Transcription and Order Verification.

Nurses. In the past, the prescribing of medications and recording of their administration to patients by nurses was handled through written records. Nurses worked with paper patient charts, where medications ordered by physicians were transcribed (by nurses and later by administrative staff such as unit clerks) and verified by a registered nurse (Robinson Wolf, 1988; E. Heikkela, personal communication, January 10, 2015). Physician order sheets included carbon copies to allow for one of the sheets to be sent to the pharmacy as a request to the hospital pharmacist to stock (send up a multidose bottle or vial of the medication) or prepare the medication in the proper format (e.g. Tablet, oral liquid, injectable liquid etc.) and send it back to the ward for a nurse to administer. The carbon copy afforded an opportunity to cross-check that the drug ordered was exactly the drug prepared and returned for administration.

In many clinical settings, a medication order was transcribed from a physician's order sheet and sent to an in-hospital pharmacist to process and send the medication to a unit (E. Heikkela, personal communication, January 10, 2015). Not all medication orders sent to a pharmacist involved the preparation and sending of a medication to a unit. Medication cabinets existed on units to keep a supply of medications for nurses to prepare and dispense and therefore, did not require a medication to be sent from the pharmacy. A review of the activities involved in

prescribing and administering medications illustrates multiple ways in which nurses and other health care team members have been enrolled in elaborate processes, ensuring the accuracy and safety of the administration of pharmacological agents (E. Heikkela, personal communication, January 10, 2015; Neander, practice experience).

Medication Orders. Medication orders were manually written by the physician onto an order sheet that was located in a patient's chart. This initial order was then transcribed from the order sheet onto various formal documents so that the doctor's prescription could ultimately be administered to a patient. For instance, a transcription of a medication order included the handwritten transfer of the medication order to a medication administration record (MAR). The MAR was a document used by nurses on each shift to record the administration of prescribed medications to patients. The MAR included a number of verification checks instituted by nurses to prevent medication errors and protect patient safety (E. Heikkela, personal communication, January 10, 2015; Neander, practice experience).

Introduction of Unit Clerks for Prescription Transcription

Practices associated with the administration of drugs evolved over time, enabling the introduction of specific administrative staff such as unit clerks who, during daytime hours, made the initial transcription of the medication order onto a patient's MAR. A unit clerk assumed the responsibility for initiating the transcriptions and sending the correct carbon copy to the pharmacy. If there was no unit clerk, the nurses performed all transcription steps and checks.

All patients' medication administration records on a nursing unit would be held collectively in a single binder (practice experience, Neander). Each medication record was then separated by dividers in the binder. Once the order was transcribed by the unit clerk onto a medication record, a nurse would need to verify the order by referring back to the physician

order sheet. The nurse verified the accurate transcription of the ordered medication by initialing the medication administration record (practice experience, Neander). Even though the work of transcription could be sequestered as "administrative work," and assigned to a unit clerk, the nurse was required to cross-check that the unit clerk had transcribed the order accurately. A multiplication of checks was required as additional staff were introduced into the process of medication administration to prevent errors.

Medications were and continue to be prescribed in three ways (E. Heikkela, personal communication, January 10, 2015; Neander, practice experience);

1. a stat or one time dose of a medication,
2. a limited duration prescription such as an antibiotic for a determined period of consecutive days and
3. long term or ongoing prescriptions

Dose Identifiers for Error Prevention

All transcribed medications had the letters ID (initial dose) in red indicating the nurse needed to verify the order again before administering the initial dose. The different formats for prescribed medications all had an "ID" verification. However, stat and limited duration prescriptions would also have a "LD" (last dose) as part of the verification process. The transcription process included two checks by different nurses prior to the initial dose (Practice Experience, Neander).

Additional practices around transcription included identifying a new medication with an initial dose identifier on the MAR. The first dose of a medication was identified with a handwritten red ID (initial dose) next to it and if the final dose was known, an order might read "give for three days", a handwritten red FD (final dose) was written in the box for the last dose.

The ID practice was a safety practice used to remind the nurse to verify that the handwritten medication, name, dose, route, and time on the MAR matched the physician's handwritten order. These practices of highlighting initial and final doses were safety checks nurses created based on professional values to do no harm and prevent medication errors (E. Heikkela, personal communication, January 10, 2015; Neander, practice experience).

Discontinued medication identification. Discontinued medications were highlighted in yellow and often had discontinued handwritten in red over the medication. The yellow highlight served as a reminder to alert the nurse that a medication was discontinued and should not to be given without a new order. Highlighting a discontinued medication was instituted by nurses to prevent a medication no longer intended for a patient from being administered (practice experience, Neander).

Patient chart identifiers. Patient charts had pull out flags to alert the ward or unit clerk and the nurse of new handwritten orders by the physician. These flags had distinct colours, (e.g. a red flag meant there were new physician orders and a yellow flag signaled the nurse to check the chart to verify orders). Constant checking of the charts was practiced to verify that new orders were enacted. If the nurse received a telephone or verbal medication order from a physician, it was handwritten on the order sheet in the chart and transcribed to a paper MAR. Physicians were reminded to confirm verbal and telephones orders with their signature when they were in the hospital. Another coloured pull-out flag on a patient's chart was used as a reminder to the physician to verify orders. Chart identifiers were yet another safety method used with a paper mediated system to prevent administration of a discontinued medication or a missed dose of a newly ordered medication (E. Heikkela, personal communication, January 10, 2015; Neander, practice experience).

Practice-Based Safety

In this section, historical literature is discussed that documents nurses practice-based medication safety. Nurses built in safety checks for medication preparation and dispensing to prevent errors in administration for patient protection. Robinson Wolf (1988) in her research found nurses, as a safety measure, prepared patients' medications with the original packaging, stuffed in a soufflé cup to be reviewed and checked with the patient at the bedside before administration.

Night shift safety practices. A common nursing safety practice on night shift was to check all MAR's against the original physician order. Nurses built in safety methods continually around medication administration practices. Safety methods evolved from nurses' medication administration practice experiences. Night shift checks were another patient safety practice method completed to identify any errors in writing and transcription of an order (Fairman & Lynaugh, 1998). As night shifts tended to be less busy than day shifts, nurses were able to carefully review medications. Twenty-four (24) hour checking included ensuring medications were as written on the Kardex (nursing reference for patient care including medications) and that the patient's medication administration record matched the physician's original medication order as written in the chart.

Medication Dispensing and Practice Specific Safety

Medication dispensing in hospital settings. As the hospital was a common place of practice for nurses, medication administration became their responsibility and included medication preparation for dispensing to patients. Nurses in hospital settings assumed the responsibility for dispensing medications either from multi-dose bottles of pills or vials for medications in a liquid preparation. In her research on bedside nursing, McPherson (1996)

documented "the careful counting and recording"(p 79) of medications was practiced in the **1930's** for hospital record keeping, driven by the administration of powerful medications, such as morphine. This "careful counting and recording" was completed by two nurses to prevent errors. Counting and recording was also completed to deter misuse and theft of a powerful medication.

Private duty nurses and medication dispensing. Private duty nurses, including those working in patient homes, had full responsibility for medication dispensing. Small amounts of narcotics were often in private duty nurses' possession for emergency and rural practice (McPherson, 1996). Physicians expected nurses to have morphine available to administer to a patient by telephone order. Due to the legal grey area of the physician's expectations, the Registered Nurses Association of Nova Scotia (RNANS) in **1936** acknowledged that an "allowance could be made for a nurse to possess morphine for practice". However, RNANS also acknowledged a nurse might not receive much protection if there was a serious involvement of a patient or doctor" (McPherson, 1996 p. 105). Morphine, as a narcotic, might be used inappropriately and had a risk for falling into the wrong hands. A nurse carrying morphine did so at some risk to her professional reputation. Nurses' responsibility and safety practices for medication administration were closely tied to the settings and circumstances in which they worked.

Northern nurses and medication dispensing. Canadian nurses working in the north often were the only health professional in a community and held great responsibility for dispensing and administering medications. Herbert (2005) wrote the following about her northern nursing experience in **1964** with medications. "Liquid medications came in gallon glass bottles, the ointments in large tins, and pills in big jars. The nurse would prescribe and then

dispense these in smaller containers. In those days, the Royal Canadian Mounted Police (RCMP) officer in charge would check the narcotics and controlled drugs" (with the nurse) (p. 176). A dual verification of a "powerful medication" became the responsibility of the nurse and RCMP officer to ensure safe medication practices in northern settings. This was a practice that was setting specific as there was only one nurse on site at some northern nursing stations. The common practice in clinical settings was a dual verification of narcotics by two nurses every shift (E. Heikkela personal communication, January 10, 2015; Neander practice experience).

Medication Delivery

Medications were often supplied from pharmacy to nursing unit in multi-dose bottles and vials. Individual doses were prepared and dispensed by the nurse in the medication room or at the patient's bedside and not by a pharmacist. Nurses became accustomed to holding full responsibility for a patient's medication.

Medication Administration Safety and Supplies at the Bedside

Specific supplies nurses used for the delivery of medications from a central medication room to the patient's bedside included a paper soufflé cup, medication identification card, medication tray, syringe and measuring cup and spoon. Medication cards were used to identify the patient and their respective medication. Medication cards were a safety feature nurses created that was aligned with the MAR. A medication card was used to identify a patient with an individual drug dose at the bedside (Neander, 2006, personal experience).

Once at the bedside, a nurse completed a final check using a medication card to match a patient with a medication to be administered. Nurses carried trays with medications to be delivered, each with a spot to place a medication soufflé cup with a slot in front or behind a cup for a medication card. A patient's name, room number, medication name, dose, and time to be

administered were included on a medication card to match with a patient's wrist band. The patient wrist band was introduced in the late 1950's as patients became more mobile and were not confined to a bed. For patient safety, nurses needed a way to confirm the identity of a patient before administering a medication (Fairman & Lynaugh, 1998).

The following picture is an example of a medication delivery cart with medications and medication cards used to carry out the three checks; right patient, right medication, and right time.

Figure 1. Medication trolley with identification cards pediatric unit Guatemala. (Neander, 2006)

Medication Administration Student and Graduate Nurses

During the **1940's** and **1950's** student and graduate nurses typically had responsibility for 45 to 60 patients on a unit. Students and graduate nurses held the responsibility not only for "hygiene and daily care but also medication administration" (Fairman & Lynaugh, 1998 p. 9). Into the late 1940's, medication administration practices were learned through frequent repetition and routine checks as nursing education evolved. Nurses developed practice-informed safety measures for medication administration. Education programs evolved simultaneously to include "formal medication administration teaching" (Fairman & Lynaugh, 1998 p. 45).

Safety Checks and the Rights of Medication Administration

As described earlier, a number of checks were completed by nurses prior to administration of a medication. These checks were referred to as the "rights of medication administration". Robinson Wolf (1988) spoke of three rights used by nurses in her research on nursing practices in the 1980's. Baker (1997) identified five rights used by nurses in her research on medication. The five rights were referred to as right time, right patient, right dose, right drug, and right route. Wilson and Divito-Thomas (2004) proposed a sixth right, the "*right response"* (p. 131) as a necessary check to decrease errors in administering drugs when no longer necessary or when not appropriate given the condition of the patient. This sixth right is described as recognition of the critical thinking required of nurses for effective medication administration. Continued acknowledgement of the practice of the five rights of medication administration and a sixth right is found in the research of Eisenhauer, Hurley, and Dolan (2007). The sixth right according to a participant in Eisenhauer et al.'s research was "the Registered Nurse who makes sure the previous five R's are correct" (p 87). Various interpretations of the

rights of medication administration imply a standardized or universal format for the rights of medication administration has not been used by nurses.

All of the medication checks developed and performed by nurses, required careful consideration, given the complexity and number of medications being administered to multiple patients with their own unique medication regimen during a shift. In 1942, Dennison documented that nurses administered as many as 1500 medications daily in a hospital with 473 patient beds (Dennison, 1942 as cited in Fairman & Lynaugh, 1998 p. 48). Medications were administered orally and parenterally. The high volume of medications administered was also documented in the 1950's with "nurses on a 25-bed ward administering 48 parental (injectable) medications in 24 hours" (Fairman & Lynaugh, 1998 p. 49).

Nursing Knowledge and Medication Administration Safety

Robinson Wolf (1988) in her study of nursing practice found nurses classified medication as “healing substances given to improve patients’ conditions” (p. 63). Baker (1997) shared in her research, how nurses administered medications “according to their knowledge of the drug in question, their knowledge of the needs of the patient and a patient’s response to a drug” (p. 158).

Eisenhauer and colleagues (2007) found nurses used “patient data and interdisciplinary professional knowledge to provide safe and effective medication administration and care” (p 87). Nurses’ values of “do no harm” and “do good” (Robinson Wolf, 1988 p. 63) were foundational for continual development of safety methods for medication administration. Nurses’ enactment of medication administration was organized around the rights of medication administration. However, it was nurses’ knowledge that supported their clinical decisions for safe medication administration beyond confirmation of the *rights*.

Summary

This historical chapter has provided a brief overview of nurses' vigilance to prevent medication errors and protect patients from harm. Administrative medication practices that evolved to protect patients from harm included specific handwritten documentation to review transcribed orders and prevent medications that were discontinued from being administered. As new staff members, such as unit clerks, assumed medication administration roles, including transcription, nurses continued to oversee the process through routine checks to promote patient safety. Similarly, nurses developed practice-based initiatives and used supplies, such as medication cards that could match a drug to be given with the correct patient.

As the volume of medications being administered increased, nurses' safety practices continually evolved through repetition and routine in hospitals and other clinical settings. As graduate and student nurses took on the responsibility for medication administration, the need for formal education for safe practices to protect the patient became apparent. Nursing education adapted simultaneously along with nurses' medication administration practices to include formalized teaching of safe medication administration and pharmacotherapeutics.

The importance of nurse's evolution of safe medication administration practice is not to be forgotten as an interesting historical artifact of nursing care. Instead, as Foucault emphasizes, history "offers a background…it determines the chronological and geographical boundaries in which… knowledge can be recognized as having validity" (p. 371). History in relation to present day nursing is recognized by the Canadian Nurses Association as a contributor to knowledge development and professional identity among nurses (CNA, 2007).

Nelson (2009) points out that history plays an ongoing role in the identity of groups. Nurses' identity has developed as the health professional responsible for medication

administration. Recognition of nurses' development of safe medication administration practices, is necessary to respond to present day public and academic literature that identifies nurses' behaviours as contributors to medication errors. Nurses to this day practice the same vigilance for patient safety despite the increased complexity of medication administration. Present day medication administration complexity includes the larger number of medications being prescribed for individual patients, new technologies, and a plethora of administrative policies and procedures (Carayon, et al., 2014; Garrett & Craig, 2009).

In subsequent chapters, NICU nurses' medication administration practices and the complexity therein, are discussed from data arising in my research. In Chapter Seven, I discuss NICU nurses' integration of past medication practices into present day practices with the goal of protecting vulnerable preterm infants. For example, a bar code scanner now reads a medication label to check that medications are matched with the correct patients. As documented in nursing literature, nurses have previously performed the check as part of the *rights* of medication administration. I observed NICU nurses' doing their own checks in addition to the bar code scanner for medication administration to preterm infants.

Chapter Six: Locations and Circumstances of Medication Administration: A Neonatal Intensive Care Nurse's Shift

To understand NICU nurses' medication administration practices I observed NICU nurses in practice to become sensitized to the situations and circumstances in which they work (Mol, 2010). A first level descriptive analysis of observational data from sixteen day shifts and two night shifts, is presented in this chapter.

A swipe of a NICU nurse's badge over a screen on a computer-mediated medication dispensing and recording unit, and presto, a nurse enters into a relationship with an electronic system. Throughout 12-hour day and night shifts, a relationship with an electronic system and medication administration is one of many responsibilities that nurses undertake to provide care to a preterm infant. A NICU nurse's daily work is guided by practice experience and knowledge (including knowledge of the electronic system) when responding to dynamic situations over 12-hour day and night shifts. The location or context of NICU nurses' medication administration practices, as part of their shift activities and preterm infant care, are described in this chapter.

NICU nurses' preterm infant medication administration practices, I discovered are a complex interweaving of knowing about vulnerable preterm infant needs, medications, pharmacists and technology. In this chapter, observation and interview data are discussed. Practice observations were used to describe knowledge incorporated in daily shift activities for preterm infant care and medication administration. Additionally, observations of NICU nurses' shift activities uncovered the network in which technology and NICU nurses enact medication administration.

Neonatal intensive care unit (NICU) nurses, all registered nurses with Bachelors of Science degrees, were observed during 12-hour day and night shifts. My observations included

watching the nurses as a group as well as watching them complete particular assignments. For example, the nurse assigned the role of resuscitation nurse (RESUS), does not receive a patient assignment. Throughout day and night shift observations nurses would often tell me what they were doing as they went about caring for a preterm infant. The following subsections in this chapter describe nurse's work during 12-hour day and night shifts.

Preparing for a Day Shift

Day shift handover begins at 0630 hours and finishes at 0700 hours. However, prior to this start of the day shift, NICU nurses arrive between 0600 and 0610 hours, to dress in a locker/change room designated for the maternal/child units. As I waited with a NICU nurse to clock in, she shared that she did not want to feel rushed before her start of shift, "I prefer to be early as it allows me to focus and relax to prepare myself before I receive shift handover. You never know who might be labouring or how an infant may have taken a turn for the worse". Nurses frequently leave their shift not sure if a preterm infant will be there the next day. An early arrival allows a nurse to 'centre herself' and get ready for the shift. Taking the time to prepare for a shift supports NICU nurses as they prepare for the preterm infant assignment they will receive once they enter the unit.

Before entering the NICU, nurses waited in the hallway outside the change room with the lineup of other maternal/child nurses, to clock in for the day. The earliest time a nurse can clock-in, is 0620 hours. Clock-in time for the nurses was set by the administration. The nurses revealed that the administration will not pay for more time beyond a start time of 0620, they waited to clock-in their start time. I noticed as the nurses queued up that they offered one another a smile or quick "good morning". There was a quiet nature to the waiting and the nurses appeared comfortable with the silence. A waiting period held the nurses in suspense and they

could not be ready for work until they found out what awaited them on the unit. It was apparent to me that NICU nurses were constantly concerned about providing safe, individualized care given the vulnerability of preterm infants.

Once entering the unit, nurse B did a two-minute hand scrub and used the time again to focus herself. Next is a meeting, a *huddle*, in a door less extension room behind one of the two nurses' stations (connected to nursing station in front of medication/supply rooms on the unit diagram below). The door less room allowed for nurses to quickly respond to urgent or emergent situations that might occur during shift handover.

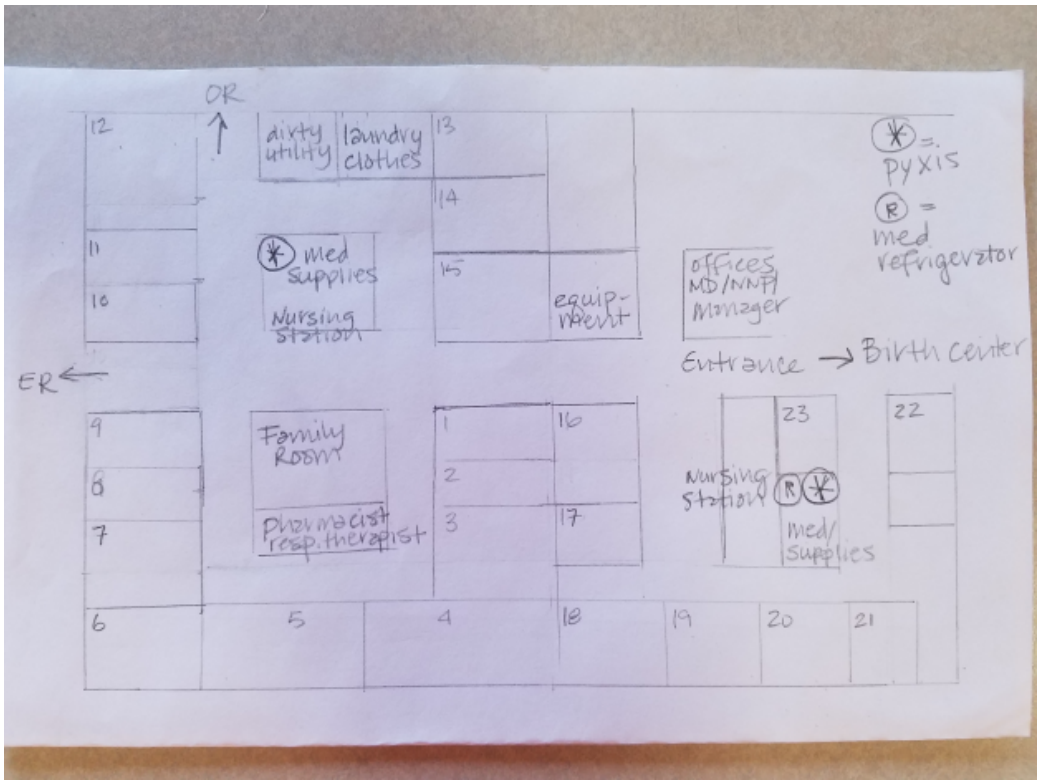

Figure 2. Diagram of research setting (Neonatal Intensive Care Unit, 23 patient beds)

Shift Handover Receiving Infant Information

A full staff shift handover report is led by the day charge nurse. In the extension room the day charge nurse shared with all the oncoming nurses a general overview of the number of

infants. Information shared by the charge nurse included: whether or not the mother has been in to see the infant on the unit, the status of women in active labour, and scheduled caesareans. Labour and delivery information was important as NICU nurses prepared for potential high risk situations that make it more likely they will need to provide emergency medications and interventions for a preterm infant.

In arranging nurse-patient assignments, the charge nurse asked if any nurse had cared for a specific infant on a prior shift. A more in-depth, individual handover takes place thereafter between individual off-going (night shift) and on-coming (day shift) nurses. In delivering and receiving shift handover, nurses used paper shift handover forms they designed and redesigned (Appendix C), to convey specific information. Nurses recorded general information during a charge nurse's report on the shift handover form. For example, information recorded includes preterm infants who may be discharged, and any labouring women. Medications and feeding times related to an infant assignment are noted on a shift handover sheet by an on-coming nurse. A shift handoff sheet is an ordering device (local map) that NICU nurses used throughout their shift. Infant feeding times are the general points of order NICU nurses use for their shifts.

The *shift handover* form has open boxes for hourly recording of information and boxes with specific infant data, such as date of birth, parents' names, and vital signs. An off-going nurse used their completed shift handover form to provide the information as an oncoming nurse began to fill in her own form. If an off-going nurse cannot answer a question posed by an on-coming nurse, a nurse accessed an infant's electronic health record (EHR) to seek out more information. When the EHR did not have the missing information the on-coming nurse required, a note was made on the shift handover form to follow up.

The movement back and forth between a paper document and an electronic record created tension for NICU nurses who historically have had all patient information on a paper document. I am told by Nurse A, as I observed her during a day shift, the transfer of information from a paper to electronic document missed information that is important for follow up. For example, a paper discharge sheet used in the past no longer exists and NICU nurses have realized that important information has not been provided to the parent after a preterm infant has left the unit.

However, a practice of using both paper notes and having access to the electronic health record allowed for a comprehensive overview of a preterm infant's current wellbeing, and supporting interventions. The inseparability of NICU nurses' practice and technology was illuminated during shift handover.

The format and questions asked by NICU nurses during shift handover indicated a concern for infant safety by ensuring that a comprehensive "picture" of care and patient were shared. Paper documents are used continually by NICU nurses as the information required for safe preterm infant care is not easily accessible from the electronic health record. A tension existed for NICU nurses when they are unable to access information previously available from paper documentation system. As Nurse A conveyed to me, "I worry I am missing something as I am not able to quickly find infant data I need for assessments for medications and interventions, if you lose your paper you might as well go home". NICU nurses guarded their shift handover sheet as it held the information that nurses relied on for safe preterm infant care. Consideration should be given to mitigating the tension nurses experienced when they were unable to access information previously available with a paper system. The practice of accessing both an

electronic and paper document system supported NICU nurses as they prepared themselves for vulnerable preterm infant care and medication administration.

When the charge nurse finished the group shift handover, day shift nurses moved to one of two nursing stations to receive an infant-specific handover from a night shift nurse. Assignments for a shift were based on the acuity of preterm infants. It was common for NICU nurses to be assigned two preterm infants. One-on-one infant specific handover was observed to happen between two different night nurses and one day shift nurse as assignments did not automatically pass from one nurse to another. The nursing station housed the computer terminals with screens and keyboards for electronic charting. A separate monitor for physiological data was also located at the nurses' station. The monitor provided preterm infant physiological data, such as heart and respiratory rates, continually for constant surveillance in the event of a change in status needing attention.

Physical Layout of the Unit

Nurses' station. Four computers for charting in addition to those in patient rooms were located on a desk that faces outward to the unit. Computer positions allowed nurses to see the flow of traffic in most of the corridors of the area, while accessing electronic health records and receiving shift handover. The physical location of the nurses' computer stations provided an easy visual access for the nurse and family members. In other words, to work at the computer terminals, nurses must face forward, and therefore, would never have their back to visitors or to preterm infant rooms. Thus, the layout of the NICU and equipment influenced nurses' practice and promoted safety.

I noticed this physical layout immediately, as it offers a welcoming atmosphere upon entry to the unit. A nurse was visibly present. A benefit of this layout afforded nurses an easy

view of anyone entering, with a quick look up from charting to give a greeting or screen any visitor. In situations where a concern arose about an infant's safety, such as an infant with a *no-contact with visitors* order, nurses could call for assistance or ask a visitor the purpose for their presence on the unit. In addition, sitting at an outward facing desk, a nurse or unit clerk was vigilant to the needs of nurses in the preterm infant rooms, thereby supporting infant safety. The unit's physical layout is presented in more detail in the gathering medications section of this chapter with respect to preterm infant medication administration.

Preterm infant patients' rooms. Preterm infant patient rooms opened to the unit corridors, which allowed access from a hall leading to the hospital elevator. All preterm infant rooms were single rooms, with the exception of the *twin* room, which was a double room. Between two of the single rooms, a wall could be opened to create one larger room for accommodating multiple births. All single rooms had a space for parents to sleep, if they desired to room-in with their infant. NICU nurses enacted medication administration and preterm infant care with or without parental presence. When a parent was present, NICU nurses explained the care being provided, taught parents about infant care, and were available for questions.

Nurses Collaborative Work to Promote Preterm Infant Safety and Well-being

Collegiality among nurses was evident as decisions focused on who would care for which infants during the shift, and who was assigned the 'resuscitation (RESUS) nurse' position (Appendix D). A RESUS nurse's responsibilities included support for colleagues and attending all high-risk births. I witnessed nurses who worked recent shifts share information with their on-coming colleagues about the care they provided for particular infants, how the family was included in infant care, and information provided to family members in preparation for discharge.

Nurses' Shift-Change Routine to Promote Infant Safety

At shift change, a handover report among day and night nurses occurred at the nursing station, not in a patient room. I observed nurse B as she listened intently to the nurse handing over information about patient #1, an infant up for adoption. Details of the pending infant adoption were given, and, as nurse B listened, she checked the chart while the nurse handing off continued to give further information with respect to a green discharge sheet, circumcision consent, upcoming vaccinations, and individualized information about this preterm infant.

Another night nurse provided report on infant #2, assigned to nurse B. Infant #2 was known to nurse B from previous shift assignments. As she reviewed the progress note in infant #2's chart, nurse B asked the night shift nurse if a Hepatitis B immunization had been administered per NICU protocol. The night nurse told nurse B the immunization had not been administered. Nurse B, upon further review, noticed that the infant's chart included a notation that the mother speaks no English. A signed consent is needed prior to administration of an immunization; thus, nurse B's next question posed to the night shift nurse concerned the need for a parental signature. "The consent still needs a signature" was the reply from the night shift nurse. Nurse B wrote a reminder to ensure that interpreter services were available to obtain informed consent from the mother on her shift handover sheet.

The focus on the infant and family was evident in the shift handover information as nurses discussed and requested more information. Nurse B requested more information not found in the chart or on the shift handover sheet. For example, Nurse B asked about family interaction with the infant, if anyone overnighted with the infant, and the mother's ability to speak English. Nurses' discussions of family interaction and individualized infant information,

were identified by them as important to support safe care and to prepare infants and their families for discharge.

As the oncoming day-shift nurse (nurse B) listened to the respective night nurses, I watched her meticulously write information on a folded piece of paper, her carefully designed shift handover sheet. The paper was folded so she could organize her care for the shift based on medications, feeding times, and diagnostic procedures. Nurse B created a local map for her shift responsibilities that intersected with institutional requirements that served as a universal map. A local map was an "ordering device" (Mol, 2002), nurse B employed to organize the complexity of preterm infant care and medication administration. A great deal of adaptability and flexibility was observed as NICU nurses designed and redesigned their paper document to respond to preterm infant needs throughout a shift. A shift handover document was a detailed local map created by NICU nurses that was connected to a universal map, an infant's electronic health record (EHR).

Shift Handover Electronic and Paper Documentation

With the tap of her name badge on the monitor screen the on-coming Nurse B brought up the EHR, while she listened and *scrolled* through EHRs of infants for whom she would provide care. The ease and flow with which nurse B performed these back and forth maneuvers between her shift handover form and accessing EHR's was seamless while she listened intently to the night nurse's spoken overview. The importance of nurse B's shift handover sheet was apparent as she wrote down information and reminders for institutional requirements to add to her local map or "ordering device".

Each infant-overview included routine and specific information, noted by nurse B on the shift handover form. The form provided a space for a NICU nurse to record routine feeding

times and scheduled immunizations, along with specifics such as adoption information, the mother's first and only language (Spanish), and a request for a circumcision. As nurse B wrote information on her shift handover form, she questioned the night nurse, "Is the consent signed for a circumcision? What about Hepatitis B immunization, has it been administered? Has a mother signed that consent? What was the availability of an interpreter for a non-English speaking parent? What about infant Glucose levels?"

Shift Handover Sheet Prompts

The value of reviewing the EHR during the shift handover with a paper document was demonstrated when nurse B found an error in a preterm infant's prescribed feeding schedule. The shift handover sheet provided entry space for feeding times and the amount of formula or breastmilk ordered. As she reviewed an order for nutritional intake on a preterm infant's EHR, nurse B noticed the order did not meet required growth and development needs. Nurse B called the prescribing physician's assistant immediately and requested an order correction. Nutritional needs were as closely monitored by NICU nurses as medications, to protect vulnerable preterm infants.

Assessments, Activities and Action to Support Safe Practices

Once shift handover was completed, nurse B proceeded to each preterm infant's room and began quick visual assessments of each of her assigned patients. A quick assessment determined if a preterm infant was awake or resting comfortably. Of note was the location of the two infant rooms. Nurse B's assigned infants' rooms were not contiguous to one another. Infant #1 and infant #2's were two rooms apart, a distance of approximately two to three metres.

The priority of each preterm infant's full assessment was organized to coordinate with a preterm infant's feeding schedule, physiological stability (as reported during the previous shift),

upcoming medication administration times, and presence of a sleeping parent. In other words, NICU nurses exercised their discretion about the order they follow with scheduled and routine activities. Their local maps created on a shift handover sheet were used for organizing shift activities to meet different preterm infant care and medication administration responsibilities.

Preterm infant assessment. In each room, lighting was maintained at a minimum setting to prevent disturbance to a sleeping infant. A monitor displaying vital signs provided a dim glow to the room. The nurse did turn on a light briefly, which allowed her a satisfactory view of the infant. She gently checked the blanket tucked around the infant to be sure it was properly wrapped. *Facilitated tucking*, the wrapping of an infant in a blanket was a common nursing intervention used to promote comfort (Hartley, Miller, & Gephart, 2015). A blanket was carefully wrapped around the infant to simulate the in-womb position given that this infant would otherwise have remained in *utero*.

As nurse B began her assessment, of infant #1, she looked at skin colour, breathing rate and effort, and facial cues before taking a note of monitor readings. Assessment findings were written by nurse B on the infant #1's shift handover form. After a visual assessment with the room lights low, nurse B gently unwrapped the blanket and applied a stethoscope, listening to the infant #1's chest and abdomen. Again, nurse B recorded her assessment on the shift handover sheet. Nurse B's next step was responding to any changes in infant #1's status and reviewing routine equipment for infant care. Infant #1 was examined for a wet or soiled diaper and bedding to prevent skin breakdown and infection. Once bedding and diaper have been checked and changed, *facilitative tucking* of infant #1's blanket was completed.

Assessment of room equipment and whiteboard information. In a review of room equipment, nurse B discovered the bulb syringe (for oral suction) was missing from its

designated spot in the Isolette (infant's bed). Nurse B told me she would replace the missing equipment as soon as she finished her checks and wrote a note on the shift handover sheet to replace the bulb syringe. Here, nurse B used her local map to navigate a situation that must be remedied to protect a vulnerable preterm infant. Once nurse B finished her equipment checks, she left the room to secure a bulb syringe. She returned promptly and placed a bulb syringe in the isolette. This action was completed to meet both nurse B's practice of protecting preterm infants and institutional requirements. Institutional requirements were a universal map or "ordering device" for ensuring equipment needed in an urgent situation was available.

In succession, information on the whiteboard in the infant #1's room was updated by nurse B to match today's date. Other information, nurse B updated on the whiteboard included the infant's age in days and her name as the assigned nurse for the shift.

Prevention of infection. Once the whiteboard is updated Nurse B wiped down all surfaces and equipment in the room, including the computer keyboard, and explained to me, "to keep the germs down to a minimum". As she wiped down the surfaces, nurse B shared her disappointment in hospital management when NICU nurses requested computer keyboard covers for infection control. Keyboard covers nurse B explained, reduced microorganisms in the room, as the covers are easy to clean while protecting the keyboard. The concerns about microorganisms expressed by nurse B were well documented in the literature on keyboard contamination (Ide, Frogner, LeRouge, Vigil, & Thompson, 2019).

Between checks and patient care activities, nurse B washed her hands at the sink. Another example of how nurse B's practices prevented the spread of microorganisms was her frequent handwashing. During a two-hour observation, nurse B washed her hands 15 times. Nurse B shared that she prefers soap and water over hand sanitizer. Hand sanitizer dispensers were

located outside all of the rooms. Sinks with soap and paper towel dispensers were located in patient rooms, in medication rooms, at the entrance to the unit, and in the unit lounge for families.

Supporting a colleague: responding to a preterm infant's alarm. A colleague's preterm infant's alarm was sounding in another room; nurse B left infant #1 to assist. When nurse B arrived, she found her colleague was struggling with the alarm and other equipment and taught her colleague how to operate them. Then, nurse B returned to infant #1 for one last-minute check. I noted that nurse B had washed her hands three times during her response to the alarm. Once her colleague's situation had been addressed, nurse B repeated the sequence of assessments and activities for her, second patient, infant #2. She then began to focus on medication administration.

Gathering Medications

It was now 0720 hours and nurse B moved to the medication room. The medication room was approximately 10 metres from the room of infant #1 and 12 meters from infant #2. In the medication room, an automated medication dispensing unit, or Pyxis cabinet stored NICU medications. Next to the Pyxis was a refrigerator that stores medications and vaccines that are required to be kept cold. Vaccines were stored in a refrigerator to maintain the bioavailability of the medication.

Nurse B expected to remove the routine medications from the Pyxis automated dispensing system, only to find the medications were not available in the infant's drawer. The Pyxis had the order on the electronic medication administration record (EMAR), but there was no prepared unit dose in infant #2's drawer. Nurse B overrode her first attempt at retrieving medications and instructed the Pyxis to open the stock medications' compartment. Infant #2's

prescribed medications were available in the stock medications' compartment. Medications that nurse B required from the stock supply were recorded in infant #2's EMAR. I was told by Nurse B a common stock medication compartment is needed as medications are often missing from preterm infants' medication drawers as routine stocking of a Pyxis is performed twice a day. If a medication was ordered after the routine stocking times it might not be available in a patient's individual Pyxis drawer.

Once medications were removed and recorded, nurse B returned to infant #2's room with the medications. A note on the shift handover sheet was written to follow up on infant #2's missing medications with the pharmacy. Nurse B related that a missing medication with an order in the EMAR may appear in a preterm infant's medications drawer, when a pharmacy technician stocked the NICU Pyxis cabinet later in the shift. A note is written on nurse B's shift handover sheet to remind her to check the Pyxis to see if missing medications were delivered to the preterm infant's drawer before her shift is completed. Removal of a medication from an individual preterm infant's drawer or a stock compartment was recorded to update the Pyxis Unit inventory. As noted previously, a pharmacy technician stocked the Pyxis Unit with prescribed and common medications based on the inventory.

Dual Medication Verification for Safety

The description below includes observations of two nurses during medication administration. One nurse is the RESUS nurse (nurse A) and the other nurse (nurse B) is assigned to be primary nurse for two specific infants.

Nurse B must find the RESUS nurse (nurse A) for the dual verification of medications (oral Vitamin D and Iron). Nurse B explained to me that a pediatric medication error was made in the larger hospital system. Dual verification was now required for all medications prior to

administration. The required institutional dual verification applies specifically to Neonatal and Pediatric units. Adult units, I am told, were required to practice dual verification only for high risk medications such as heparin and insulin. Nurse B informed me she does not know anything about the original error that led to dual verification, although she wished she did because it might help her prevent possible medication errors.

Vocera for Communication and Medication Administration

Nurse B used her *Vocera* to call nurse A (Resus nurse): Vocera is an intercom calling system used among the nurses on the unit and throughout the hospital. All NICU nurses carried a Vocera on their person. At first, the Vocera did not recognize the name of nurse A and nurse B continued calling. When there was no response, nurse B proceeded to call another one of her colleagues to ask for assistance with the medication preparation, but no one was immediately available. While nurse B waited, she charted on the computer and updated her shift handover sheet. She also used the time to stock supplies in the infant's room. The waiting period also provided an opportunity for nurse B to share her Vocera experiences.

I learned from nurse B that it was common for the Vocera to ring when the nurse is in the middle of completing an infant's position change, feeding an infant, or teaching a parent. In other words, the Vocera, intended to support the nurse, also became a source of distraction and interruption for the nurse (and family). The voice projection over a Vocera was often unintelligible. When a Vocera call was received, a mechanical voice named the person calling. Similarly, when a nurse placed a Vocera call, a mechanical voice said calling followed by the name of the person to whom the call is intended. The intention of Vocera communication was to insure a NICU nurse could call for assistance with a preterm infant without leaving the bedside.

However, in nurse B's view, Vocera also disrupted nurses engaged in preterm infant care. The interruptions, she cautioned, can create a safety risk.

Dual Verification and Computer Capability

When nurse A did arrive after 10 minutes, she reviewed the medications with nurse B. In preparation for dual verification, nurse B had the computer screen open to the correct page. The medication information was easily visible to both nurses. However, nurse A had to make repeated attempts to log into the EMAR to verify the order and the medication that was chosen from the Pyxis stock drawer. The difficulty, nurse A told me, was the computer system was not recognizing her password. After three attempts, nurse A was able to verify the medication. I noted that it took 10 minutes of both nurses' time, before the verification was completed. The medication was recorded and verified by both nurses in infant #2's medication record. Documentation for all medications was completed in the EHR. Each infant had a medication administration record that was one of the components of the EHR.

Nurse A remained in the room, while nurse B administered the medication slowly, into the infant's mouth. The infant was tucked snugly in a blanket while nurse B held the infant upright to administer oral iron and vitamin D.

Resus Nurse NICU and Pediatric Coverage

Once the medication verification and documentation were completed, nurse A received a Vocera call from a nurse on the Pediatric Unit for a dual verification of a medication. The Resus (Appendix D) nurse position covered the NICU, Pediatric Unit and Labour and Delivery Unit. If the Resus nurse was busy on another unit or with another colleague, NICU nurses would call other colleagues for dual verification of medications.

Vocera, Pyxis Unit, medications, oral syringes and an infant's electronic medication record were all connected to a NICU nurse's medication administration practices. In the NICU, the safety of medication administration, practices involved two nurses who work together for dual verification in relationships with Vocera and Pyxis Unit technologies.

I noticed as I observed in preterm infant rooms there were emergency medication documents (Appendices, E, F & G) on the window just next to the entrance to a patient's room. I was told by the Resus nurse there was no time in an emergency to be looking up medications and the technologies in use were not capable of providing a correct dose. Preterm Infant weights were measured and recorded daily in the patient's electronic record. A pharmacist checked daily for a preterm infant's weight and updated an emergency medication sheet for posting outside of the patient room.

Morning Care and Feeding Dual Verification of Breast Milk

Once verification of medications and administration was completed, nurse B proceeded to prepare the infant feeding. Breast milk preparation and administration was similar to medications, thus required dual verification, in order to confirm its source as being the infant's mother. Nurse B told me there had been incidents in which the incorrect breastmilk had been given to a preterm infant. In response to errors in breastmilk administration, dual verification was instituted by NICU nurses and was now a hospital policy. To protect preterm infant's NICU nurses remedied a gap in institutional policy.

I noticed that the walk from the infant's room to the milk storage area was twice as far (20 meters) as the walk from the infant's room to the medication room. Depending on the location of an infant's room, a NICU nurse may walk from one end of the unit to the other to access a preterm infant's breastmilk.

Once the milk was dual verified, it was mixed with donor breast milk to 'top up' the volume the mother was able to provide. Prior to feeding the infant, breast milk was warmed (either in the storage area near the fridge or in the infant's room). Breastmilk was treated with the same diligence as medications by NICU nurses.

Morning Care: Feeding and Bilirubin Lights

Patient #2, who is assigned to nurse B was under special lighting to treat a high bilirubin blood count. The infant's eyes were covered, and the infant was not wrapped in the usual blanket for facilitated tucking (Hartley, et al., 2015). The 'bilirubin lights' were turned off before the nurse removed the eye patches and picked up the infant. Nurse B wore gloves as she fed the infant, apparently, a newer unit policy, I learned from nurse B. The policy was instituted by physicians who wanted to follow the policy of a larger NICU in the area. The rationale that was provided for wearing gloves when touching preterm infants was for infection control. Nurse B told me wearing gloves had an effect on her ability to provide care and assess a preterm infant. *"You can't feel the body temperature very well through a glove, I don't just look at a temperature gauge, I want to assess the baby to feel how hot or cold their skin feels".* Nurse B fed infant #2 using a bottle. As with many of the infants, nurse B gavage fed (tube feeds) the remaining milk. Nurse B held infant #2 as she bottle fed, speaking to the infant softly, watching for cues that suggested infant #2 needed to burp or was in any distress.

She watched for neck movement to indicate swallowing was occurring. Nurse B focused on infant #2 but also followed the vital signs monitor, an activity that required her to position herself as she sat with infant #2, with her back to the infant bed. She was verifying the different sources of physiological data, by watching the infant's appearance, swallowing and breathing in concert with the monitor display.

Infant feeding shared similar safety practices with medication administration, such as holding the infant upright when giving an oral medication and watching for swallowing. A difference between infant feeding and medication administration, however, was the volume that was being administered. Oral medication doses were less than one milliliter in volume, whereas breastmilk and formula quantities could be 15 to 20 milliliters in volume per feeding.

Observing a RESUS nurse in Dual Verification

The RESUS nurse position was located in the NICU. Position responsibilities included coverage of pediatric and perinatal units. Evident in dual verification of a medication was the knowledge the Resus nurse used before she would sign off on a patient's electronic medication administration record (EMAR). Opportunities for learning and teaching about medications and the delivery of medications to small, vulnerable patients occurred during the dual verification process. A Resus nurse who had been called to the paediatric unit for dual verification of a medication began to gather the information about the child. The medication being verified was potassium and was to be added to intravenous (IV) fluid D5 1/2 NS (5% dextrose with half-strength normal saline). I noted that before the Resus nurse looked at the prescribed medication, to read and verify the label, she decided to:

1. view the most recent blood Potassium level of the child,
2. review the child's diagnosis and reason for hospitalization and
3. review any recent or present episodes of dehydration for the child.
4. verify prescribed order for the medication
5. calculate rate of infusion for administration through IV fluid
6. verify the weight of the child as a part of the calculations in her verification.

Once the Resus nurse reviewed all of the above, she completed mathematical calculations for dose, based on weight and compared her calculations with those of the nurse who will administer the medication. Their calculations matched, the Resus nurse accompanied the paediatric nurse to the patient's bedside and witnessed the set-up of the intravenous fluid (IV) with the potassium to an IV pump. The Resus nurse interacted with the patient, consoling the child as the paediatric nurse focused exclusively on medication administration. An unintended benefit of dual verification was a focus on the child while a medication was administered.

Computer Scrolling, Moving and Clicking the Mouse

Scrolling, moving and clicking the mouse connected to a computer terminal was a continual nursing activity during day and night shifts. The use of a mouse for scrolling, moving a cursor and clicking was required for electronic charting and reviewing patient information. A nurse used the mouse to scroll and move a cursor, to review nursing notes about care performed, diagnostic tests, and interdisciplinary notes. A computer terminal was present in each individual infant's room next to the isolette and also at the nurses' station.

As mouse movement and clicking was such a frequent activity, I began counting movement and clicks during a five-minute period in a patient's room. At the start of a shift following a nurse's (nurse C) initial activities and actions in an infant's room (see section above for description of activities and actions), I counted five clicks as nurse C opened up one of the screens on a computer for charting. Then another three clicks, followed by another three clicks and five more clicks to enter data and chart.

Each mouse click required movement between different screens and scrolling through sections of an electronic health record (EHR). To direct the cursor through mouse movement and clicking required thinking and pauses to read and search for the correct section of an EHR.

Movement of the mouse required concentration and focus to select the correct screen and column for charting.

After 11 clicks of the mouse, nurse C moved from one screen to another clicking on a side bar to change screens. Data entry required a minimum of two mouse clicks with cursor movement and scrolling. After completion and documentation of initial activities in the infant's room, nurse C moved to the nursing station to complete her charting. Nurse C informed me her move to the nursing station was to keep noise levels and interruptions to a minimum for the infant.

Correcting Misplaced Charting and Computer Mouse Clicking

As nurse C sat at the nursing station, she began her charting and realized that the system had put her into the charting section belonging to the respiratory therapist. Nurse C had performed 20 mouse clicks with movement and scrolling when she realized she was not charting in the correct spot. She had been charting in the Respiratory Therapist's charting section. Another 190 clicks with movement and scrolling were required to be able to remove the charting she had begun in the Respiratory Therapist's spot and do her own charting. Nurse C voiced her frustration of having had this experience in the past, charting in an incorrect spot. Nurse C's vigilance to carefully check her charting, prevented a preterm infant's information from being inappropriately recorded. A consequence of inappropriately recorded information results inaccessibility for future nursing assessment and review.

Mouse movement, scrolling and clicking observations allowed me an opportunity to trace the activities of a NICU nurse as she engaged in a practice relationship with technology. As I observed nurse C, I witnessed how her relationship with technology influenced her ability to

document preterm infant care. In this relationship, NICU nurses' practices unfolded in a network that included a computer, EHR, EMAR and Pyxis.

Past and Present Charting Practices

Nurse C, told me she had extra training on the use of the electronic system and felt competent in this activity. Nurse C holds a resource nurse title for the electronic system; she was able to help colleagues who struggle with an EHR. Despite all of her experience and extra training for EHR's, nurse C found herself charting in the respiratory therapist's section.

A difference between a paper chart and nurse C's electronic charting was identification of specific pages for nurses' documentation. Nurse C, shared with me her experience with a paper chart included specific pages for nurses' documentation of patient care. Patient care notes indicated, in the left-hand column, a health professional's designation and a signature at the end of an entry, including the credentials of the writer.

Has the switch to electronic systems missed the importance of separate charting areas and sections for health professionals, including interprofessional progress notes? How might an alert or identifier be included in an EHR for health professionals' specific charting requirements? A review of past paper documentation may provide useful information to prevent charting errors in electronic systems.

End of Shift Preparations

Nurse A, began her final preparations at 1800 hours for shift handover at 1900 hours, reviewing the paper document she created from morning report on her assigned infants. I noticed she began by reviewing the EHR to ensure her notes for feeding times and preterm infant care on her paper document had been entered. Nurse A rechecked the EMAR to ensure all medications scheduled for her shift had been administered and recorded. As she provided a shift

handover report to the oncoming nurse, she shared the standard physiological data, such as preterm infant age, weight and cardiac and respiratory status. As Nurse A continued her report, she shared times and amounts of a feeding and how well a preterm infant had tolerated a feeding. Specific details such as position for feeding and the amount of breast milk that had to be administered as a gavage feeding (through a stomach tube inserted in the infant's mouth) were also provided in nurse A's report. Details of nursing care and medications the preterm infant received were also included in Nurse A's handover report. Further preterm infant specific information nurse A shared, included, visitors' identities, and the presence of people at the bedside. Nurse A, shared with the oncoming nurse, parent teaching she had completed, neonatologist assessments, and discussions with parents.

The oncoming nurse, who had not cared for this preterm infant on a previous shift, asked nurse A for pointers on how to best coordinate feeding and medication administration times, and about possible breast feeding teaching and discharge planning. Nurse A provided detailed answers to the oncoming nurses' questions with examples of how she had designed and redesigned a preterm infant's care during her shift.

Summary

This chapter described the situations and circumstances in which NICU nurses' activities and preterm infant care and medication administration occur during day and night shifts. To "map out" NICU nurses' shift activities that included preterm infant care and medication administration, I observed the actions and involvements of human and non-human actors. Observed shift activities documented the inseparability of technology and NICU nurses' preterm infant care and medication administration practices. Descriptions of the inseparability of technology's and NICU nurses' preterm infant care and medication administration practices were

intended to eliminate the subject-object divide that renders technology as a tool (Latour, 2005). Technology was not described as a separate object or tool for the subject of NICU nurses' preterm infant care and medication administration practices, instead, technology was presented as an integral part of NICU nurses' practices. Neither the technology nor a NICU nurse was assumed to perform preterm infant care and medication administration independently.

Of note was the observation of preterm infant food preparation practices. Food was not usually thought of as a medication in other nursing practice settings. However, breastmilk, a preterm infant food source, was understood differently in a NICU. Breastmilk preparation and delivery, as discussed in this chapter, followed a process similar to that of medication administration. A more in depth description of medication administration practices is presented in Chapter Seven: Locations and Circumstances of Medication Administration Practices in a Neonatal Intensive Care Unit: A Medication's Journey.

Chapter Seven: Locations and Circumstances of Medication Administration Practices in a Neonatal Intensive Care Unit: A Medication's Journey

To gain an understanding of the locations and circumstances of nurses' medication administration practices in a Neonatal Intensive Care Unit (NICU), this chapter begins by tracing a NICU medication's journey. The journey began in a birthing room and continued through three centers of activity: the pharmacy, the medication Room where the Pyxis medication dispensing unit is located (Pyxis), and at the preterm infant's bedside.

Following a discussion of a medication's journey, I map out how NICU nurses' medication administration practices unfolded in three centres of activities. Despite a physical separation of the three centres of activity, a medication's electronic journey indicated an inseparability between centres of activity. Observational and interview data are used to provide examples of NICU nurses' medication administration practices in these three centres of activity.

Birth of A Preterm Infant and a Medication's Journey

Computerized provider order entry (CPOE). At a preterm infants' birth, a medication began its journey, when a prescriber (physician, physician's assistant or nurse practitioner) ordered a medication. A medication was prescribed electronically and identified as a computerized provider order entry (CPOE). Each CPOE medication entered a hospital wide electronic queue of medications that was accessible to a pharmacist. All CPOE medications connected to a pharmacy computer for processing and dispensing by a pharmacist.

Weight for preterm infant medication administration. A preterm infant's weight must be recorded prior to the administration of a medication. A NICU nurse recorded a preterm infant's weight in an electronic health record (EHR) following birth. Once a preterm infant's weight had been recorded, a pharmacist created a preterm infant's electronic medication record

(EMAR) for documentation of medications prescribed and administered. Computer stations were generally kept outside the birthing room to keep the delivery area as unencumbered as possible and brought into the birthing room only after a preterm infant was born.

Electronic Journey

A medication's journey continued electronically from the pharmacy to a NICU medication room computer acquiring an electronic and physical holding place in a Pyxis dispensing unit (Pyxis). First the pharmacist processed the medication, including verification of the appropriate dose for a preterm infant. Following the pharmacist's verification, a medication entered electronically into a preterm infant's electronic medication administration record (EMAR). After order verification was complete in the electronic system, a medication left the hospital wide electronic queue and was ready for a physical journey.

Physical Journey: Medication Transporters

Pharmacy technician and hospital tube system. Physical journeys of most medications from pharmacy to Pyxis unit followed a routine schedule via pharmacy technicians (human transporters), in the morning and afternoon. An exception to routine transportation of medications was an antibiotic prescription. Antibiotics for preterm infants were generally prescribed for serious infections or sepsis. A pharmacist prepared and sent antibiotics to the NICU immediately so as not to delay treatment. Medications were also transported by a hospital tube system (non-human transporter) for unavailable prescribed medications and unit inventory needs, outside of routine transport times.

Pharmacists as transporters and overseers of medications. Pharmacists were another physical transporter of preterm infants' medication. A pharmacist, when present on the unit, returned to the pharmacy to retrieve a medication that was unavailable from the Pyxis.

Pharmacists retrieved preterm infant medications for urgent situations, such as cardiac arrest. Intravenous preterm infant medications were also retrieved by pharmacists when not available in the NICU.

Eye drops were another medication a pharmacist retrieved from the pharmacy if the medication was not available on the unit. Given the fragility of preterm infants' eyes, an ophthalmological exam was required to assess a preterm infant's eyes, which required medication. Nurses in preparation for an ophthalmology exam, alerted the pharmacist when eye drops were not available on the unit. For caesarian sections and critically ill preterm infants' births, pharmacists were present and wore full surgical attire to oversee medication requirements in the birthing room.

Physical Routes and Vehicles for Medication Drop Off Locations

The routes and vehicles (human and non-human transporter) of a medication's physical journey can create confusion and may interrupt patient care. Notwithstanding that the birth of a preterm infant was most often accompanied by the prescription of a routine set of medications, the journey taken by these medications was often more chaotic in actuality than the routine nature would suggest. While I observed NICU nurses in practice I watched as they searched for missing medications among a variety of physical transport routes (e.g., the medication room, hospital tube system). A NICU nurse also asked the unit clerk to phone the pharmacy if the medication was not found via one of the physical transport routes. Locating medications added to the complexity of preterm infant medication administration. NICU nurses' knowledge of variable medication delivery routes was a feature of the "local map" they used for organizing medication administration.

Nursing Station: A Medication Drop-off Location

NICU nurses, when searching for a medication that was not available in the Pyxis Unit, checked the nursing station first. Once located at the nursing station, a medication was transported by a nurse to a preterm infant's bedside. Nurses transported medications from the nursing station for their assigned patients and to their colleagues. At the start of a shift I witnessed NICU nurses check the nursing station for medications on their way to an infant's room. NICU nurses accessed many transport drop off locations as they enacted preterm infant medication administration practices.

I learned from my observations that there was no standard pathway by which medications were transported from the pharmacy to the preterm infant's bedside for administration. Multiple pathways for the delivery of medications have not been noted previously in the literature as a potential source for error. As discussed in my literature review chapter, authors shared many examples of how to prevent errors. However, transport routes as possible loci of errors, were not noted in the literature I reviewed. The time spent searching for medications, I was told by NICU nurses, created pressures during busy shifts.

Medication administration practices in a NICU became reality (Mol, 2002) as nurses engaged in relationships with human and non- human transporters, technology, and institutional policies. The different routes by which medications reached the NICU exemplify one of many activities of human and non-human actors connected with medication administration practices (Latour, 2005). I observed how nurses (human actors) had the capacity for action through relationships with a Pyxis (a non-human actor) as they searched for missing preterm infant medications.

In these preceding three pages, I have presented a description of how medications move electronically and physically from place to place, before administration to a preterm infant. The discussion that continues in this chapter recounts the story of how medications moved to and from three centres of activity connected to NICU nurses' medication administration practices.

Centres of Activity: Pharmacy

A medication enters the pharmacy. A computerized provider order entry (CPOE) placed a medication into a hospital wide electronic queue that was accessed by a pharmacist. The hospital pharmacy computer received as many as 300 to 400 CPOE medications during a one hour period. As a medication entered the queue, a pharmacist processed the order for dispensing to a hospital unit. A large computer screen was monitored by a pharmacist as CPOE medications continued to enter the queue. Pharmacists observed this line-up of unfilled CPOE medications even while they were processing individual patient orders.

The pharmacy, when a medication's journey was traced and NICU nurses' medication administration practices were mapped out, became visible as the hospital centre of activity that received, processed, and sent out all hospital medications. I observed the pharmacist's work environment and practices that included the demanding reality, illuminating the inseparability of technology and medication processing by the electronic system being used. A pharmacy directed by pharmacists was a mediator and held the responsibility to efficiently and safely process and distribute medications throughout the hospital. As a mediator, the pharmacy translated and transformed a prescriber's medication orders through a pharmacist's knowledge of safe drug doses. A pharmacy also modified medications from a multi-dose to an individual dose preparation before it was sent to a NICU medication room-Pyxis dispensing unit.

A pharmacy, as a mediator in NICU nurses' medication administration practices network may "translate, transform, modify and distort" meaning. If viewed as an intermediary, a pharmacy would "transport meaning without transformation" (p.39) and in doing so places medication administration with the sole responsibility of NICU nurses, giving no consideration for a pharmacy's capacity for action (Latour, 2005, p.39).

Pharmacy medication safety check. A pharmacist and pharmacy technician reviewed and initialed the medication label to verify it was correctly packaged before it was transported to a Pyxis-Medication Room. A review of the packaged medication before transport to a patient unit was a pharmacy instituted safety check.

Medication labels. All patient medications were identified with a computer-generated label after a CPOE had been processed. A label included a bar code that was scanned into a hospital unit's Pyxis when routine stocking occurs. A medication label prepared in the Pharmacy centre of activity included the patient name and named and amount of the drug. A medication label's bar code was also be used to trace the medication's origin.

Pharmacists' Medication Administration Practices: Processing Medication Orders

> **Observation:** *The pharmacy could receive 400 orders during a one hour period. Two pharmacists monitored two large computer screens as CPOE medications were added continually into the hospital wide queue, while they processed individual patient orders. Two pharmacists interacted with the computers simultaneously, checking the CPOE for information such as dose and route. One pharmacist checked the conformity of a medication ordered, was the drug available in a 50mg tablet? If not, the pharmacist looked to see if a 100mg tablet could be cut in half? Further research of the available preparations revealed tablet splitting will not work. A phone call was made to the*

prescriber and the pharmacist waited for a response, the processing of the order was not completed. So as not to duplicate efforts, a verbal alert by the pharmacist processing the order to a colleague, "I started the processing of… so ignore it as I am waiting for…to call back". The computer system placed the unprocessed order back into the queue, despite the pharmacist having begun the initial steps of processing. The pharmacist continued with processing another order in the queue.

While the medication orders flowed continually into the queue the pharmacist had another phone call to make. This time the call was made to one of the nursing units for a patient's weight. Full focus on the computer screen and a system override was needed to safely process the order as the computer did not do a weight adjustment for the dose. (Field Notes)

The preceding description is an example of a pharmacist (human actor) and a computer (non-human actor) relationship that occurred with medication processing and dispensing. Observations in a pharmacy afforded me the opportunity to trace the activities of human and non-human actors connected with human-technology achievements for medication processing and distribution within a hospital system (Latour, 2005). I observed how a pharmacist (a human actor), through a relationship with an electronic system (a non-human actor), had the capacity for action (became an actant) and overrode an electronic medication order that did not have the information needed for safe medication processing. A pharmacist who factors in a patient's weight to adjust a computer-generated drug dose is an example of what happened in the pharmacy centre of activity for prevention of medication errors.

The pharmacy as a centre of activity had relationships with other centres as a medication was transported to a Pyxis to be accessed by a nurse (see Figure 2). The original processed

order, completed by a pharmacist, was electronically entered onto a preterm infant's medication administration record (MAR) and connected electronically to the Pyxis.

Attention to detail was evident in the pharmacist's work of processing a medication order in an electronic system. For example, when I asked about potential medication errors a pharmacist might anticipate the pharmacist responded:

"I always have to check whether or not a first dose of a newly ordered medication has been given in the emergency department, before processing the order for a patient being admitted to a hospital unit".

A pharmacy computer had the capacity for action in a relationship with a pharmacist, who entered information for patient safety. As I observed a pharmacist in practice, the pharmacist made a call to the emergency department to inquire about a first dose of a CPOE medication. An affirmative response that a medication was administered in the emergency department prompted the pharmacist to adjust the electronic medication dosing. Documenting that a first dose was administered in the ER prevents a patient from receiving an unnecessary dose of a medication. A pharmacist's action in a relationship with a pharmacy computer prevented errors that the electronic system was incapable of catching. An unintended dose of a medication can be life threatening, particularly for a vulnerable preterm infant.

Physical Layout of the Pharmacy as a Distractor

The physical layout of the central pharmacy was conducive to distraction. There were no isolated rooms or cubicles where orders were processed. Computer terminals used for processing orders were proximate to medication pouring and sorting areas. Interruptions appeared to be the norm during the processing of medication orders. As I observed a pharmacist engaged in the central processing of medication orders, the following occurred:

> **Observation:** *A pharmacy technician appeared at the pharmacist's side to ask a question about the packaging of a medication. While medication order processing continued, a colleague pharmacist, also processing orders asked about a medication dose and availability. All of these interruptions occurred as a continual queue of medication orders replenished on the computer screen for processing. A medication popped into the queue, and since more information was needed, the pharmacist reached to the left and above the computer screen for a reference book that they required to finish processing a medication order. This pharmacist had long arms and was of tall stature, which made it easier to grab a reference book without moving from his chair. (Field Notes)*

How, I wonder, would a pharmacist of small stature be able to manage this quick maneuver? *(Field Notes)*

Centre of Activity: NICU Medication Room-Pyxis

A Pyxis Medication Dispensing Unit (Pyxis) stored NICU medications in designated medication rooms. A Pyxis included pre-packaged individual doses located in a compartment or drawer identified by a patient room number, compartments for controlled medications and a stock medications drawer. Medications, housed in a Pyxis, continued on electronic and physical journeys for administration. Electronically, a medication was entered into the electronic system as located in a Pyxis and connected to a preterm infant's electronic medication record. A physical journey occurred for a medication when it was removed from the Pyxis to a preterm infant's bedside.

There were two medication rooms in the NICU. The two rooms were different in size and in storage capacity. The larger of the two medication rooms included a refrigerator and freezer for breast milk storage and ample shelf space for general storage, including gauze and diapers.

The smaller medication room had a small refrigerator for breastmilk storage. Figure 2 is a picture of the Pyxis dispensing unit in the smaller medication room. A small silver refrigerator was located in the smaller medication room, next to the Pyxis, for medications requiring cold storage, such as vaccines.

Figure 3. NICU smaller medication room with Pyxis on right. (Neander, 2016)

As the above picture illustrates, the NICU's Pyxis was tucked into a corner of the medication room. The tall cabinet with a computer screen on top and medication refrigerator to the left are all Pyxis components. NICU nurses used their figure print as identification (FPID) to sign in to the Pyxis. A finger was placed on finger print reader pad below the Pyxis monitor to verify a nurse had access to remove medications.

Nurse D explained to me that you can use any finger for your initial registration and verification of a finger print for Pyxis access. I observed nurse D use her finger to enter the Pyxis. After the Pyxis accepted nurse D's finger print a prompt appeared to enter a password to

proceed. Nurse D entered the Pyxis computer screen and opened a unit specific electronic medication administration record (EMAR) to select a patient. Selection of the preterm infant's name on the EMAR was completed by touching the Pyxis monitor. Acceptance of the nurse's EMAR patient selection by the Pyxis opened a drawer that houses medications in room specific patient compartments. A compartment was unlocked for medication removal as a result of a relationship with a nurse who had completed a patient selection. Nurse D quickly moved to the side as the Pyxis drawer opened to prevent interference with the drawer.

Once a medication was removed from a preterm infant's compartment its label was scanned using a handheld bar code scanner attached to the Pyxis. The bar code scanner was located to the right of a Pyxis Unit's computer monitor. Scanning a medication's bar code recorded the removal of a medication and updated the Pyxis inventory.

After the compartment and drawer were shut and the medication documented as removed, Nurse D signed herself out of the system. Once signed out of the system, nurse D proceeded to the preterm infant's room for the next series of scans and documentation prior to the administration of a medication.

Beyond the space required by the Pyxis, the medication room also served as a storage unit for items such as infant feeding tubes, bottles, syringes, intravenous tubing, formula, breast milk and breast milk fortifiers. The NICU housed two medication rooms. One of the medication rooms housed a refrigerator for medications including vaccines (Chapter Six P# 76, R *on the unit diagram).

Dual verification at the Pyxis. Institutional policy required all controlled medications were to have two separate dual verification practices. The first verification happened at the Pyxis unit, the second medication verification occurred at a preterm infant's bedside. Two nurses

(nurse D and nurse E) were present while I observed dual verification of morphine, a controlled medication. The observation began in the NICU Medication room.

> ***Observation:*** *To log on to the Pyxis for the removal of a controlled medication, both nurses used the finger print reader and entered their respective passwords before a preterm infant's EMAR can be accessed. The first attempt at using the finger print reader did not work for Nurse E to access the Pyxis. She washed her hands and dried them well before the second attempt; it took a third attempt before she was able to access the Pyxis. Each time she washed and dried her hand before the next attempt.*
>
> *Nurse D who had responsibility for a preterm infant requiring morphine selected the preterm infant's name from the unit specific EMAR. This action of selection opened up the preterm infants EMAR for selection of a medication. Nurse D selected the preterm infant's prescribed morphine from the EMAR. A Pyxis drawer that housed controlled medications opened and the morphine specific compartment opened for removal. Morphine dosage was based on a preterm infant's weight and NICU nurses had to calculate the correct amount of morphine prescribed. Morphine was supplied in syringes with amounts greater than what was prescribed for a preterm infant and NICU nurses wasted a portion of the morphine in the hospital supplied syringe.*
>
> *Next, Nurse D drew the morphine from the vial as Nurse E watched. The full volume of morphine from the vial was drawn up into the syringe. The morphine volume in the syringe removed from the Pyxis was more than the preterm infant's prescribed dose. Nurse D with Nurse E watching discarded the excess morphine into the "cactus" or container for medication waste. The "cactus", as the nurses call it, is a green rectangular shaped container with a silver top that is secured on the counter in the*

medication room (see Figure 2, medication room picture). After the morphine and the amount wasted were recorded, Nurses D and E logged off the Pyxis machine. Nurses D and E proceeded to the preterm infant's bedside for a second dual verification and administration of the morphine. (Field Notes)

A Pyxis Unit, as a centre of activity, fulfilled institutional purposes for a standardized secure medication storage unit. As a standardized storage unit, a Pyxis housed unit drugs and documented nurses' retrieval of medications. A Pyxis connected to a larger hospital system for updating the medication inventory. Pyxis activity was recorded in the larger system to track medication use and costs. The Pyxis as an automated dispensing device (ADD) functioned as a universal organizing feature for institutional medication administration policy and practices.

Centre of Activity Preterm Infant's Bedside

After a preterm infant's medication had been documented as removed from a Pyxis Unit, a nurse transported the medication from the medication room to the bedside. At the bedside, the medication administration process continued. Although, physically present at the bedside, a medication continued on an electronic journey. All NICU nurses employed a series of scans before administering a medication to a preterm infant. These scans were accomplished with bar codes on the medication label and a preterm infant's bracelet. In order to successfully complete a scan of a preterm infant's identification bracelet and medication label, the electronic medication administration record (E –MAR) had to be opened.

I observed Nurses D and E, who earlier signed out the morphine from the Pyxis Unit while they completed a second dual verification of the morphine, before administration to a preterm infant. Institutional policy required that a second dual verification of all controlled mediations, such as morphine, occurred at a preterm infant's bedside.

Observation: *Nurse D swiped her hospital identification badge across the monitor to log on to the computer. With the preterm infant's EMAR opened on the computer screen, Nurse D scanned the medication label to match the medication to the preterm infant's EMAR. Nurse E, acting as the second verifier, checked the medication (name, dose and time of administration) with the order in the infant's EMAR. Nurses D and E completed separate mathematical calculations of the amount of liquid morphine required to match the preterm infant's prescribed dose. Nurses D and E visually inspected together the morphine in the syringe to confirm that the correct amount of medication was about to be administered. The nurses' calculations matched; both agreed on the volume of morphine in the syringe as the correct dose. Nurse E tapped her ID badge on the computer screen and logged in as a dual verifier. (Field Notes)*

Bedside activity included the checking, timing, and administration of medications by nurses D and E. Prior to completing the medication administration process, the bedside is activated as a centre of activity where nurses focus on preterm infant safety to prevent medication errors in the NICU. I witnessed, the following challenge that Nurse E encountered when she attempted to sign into the computer as a dual verifier of morphine.

Observation: *Nurse E attempted four times with the bar code scanner to record the morphine as being administered to the preterm infant, without success. The preterm infant's bracelet scanned without difficulty; however, the morphine label for scanning (label located on the barrel of the syringe) was not recognized by the bar code scanner. To complete the required documentation of the medication administered, Nurses D and E documented in the preterm infant's EMAR that the bar code scanner was not working as it did not recognize the morphine. (Field Notes)*

Here, I observed two nurses who were focused on the importance of properly documenting the removal and administration of morphine, a controlled substance. I also observed how nurses D and E remained calm and without distraction when the faced with a medication administration challenge. The diligence of the nurses was evident in their repeated attempts to properly sign off the administration of morphine.

The EMAR recorded a medication error when a medication was not documented as administered to a preterm infant. Nurses D and E shared with me, as I observed, that information technology specialists (ITS) who oversee the design and development of the EMAR, created an override or new feature for recording an unsuccessful barcode scan, as "not working". The override feature was created after repeated incidents of a bar code scanner's non-recognition of a prescribed medication's label.

NICU nurses now possessed an option to record a medication as administered when a bar code scanner did not recognize a medication label. To record a required dual verification on a preterm infant's EMAR, nurses can choose an option in the administration box that documents a barcode scanner did not recognize the medication.

As I observed Nurses D and E during dual verification, they explained that, without the additional administration option, the preterm infant's EMAR would record the morphine as not received. Therefore, a preterm infant could receive erroneously an extra dose of morphine in response to an electronic system alert that a medication was not administered on time. An extra dose of morphine, I am told had serious consequences for a preterm infant whose physiological immaturity did not tolerate large doses of medications.

A bar code scanner, as an ordering device to ensure the *rights of medication* administration are followed, was unable to reliably recognize a medication label. Nurse D

showed me, the label that the bar code scanner was to read, which included *five rights of medication administration*. The label contained the *patient's name, drug, dose, route and time of administration.* Consequently, a NICU nurse driven change was instituted for electronic documentation, due to a bar code scanners' unreliable reading of medication labels. Inclusivity of bar code scanners' variable capability to perform its function as an ordering device was necessary to prevent an error and a disruption in preterm infant medication administration practices.

In another bedside observation, Nurse H, while documenting on the electronic health record, pointed out to me how difficult it was to visualize the infant's full EMAR.

> *Nurse H: "Look at this. You have to scroll to the bottom of the page to see all of the medications. Paper would have all medications visible if you looked at the paper, even if you had two sheets of paper you could see all of the medications on a page and did not need to scroll to find the end of a patient's medication administration record (MAR). Icons that pop up on the EMAR were not known to nurses whereas on a paper MAR, the information was written right next to the medication on the MAR, such as "take medication with food" or "take with water" or "do not give with another medication". They should know better than to hide things from nurses. I missed doing a cardiac screen on a preterm infant before discharge because they took away our paper sheet and put the screening into the electronic health record, I have since created my own checklist for infant discharge". (Field Notes)*

Nurse H used a paper shift handover sheet that she carries on her person to keep organized and prioritize care. For her, accessing an electronic health record was not as efficient as referring to a paper check list in her pocket. As I observed her document preterm infant care

she transferred information from her shift handover sheet to the EHR. Nurse H explained to me that for documentation of preterm infant care she can record information on her sheet faster than logging on to the computer and opening an infant's EHR. To remain aligned with preterm infant care needs, nurse H told me:

Nurse H: *I chart an infant's feeds, medications administered and physiological data routinely in the EHR and wait until later to complete all my other charting I would fall behind if I didn't do this".*

A paper shift handover sheet was used by NICU nurses throughout a shift to remind them of the care needs to be provided and the charting to be completed. NICU nurses' paper shift handover sheet was NICU nurses "co-existence" of past and present practices. "Co-existence" provides order to the "messiness" of a hospital system, to protect vulnerable preterm infants (Mol, 2002 p. 143). NICU nurses' paper shift handover sheet was a detailed local map that was connected to a universal map that ensured safe preterm infant care and medication administration.

A bedside centre of activity was a foundational setting for NICU nurses' safe medication administration and nursing care for a preterm infant. At the bedside, NICU nurses were the "end user" and oversaw the final step in the process of medication administration for a preterm infant. NICU nurses' diligence was observed as they engaged in a final thorough review of a medication to be administered to a preterm infant at the bedside. The bedside dual verification of morphine was one of many observations I recorded of NICU nurses' adherence to non-negotiable diligence to protect vulnerable preterm infants.

Summary and Conclusion

Tracing a medication through three centres of activity uncovered NICU nurses' situated medication administration practices as they interfaced with technology. NICU nurses retrieved a medication for administration from the Pyxis-Medication Room Centre of Activity, which required physical presence and direct participation. At the bedside NICU nurses were the final safeguard for preterm infant medication administration, which required physical presence and direct participation. The pharmacy as a centre of activity connected to NICU nurses electronically and did not require physical presence or direct participation. All three centres of activity required NICU nurses for completion of their medication administration practices through direct physical and electronic relationships.

The physical separation of centres of activity for preterm medication administration and technology may be designed to prevent medication errors; however, separations created tensions for NICU nurses' preterm medication administration. The physical separation of centres of activity hid tensions. Technology packaged what was considered safe for medication administration while practices in other centres remained invisible. A lack of an understanding of what occurred in other centres of activity may contribute to possible medication errors.

Tracing a medication's journey through three centres of activity illuminated NICU nurses' connection to pharmacists' and technology's medication administration practices. NICU nurses moved through three centres of activities electronically and physically for medication administration. Connected to all three centres, NICU nurses considered care alternatives and implemented adjustments as needed for preterm infant health and medication error prevention.

Mol (2002) in her research, reminds us that introduction of "ordering devices" in health care practice does not rid the system of "messiness". An "ordering device", such as a Pyxis

dispensing unit for medications, merely shifts the messiness or pushes it along within the health care system (p 165). The introduction of an ordering device may solve some problems while creating others.

A transition from a paper documentation system to an electronic system has shifted the "messiness" of complex NICU medication administration and preterm care practices. When observing and listening to NICU nurses, I recognized how their past paper and present electronic documentation practices "co-existed" (Mol, 2002 p. 143), in response to the shift of messiness within the system. "Co-existence" of past and present documentation reduced and provided order to the messiness of technology for NICU nurses as they protected vulnerable preterm infants from harm. In response to the shift of messiness, NICU nurses, as mediators, translated, transformed and modified past ordering devices, such as shift handover sheets, to co-exist with technology's ordering devices.

In the next chapter, discussions of observation and interview data focus on what I have named as NICU nurses' *kintsugi* practice. Practice observations and interview data that described *kintsugi* practice, included NICU nurses' ability to remain organized, flexible, and adaptable, in challenging circumstances. My reflections on NICU nurses practice observations and interview data illuminated how they navigated (*kintsugi* practice) preterm infant care and medication administration amid a highly technical environment.

Chapter Eight: *Kintsugi* NICU Nurses Design and Redesign Practice

In this chapter, I describe NICU nurses' evolving medication administration practices as expressions of their art and philosophy that align with *kintsugi art* and philosophy. As I witnessed NICU nurses' enactment of medication administration practices, and reflected field note and interview data, I was reminded of my recent learning about the Japanese art and philosophy of *kintsugi,* or golden joinery. The following description is a field note reflection I wrote while observing a NICU nurse in practice.

Observation: *She stretched the coiled cord of the bar code scanner, moving between the isolette and computer terminal, rose up on her toes, and brought her arm over the back of the chair to reach the infant's identification bracelet. It was medication time; father and infant were engaged in skin-to-skin bonding. Despite the confines of equipment, room configuration, and the bar code scanner's permanent attachment to the computer, the nurse did not interrupt father and infant, while following institutional policy to verify an infant's identification bracelet with an intravenous medication to be administered. Instead, this NICU nurse demonstrated a fluency of practice, overcoming visible obstacles to prevent disruption of the benefits of bonding between a parent and their preterm infant* (Maastrup, Weis, Engsig, Johannsen, & Zoffmann, 2018).

Kintsugi Art and Philosophy

As an art form, *kintsugi joins* broken pottery pieces with lacquer dusted or mixed with powdered gold, silver or platinum. The philosophical foundation of *kintsugi accepts* breakage and repair as part of the natural history of an object and celebrates the object's renewal. The value of a full history as an important component of present is the crux of the art of *kintsugi* (Jobson, 2014).

NICU nurses' enactment of preterm infant's medication administration and care embodied *kintsugi's* philosophical foundation. In the "NICU Nurse's Shift" and "Medication Journey" Chapters, I described preterm infant medication administration and care enacted in more than one location and with more than one actor (human and non-human). NICU nurses' medication administration practices are enacted in relationships with multiple actors, in three centres of activity, and responded to changing circumstances to protect vulnerable preterm infants. The following sections describe observation and interview data that highlight NICU nurses' *kintsugi* practice.

Kintsugi and Medication Administration

NICU nurses' *kintsugi* practice was exemplified as they enacted medication administration and mended the breaks and gaps to protect preterm infant infants. Nurses also shared stories of the application of past practices for preterm infant safety. The integration of past practices was enfolded into NICU nurses' response to breaks and gaps in the present-day process of medication administration and preterm infant care. For example, NICU nurses' request drug information when it is missing from a medication label, a medication administration practice they have applied consistently for preterm infant well-being (Please see section titled "Voice and Visibility for Medication Errors and Near misses" later in this chapter).

Repairing Breaks to Avoid Preterm Infant Harm

Within this section, I present NICU nurses' interview data that included their experiences of breaks and gaps in technology. Through observations of NICU nurses in practice, I also witnessed how they repaired the breaks and bridged the gaps in technology to protect vulnerable preterm infants. Experienced NICU nurses integrated previous practice experience and

knowledge as the golden joinery (Jobson, 2014), protecting vulnerable preterm infants while they navigated gaps and breaks in technology connected to medication administration.

An excerpt from Nurse A emphasized her use of practice experience and knowledge, when mentoring a nursing student. Nurse A shared with me how she applied her nursing knowledge to seal a break or rejoin the correct pieces of medication administration for preterm infant safety.

NURSE A: *"I wanted to let you know I worked with a student nurse at the hospital who was assigned to me for the day. We talked about medication administration. She was working with me when a medication was dropped off to me on my unit that was 10 times the dose that was supposed to be given to the patient and it was iron and would have been lethal if it had been given to the baby. I saw the brown colour of the syringe and knew it was for my patient. It was my clinical practice that I know so well! I could spot it across the room and that alerted me to the incorrect dose of medication.*

When I told that student nurse the bar code scan would have let me give the medication despite the incorrect dose, she was surprised. And I let her know that the bar code scan would let me give the med as if it was the right med and right dose, it wasn't the right dose. That is where my clinical practice came into play and it showed me that the bar code scanning method is a nice safety precaution, but really the true safety comes from the nurse in her practice. It is ***so important*** *to* ***know*** *your clinical area well* ***and know*** *your medications well. The syringe medication label had been initialed twice by pharmacy and it (incorrect volume) was not picked up!"*

Nurse A was able to repair a break in the system as she drew upon her practice knowledge and experience. Nurse A's ability to stop her enactment of medication administration

protected a vulnerable preterm infant from harm. As a veteran NICU nurse, nurse A recognized an incorrect medication dose based on the amount of liquid in a pre-packaged syringe.

Medication complexity. The complexity of how a medication was packaged and transported to the NICU was evident in nurse A's excerpt. For instance, the transportation route of the iron to the NICU, was exceptional to the usual routine for a scheduled medication. A scheduled medication is found routinely in the Pyxis. An additional circumstance that contributed to the complexity was that the medication label had passed the pharmacy dual verification with two sets of initials, (see chapter seven) for transport to a patient unit. However, the syringe held the incorrect volume for a safe preterm infant dose of iron. A bar code scanner verifies a medication for administration based on a match between a medication label and a preterm infant's identification bracelet. The potential error was halted by Nurse A's practice experience and knowledge of a correct volume for a safe preterm infant dose of iron. As an experienced NICU nurse who has administered iron previously to a preterm infant, nurse A knew what the colour and quantity of iron should be in a pre-packaged dose. When a nurse is aware of the complexity of the medication administration process, nurse A explained to the nursing student then "*the true safety comes from the nurse in practice*". *(Field Notes)*

This student nurse was now aware of the complexity of nurses' practices of medication administration and the potential for error. However, not all nursing students will witness a situation with an experienced RN. This raises the question: How do new nurses, learn to navigate medication administration complexity without student experiences of medication error near misses or mentorship to protect vulnerable patients? *(Field Notes; question noted following observation)*

Bar code scanner. Nurse A's practice experience and her professional history (30 years of NICU nursing experience) were the "lacquer" that created a bond to repair a gap in a bar code scanner's capacity for medication verification. The combination of a bar code scanner interfaced with an electronic medication record (EMAR) was developed to insure the correctly prepared medication is administered to the correct preterm infant. However, a bar code scanner's capability was only designed to identify the correct packaging and labeling of a medication to achieve its intended purpose of medication and patient verification. Nurse A taught the student nurse that clinical knowledge ("lacquer") can prevent medication errors for preterm infants when working in a relationship with a bar code scanner.

A bar code scanner, Nurse J revealed, is not capable of detecting the correct colour, volume, temperature, and expiry date of a medication. The pharmacy prepares and packages IV antibiotics in syringes with a number that identifies the first and subsequent doses. Nurse J, discovered as she retrieved the first dose Cefotaxime (IV antibiotic) for preterm administration, three pre-packaged doses of Cefotaxime (in syringes) had been delivered to the Pyxis. Each pre-packaged dose of Cefotaxime had an identical medication label but a different shade of a yellow liquid in the syringe.

NURSE J: *"It was Cefotaxime, I was to give, when I examined the three syringes all with the same information on the label, I noticed immediately, one syringe had a light yellow liquid, another had a bright yellow liquid and the third liquid had a dark yellow. I called the pharmacy and requested new doses due to such a difference in colour in the syringes. The bar code scanner would have said it was okay to give the medication as the label would have matched up with the baby's bracelet. I could only think, someone had not prepared the correct concentration or mixed the medication improperly to have three different colours. I did not want to give my*

patient an incorrect dose. It scares me to think that medications I am receiving may not be properly prepared. I always check colour, temperature, and volume, and expiry date to prevent any errors."

Nurse J's medication administration practice of assessing a prepared reconstituted medication was "lacquer" that prevented an incorrect dose from being administered to a preterm infant. *Kintsugi* practice for Nurse J included assessing before matching a drug label to a preterm infant's identification (ID) bracelet.

A bar code scanner was introduced into NICU nurses' preterm infant medication administration practices to verify that the correct patient was receiving the correct medication. A universal map of medication rights such as the right drug, right patient, and right time was programmed into the bar code scanner for the verification process. As an ordering device, a bar code scanner translated and transformed drug information from a medication label prepared in the pharmacy to verify that the correct preterm infant was to receive the medication.

A bar code scanner's capability did not include an assessment of the actual liquid in a pre-packaged syringe. A distortion could occur unless another mediator was able to modify the administration process. As simple as a bar code scanner may appear to be for verifying a drug with a preterm infant, it was not able to modify contradictory packaging. A medication error may occur.

Bar code scanner examples represented NICU nurses' *kintsugi* practice, as they responded to unanticipated interruptions, and redesigned medication administration practices to prevent harm to vulnerable preterm infants. An artist who creates *kintsugi* pottery, combines pieces to create a new ceramic, often considered more beautiful than its prior form (Jobson, 2014). NICU nurses' *Kintsugi* practice combined practice knowledge with technology (bar code

scanner) to protect a vulnerable preterm infant in an artful demonstration of the complexity of nursing work. In the next section, I explore how NICU nurses' *kintsugi* practice goes beyond the individual situation of medication administration for the safety of all preterm infants.

Voice and Visibility for Errors and Near Misses

In her research, Robinson Wolf (1988) found that nurses experienced great moral concern when they made medication errors and shared openly their errors and concerns. As I observed NICU nurses in practice, I witnessed their informal discussions of practice experiences and knowledge of potential medication errors.

Informal sharing of NICU practice experience and knowledge was "lacquer" that supported nurses' commitment to protect vulnerable preterm infants from medication errors. NICU nurses spoke of the importance of being open about the error to enhance understanding of the "break in the medication process". As Nurse A continued to disclose her experience with a "near miss" with an incorrect dose of iron, she emphasized the importance of sharing errors or possible errors to support nurses' learning and promote safe medication administration practices.

NURSE A*: "I told my charge nurse I felt it could have been a sentinel event and I could have killed that patient. I felt that the administration in my nursing unit really did not take it forward for discussion with the other nurses. I felt it should have been shared that we have received a medication that was potentially lethal to a patient. We have also been notified of other medication errors in our hospitals and other hospitals, but nobody would give us specifics. They would just tell us we had to double check all of our medications with another nurse and bar code scan. I just feel the hospital could do better by giving us more specifics.*

For example, a nurse in our unit gave morphine to a baby and when she was done giving it she looked down and saw that the medication syringe our unit received was labeled with an adult

dose. The label information showed that it was an adult concentration, not a neonatal concentration. And the nurse was sick to her stomach! So they called up pharmacy and the pharm tech said she put the ***wrong label*** *on the medication but that it* ***was the right dose*** *for the baby.*

But once I hear about this type of error, you know, I look at those morphine doses very closely to make sure it says NICU dilution on it. I just feel it is important that the hospital share that kind of information with the nurses; not names but system errors so that we can be more aware of potential errors and stop it from hurting our patients".

Openness for disclosing challenging practice experiences was "lacquer" that NICU nurses requested to rejoin gaps and breaks in the practice of medication administration. The seriousness with which NICU nurses approached the practice of medication administration was evident in my observational and interview data. It was not uncommon for me to arrive at the NICU and a nurse would reveal to me a recent near miss or medication error. A question arose from this practice example: How can nurses develop a formal venue for disclosure of medication errors and near misses to protect vulnerable patients? *(Field Notes)*

Medication Labels and *Kintsugi* Practice

Also, NICU nurses spoke of how missing information on medication labels did not support safe preterm medication administration practices. A drug concentration was information that was integral for NICU nurses' medication administration practices for preterm infant safety. Nurse L explained to me her concerns for safety in the following excerpt:

NURSE L: "*Giving sodium chloride replacements you want to know what the baby's status is.". It's not a simple just make sure you've done the five rights or seven rights or how many you want to do. You definitely have to go into that patient's chart possibly to see a*

diagnosis and a treatment plan. You're definitely looking at appropriate milliliters/kilogram for patients. because we may not know that much about the patient, and we only have so much time to spend before we say let's give the sodium chloride for the weight. But you want to make sure it's appropriate for the diagnosis.

NURSE L**:** *"So the sodium chloride dose I got the other day did not have the milliequivalents/ml on it, so we had to call them (pharmacy) for it. It took them a long time (for pharmacy) to come back to the phone. And the person who I was checking with was saying why do you need to know that?"*

A request for more information from the pharmacy regarding the sodium chloride concentration was the "lacquer" nurse L required to ensure safe preterm infant medication administration. Nurse L's assessment was "lacquer" as she reviewed a preterm infant's chart to connect the medication being given with the diagnosis and treatment plan.

Practice Reflections as Lacquer

The following excerpt from a joint interview illustrates how NICU nurses reflected on tension- producing practice experiences when they enacted medication administration. Nurse L and M reflected on medication labels created by pharmacy. Reflection on practice supported NICU nurses' ability to create and apply "lacquer" as they redesigned their medication administration practices to seal breaks and gaps.

NURSE M: *"That just shows that it is not important that the end user (NICU nurse) has that thinking step".*

NURSE L: *"That final step, No I think it's cause they want us to trust them".*

NURSE M: *"Well they just want to get it done. It is an issue of them not honouring that we are the end user and we are ultimately responsible".*

NURSE L: *"I wonder if it is a computer system. They are using some computer system or something and it is telling them what to do? Ok computer said it once and why does the nurse need to know. I don't know. I am just wondering"*.

Nurses L and M reflected as they discussed medication labels prepared by the pharmacy. The discussion among two NICU nurses included their attempt to understand the labeling of medications from a pharmacist's perspective and clinical setting, for example *"I wonder if it is a computer system?"* Nurses L and M, held practice experience and knowledge ("lacquer") that was foundational for safe medication administration.

In their earlier years of NICU practice, Nurses L and M held the responsibility for preparation of preterm infants' medication for administration. Past practice experiences of Nurse L and M included preparation of medications that were drawn up or poured from larger containers that included the drug concentration. Nurses L and M's past medication administration practices included preparation of a preterm infant's dose. A request for drug information on a medication label from pharmacy is an example of knowledge NICU nurses held and applied presently, to protect vulnerable preterm infants. A change in how preterm infant's medications are prepared has not recognized the importance of nurses' past medication practices for error prevention.

Preterm infant medications come to the unit pre-packaged by the pharmacy. NICU nurses had to trust the medication was prepared properly by the pharmacy. However, given their present practice experience with incorrectly packaged medications and a bar code scanners' limited capability to detect errors, NICU nurses lost a historical safeguard. Furthermore, this loss of a historical safe guard combined with NICU nurses' extensive knowledge of the physiological vulnerability of their patients created tension. They worry about the safety of a

preterm infant. NICU nurses' experienced tension when they did not have the information they needed to scrutinize, examine, and think fully about a medication for safe administration.

Incommensurability surfaced between pharmacists' and NICU nurses' medication administration practices. For pharmacists to complete their medication processing, it was not necessary to know how NICU nurses would make use of the pharmaceutical materials sent to the unit. From a pharmacist's perspective, what was sent was complete. However, for NICU nurses what was received was in fact, incomplete and "lacquer" was sought to repair the incommensurability gap. What may seem to be small details, such as the drug concentrations for pre-packaged medications, were crucial pieces of information that supported nurses' confidence in their ability to practice safe medication administration.

Collaboration between Nurses and Pharmacist

In an interview with the NICU nurse educator, I learned how she had assembled a committee to follow up with pharmacy to discuss NICU medication safety issues. In a meeting with the pharmacist I witnessed how Nurses L's and M's concerns about drug information on medication labels were brought forward for a solution by the nurse educator. The nurse educator, through her practice in the NICU became the "lacquer" to repair nurses' medication administration practice gaps. NICU nurses had identified their practice experiences that created tensions around medication administration to the nurse educator for follow up with the pharmacist.

The nurse educator's "lacquer" also addressed NICU nurses' concerns about unnecessary medication label information. Nurse A shared her concerns that unintelligible information for nurses on medication labels can create preterm infant medication administration errors. The

excerpt below describes how in an urgent situation, a NICU nurse made a medication error based on what was read from the label.

NURSE A: *"And then get rid of everything on [the label], because people have given drugs thinking it was IV and it said 'solution', because the pharmacy has* ***so much stuff on the label*** *that the nurse saw IV on the label somewhere and it was an emergency! You know what I mean"?*

Researcher: *and it was a PO?*

NURSE A: *Yeah it wasn't the right route and they said I saw it on the label somewhere and that kinda looks like IV. That's what happens to us. There is so much gobbledy goop and signatures on the label, like put it on the back of the medication for pharmacy's reference. You know what I mean? Get rid of everything they need for housekeeping. I don't need to know all their little bottle numbers whatever, you should see our labels for hyperalimentation they give us too much information that is not helpful to us" (Nurse B, nods her head in agreement).*

As with missing information, too much information on a medication label created tension in practice for NICU nurses. What was needed was an understanding of what each professional required on a medication label. Taking the lead on developing an interdisciplinary pharmacy-NICU medication committee, the nurse educator was the "lacquer" to seal a professional incommensurability gap in order to protect preterm infants from medication errors. Incommensurability of NICU nurses' and pharmacists' practices, did not "imply fragmentation but instead an accomplishment as a result of coordination" (Mol, 2002 p 119). NICU nurses enacted medication administration practices through relationships that required coordination to protect vulnerable preterm infants.

Sealing the Breaks of Technology for Medication Administration Safety

Kintsugi nursing practice is exemplified in NICU nurses redesign of technology's step wise approach to medication administration. NICU nurses' medication administration practices included much more than a step wise approach. The following field notes of a practice observation included technology's ordering or step wise approach of medication administration and a NICU nurse's practice of medication administration:

Observation: *Technology's universal ordering or step wise approach for medication administration*

1. *an electronic medication administration record with the time and dose on the neonate's electronic health record;*
2. *a log in to the Pyxis system in the medication room to retrieve the unit dose;*
3. *a retrieval of a unit dose, the Pyxis documents a medication as removed.*
4. *a log in to the computer in the neonate's room;*
5. *a bar code scan of the medication and*
6. *a scan of the neonate's identification band*
7. *a click of the mouse to record the administration of the medication, by the nurse administering*
8. *a click on the medication record by the nurse verifier. (field notes)*

What did not get captured in technology's step wise approach was the application of NICU nurses' "lacquer". NICU nurses' used experience and practice knowledge as they navigated the complexity of medication administration to protect a vulnerable preterm infant.

Observation: *NICU Nurses' medication administration practices*

1. *reviewing the order for the medication beyond what is visible on the electronic medication administration record, questioning and verifying appropriate dose and reason based on the preterm infant's physiological condition.*
2. *timing the administration of the medication following the preterm infant's feed,*
3. *a nurse not able to find a medication from the Pyxis machine, and walked around the unit to search two different nurses' desks to see if by chance the medication had been dropped off by a pharmacy technician, next the hospital tube system is checked and finally a call to the pharmacy is made for the missing medication.*
4. *two nurses checking the math on the dosage, assessing the contents in a syringe for volume and colour of the medication and double checking it was correct for the neonate.*
5. *two nurses reviewing the information in the NeoFax (medication book used for neonatal dosing etc.,) before the medication was administered and*
6. *repeated attempts by a NICU nurse to enter the computer system to sign off a medication as administered. (field notes)*

The "lacquer" used by NICU nurses included knowledge of the individual characteristics of preterm infants beyond the "right patient and right medication" check list. NICU nurses searched for what was not visible on an EMAR to ensure that medications were administered safely to preterm infants. NICU nurses' knowledge was central to their preterm infant medication administration enactment in relationships with technology. The inseparability of NICU nurses and technology comes into focus when a local lens was used to investigate practice realities for preterm infant medication administration.

Standardization and *Kintsugi*

Distractions. Technology created distraction and tension for NICU nurses with information not specific to a preterm infant's medications and care. Standardized information was programmed into the system for all patients, independent of individual characteristics. As I observed nurse K, the electronic medication administration record (EMAR) exhibited pop ups as red stop signs. Nurse K's quote below illustrates the tension pop ups created in practice.

NURSE K: "*The MAR (medication administration) pops up all these red stop signs, when you are trying to document or review scheduled medications. Nurses develop alarm fatigue, so we just ignore them to move past these red stops popping up all the time. So one that I get popping up consistently, '**Have you given your patient a flu shot?**' each time you open up the MAR. My patient is a preterm infant who is not eligible to receive a flu shot. However, you may miss an important **red stop pop-up** due to alarm fatigue and the result could be a med error".*

A standardization of alerts on an EMAR has created distraction and tension for Nurse K as she practiced medication administration for a preterm infant. As Nurse K emphasized, one risk of standardization is the introduction of potential medication errors for preterm infants.

Similarly, a request for a NICU specific alert on preterm infants' EMARs that was not incorporated was an alert for morphine. The hospital IT department informed the nurse manager that an alert for morphine could not be created as it would have to be hospital wide. A morphine alert, needed for a NICU, would create problems for adult units. Therefore, NICU nurses shared that the need for a closer vigilance was required given the inability to adapt technology for vulnerable preterm infants.

NICU nurses were left with navigating a standardized EMAR that did not take into consideration the individual characteristics of vulnerable preterm infants. NICU nurses'

knowledge (“lacquer”) of preterm infant’s individual characteristics also helped them navigate the EMAR pop-ups to prevent medication errors. NICU nurses created a local map for preterm infant safety, for those situations where a universal map did not fully protect vulnerable preterm infants. NICU nurses’ local map was a shift handover sheet that included reminders about morphine administration times.

Policy and standardization interrupting thinking. Nurses spoke of being "policied out of thinking" with respect to technology’s institutional standardization of medication administration. Concerns voiced by NICU nurses related to technology that was not designed to take into consideration nursing care and medication administration specific for preterm infants. The following excerpt from Nurse C illustrated her concern about standard policies interrupting nurses’ thinking.

NURSE C: *“**We are being policied out of thinking**. I think the best example is our glucose babies. The nurses on the floor (postpartum) will check a glucose and if it doesn’t say to check that glucose ½ hour after baby goes to breast they aren’t going to check the glucose cause they are not going to want to **not follow policy**. If you put the baby to breast at 59 minutes then that’s within an hour so I don’t have to check a glucose until another ½ hour after that, which could leave a baby on the low side for quite a while. And they finally check it and put the baby back to breast and it’s still low.*

Okay the baby already got what it would get from the breast at that point. It needs more help! But they don’t do that because the policy says to feed the baby, which means breast feed, which is fine, I totally understand that. They wait another ½ to an hour to check it and it is still low. And then, they put the baby back to breast, but then it’s like people…. couldn’t they figure out that the baby needed food? Hello?

Because they're following policy and doing what they are told to do so the step ***of critical thinking*** *is not coming out. The baby is not getting enough glucose from breastfeeding so what other steps do I need to take? Maybe you need to consider formula. The baby doesn't want any because he is sleepy. Okay but that is not an option now. You know what I am saying, there will be times when it is low for quite a while and they call (the NICU) because now it is 26 and it has been in the 30's for the last 6 hours simply because the policy did not require a blood glucose check".*

Nurse C was referring to a policy for postpartum nurses that directly impacted NICU nurses. NICU nurses are required to respond to any possible deterioration in a neonate's status. Nurse C's concern was a policy that is not connected to the importance of a nurse's thinking for neonatal assessment. In Nurse C's example, she stressed that thinking was important to protect vulnerable neonates from a significant drop in blood glucose. Nurse C emphasized nurses needed to respond when a low was first detected. A neonate may be sleepy due to low blood glucose. However, policy was instructing nurses to check blood glucose levels based on a time frame and not on a neonate's status. And as Nurse C shared with me the time frame may result in an urgent situation because a neonate's blood glucose had not been checked earlier. A neonate with significantly low blood glucose would need to be transferred to the NICU for monitoring and stabilization of blood sugar.

Neonate blood glucose monitoring standards were developed with a universal lens, one that concentrated on errors that occurred and implicated human behaviours. NICU nurses, by the nature of their work, responded to urgent and emergent infant situations and held practice knowledge of manifestations of low blood sugar in neonates. Although a universal standard was developed to protect neonates, nurses were instructed to follow a routine time frame for blood

glucose monitoring that was not sensitive to the context of practice. Nurses' infant care practices included the context of the clinical setting and knowledge nurses used to support decisions.

Policy and urgent circumstances: preterm infant deterioration. Policy also caused tensions for nurses around medication administration. Urgent situations created tension when NICU nurses who had not followed steps exactly as set up electronically were reprimanded for not administering a pre-packaged medication in the correct order. Pre-packaged medications were sent from the pharmacy with a number on the label indicating the dose, e.g., dose #1. Nurse A told me about a situation on a night shift in which dose labeled syringes of the same medication had not been administered in chronological order.

NURSE A*: "There was a septic baby during the night and the nurses were on edge as the antibiotic was not available until a urine culture was completed. The baby was sick and dehydrated so it was very difficult to get a urine sample and the nurses were worried the baby would die before antibiotics could be started. Finally, a urine sample was obtained and an antibiotic was prescribed, pharmacy usually sends up three doses all in syringes labeled 1, 2, and 3. However, the nurse caring for the baby only received syringes 2 and 3, #1 was not located.*

In best interests of the baby, she gives syringe labeled #2 and #3. She then received a reprimand from the pharmacy because she did not give dose #1as per policy. She had to push past any red stops that appear on an infant's MAR with respect to dose #1 not being given to record dose given as syringe #2 and followed with dose #3 at the correct time. In report, we heard we ***must always*** *give antibiotics by the number of the syringe. When I heard this comment, I said to the charge nurse 'We are here to fight sepsis and not the computer system'. Thank goodness the baby survived".*

A preterm infant with sepsis was not uncommon for NICU nurses. Given the vulnerability of a preterm infant, a septic status required timely antibiotic treatment for a positive outcome. Therefore, NICU nurses were on edge while they waited for a confirmation of sepsis. Nurse A emphasized the tension and difficulty with respect to a policy that did not take into consideration what was happening in practice, the critical need for timely antibiotic administration.

Clustering of care and medication administration. NICU nurses' *kintsugi* practice aligned medication administration with clustering of care to preserve preterm infants' energy. I frequently observed NICU nurses' administering oral medications in alignment with preterm infant feeding times. Nurse I's excerpt below illustrates how early and late medication administrations practices supported clustering of care to preserve preterm infant energy in concert with individual patient needs.

NURSE I: *"So like in the morning, we usually have multivitamins that we do and sometimes it's ordered at 8 o'clock but the feed isn't until 9:30 and you don't want to give it on an empty stomach and so you just say, oh well I'm going to give it at 9:30 even though it says to do it at 8. And then it (EMAR) will alert you that you made a med error but really it's best for the baby to get it at 9:30 so you give it at 9:30".*

Nurse I's late administration of a scheduled medication (multivitamins) that was not documented until received by a preterm infant was considered an error by the EMAR. A pop-up was generated by the electronic system that appears on a preterm infant's electronic health record and EMAR that told Nurse I, she had made a medication error. Nurse I adjusted (lacquer) medication administration times to suit a preterm infant's individual needs and "keep the patient in the best condition for nature to act upon him" (Nightingale 1969, p138). Nurse I related to me

she does not (and should not) follow technology's scheduled medication administration times if the times could compromise a preterm infant's wellbeing.

NICU nurses preterm medication administration practices co-existed with technologies, pharmacists, and a pharmacy and hung together despite human and non-human actor's differences (Mol, 2002). Technology's standardized (universal lens) medication administration times for preterm infants differed from a NICU nurses' practice of aligning administration times with feeding times. A local focus on preterm infant care and medication administration illuminated the particularities of NICU nurses' practices that promoted preterm infant well-being. NICU nurses' *kintsugi* practice included a "local specification" of preterm infant needs that supported clustering of care and medication administration.

Storage of NICU Nurses Electronic Documentation: A Tally of Incompetence?

I learned through observations of NICU nurses in practice that the EMAR did not permit documentation of medication until the scheduled time. NICU nurses made note of medications administered ahead of their scheduled time on their shift handover sheets as a reminder, to document the dose given in a preterm infant's EMAR. A potential for error existed with standardized medication administration time that did not align with preterm infant health and healing needs. For example, a preterm infant's feeding was scheduled at 0800 hours and a medication that is ordered for 0930 is given at the time of feeding.

When medications are administered at an earlier feeding time, NICU nurses had to be vigilant and remember to document the medication as administered at the scheduled time of 930. I observed Nurse A negotiate the EMAR medication error pop-up for a medication she would administer after its scheduled time as she clustered care for her assigned preterm infant. As the

alert popped up on the monitor she ignored it and shared with me the potential for a system annotation of a nurse's medication errors.

NURSE A*: "Your med errors are probably tallied in the electronic system. So the more you tailor your med administrations to suit your patients, you risk appearing incompetent!"*

Electronic documentation is presented in nursing literature as a valuable tool for patient care innovations and improvements. The value of electronic documentation is identified as the opportunity to compile large data sets of information (Brennan & Bakken, 2015). Nurse A's concern was not unfounded as nursing literature confirmed the ability of electronic documentation to compile data. Medication administration documentation is a source of data that an electronic health record compiles. Nurse A mediated a tension in practice to provide sensitively tailored care for preterm infants, despite an electronic system that identified her actions as an error.

Systems Approach Versus Practice Approach

Nurse C told me *"it is a systems approach and not a practice approach. The computer is not aware of what we do in practice, just a programmed time for medication administration"*. Nurse C, along with her colleagues, articulated concerns with the clinical nurse educator who met with the hospital Information Technology (IT) designers to request changes. I observed Nurse C's practice approach while she administered morphine to a preterm infant.

Observation*:* *Nurse C placed a soother in the preterm infant's mouth to stimulate sucking. Next Nurse C gently squirted the liquid morphine into the mouth, a small amount towards each cheek. She then watched for swallowing movements. Nurse C continued to hold the soother in the preterm infant's mouth after all of the morphine had been administered. (Field Notes)*

Nurse C explained to me, as I observed, that there was no place to record her medication administration practice that was sensitively adapted to a preterm infant's individual needs. All that was captured in an EMAR was the time of morphine administration. Nurse C's *kintsugi* practice remained invisible as it could not be documented. The value of my observation was evident as I uncovered NICU nurses' *kintsugi* practice was a way of being, their "ontology in practice" (Mol, 2002, p 150).

As I observed and listened to NICU nurses, their ability to navigate the complexities of preterm infant medication administration was illuminated. NICU nurses' *kintsugi* practice bestowed an order to changing situations and circumstances while they responded to gaps and breaks in medication administration to protect vulnerable preterm infants.

A co-existence was made possible as NICU nurses' *kintsugi* practice adapted different medication administration practices to protect vulnerable preterm infants. Clustering of care was adapted to characteristics and needs of a preterm infant, which involved a "tinkering" of technology that was connected to medication administration practices (Mol, et al., 2010). *Kintsugi* practice included a "tinkering" of technology that brought into being the adaptability of NICU nurses' knowledge practices in relationship with a a) computer, b) bar code scanner, c) EMAR, and d) Pyxis. NICU nurses tinkered to adapt technology to meet preterm infant specific needs. Tinkering of care as taken up by Mol, Moser, and Pols (2010) recognizes that care and technology are inseparable in practice. Inseparability moves away from technology as a tool for practice and recognizes technology as a practice. *Kintsugi* practice recognized the inseparability of technology and NICU nurses' medication administration practices.

Summary

In observing the particularities of medication administration, I described NICU nurses' *kintsugi* practice that navigated practice complexity. NICU nurses' medication administration practices were kept flexible to respond to different situations and circumstances. Clustering of care, practiced commonly by NICU nurses, required coordination of nutritional needs (when to wake or disturb a sleeping or resting preterm infant) with medication administration.

In Chapter Nine, I continue the discussion of the complexity of NICU nurses' preterm infant care and medication administration practices. Implications for nursing education and research are also discussed.

Chapter Nine: Discussion

In this chapter, a summary of research findings is discussed. The discussion of findings includes an argument outlining the significance of studying practice for the discipline of nursing, and particularly as is the case in this dissertation where the chief concern has been NICU nurses' practices of medication administration, with the inseparability of technology and nurses' practices in focus. NICU nurses' use of local and universal maps to navigate practice demonstrated how complexity can be tracked and reported in a study of nursing practice. In a final section, implications for nursing education and practice are presented and recommendations for future research are proposed.

This study has tracked and reported on NICU nurses', pharmacists' and technologies' medication administration practices. The study findings add to what I have described as *practice- informed evidence* that illuminates nurses' practices that prevent patient harm (Bristol, Nibbelink, Gephart, & Carrington, 2018; Bucknall, et al., 2019; de Ruiter, Liaschenko, & Angus, 2016; MacKinnon, 2012; Smeulers, Onderwater, Van Zwieten, & Vermeulen, 2014).

Summary of Key Findings

Inseparability. A NICU nurse and technology, through a relationship in a network, enact medication administration practices for the safety and wellbeing of preterm infants. I began this study confounded by what I have come to understand as a predominant way of studying complex practice professions such as nursing. Much of the research I reviewed on the topic of medication administration treated nursing practice as separate from the technological devices now interpenetrating the process of medication administration in all practice settings. This dichotomous view expressed in the literature, instantiates a separation of subject and object that does not allow for an understanding of the *effects* of technology in the NICU practice setting.

Drawing on Mol's praxiography, I entered this field adopting an analytic stance that sought not to privilege nurses' practices over technologies used to accomplish medication administration. As a result, the subject-object divide became irreducible and technology and nurses' practices were understood to be inseparable (Latour, 2005). Technology was not treated as a separate object or tool with which the nurse-subject accomplished medication administration. Instead, technology was analyzed from a perspective that sought to show relationships operating between technology and nursing practice. Neither the technology nor a NICU nurse was assumed to perform medication administration independently. Accordingly, the inseparability of a central hospital pharmacy, pharmacist, and technology from NICU nurses' preterm infant medication administration practices became visible when a medication's journey was traced. When inseparability was recognized, technology was not merely a tool to carry out a practice. Technology was a practice in the NICU medication administration network.

When technology is treated as a tool, the assumption is that it operates as an "intermediary that transports meaning without transformation and as such defining its inputs is enough to define its outputs" (Latour, 2005 p. 39). Despite decades of technological advancements aimed at reducing medication errors, mistakes still occur at an unacceptable level and require a more complex understanding of the entire process of medication administration to grasp how improvements might be made. To prevent errors in practice, a critical awareness of how interactions between nurses and technology translate and transform medication administration is required. Integral to a critical awareness is the inseparability of technology and nurses' medication administration practices. A critical awareness requires tracing a medication's journey from an order through the pharmacy to the bedside. When a medication administration network is traced, nurses, educators and students develop an awareness of how a pre-packaged

medication has been processed and transported to an automated dispensing unit for storage and retrieval.

A liquid drug in a pre-packaged syringe for a patient does not reveal where this medication originated. Understanding a medication's journey facilitates students' and educator's thinking of how the enactment of medication administration prevents potential errors. As I learned from my own research, pre-packaged medications were carefully checked by NICU nurses during medication administration to prevent errors.

In my research, technology was treated as a "mediator" (Latour, 2005 p. 39) in the NICU nurses' medication administration practices network. As a mediator, technology is treated as having the capacity to "translate, transform, modify and distort" meaning. If viewed as an intermediary, technology simply "transports meaning without transformation" (p.39) and in doing so places medication administration as the sole responsibility of NICU nurses, giving no consideration for technology's capacity for action (Latour, 2005, p.39). With an intermediary designation for technology, error prevention focuses on human behaviour and excludes a computer, bar code scanner and Pyxis as potential source of errors. As described in Chapter Eight, an NICU bar code scanner translated a medication label to match a pre-packaged medication with a preterm infant. A bar code scanner can distort meaning as it is not able to assess an incorrectly pre-packaged medication that can cause an administration error. Without human intervention, a serious error can result. Understanding how technology functions to show some information while obscuring other information such as in this circumstance, illustrates technology as a mediator in a NICU medication administration network (Latour, 2005 p. 39). I was able to move beyond a view of technology as "transporting meaning without

transformation" towards an understanding of technology as having the capacity to "translate, transform, modify and distort" meaning.

A good deal of contemporary research focuses on errors and attempts to control and predict nurses' behaviours to prevent errors. With a focus solely on nurses, a bar code scanner becomes an intermediary or tool for practice and its capacity as a mediator is not considered for error prevention. As a mediator, technology may distort information that may cause a medication error. NICU nurses drew on historical knowledge and experience working in the NICU setting to intervene in situations where technology had distorted information to prevent medication errors. The inseparability of medication administration practices became evident when NICU nurses' interventions were illuminated when technology failed to prevent an error. Their interventions prevented administration of an incorrectly prepared medication.

Furthermore, inseparability of medication administration practices indicated when technology fails, nurses fail, and vice versa. To prevent medication errors, interventions were required to address failures in technology. NICU nurses draw on experience and knowledge that included alternative practices of medication administration that prevented an error. These nurses' practices included assessment of preterm infants and pre-packaged medications as interventions to prevent errors. In their interviews with me, nurses talked about specific NICU technologies that had been developed in response to medication errors treated by the organization as nurses' failures. Dual verification of all medications by two nurses and technology was one such response instituted in the NICU (Appendix G).

Complexity and Standardization

Previous research investigating nurses and medication administration has acknowledged the complexity of nurses' practice (Bucknall, et al., 2019; Carayon, et al., 2014; Edwards & Axe,

2015; Rohde & Domm, 2018; Smeulers, et al., 2014). Given the potential gravity of a medication error, research to prevent medication errors commands utmost importance.

However, the predominant response to the acknowledged complexity is to recommend standardized strategies for medication administration (Colligan & Bass, 2012; Freeman, et al., 2013; Flynn, et al., 2016; Hayes, et al., 2015; Raban & Westbrook, 2014). A standardized approach treats practice complexity as something to be ignored and does not capture fully the inseparability of practices with technologies that enact medication administration understood as a network. Standardization follows a generalized approach for medication error prevention. However, Mol (2006), contends "good care", which includes prevention of medication errors "must be established closer to home: in day to day health care practice" p. 408).

Medication administration education of nursing students includes standardized solutions to reduce errors. This begs the question; are we missing important practice knowledge in educating student nurses? I will address this question later in this discussion chapter.

The complexity of preterm infant medication administration was apparent as NICU nurses' practices were enacted in relationships with three physically separate centres of activity (Pharmacy, NICU Medication Room-Pyxis and Preterm Infant's Bedside). The inseparability of NICU nurses and technologies was evident when a medication's electronic journey was mapped. NICU nurses' medication administration practices were enacted in a network and their capacity for action was in relationships with those technologies (Mol, 2010). Observations of NICU nurses in practice uncovered the transference of medication errors from one centre to another. For example, errors in pre-packaged medications transported from the pharmacy, were not halted by electronic safeguards such as a bar code scanner. These same medications were considered safe for bedside administration to a preterm infant when they were, in fact, harmful. Nurses'

medication administration practices were required to prevent errors as actors in a network that may falter. This finding begs the question; how might less experienced nurses than those in my research act in a network that may falter?

To institute order within the complexity of medication administration that risks error, nursing literature and research places a strong emphasis on nurses' behaviour (Carayon, et al., 2014; Chang & Mark, 2009; Hayes, et al., 2015; Ulrich, 2008). The creation and insertion of practice standards impose a universal lens that aims to prevent errors. A universal lens assumes all clinical settings are identical. Development of practice standards concentrates on errors that have occurred and implicates human behaviours in practice situations. Suggestions to change behaviours that are considered risks for medication errors include education programs for nurses that include pre- and post-testing to measure change. Other interventions included no interruption zones and education of family members and patients to refrain from distracting or interrupting a nurse when administering medications. A "no interruption zone" suggests nurses' actions can be excised from the everyday work flow on a unit. This strategy of "no interruption zones" has implications for practice if nurses' actions are considered easily put on hold while medication administration is enacted.

Practice observations and interview data illuminated NICU nurses' preterm infant care and medication administration needs included the use of institutional and local ordering devices or maps to organize their shift responsibilities. A local map created by NICU nurses was necessary to navigate the complexity of preterm infant needs that standardized institutional ordering devices did not recognize. Other research has also identified that standardization of practice is not easily achievable. Lapkin, et al. (2016) documented the high occurrence of medication errors despite the introduction of a range of patient safety interventions. These

researchers argue for additional research in order to understand medication errors given the inconsistent effectiveness of prevention strategies and interventions.

Nurses, by the nature of their work, are the main purveyors of patient care and are therefore, closely connected to patient safety and medication error. In light of patient safety concerns, error prevention gravitates towards solutions that seek to predict and control nursing behaviours. Solutions are often stepwise approaches (ordering devices) with mental reminders integrated into technology. One example of a mental reminder that has been integrated into technology is the bar code scanner (Koppel, et al., 2008; Shah, et al., 2016). Koppel and colleagues (2008) investigated bar code scanner workarounds and recommended attention to *"in situ"* application to address clinical workflow to protect patient safety. Shah and colleagues' (2016) systematic review found inconclusive evidence as to whether bar code scanners actually reduced preventable medication errors when hospitals were using other safety measures such as CPOE.

A bar code scanner used by NICU nurses required careful monitoring due to its inconsistent performance. Practice observations and interview data uncovered the bar code scanner's capability was inconsistent in reading medication labels to match a drug with the correct patient for administration. NICU nurses' repeated experiences with a bar code scanner's inconsistent capability were communicated to IT specialists for a solution.

Medication administration research has documented situations in which nurses' clinical practices, while performed in the patient's best interest, were understood as medication errors, according to standardized institutional policy (Baker, 1997; Bucknall, et al., 2019; Rohde & Domm, 2018; Smeulers, et al., 2014). NICU nurses were also found to prioritize preterm infant needs over standard institutional medication administration times. Oral medications were given

to align with infants' nutritional and energy needs. These oral medications were administered early or late as defined by institutional policy.

In Chapter Five, I included a discussion of the development of the *rights of medication administration* as a standardized step wise approach to prevent medication errors. Historically, nurses had what was considered a solid norm to prevent medication errors. However, medication errors continued to occur despite nurses' practice of the *rights of medication administration* (Tamuz, et al., 2011).

NICU nurses in this study identified five *rights of medication administration* as a standardized check list they were taught. Practice observations and interview data revealed NICU nurses' medication administration practices, also included, preterm infant assessment and status, visual inspection of a pre-packaged medication, and drug knowledge. NICU nurses did not rely solely on the *rights of medication administration* for medication administration safety. Rather, NICU nurses supplement the *rights of medication administration* with their practice-based knowledge of distinct patient characteristics to protect vulnerable preterm infants.

Bar code scanners utilized for medication administration are programmed with five *rights of medication administration* (Koppel, et al., 2008). However, as discovered in this study, a bar code scanner's capability to prevent medication errors was limited to a medication label that identifies the drug with a patient (Chapter Eight). Practice observations and interview data collected in this study documented circumstances where medication errors were not detected by a bar code scanner. Instead, these medication errors were prevented by NICU nurses' activation of clinical knowledge and not a reliance solely on the five *rights of medication administration* for safe practice.

Medication administration is a complex process that precludes standardization such as the five *rights of medication administration* (Macdonald, 2010). As noted in Chapter Two, researchers' have proposed a variety of additions to the *rights* in an attempt to address medication complexity and protect vulnerable patients (Edwards & Axe, 2015; Macdonald, 2010; Robinson Wolf, 1988). NICU nurses' enactment of medication administration included clinical knowledge that went far beyond the *rights of medication administration*. NICU nurses assessed preterm infant status, researched medications in a drug guide, and requested more information from the pharmacy to protect vulnerable preterm infants.

NICU nurses' medication administration practices included requests by nurses to the pharmacy for drug information that was not included with a pre-packaged medication. The pharmacy centre of activity prepared medications with a label that met their required medication administration practice (Chapter Eight). However, a pharmacy prepared medication label did not fully address NICU nurses' requirements for safe medication administration to preterm infants.

A standardized practice to prevent medication errors may be difficult to achieve, keeping in mind the divergent practices and understandings held by health professionals responsible for medication administration (Stewart, et al., 2018; Tamuz, et al., 2011; Tamuz & Thomas, 2006). These divergent practices and understandings contribute to the complexity of medication administration and error prevention. Similar to research about divergent perspectives, my research uncovered differing medication administration practices between pharmacists and nurses. Although there are strategies being recommended and employed to prevent medication errors and near misses, medication errors and near misses still occur (Lapkin, et al., 2016). In alignment with the literature, my data documented near misses of medication errors in the NICU (Chapter Eight).

Protecting preterm infants. Data collection for this research illustrated NICU nurses' practices privileged preterm infant needs as a priority over institutional policy, such as standardized medication administration times. NICU nurses' practice of preterm infant needs as the priority suggests that more flexible guidelines might be needed. Similarly, Baker's (1997) research included nurses' accounts of clinical practice that did not follow institutional rules or physician's orders in "the pursuit of supporting patient care and safety" (p 156).

Nurses' practices of positive deviance. Recent research has studied nurses' positive deviance practices that did not follow institutional policy to protect patients. Bristol, et al. (2018), discovered nurses used workarounds when they encountered EHR barriers to providing safe patient care. NICU nurses' also encountered barriers with an electronic system that did not meet vulnerable preterm infant care needs (Chapter Eight). NICU nurses ignored EMAR warnings and administered medications after scheduled times in order to promote preterm infant health and healing. Of particular importance is the failure of standardized solutions to reduce errors and their long term effects.

Local and universal maps. As I mapped out NICU nurses' medication administration practices, I discovered how they used local and universal maps for organizing shift responsibilities and activities. Circumstances arose in which nurses connected to the pharmacy and not to the Pyxis-medication room centre of activity, as medications were missing and delivered with incorrect doses. The pharmacy was a detour from a universal map or the standard institutional design that determines a medication's path from pharmacy to Pyxis-medication room and bedside for administration. All hospital units follow the same universal map for medication administration. NICU nurses created a local map designed to enhance preterm infant safety in those situations where a universal map led to a dead end.

Although technology is able to translate and transform information about medications and administration times, it does not have the capability to identify an incorrectly packaged drug or locate a missing dose of a medication. As a mediator, technology (Pyxis, bar code scanner and computer), translated and transformed drug information using a universal map, such as the rights of medication administration. NICU nurses, as mediators, used local maps to translate, transform, and modify, when a medication was missing or incorrectly packaged. Universal (technology) and local (NICU nurses) maps were intertwined for safe preterm infant medication administration. An inseparability of technology and NICU nurses was evident in the intersections of universal and local maps with respect to medication administration practices.

NICU Nurses' medication administration practices were required to prevent errors as actors in a network that may falter. This finding begs the question; how might less experienced nurses than those in my research act with technology that may falter?

NICU nurses' assessment. Nurses' thinking and assessment of patient status that prevented errors, although highlighted in the literature, were not recommended as often as suggestions to change nurses' behaviours to align with standardized protocols. Smeulers and colleagues' (2014) research, documented nurses' "clinical reasoning as essential for medication safety" (p 276). These researchers found nurses evaluated medications in relation to patient's conditions prior to medication administration. Bristol and colleagues' (2018) research recommended that health care institutions should include nurses' unique perspectives to develop technology for patient safety. NICU nurses were observed reviewing preterm infant medical records prior to medication administration to assess the appropriateness of a drug. My research uncovered examples of NICU nurses' drug knowledge that prevented administration errors of pre-packaged medications.

Additional research is needed to document what is working to prevent errors to address the applicability of recommended strategies for practice. To overlook the importance of what is working in practice supports a simplification that not only does not acknowledge the complexity, but also overlooks the ways in which nurses' actions that deviate from the standard sometimes have the effect of preventing harm. I will elaborate on this point further below.

Nurses' suggestions for practice improvement: good care in the NICU. NICU nurses had their own suggestions about methods aimed at improving practice for medication error prevention. Dual verification became an institutional policy based on an error that occurred in the hospital system. However, NICU nurses pointed out aptly that knowing the situation and circumstances of a medication error would have added important context to nurses' knowledge about *how* to be vigilant in practice.

In Chapter Eight, I documented practice tensions related to missing information on medication labels that NICU nurses required for safe administration of pre-packaged medications. NICU nurses brought their concerns about medication labels forward to the clinical nurse educator. A committee was formed with a pharmacist, NICU clinical nurse educator, and nurses to address practice tensions related to medication labels and different medication administration practices. "Good care" in this NICU included a site specific intervention staffing model with a RESUS nurse. A RESUS nurse was able to adapt to workload changes, as a staff member without a patient assignment. The RESUS position prevented a NICU nurse from having to double up on a patient assignment to respond to urgent perinatal situations. As researchers have documented, medication errors have been linked to workload and inadequate staffing (Härkänen, et al., 2020)

Implications for nursing practice research. In the preceding sections, I have noted several opportunities where future research could further elaborate the insights gained by this research project. For instance, prevention of patient harm warrants a closer investigation of practice situations and circumstances in which medication errors occur. In this study, I have examined how practice is enacted in relationship with technology to prevent medication errors. This approach has not previously been used in the context of nursing research. Rather, medication administration research has used more often, retrospective designs and analyses of errors to recommend prevention strategies and interventions (Lapkin, et al., 2016).

Practice-based methodologies, drawing on ethnographic techniques to studying a complex field of action, represent a research approach that can study settings and circumstances in depth that affect patient safety. Further research focusing on medication error prevention would benefit from practice-informed evidence. Practice that includes near misses are rarely documented in the literature, however, my study uncovered several near misses that NICU nurses prevented.

Further studies in other clinical areas are needed where larger volumes of medications are administered. As one NICU nurse stated, “I can’t imagine how a nurse on a medical unit handles medication administration with so many medications and a higher patient load”. A NICU nurse is assigned two patients for a shift some with only four medications to be administered twice a day. A nurse on a medical unit, is often assigned five patients, includes the administration of as many as” thirty medications to one patient in the morning alone” (K. Ringstad, personal communication, April 20, 2018).

Implications for Nursing Practice

Mol (2002) argues health care research requires an ontological inquiry to focus on how practice is enacted, rather than an epistemological focus of how practice should be done. In other words, a more fulsome understanding of the circumstances and settings in which practice is enacted could be the focus of intervention research intended to improve practice. Praxiography affords the opportunity of designing research studies that offer direct evidence to inform better practice. Additionally, with its focus on practices of actors operating in complex networks, praxiography further illustrates how practice proceeds, drawing on actual practice examples, in ways that provide interesting cases to support education for new nurses.

Leeman and Sandelowski (2012) advocated for qualitative research that documents practice-based evidence interventions in healthcare. These authors define practice-based evidence as, "experiences and practices of health care providers working in real-world practice settings" (p 171). Exclusion of practice-based evidence, Leeman and Sandelowski aver, threatens the applicability of evidence-based interventions, given the diverse realities of practice.

Thorne and Sawatzky (2014) also warn against the application of evidence-based practice to generalize the particularities of practice. These authors argue that generalizing knowledge for nursing practice, "represents only part of the knowledge nurses need to inform practice in particular situations" (p.11). Therefore, Thorne and Sawatzky maintain that nursing knowledge includes both practice-based evidence and evidence-based practice.

Practice-based research methodologies are rare and this deserves further consideration by nursing as a practice-based profession. My research makes a contribution to this small but growing sub-field of nursing research. I offer the following review of select practice-based

nursing research to illustrate the contributions to knowledge development for patient safety that this approach to research has to offer the discipline of nursing.

Bucknall and colleagues (2019) investigated nurses' decision-making practices and patient involvement in medication administration. These researchers documented practice complexity and nurses' decision making that protects patients from harm. MacKinnon's (2012) practice-based research found rural nurses' developed *"safeguarding practices"* to protect patients from harm. Rural nurses *"safeguarding practices"* were invisible in management strategies that focus on measuring patient outcomes and efficiency without understanding the how of everyday practice. Recommendations from MacKinnon's research call for the inclusion of nurses' experiences to address the particularities of practice that are not included in institutional strategies for patient safety. Similar to my research findings, Bristol and colleagues (2018), studied nurses' practice experiences of electronic health records. These researchers discovered nurses engaged in positive deviance to mitigate unintended consequences of an electronic system to prevent errors. Bristol and colleagues recommend that any implementation of an electronic system should incorporate nurses' experiences such as positive deviance for patient safety and usability.

I locate my study in this tradition. This research study offers detailed insights into the complex practice of administering medication to small, vulnerable neonates. The analysis shows the extent to which standardizing frames used by health care organizations to track medication errors tend to focus primarily at the delivery end. A focus on the delivery end results in targeting nurses most often as the group of health care professionals most responsible for making errors. The study shows how nurses, pharmacists, neonates, parents and physicians work in unique networks as human and non-human actors to administer important medications designed to

maintain and enhance the health of the baby. Understanding the operations of such complex networks reveals a depth of knowledge based on experience that nurses use to fulfil their mandate to promote the health of preterm infants. Nurses' values for preterm infant health and healing conflicted with institutional policy and demanded flexibility for providing care and medication administration. Achievement of policy directions is often written into practice as though it can be achieved in a standard way. As was discovered in my research, a dialogue was needed between nurses and pharmacists to achieve patient safety through flexible applications of institutional policy. This understanding represents a significant challenge to educators whose job it is to prepare new nurses to work safely in these complex practice settings. It is to the implications for education that I turn next.

Implications for the education of future nurses. An important question raised by this research is, how do new nurses without experiences of a near miss medication error learn to navigate medication administration complexity to protect vulnerable patients? In Chapter Eight, I documented how an experienced NICU nurse averted a medication error that a bar code scanner did not recognize. Although this was not an ideal practice situation for the NICU nurse and preterm infant, a student was present who witnessed how the error was prevented. The student was also shown how a bar code scanner did not recognize the error. For this student, learning in practice was foundational for future practice and medication error prevention. My own research of NICU nurses' medication administration practices has illuminated for me how these nurses are organizing the complexity of practice to enhance patient safety. This realization raised the very important questions for me regarding how students are prepared for practice experiences without an educator on the unit. As the student example from my research documented, nurses' medication administration practices were required to prevent errors as

technology may falter. This finding begs the question; how might educators prepare student nurses to act when technology may falter?

Ongoing dialogue and reflection with nurses, nurse educators and students can reveal how safety can be achieved through a more flexible application of unit/institutional policy. Prevention of patient distress can be achieved with a more flexible application of the institutional medication administration policy. NICU nurses in my research administered medications with infant feeding to prevent distress despite institutional policy that required medications to be given at set times. Left undiscussed, these practice and institutional conflicts, establish two separate options: the "right" way and the "best" way. A student in practice is faced with following institutional policy or the "right" way over critical reflection that queries the "best" way.

I now return to the nurse educator practice experience of the student who made a medication error that was the trigger for this dissertation. The student who made a medication error may have benefitted from an ontological inquiry into nursing practice. An ontological inquiry implies that a student fully observes practice followed by reflection before taking responsibility for medication administration or any other aspect of patient care. Reflective discussions about observations, provides students with an opportunity to discuss what they have seen to engage in critical inquiry about practice. Facilitating student inquiry includes developing their ability to learn how to ask questions about practice. A nurse educator holds not only the responsibility for facilitating a student's vision of an ontological inquiry into practice but also the responsibility to negotiate with a practice placement setting for observational experiences.

Mol's (2002) challenge to researchers to take ontological inquiry into practice is in alignment with educators who have called for a shift from the acquisition of knowledge to "ways

of being" for professional learning (Dall'Alba & Barnacle, 2007, p. 686; Doane & Brown, 2011). These same authors have written about the benefits of ontological learning and curricula design for professional education.

A nurse educator who facilitates students' learning of not only the administration of medications but also, and more importantly, the ability to step back before jumping right into practice, may prevent student medication errors. Students enter practice with standardized knowledge for safe, competent practice and also life experience that needs to be recognized as integrated into their enactment of practice. It has been my experience that educators have privileged the conveyance of *standardized knowledge for practice* at the expense of supporting students to learn the complex contexts of *practicing*. To prepare future nurses to prevent errors in practice a critical awareness of how interactions between nurses and technology translate and transform medication administration practices is needed.

To understand the inseparability of technology and nurses' medication administration practices, education of future nurses requires an awareness of a medication's journey. Following a medication's journey includes the preparation, packaging and stocking of a medication for administration. All points along a medication's journey have the potential for error. When a medication administration network is traced, nursing educators and students develop an awareness of the information that is available and not available for patient safety. This awareness includes following a prescribed medication to a pharmacy for packaging and distribution to a unit. Students' awareness of the medication administration process prior to reaching the unit provides more than the available information on a pre-packaged medication. An understanding of unavailable information on a pre-packaged medication promotes critical questioning that can

prevent potential errors. For example, the volume of a medication in a syringe, does it match with an expected dose or route for administration?

The following questions arose for me as I reflected further on my experience as a nurse educator based on my research findings of how NICU nurses prevented medication errors in changing situations and circumstances. What do we know as nurse educators about student's medication errors? How and what information are we collecting when a student makes a medication error? For example, is there a) a pattern related to the time of the error or b) the type of system being used or c) the initial shift in a new practice model with no educator on site? More student specific questions are also needed for a reflective review of a medication error:

1. Was there an observation shift?
2. What did you propose you would observe for your observation shift?
3. What is happening on the unit?
4. What did you do write down (practice notes before leaving the shift)
5. How will you use your notes for your next shift?
6. What did your observation mean to you?
7. How did you make sense of what you observed that was a standardized (universal maps) or "right way of practicing" and "good ways of practicing" (nurses' local maps?)

Research findings from this study uncovered that NICU nurses created local maps to navigate the complexity of preterm infant medication administration and care. This finding suggests student nurses should learn to create their own local maps beyond the institutional maps presently used in clinical settings, to support safe medication administration and patient care practices.

Conclusions

This research was undertaken to gain an understanding of medication administration practice as enacted by NICU nurses who co-exist with technology. Mol (2002), maintains praxiographic research intends to raise questions and in turn possibilities for future research. To further develop knowledge of NICU nurses' medication administration practices, I would include physician's assistants, nurse practitioners and physicians as participants. An understanding how nurses and pharmacists co-exist with medication prescribers who spend a limited time in the NICU would further add to my research findings.

The interest of the NICU nurses, manager and nurse educator supported my ability to fully engage in unit observations. The individual patient rooms with large glass windows afforded observations outside of patient rooms to prevent distraction. I was able to observe during urgent situations as I was located outside of the patient room. One of the NICU nurse participants with five years of experience had only used electronic records. Similar to the NICU nurses who had transitioned to electronic documentation, this participant had incorporated practices such as a local map and flexible applications of institutional policy to support patient health and healing.

The strength of this research lies in practice observations that were cross checked with interview data. The flexible nature of the unstructured interviews allowed for a clarification of interview data to construct a shared meaning between researcher and participant.

To add to my research findings, physician assistants, nurse practitioners and physicians could be interviewed about their medication administration practices. In particular, how these prescribers define their role in a medication administration process that is directed by a pharmacist with an office physically located in the NICU. Practice observations in my research

discovered the pharmacist oversaw prescribers' medication orders and provided input on dosages during patient rounds.

As my research focused on NICU nurses enactment of medication administration, inclusion of nurses in other practice settings would add to medication administration knowledge. Nurses who practice on medical units have a larger patient to nurse assignment. Understanding how nurses with larger patient assignments enact medication administration adds to practice-based knowledge. A larger patient assignment adds to the complexity of practice as nurses manage more medications. These medications are often scheduled for administration at the same time. Research that includes how medical nurses navigate the complexity of larger numbers of medications has the potential to document practices that prevent errors.

This research did not address power and structural influences on NICU nurses' medication administration practices. Power and institutional structures that influence nurses' medication administration practices and the culture in which it occurs are also worthy of study.

Generalizability (i.e., the ability to claim that similar findings would arise in a range of different but comparable settings) is often cited as an important outcome of a research project. However, this was not a goal for the research I undertook. Instead, my findings pertain specifically to the setting in which my observations were completed and at the time that I was present. Some might think this approach a limitation of praxiography as a research model. I argue that a critical value of the praxiographic research methodology is it provides highly detailed descriptions of specific practices. For example, in examining the instance of medication administration (my topic of interest), I noted that most studies frequently focus primarily on errors *instead of* examining relations between people and the technological devices with which they work. In my doctoral studies, my interest was in describing the complex relationships

between nurses, their patients, their patients' families, the wider health care team, and the technological devices that make the administration of medications possible. This methodology was chosen specifically to answer the question: ***How do NICU nurses' enact medication administration in a highly technical environment with vulnerable preterm infants?***

I contend that, as a result of this praxiographic study, much more is now known about NICU nursing practices. The knowledge I have gained through this research will assist me to be a better teacher of students learning how to be good nurses.

Another specific focus for this research was the use of a *purposeful sample* (Morse, 1991) in seeking participants, a location, and an electronic health system for the study. Thus, the participants in my research do not necessarily represent the wider population of all the nurses in the NICU where I conducted research. Study participants were NICU nurses who had five or more years of practice experience. Medication administration practices of NICU nurses with less than five years of experience were not explored. The electronic health system used in the research site is also not fully representational of every electronic health system in every NICU. Further research could explore practices involving different electronic health systems, NICUs, and NICU nurses with less than five years of experience. Research with NICU nurses with less than five years of experience and in one location provides an opportunity to gain knowledge of their particular medication administration practices. NICU nurses with less than five years of experience will *not* necessarily have experienced a transition from paper to electronic medication administration documentation. One of the participants in my study, with five years of experience, had only used electronic documentation for medication administration. In practice observations of this participant, I observed how she used a local map to coordinate medication administration with preterm infant feeding schedules.

In other words, I can see how repeating and expanding praxiographic studies of medication administration and electronic health systems will be important. For instance, research is needed to document how many medication errors prevented through nurses' enactment of medication administration practices. Such research could document the reasons why *workarounds* with technology occur in practice to prevent medication errors. Importantly, research into medication administration should include documentation of what is working in practice to prevent medication errors with a bottom- up approach rather than a top-down dictum. A top-down dictum (institutional policy) is often based on why something is needed (such as error prevention) without fully understanding how a practice is enacted in different situations and circumstances. My research discovered NICU nurses' medication administration practices were enacted to support infant health and healing and prevent errors. Nurses' practices conflicted with standardized institutional policies that did not understand NICU circumstances and situations. A practice-informed research approach into medication administration requires the researcher to begin where the enactment of medication administration occurs (Mol, 2002).

Past medication practices of NICU nurses promoted health and healing of preterm infants and prevented medication administration errors. The rapid transformation from paper to electronic medication documentation has not been addressed fully with respect to the effects on medication safety. Despite the ubiquity of technology in a NICU setting and changes from past medication administration practices, nurses still enact medication administration relying on handwritten documents to prevent medication errors. NICU nurses transference from paper to electronic documentation in a highly technical environment introduces workarounds and unanticipated consequences that affect preterm health and healing. Of critical importance is NICU nurses adherence to a non-negotiable integrity in a system that is unaware of how these

nurses enact practices that contribute to infant health and healing. Furthermore, institutional viability and preterm infant protection from adverse effects is closely linked to NICU nurses enactment of medication administration practices.

As I conclude this chapter, I am reminded of observations and interview data of workarounds that came into being as NICU nurses enacted preterm infant care and medication administration practices. This begs the question; are nurses' workarounds simply part of the complexities of practice that come into being when practice is enacted?

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Appendix A

Interview Consent Form

University of Victoria School of Nursing

Consent Form

"Uncovering How Nurses Learn about Medication Administration and Create Space to Think and Space to Work"

Researchers:

Wendy Neander RN MN, PhD (c)
Telephone: 250 471 4702. Email: wneander@uvic.ca
Mary Ellen Purkis RN, PhD, Dean and Professor Faculty of Human and Social Development
Telephone: 250 721 8050
Email: hsddean@uvic.ca

Purpose: You are invited to participate in Wendy Neander's doctoral dissertation research. The research aims to uncover the thinking and strategies nurses employ to maintain a practice of excellence around medication administration. You have been identified as a candidate for this study who is knowledgeable and experienced and who has been involved in fulltime nursing practice for at least 5 years.

Nurses are required to use knowledge, skills, and technology to practice safe medication administration. To contribute to nursing knowledge, which responds to diverse practice needs, a research study is being conducted to uncover, experienced nurses use of knowledge and technology to support safe medication administration.

The purpose of this consent form is to provide you with the information you will need to decide whether or not you would consent to participate in the study. You may ask any questions about the purpose of the research or this form. You will be given a copy of this form to keep.

Procedure:

Your participation in this study will include a maximum of two interviews each lasting approximately one (1) hour. The purpose of the interview is to provide an opportunity for the researcher to ask you questions, based on your knowledge and experience related to medication administration. All interviews will be audiotaped and transcribed verbatim. After transcription of the interviews, the audiotapes will be erased. The transcripts of the interviews will be coded and analyzed for recurring themes.

A second interview will be conducted to verify that the researcher's interpretation of the interview data is correct and to pose further questions that arise from the coding and analysis of the initial data. These interviews will also be transcribed. After transcription, these audiotapes will also be erased. All personal information will be removed during the transcription process and interview data will be stored in a locked file cabinet and by password protected computer files.

At any time during the interviews, you have the right to withdraw from the study.

The data collected up to that time will be analyzed to support the proposed dissertation research unless you advise the researcher that you do not want to have your data used in the study. All data collected will be used to improve the quality and relevance of nursing education and for future research that builds on the dissertation research. The data will be archived for on-going analysis and possible educational use because access to detailed descriptions and accounts of practice are valuable data components that can be used for many years into the future. The expertise of the study participants provides first-hand knowledge of how nurses integrate knowledge into practice. The descriptions provide realistic praxis examples for the education of nurses.

Risks and Discomforts:

There are no risks or discomforts associated with this research.

Benefits:

By serving as a participant, you will contribute to nursing knowledge about safe medication administration to support the education of registered nurses.

Confidentiality:

Your name or your identity will not be used in connection with any of the data or publications from this study. Audiotapes of interviews will be erased once the interviews have been transcribed for analysis.

Participant's Consent

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have general questions about the research, I can ask one of the researchers listed above.

_____Printed name of Participant

_____Signature of Participant

_____Date

Appendix B

Observation Consent Form

University of Victoria School of Nursing

Consent Form

"Uncovering How Nurses Learn about Medication Administration and Create Space to Think and Space to Work"

Researchers:

Wendy Neander RN MN, PhD (c)

Telephone: 250 471 4702. Email: wneander@uvic.ca

Mary Ellen Purkis RN, PhD, Dean and Professor Faculty of Human and Social Development

Telephone: 250 721 8050

Email: hsddean@uvic.ca

Purpose: You are invited to participate in Wendy Neander's doctoral dissertation research. The research aims to uncover the thinking and strategies nurses employ to maintain a practice of excellence around medication administration. You have been identified as a candidate for this study. You are a knowledgeable and experienced nurse who has been involved in nursing practice in a specialty area known as being at high risk for medication errors.

Nurses are required to use knowledge, skills and technology to practice safe medication administration. To contribute to nursing knowledge, which responds to diverse practice needs, a research study is being conducted to investigate experienced nurses use of knowledge and technology to support safe medication administration.

The purpose of this consent form is to provide you with the information you will need to decide whether or not you consent to participate in the study. You may ask any questions about the purpose of the research or this form. You will be given a copy of this form to keep.

Procedure:

Your participation in this study will include a maximum of four, two-hour observation shifts in your place of practice. To follow up on each observation period, an interview lasting approximately 20 to 30 minutes will be undertaken. The purpose of the interview is to provide an opportunity for the researcher to ask you questions, based on the shift observation. All interviews will be audiotaped and transcribed verbatim. After transcription of the interviews, the audiotapes will be erased. The transcripts of the interviews will be coded and analyzed for recurring themes.

A final interview will be conducted to verify that the researcher's interpretation of the observations and post-observation interview data is correct and to pose further questions that arise from the coding and analysis of the initial data. These interviews will also be transcribed. After transcription, these audiotapes will also be erased. All personal information will be removed during the transcription process and interview data will be stored in a locked file cabinet and by password protected computer files.

At any time during the interview or entire study you have the right to withdraw from the study. Any data collected up to that time will be analyzed to support the proposed dissertation research unless you advise the researcher that you do not want to have your data used in the study. All data collected will be used to improve the quality and relevance of nursing education and for future research that builds on the dissertation research. The data will be archived for on-going analysis and possible educational use because access to detailed descriptions and accounts of practice are valuable data components that can be used for many years into the future. The experience of the study participants provides first-hand knowledge of how nurses integrate knowledge into practice. The descriptions provide realistic praxis examples for the education of nurses.

Risks and Discomforts:

There are no risks or discomforts associated with this research. As a registered nurse, I do have the duty to report unethical and unsafe practice. I have spoken with the unit manager and will follow unit policy in reporting any unethical or unsafe practice I observe. I will clarify with you as a participant, that my observations were correct and ask you to follow up with your unit manager.

Benefits:

By serving as a participant, you will contribute to nursing knowledge about safe medication administration to support the education of registered nurses.

Confidentiality:

Your name or your identity will not be used in connection with any of the data or publications from this study. Audiotapes of interviews will be erased once the interviews have been transcribed for analysis.

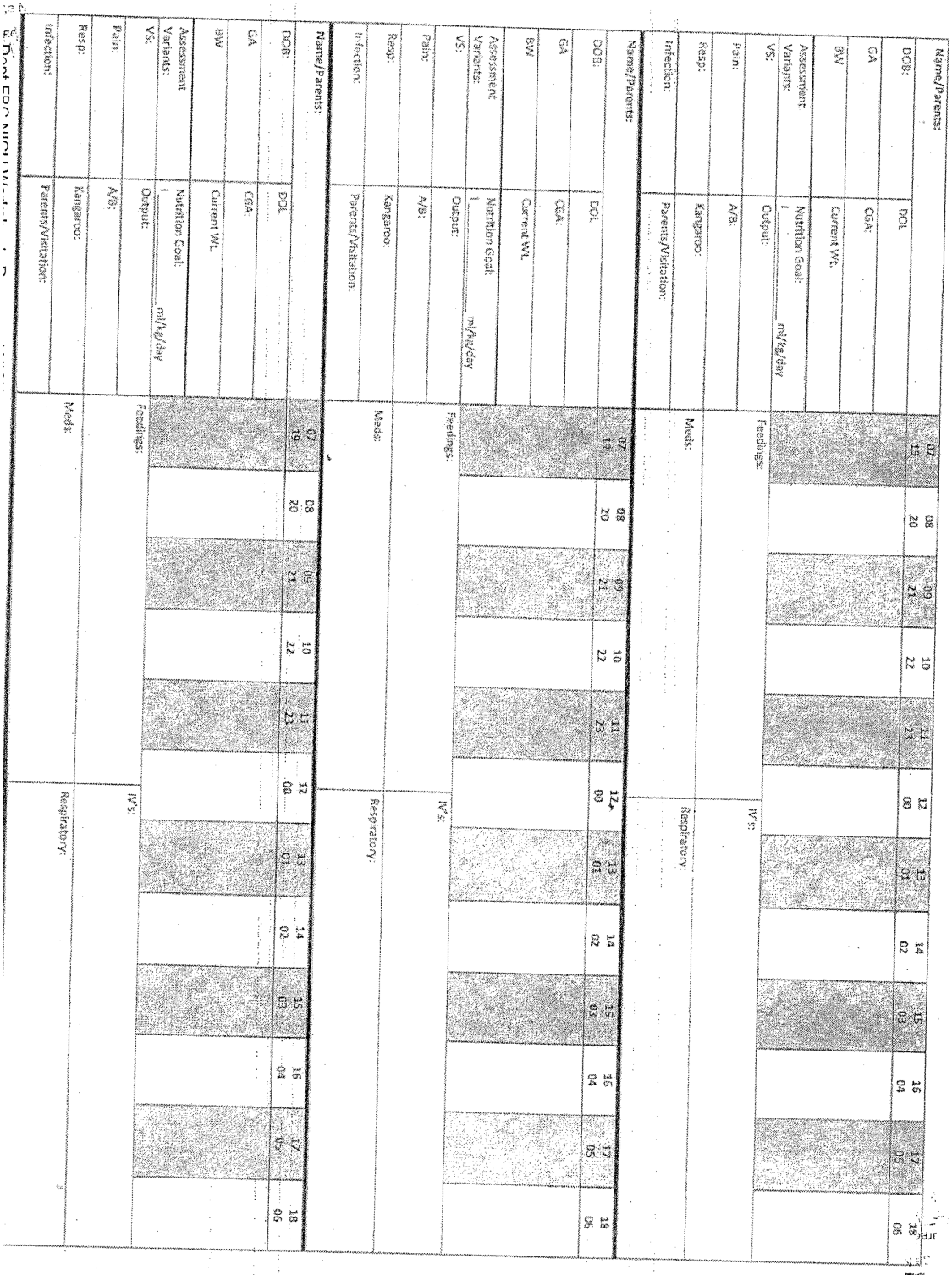
Participant's Consent

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have general questions about the research, I can ask one of the researchers listed above.

_____Printed name of Participant
_____Signature of Participant
_____Date

Appendix C

Shift Handover Sheets



Patient Sticker

Name:_____
BD___/___ Time: ____GA:_____ DOL:_____ CGA:_____
Dx: _____ Admit from: ER or FBC ___/___ @_____
Hx:_____
Parents:_____ Pt. Provider:_____ Mo.'s OB/Grp:_____
OBHx _____

Weight: Birth _____gm Prev. Wt. _____gm Current Wt: _____gm Wt. Change: _____gm

Vitals: Temp: _____HR:_____RR:_____B/P:_____ NPASS_____
Comments: _____

Neuro: Sedation Meds:_____ NAS_____
NPASS sedation_____ General Neuro :_____ MAE_____
Comments: _____

Cardiovascular: Temp: _____HR:_____ B/P:_____
Murmur_____ Cap Refill _____ Pulses_____
Comments: _____

Pulmonary: FiO2 _____: Mode: NC ____L, HFNC_____L, CPAP _____cmH2O (Cares Due____)
Vent settings_____ ET tube _____cm at the gum X-ray Due_____
Blood Gases :Results: _____ Due:_____O2 Sat: _____Limits:_____
Hx:_____
A & B: Total events last 12 hrs:_____ Last 24:_____ Desaturations:_____
Associated with feeds_____ Stimulation Required:_____

Fluids/Nutrition: IV Fluids:_____ Goal TF_____Received TF_____ml/kg/24h
Vascular Access: PIV_____ UAC@____cm UVC@___cm PICC/Site_____Length exposed_____
Dressing secured_____ Tubing changed_____ Microclave changed_____
Vascular access concerns_____

GI/GU: 12 hr. total_____ 24 hr total._____ ml/kg/hr_____
Diaper Count: Voids_____ Stools_____ Abdomen assess/bowel sounds_____
Milk recipe:_____ Volume:___ml q___hrs/adlib Mode: N,NG,Breast____x day
% of PO to total PO volume:_____% Feeding Times_____/_____/_____/_____
Feeding concerns_____ Nipple type_____
Comments_____

Integumentary- Rash/lesions_____ Treatment_____ Other_____

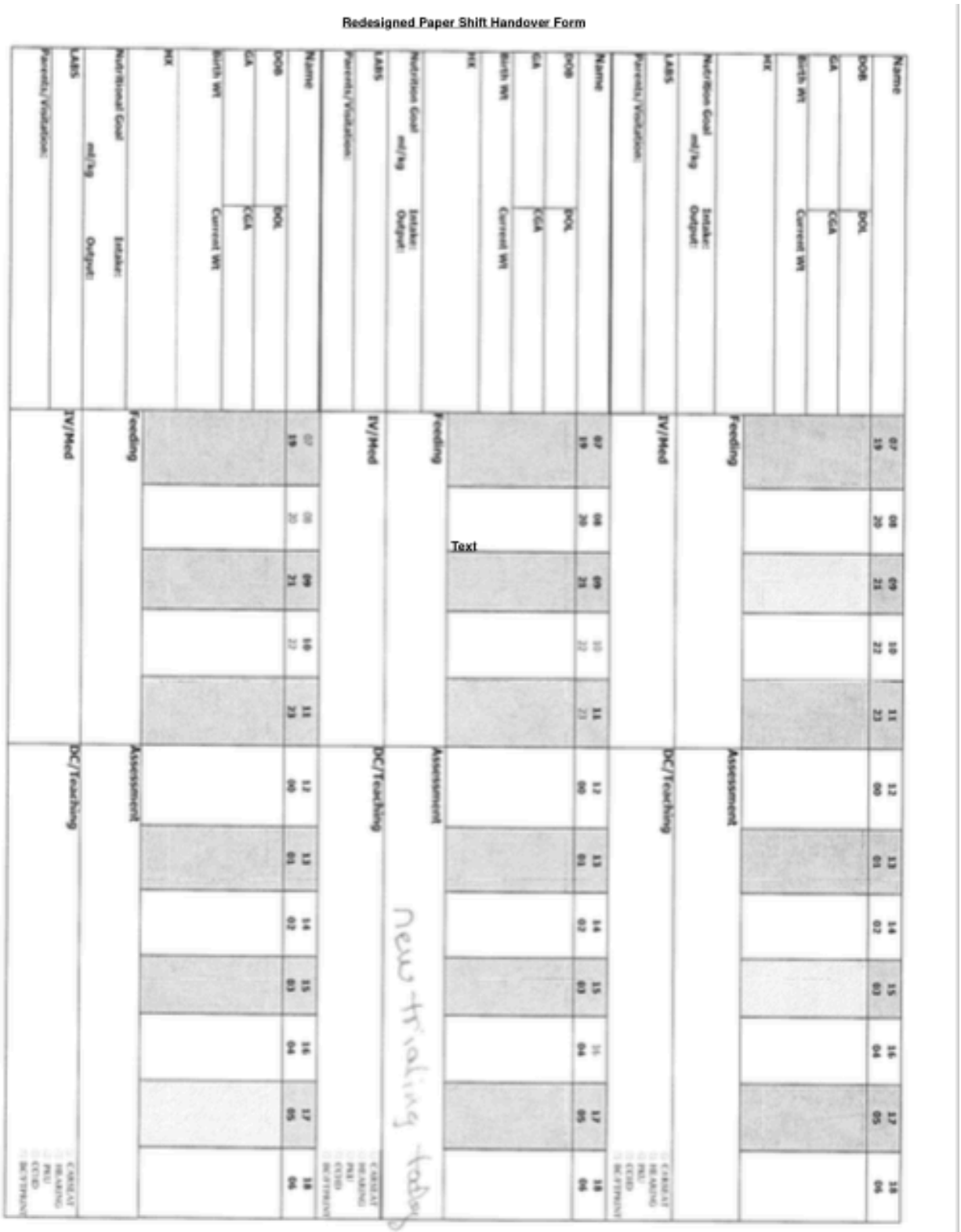
Labs: Pending: _____Due_____ Blood Sugar_____
Results:_____Bili _____Other_____
EKG/ECHO/HUS/ Other Test_____

Medications:_____
_____

PCP visit_____ **Family Interaction:**_____
Social concerns:_____
Discharge:_____
Comments_____

Goals for the day:

07/19
08/20
09/21
10/22
11/23
12/24
13/01
14/02
15/03
16/04
17/05
18/06


Redesigned Paper Shift Handover Form
Name
DOB
GA
Birth Wt
Current Wt
DOL
CGA
HX
Nutrition Goal
ml/kg
Intake:
Output:
LABS
Parents/Visitation:
Feeding
IV/Med
DC/Teaching
Assessment
Text
new training tabs

Appendix D

RESUS Nurse Position

This position is a supernumerary position in terms of the patient census in the Neonatal Intensive Care Unit (NICU). The RESUS nurse does not receive an infant assignment in the NICU. The responsibilities of the RESUS nurse include:

1. Available for dual verification of medications in the NICU and also a nearby paediatric unit
2. Available for dual verification of breast milk.
3. Checks carts for deliveries and neonatal resuscitation, located in the Maternity area of the hospital across the hall from the NICU.
4. Attends or responds to high risk deliveries.
5. Supports colleagues with infant assignments.
6. Accompanies infants going for Computerized Tomography examinations and other diagnostic tests.

Appendix E

Emergency Medications 1500 Grams Protocol

Standardized Weight: 1500 Grams

Patient Weight: _____Grams (___/___/_____)

	Size	Depth
ET Tube	3	7.5 cm

	Route	Dose	Volume
Epinephrine (1:10,000=0.1mg/mL)	**IV, IC**	0.015 to 0.045 mg (0.01 mg/kg - 0.03 mg/kg)	**0.15 to 0.45 mLs**
	ETT	0.075 to 0.15 mg (0.05 mg/kg - 0.1 mg/kg)	**0.75 to 1.5 mLs** Follow ETT dose with 1 mL NS flush.
Naloxone (Narcan) (1mg/mL)	**IV,IM**	0.015 to 0.15 mg (0.01mg/kg - 0.1mg/kg)	**0.015 to 0.15 mLs**
Dextrose Bolus (D10%W)	**IV**	2 mL/kg	**3 mLs**
Normal Saline (0.9% NaCl)	**IV** **slow push**	10 mL/kg	**15 mLs**
Adenosine (3mg/mL) (3000 mcg/mL)	**IV** **Rapid push** Close to heart Not via central line	Starting dose: 75 mcg (50 mcg/kg) Increase dose q 2minutes until return of sinus rhythm:	**0.03 mL**
		150 mcg (100mcg/kg)	**0.05 mL**
		225 mcg (150mcg/kg)	**0.08 mL**
		300 mcg (200mcg/kg)	**0.10 mL**
		375 mcg (250mcg/kg) **max**	**0.13 mL**

Medications not routinely used during Neonatal Resuscitation			
Atropine (0.1mg/mL)	IV over 1 minute IM, ETT	0.015 to 0.045 mg (0.01mg/kg - 0.03mg/kg) Cumulative Max: 0.06 mg (Cumulative Max: 0.04mg/kg)	0.15 to 0.45 mLs Follow ETT dose with 1 mL NS flush.
Sodium Bicarbonate (0.5mEq/mL) (Ensure adequate ventilation first)	IV over ≥ 30 min	1.5 to 3 mEq (1mEq/kg - 2mEq/kg)	3 to 6 mLs

Neofax 2009. Young TE, Mangum B. Thomas Reuters, 2009. Approved: 01/2010 EP

Appendix F

Emergency Medications 3000 grams Protocol

Standardized Weight: 3000 Grams

Patient Weight: _____**Grams** (___/___/_____)

	Size	Depth
ET Tube	3.5	9 cm

	Route	Dose	Volume
Epinephrine (1:10,000=0.1mg/mL)	**IV, IC**	0.03 to 0.09 mg (0.01 mg/kg - 0.03 mg/kg)	**0.3 to 0.9 mLs**
	ETT	0.15 to 0.3 mg (0.05 mg/kg - 0.1 mg/kg)	**1.5 to 3 mLs** Follow ETT dose with 1 mL NS flush.
Naloxone (Narcan) (1mg/mL)	**IV,IM**	0.03 to 0.3 mg (0.01mg/kg - 0.1mg/kg)	**0.03 to 0.3 mLs**
Dextrose Bolus (D10%W)	**IV**	2 mL/kg	**6 mLs**
Normal Saline (0.9% NaCl)	**IV** **slow push**	10 mL/kg	**30 mLs**

Adenosine (3mg/mL) (3000 mcg/mL)	**IV** **Rapid push** Close to heart Not via central line	Starting dose: 150 mcg (50 mcg/kg)	**0.05 mL**
		Increase dose q 2minutes until return of sinus rhythm:	
		300 mcg (100mcg/kg)	**0.1 mL**
		450 mcg (150mcg/kg)	**0.15 mL**
		600 mcg (200mcg/kg)	**0.2 mL**
		750 mcg (250mcg/kg) **max**	**0.25 mL**

Medications not routinely used during Neonatal Resuscitation			
Atropine (0.1mg/mL)	IV over 1 minute IM, ETT	0.03 to 0.09 mg (0.01mg/kg - 0.03mg/kg) Cumulative Max 0.12 mg (Cumulative Max: 0.04mg/kg)	0.3 to 0.9 mLs Follow ETT dose with 1 mL NS flush.
Sodium Bicarbonate (0.5mEq/mL) (Ensure adequate ventilation first)	IV over ≥ 30 min	3 to 6 mEq (1mEq/kg - 2mEq/kg)	6 to 12 mLs

Neofax 2009. Young TE, Mangum B. Thomas Reuters, 2009. Approved: 01/2010 EP

Appendix G

Emergency Medications 500 grams Protocol

Standardized Weight: 500 Grams

Patient Weight: _____**Grams** (___/___/_____)

	Size	Depth
ET Tube	2.5	6.5 cm

	Route	Dose	Volume
Epinephrine (1:10,000=0.1mg/mL)	**IV, IC**	0.005 to 0.015 mg (0.01 mg/kg - 0.03 mg/kg)	**0.05 to 0.15 mLs**
	ETT	0.025 to 0.05 mg (0.05 mg/kg - 0.1 mg/kg)	**0.25 to 0.5 mLs** Follow ETT dose with 1 mL NS flush.
Naloxone (Narcan) (1mg/mL)	**IV,IM**	0.005 to 0.05 mg (0.01mg/kg - 0.1mg/kg)	**0.005 to 0.05 mLs**
Dextrose Bolus (D10%W)	**IV**	2 mL/kg	**1 mLs**
Normal Saline (0.9% NaCl)	**IV** **slow push**	10 mL/kg	**5 mLs**

Medications not routinely used during Neonatal Resuscitation			
Atropine (0.1mg/mL)	IV over 1 minute IM, ETT	0.005 to 0.015 mg (0.01mg/kg - 0.03mg/kg) Cumulative Max: 0.02 mg (Cumulative Max: 0.04mg/kg)	0.05 to 0.15 mLs Follow ETT dose with 1 mL NS flush.
Sodium Bicarbonate (0.5mEq/mL) (Ensure adequate ventilation first)	IV over ≥ 30 min	0.5 to 1 mEq (1mEq/kg - 2mEq/kg)	1 to 2 mLs

Neofax 2009. Young TE, Mangum B. Thomas Reuters, 2009. Approved: 01/2010 EP

Appendix H

Dual Verification Policy

Independent Dual Verification

KEY POINTS

PROCEDURE: Prior to medication administration, a second staff member authorized to order, dispense or administer medications, independently go through the steps in the double-check procedure to arrive at the same conclusion (alone and apart from each other). Independent double checks must be performed before the start of an infusion and before administration of the medication.

Independent Dual Verification is required prior to administration of:

- Designated high alert medications for all adult and pediatric patients
- For all pediatric medication orders that are weight based and requires calculation by the individual administering the medication

Note: Pediatric patient is defined as < 14 years

- Independent dual verification requires that a second staff member authorized to order, dispense, or administer the medication, independently verify the following prior to medication administration:
  a. Medication order
  b. Two patient identifiers
  c. Drug name
  d. Dose/Strength/Rate
  e. Route
  f. Frequency
  g. Time of administration
  h. Dosage calculation (may include use of an electronic dosage calculator)
  i. IV Electronic Infusion Device: Program IV pump and review settings, including concentration and confirm rate

Sign and return this form to your Manager by February 28th, 2015

I have read, asked questions and understand the educational information presented to me. I understand how I am to incorporate these key points into my practice.

Signature: _____ **Date:** _____