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# Understanding the Prevailing Practices of Pain Management in Extremely Preterm Neonates During the First 14 days of NICU Stay

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# Understanding the Prevailing Practices of Pain Management in Extremely Preterm Neonates During the First 14 days of NICU Stay

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Currently neonates as young as 23 weeks are considered viable and are admitted to the neonatal intensive care units (NICU) for life support. Many of the supportive activities in these units are both invasive and painful, yet little is known about the experience of pain in the extremely preterm neonate of 23-28 weeks of gestational age. Preterm neonates are often very unstable with immature physiology and organ systems; therefore the management of pain in these extremely preterm neonates creates unique challenges to the entire healthcare team.

The purpose of this research study is to describe both pharmacologic and non-pharmacologic pain management strategies in extremely preterm neonates. The ultimate goal of this study is to contribute to the body of knowledge on procedural pain management in extremely preterm neonates, and provide evidence for clinical guidelines and the need for further research.

This research study implements a normative case series methodology, using a descriptive, correlational analysis. The sample consisted of 28 extremely preterm neonates between the gestational ages of 23-28 weeks. Logistic regression was used in this study to determine the likelihood that painful procedures would be managed by either pharmacologic or non-pharmacologic interventions.

The equation that was used estimated was:

Equation: $\text{Log } (p/1-p) = \beta 0 + \beta 1 * x1 + \beta 2 * x2 + \beta 3 * x3$

*Where:* p=the probability of pharmacologic intervention, $\beta 0$ = constant; x1 = highly painful procedures; x2 = moderately painful procedures; x3 = least painful procedures.

This study found that most painful procedures were performed without adequate analgesic measures. The normative conceptual framework used in this study highlights that the current pain management scenario in this vulnerable population is suboptimal and should not be the norm in this population. Some of these uncertainties can be reduced by drawing attention to conducting further research and developing guidelines and policies for creating an optimal standard for pain management in this vulnerable population.

This dissertation by Santy N Sajan, MBA, MSN, R.N. fulfills the dissertation requirement for the Doctoral degree, Ph.D. approved by Dr. Mary Paterson, Ph.D., MSN, R.N., as Director, and by Dr. Elizabeth Hawkins-Walsh, PhD., R.N., CRNP and Dr. Teresa Walsh, R.N., PhD, as Readers.

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# CHAPTER I

# THE PROBLEM

## Introduction and Background

The technology available to sustain preterm neonates is constantly evolving. Currently neonates as young as 23 weeks are considered viable and are admitted to the neonatal intensive care units (NICU) for life support. Many of the supportive activities in these units are both invasive and painful, yet little is known about the experience of pain in the extremely preterm neonate of 23-28 weeks of gestational age. This study focuses on the experience of pain in this population.

The management of pain is a major challenge in healthcare, and has been the subject of numerous clinical studies. In the neonate, the experience of pain has both ethical and biological dimensions. It has been well-established that pain in this population should be managed, and that pain may cause later developmental problems that are not, as yet, clearly understood. In the extremely preterm neonate little is known about pain management techniques. We do not clearly understand the nature, frequency, and type of procedures to which this population is exposed, nor do we understand clearly what is done for pain management. In this situation a normative case study is a robust investigational approach since we wish not only to describe the experience of pain, but we also want to reflect on the ideals and obligations pertinent to pain management in this vulnerable population.

## Neonatal Intensive Care Unit

At the turn of the 20th century a French physician named Pierre-Constant Budin had discovered that incubator care was associated with improved survival of premature infants.

In 1965, the first American newborn intensive care unit (NICU), designed by Dr Louis Gluck was opened at Yale Hospital in New Haven, Connecticut (Jorgensen, 2010). Newborn infants were ventilated with respirators and monitored with EKG machines designed for adults. While, initially, there were few well-established techniques for neonatal intensive care, development over the past few decades of neonatal intensive care has resulted in more survivors and healthier survivors. (U.S. Department of Health and Human Services [HHS], Public Health Service, National Institute of Health [NIH], 1992). By the 1990's advances in medical and technology fields, such as surfactant replacement therapy, improved perinatal management, new technologies for maintaining temperature, precision of fluid delivery, sophisticated nutritional management, and continued improvement in ventilatory management made successful treatment of extremely preterm newborns with gestational ages of 23 to 25 weeks and birth weights of 500 to 750 grams possible (Jorgensen, 2010).

Level III (subspecialty) NICUs are defined as having continuously available personnel (neonatologists, neonatal nurses, respiratory therapists) and equipment to provide life support for neonates as long as needed. Level III NICUs are differentiated by their ability to provide care to newborn infants with differing degrees of complexity and risk …..The American Academy of Paediatrics (AAP, 2004). This is the setting for this study, a high-tech environment "level III NICU", where life is sustained with the highest possible technology. (Naisbitt, J., Naisbitt, & Philips, 2001). Along with life sustaining technology, there is a need for comfort, pain relief and nurturing- the high touch issue. The concern in this setting is the conflict between high-tech/high-touch. This complex and perplexing environment is the challenge, and has been the challenge for the care giver since the inception of the NICU.

The March of Dimes (2009) reports that approximately 543,000 babies, or 1 in 8, are born prematurely each year in United States and the rate of prematurity has risen by 30 percent since 1981. Prematurity is a leading cause of admission to the NICU requiring prolonged stays and the most advanced NICU care possible. Extremely preterm neonates i.e., neonates born between 23-28 weeks of gestation, (Tout, 2006; Tucker & McGuire, 2004) remain in the NICU for a long period of time and are frequently subjected to multiple painful invasive procedures during their NICU tenure. Many of the procedures done on both term and preterm neonates have been estimated to be painful, with pain scores of >4 on a 10-point scale (Ciganaco et al., 2006; Simons et al, 2003). Newborn infants, especially those who are born extremely preterm, are at high risk of experiencing pain while being cared for in the NICU. Multiple studies have documented a high frequency of invasive procedures during neonatal intensive care, particularly in this vulnerable group.

Literature shows that preterm infants are capable of experiencing pain even at a young gestational age. Sensory fibers are abundant by 20 weeks; a functional spinal reflex is present by 19 weeks; connections to the thalamus are present by 20 weeks; and connections to subplate neurons are present by 17 weeks with intensive differentiation by 25 weeks. (Lowery, Hardman, Manning, Hall, & Annand, 2007). The repetitive acute pain caused by invasive procedures, established pain resulting from neonatal diseases or surgery, and chronic/prolonged painful stimulation experienced by the NICU population often causes severe stress, probably leading to adverse neurologic outcomes in preterm neonates (Hall & Anand, 2005).

The premature infant reacts to painful stimuli with activation of highest level of sensory function, in infants with a lower gestational age the somatosensory cortical activations are more pronounced than older infants (Bartocci, Berqqvist, Lagercrantz &Annand, 2006). Prior studies show that extremely preterm neonates are different and very fragile, and are particularly vulnerable to the effects of repeated episodes of handling whether they are invasive or not (Holsti, Grunau, Whitefield, Oberlander & Lindh, 2007). The rapid changes in liver metabolism involving maturation of liver enzymes and renal clearance of drugs render very low birth weight infants more vulnerable than newborns of later post-conceptual age to the use of opioids such as morphine and fentanyl (Tibboel, Anand & Anker, 2005). There are also difficulties in choosing the right type of medication for pain management in preterm neonates. For example one of the current pharmacological agents, morphine which is routinely used for neonatal pain does not provide adequate pain control in premature neonates (Carbajal et al., 2005). Therefore a great deal of uncertainty still exists in management of pain in these extremely preterm neonates.

## Statement of the problem

Procedural pain is a major issue in extremely preterm neonates during their stay in NICU, and the management of pain in the extremely preterm neonates is important. In fact, the healthcare providers do not know precisely what is being done. There is a gap between what we do know and what we should do in order to provide adequate pain management. In general, neonates are subjected to multiple painful procedures and we suspect that pain in extremely preterm neonates may be undertreated. Pain assessment, documentation and management vary across the NICU's. Neonatal Intensive Care Units with standard written

guidelines on pain management generally performed better on pain assessment, documentation and management (Gharavi, Schott, Nelle, Reiter & Linderkamp, 2007). However, no study has examined specific strategies for pain management in extremely preterm neonates, and no clear guideline currently exists for pain management in this group.

Differences exist in the management of pain among term and preterm neonates. Use of some pain medications need more caution in extremely preterm neonates. For example morphine should be used cautiously for 23- to 26-week neonates **(**Richard et al., 2005). Opioids, while commonly used as analgesics in neonatal intensive care units, have significant side effects (Anand et al., 2004). The AAP (2006) published policy statements on the prevention and management of pain in neonates (preterm up to one month) with recommendations for reducing pain during various invasive procedures. In this policy there are guidelines for use of pain assessment tools, and the use of appropriate pharmacological and non pharmacological measures. These guidelines have been shown to be helpful in the treatment of pain in neonates, but are not specific for the treatment of pain in extremely preterm neonates.

Previous studies have given us important guidelines and directions in understanding the complexities and challenges of pain management, but these recommendations and guidelines have been based on the knowledge gained mostly from the general neonatal population. Moreover the limits of viability are changing; the number of weeks of completed gestation that defines whether a birth is preterm rather than a fetal loss has become smaller. A pregnancy loss is considered a miscarriage when it occurs before 20 weeks' gestation (Michels & Tiu, 2007; Tout, 2006; Tucker & McGuire, 2004). Advances in perinatal care

have improved outcomes for infants born at 23 weeks of gestation. Additional insight through clinical research is needed to understand the current pain management practices for this vulnerable population.

## Statement of the purpose

The primary purpose of this study is to describe both pharmacologic and non-pharmacologic pain management strategies in extremely preterm neonates. The ultimate goal of this study is to contribute to the body of knowledge on procedural pain management in extremely preterm neonates, and provide evidence for clinical guidelines and the need for further research.

## Conceptual framework

A normative conceptual framework is proposed to identify the pain relief measures adopted in extremely preterm neonates. The framework proposes that when early preterm neonates are admitted to NICU they do undergo multiple painful procedures and should receive appropriate monitoring and pain relief measures. Descriptive research is about what exists, here the case series describes what is currently happening in the clinical situation with regard to pain management in this vulnerable population.

Normative theory is about what ought to be, despite whether a situation is desirable or undesirable, it expresses what ought to be in a particular situation. Ethically we know that pain is undesirable and the healthcare team is ethically and morally obligated to provide pain relief to this vulnerable population. Amplifying the descriptive approach with a normative framework gives grounds for further improvements. Thacher (2006) draws our attention to ethical reasoning and argues that case studies can contribute to normative theory.

According to John (2010) a normative theoretical work justifies rightness or wrongness of various individual actions or social policies. It also helps to engage in the social practice of offering, accepting, and criticizing what we take to be good reasons for our judgments. In other words, normative theory helps to make recommendations for future actions. Therefore, grounding this study on the ethical reasoning of normative theory lays a foundation for evaluating the observations made through the descriptive research and provides a theoretical basis to support recommendations to improve pain management outcomes for extremely preterm neonates.

The following normative conceptual model is presented to illustrate what should be happening in the NICU with regard to pain management in extremely preterm neonates. This model depicts the normative research process, in which the object of the study, pain management, is evaluated for the desired outcome and the expected norm improved pain management. The unit of analysis is a system of action rather than an individual or group of individuals (Tellis, 1997). Pain control is an expected norm in healthcare. Therefore, this model presents the desired outcome with regard to pain management in extremely preterm neonates.

Figure1. Normative Conceptual Model

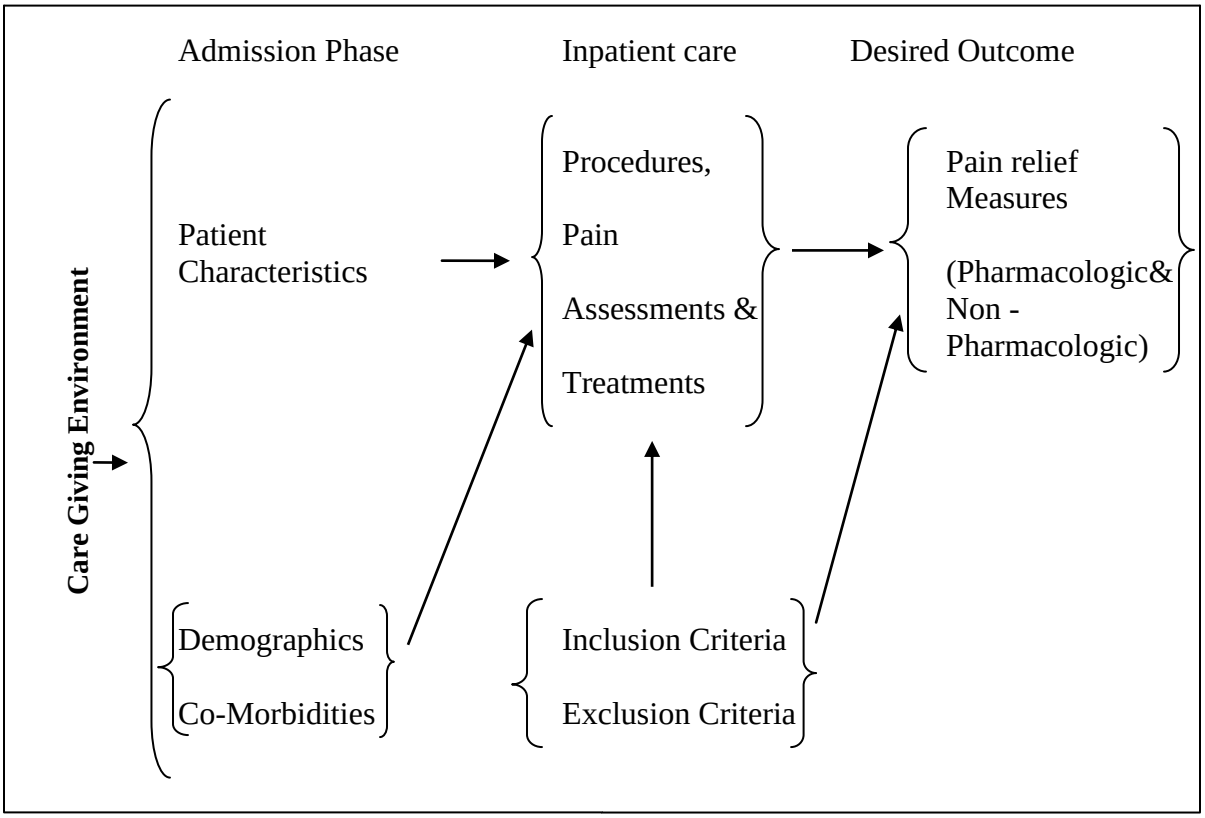


Figure1. This conceptual model describes the pain management process in extremely preterm neonates. The object of the study, pain management, is evaluated for the desired outcome and the expected norm-improved pain management. Concept adapted from "Adding a normative dimension to a descriptive analysis". Retrieved from http://www2.uiah.fi/projects/metodi/179.htm#case

## Definition of terms

Operationalising a study variable involves developing both conceptual and operational definitions, which reduces researcher bias; in correlational research concepts tend to be more abstract and broadly defined (Burns& Grove, 2005). Terms to be used in this study are: extremely preterm neonate, pain, pain assessment, Level III NICU and painful procedure.

### Extremely preterm neonate

*Theoretical:* Neonates born between 23- 28 weeks of gestation (Tucker & McGuire, 2004).

*Operational:* In this study extremely preterm neonate is a preterm neonate born between 23 weeks to 27.9 weeks of gestation.

### Pain

*Theoretical:* Pain is "an unpleasant sensation caused by noxious stimulation of the sensory nerve endings. (Mosby, 2002)

*Operational:* In this study pain is quantified using a 10 point rating scale (Simons et al., 2003).

### Level III NICU

*Theoretical:* Neonatal Intensive Care Unit (NICU) have capabilities to provide care for infants born ≤1000 g and ≤28 weeks gestation. (Carole, & Jana, 2007)

*Operational:* Level III NICU in this study refers to any NICU capable of providing care for neonates including extremely premature neonates.

## Painful procedure

*Theoretical:* Act or conduct of diagnosis, treatment, or operation (Stedman's Medical Dictionary, 1999).

*Operational:* In this study painful procedure is any skin breaking procedure or invasive procedure done for diagnosis or treatment as documented in the patients chart.

## Significance of the study

This study will contribute to our understanding of current pain management in extremely preterm infants. The results will contribute evidence for the development of new guidelines for pain management decision making in extremely preterm neonates. The overall goals of this study are to contribute to patient outcomes by providing evidence to guide adequate pain management interventions, and adopt policies and protocols to manage procedural pain. This study will form the basis for pain management protocols and future investigations of comparative patient outcomes in extremely preterm neonates.

## Assumptions

For the purpose of this study, following assumptions were made:

1. Extremely preterm neonates in NICU routinely undergo painful procedures.
2. Extremely preterm neonates can experience pain as a result of undergoing diagnostic, monitoring and therapeutic procedures.
3. Pain is assessed and documented routinely in all neonatal intensive care units.
4. Chart documentation of specific medical and nursing procedures was accurate and complete.
5. Some action may be taken in response to observed pain.

## Summary

Extremely preterm neonates survive due to technologic advances. They are subjected to numerous monitoring and diagnostic procedures each day and most of the procedural interventions in extremely preterm neonates are painful. Pain management in these extremely preterm neonates requires a comprehensive approach from the care providers using both pharmacologic and non pharmacologic strategies. The AAP (2006) provided guidelines for pain management in neonates (preterm up to one month) but has not provided specific recommendations for pain management in extremely preterm neonates. Pharmacologic management of pain in neonates varies across neonatal intensive care units. The incitation of this study is established from the clinical challenges and the empirical evidence related to caring for extremely preterm neonates in the NICU. Effective management of pain in these vulnerable populations requires clear understanding of epidemiology and current management modalities. Extremely preterm neonates are often very unstable with immature physiology and organ systems; therefore the management of pain in these extremely preterm neonates creates unique challenges to the entire healthcare team.

# CHAPTER II

## Review of literature

### Introduction

Extremely premature neonates are at high risk for being exposed to repeated painful procedures especially during the first 14 days of their stay in NICU. Pain in extremely preterm neonates has both immediate and long term consequences. Effective pain management in extremely preterm neonates is one of the most important and challenging tasks of the care providers in the NICU. Neonates depend on their care providers, especially nurses, to recognize and treat their pain. The AAP (2006) highlights that the smallest and sickest neonates (preterm neonates) are at highest risk to be exposed to greatest number of painful stimuli in the NICU and are at greatest risk of neurodevelopmental impairment. The AAP, further suggest that the prevention of pain in neonates should be the goal of all care givers, because repeated painful exposure has the potential for deleterious consequences. Although much progress has been made, this vulnerable population continues to be exposed to multiple painful procedures (Brown & Timmins, 2005). Therefore, pain management in these extremely preterm neonates needs further exploration.

An ongoing literature search was conducted via the MEDLINE, CINAHL, and Cochrane library database until the research was completed. The literature search covered the period from 2007 until the present time using key words of extremely preterm infants, neonatal pain and pain management. The Cochrane library was searched for systematic reviews and randomized control trials for pain management in extremely preterm neonates. The primary basis of the study was the nature and the type of invasive and painful procedures

and pain management strategies in extremely preterm neonates. The AAP has provided general guidelines for pain management in neonates (preterm and up to one month) based on expert opinion. The guidelines provide a foundation for further exploration of the main variables in this study: pharmacologic pain management, and non-pharmacologic pain management in neonates.

Limits of neonatal viability is an ongoing debate, the grey zone of gestational ages at which aggressive perinatal care should be offered is less clear and ranges from 22- 25 weeks (Haumont, 2005). The limits of viability are constantly being extended leading to the survival of extremely preterm infants**.** Technological advancement in medical science increases the survival rate for extremely preterm neonates. The National Institute of Child Health & Human Development (NICHD) study involving 4,446 infants born at 22-25 weeks' gestational age, by Tyson, Parikh, Green, Langer and Higgins (2008) reveals that 40,000 babies are born annually in the United States that are extremely low birth weight (those weighing less than 1,000 grams, or 2.2 pounds). One in five extremely preterm-birth infants can and do survive in the United States if they are born at 22 weeks gestation in a major level III neonatal intensive care facility; and over three in every 4 infants born at 25 weeks can and do survive . Of the 4,446 babies studied , survival at 22 weeks = 20% , survival at 23 weeks = 37%; survival at 24 weeks = 59% ; survival at 25 weeks = 76%.

## Extremely preterm neonates

As technology and care knowledge increase so does the complexity of care. The limits of viability are changing, therefore, the issue in caring for preterm neonates is a moving target, as we move to younger viability. The literature does not address this cohort,

and we lack knowledge regarding the management of pain. Therefore care providers often find difficulty in making clinical management decisions in this vulnerable population.

Premature birth is a crisis and creates unique challenges in case management for all health care providers. Preterm infants' behavior is also affected by their underlying physiologic status. Extremely premature neonates are often very unstable with compromised physiology and immature organ systems. Although preterm neonates have the anatomic and functional ability to experience pain at birth (Anand & Hickey, 1987) they have poorly-developed inhibitory mechanisms for pain, which may make them more sensitive to painful stimuli. Sensory fibers are abundant by 20 weeks; a functional spinal reflex is present by 19 weeks; connections to the thalamus are present by 20 weeks; and connections to subplate neurons are present by 17 weeks with intensive differentiation by 25 weeks (Lowery et al., 2007).

The immature descending pain pathway and lack of serotonin until 6 to 8 weeks after birth along with a greater density of pain receptors in the skin mean that preterm infants experience more severe pain than adults (Evans, 2009). Pain experiences in the neonatal intensive care unit triggers a series of altered physiological, behavioural and hormonal responses which may lead to altered neurodevelopmental outcomes in preterm infants. The preterm infant is hypersensitive to pain and is at even greater risk for pain because of immature mechanisms at birth to inhibit or dampen nociception (Fitzgerald & Beggs, 2001).

## Painful procedures in NICU

Pain in preterm neonate is caused by diagnostic and therapeutic interventions. Premature neonates are at high risk for being exposed to repeated painful procedures. It has

been documented that hospitalized neonates undergo multiple painful procedures during their stay in the NICU. This is especially true in the case of extremely preterm neonates. A prospective multicenter study by Carbajal et al. (2008) demonstrated that neonates undergo numerous procedures during the first 14 days of their admission to NICU. The mean number of painful procedures per day was 16, with some neonates experiencing as many as 62 procedures per day. Similarly, Harrison, Loughnan, Manians and Johnston (2006) prospectively studied 55 neonates and recorded a total of 3605 procedures, with a mean of 65 minor procedures per neonate per day.

Prior research shows that preterm neonates undergo approximately 10 to 15 painful procedures per day during their first two days of life; heel sticks and suctioning were the most common types of pain experienced in the NICU, and were often not treated adequately (Barker & Rutter, 1995; Evans, McCartney, Lawhon, & Galloway, 2005; Porter & Annand, 1998; Simons et al., 2003; Stevens et al., 2003).

Similarly, Barker and Rutter (1995) give an important prospective study on the frequency and management of painful procedures in the NICU. This study reported the frequencies of painful procedures performed in 54 infants (76% were preterm infants) admitted to a NICU, and recorded that an aggregate of 3,000 procedures were performed. This study further highlights that 74% of the painful procedures were done in infants of less than 31 weeks gestation. Approximately 10% of the youngest infants with the most complications were exposed to more than 300 painful procedures during the first 14 days of intensive care, this study recorded that one infant born at 23 weeks gestation experienced almost 500 procedures.

## Effect of pain on the extremely preterm neonate

Extremely preterm neonates show responses to pain even if they cannot verbalize their pain experiences. Evidence shows that despite being premature, preterm neonates are highly sensitive to pain. The exposure of premature infants to stressors, such as pain may alter their brain development and contribute to several learning and behavioral difficulties observed in later childhood (Badar et al., 2010). Evidence suggests that in prematurely born infants, repeated and prolonged pain exposure may affect the subsequent development of pain systems, as well as potentially contribute to alterations in long-term development and behavior (Grunau, 2002).

Early exposure to pain may alter the stress response in preterm infants later in their life. The premature infant reacts to painful stimuli with activation of highest level of sensory function. The somatosensory cortical activation is more pronounced in preterm neonates than older infants. Bartoccci et al. (2006) studied 40 preterm neonates from 28-36 weeks gestation, following standardized tactile (skin disinfection) and painful (venipuncture) stimuli. Heart rate (HR) and peripheral oxygen saturation (SaO2) were recorded simultaneously with Near Infrared Spectroscopy (NIRS) parameters: oxygenated [HbO2], deoxygenated, and total hemoglobin. This study showed that pain-related [HbO2] increases were more pronounced in male neonates ($p<0.05$ on left, $p<0.001$ on right), inversely correlated with gestational age ($r=-0.53$ on left, $p<0.01$; $r=-0.42$ on right, $p<0.05$) and directly correlated with postnatal age ($r=0.75$ on left, $p<0.0001$; $r=0.67$ on right, $p<0.0001$). In contrast to mature infants, painful and tactile stimuli elicit specific hemodynamic responses in the somatosensory cortex, implying conscious sensory perception in preterm neonates.

Somatosensory cortical activation occurs bilaterally following unilateral stimulation and these changes are more pronounced in male neonates or preterm neonates at lower gestational ages.

Repeated exposure to pain can cause detrimental effects in the extremely preterm neonates' brain. For example, alterations in neural activity due to pain and injury in early development may produce long-term effects on sensory processing and future responses to pain. Walker et al. (2009) performed a qualitative sensory testing (QST) in extremely preterm (EP) children (n=43) recruited from the UK EPICure cohort (born less than 26 weeks) and in age and sex matched term-born controls (TC; n=44). Extremely preterm children had a generalized decreased sensitivity to all thermal modalities, but no difference in mechanical sensitivity at the thenar eminence. Extremely preterm children who also required neonatal surgery had more marked thermal hypoalgesia, but did not differ from non-surgical EP children in the measures of neonatal brain injury or current cognitive ability. Adjacent to neonatal thoracotomy scars there was a localized decrease in both thermal and mechanical sensitivity that differed from EP children with scars relating to less invasive procedural interventions or from those without scars. Generalized decreases in thermal sensitivity but not in mechanical sensitivity suggest centrally mediated alterations in the modulation of C-fibre nociceptor pathways, which may impact on responses to future pain or surgery.

Extremely preterm neonates also show heightened states of arousal and poor ability to modulate heart rate during recovery when an invasive procedure was preceded by routine tactile nursing procedures. Preterm infants are particularly vulnerable to the effects of repeated episodes of handling whether they are invasive or not. Holsti et al. (2007) in a

randomized study examined 43 preterm infants (19 female, 24 male) born ≤ 32 completed weeks gestational age (GA) [mean 30 weeks (range 25 to 32)].They studied sleep/wake state and heart rate (HR) responses across 3 phases of blood collection. This study showed that later born infants (≥ 30 wk GA) showed heightened facial responses indicative of sensitized responses during blood collection when it was preceded by clustered care ($P = 0.05$). Moreover, later born infants had significantly lower facial ($P = 0.05$) and HR ($P = 0.04$) reactivity during recovery when blood collection followed clustered care, indicating that pain in extremely preterm neonates evokes different responses from those of more mature neonates.

A neonate's early experience of pain experiences in the neonatal intensive care unit triggers a series of altered physiological, behavioral and hormonal responses which may lead to altered neurodevelopmental outcomes in preterm infants. The preterm neonate is hypersensitive to pain and is at even greater risk for pain because of immature mechanisms at birth to inhibit or dampen nociception (Fitzgerald & Beggs, 2001). Strong and recurring stimuli may result in the formation of abnormal synapses; once formed, these aberrant connections may remain and result in hyperactive responses to stimuli. Preterm infants exposed to 4 weeks of neonatal intensive care units have shown increased cardiovascular responses during the pain of heel prick when compared with infants born at 32 weeks (Johnston& Stevens, 1996). Differences in response patterns were correlated with the number of invasive procedures performed on the infants after birth, rather than demographic factors such as Apgar scores, birth weight, or severity of illness.

Pain response may be altered in infants born very preterm owing to repeated exposure to procedures in the neonatal intensive care unit. Grunau et al. (2010) studied the cortisol, facial behavior, and heart rate reactivity before, during, and after immunization in infants born preterm at extremely low gestational age (ELGA 24 to 28 wk), very low gestational age (VLGA 29 to 32 wk), and full-term, at corrected age 4 months and found that stress regulation seems altered in preterm male infants. As cortisol impacts development and functioning of the brain, altered stress regulation has important implications beyond pain systems.

## Guidelines for pain management in extremely preterm neonates

Guidelines and policies for pain assessment and management specify general principles and guidelines for pain management in neonates. They do not address pain management in extremely preterm neonates. Currently, no definitive guideline exists in the treatment of pain for extremely preterm neonates. The American Academy of Pediatrics (2006) provided guidelines for pain management in neonates; (preterm up to one month); these guidelines provide specific recommendations for pain management during certain procedures and different types of pain. These recommendations and guidelines and interventions to alleviate preterm infant pain have been questioned by some investigators. For example, a study conducted by Carbajal et al. (2005) found that morphine given as a loading dose followed by continuous intravenous infusions does not appear to provide adequate analgesia for the acute pain caused by invasive procedures among ventilated preterm infants, despite its routine use in the NICU.

Despite accumulating evidence that procedural pain experienced by newborn infants may have acute and even long-term detrimental effects on their subsequent behavior and neurological outcome, pain control and prevention remain controversial issues. Lago, et al. (2009).Clinical staffs differ in their opinions with regard to the current management and the optimal treatment of pain in neonates. Although most procedures in NICU are painful, pain relief measures are underutilized; pharmacological agents are rarely used except for procedures like intubation and chest tube insertion (Anderson, Greve-Isdahl & Jylli, 2007). Pain management in preterm neonates should differ from full term neonates.

According to Taddio, Shah, Gilbert-MacLeod, and Katz (2002) premature infants are more sensitive to nociceptive stimuli compared to full-term infants because immature sensory processing within the spinal cord leads to lower thresholds for excitation and sensitization, thereby potentially maximizing the central effects of tissue-damaging inputs. Effects of certain pain relief agents such as the effects of routine use of sucrose for analgesia in preterm infants have not been evaluated fully. Johnson, Fillion, Snider, Majnemer, Limperopoulos, Walker, et al. (2002) tested the use of sucrose as analgesia in 107 neonates born younger than 32 weeks and found that repeated use of sucrose analgesia may put these neonates at risk of poor neurodevelopment and physiologic outcomes. Where possible, pain management in preterm neonates should involve the use of both pharmacological and non-pharmacologic measures. In a randomized trial by Lago, Tiozzo, Boccuzzo, Allegro and Zacchello (2008) in 52 preterm neonates with a [mean gestational age 28 +2 weeks] low dose remifentanil was found to have a more measurable, synergic analgesic effect in combination with 12% sucrose and non nutritive sucking than when remifentanil was used alone.

The use of some pain medications need more caution in extremely preterm neonates. For example morphine should be used cautiously for 23- to 26-week neonates. A multicenter randomized control trial by Richard et al. (2005) show in 898 neonates that hypotension occurred more frequently with increasing morphine exposure, during the loading dose ($P$ = .0004) and in the first 24 hours of morphine infusion ($P < .0001$). The incidence of hypotension was highest among the 23- to 26-week preterm neonates ($P < .005$), despite progressively increasing morphine infusion rates. This study suggests that morphine predisposes patients to hypotension, which has other adverse effects. Therefore it should be used with caution among 23- to 26-week neonates and those with preexisting hypotension.

Opioids are commonly used as analgesics in neonatal intensive care units and have significant side effects. Morphine decreases clinical signs of pain but can cause significant adverse effects in ventilated preterm neonates. A randomized control trial of morphine with placebo conducted in 898 ventilated preterm neonates showed that intermittent boluses of open-label morphine were associated with an increased rate of the composite outcome [neonatal death, severe intraventricular haemorrhage (IVH), and periventricular leucomalacia (PVL)]. (Anand et al., 2004)

Although non-pharmacologic pain relief measures have been shown to be efficient in pain relief there is still a lack of evidence related to their efficacy after infants have been exposed to a high number of painful procedures and the accompanying chronic stress. In a multicenter pilot clinical trial completed by Cignacco (2010), 71 preterm neonates between 24 0/7 and 32 0/7 weeks of gestation were studied using an alternative approach to pharmacologic management for mild and moderate painful procedures. In this study a

combination of 3 interventions such as 25% sucrose facilitated tucking and 25% Sucrose and facilitated tucking were used in preterm infants during the first 14 days of life. This study highlights that larger studies are needed to understand the efficacy of various non-pharmacologic interventions for pain management in preterm neonates.

## Pain management in NICU

Effective management of pain in neonates requires a clear understanding of the epidemiology of pain. Carbajal et al. (2008) collected data on painful and stressful procedures and corresponding analgesic therapy in 430 neonates between the gestational ages 24 - 42 weeks during the first 14 days of their admission to NICU. The data reveals that the mean gestational age of the neonates were 33.0 weeks and these neonates experienced 60,969 first attempt procedures, with 42,413(69.6%) painful and 18,556 (30.4%) stressful procedures. This study highlights that each neonates experienced a median of 115 (range, 4-613) procedures and 16(range, 0-62) procedures per day of their hospitalization. This study found that of the 42,413 painful procedures, only 2.1% procedures were performed with pharmacological pain management, and 79.2% without any analgesia.

Surveys conducted among nurses and doctors highlight that pain management varies across different NICU's. For example, Harrison, Loughnan, and Johnston (2006) surveyed 105 neonatal intensive care units in Australia, and found that only 24% of the units used some procedural analgesics such as oral glucose for procedural pain relief. Lago et al. (2005) surveyed level II and level III NICU in Italy and found that only 25% of the units had a written protocol for acute pain management. Latimer, Johnson, Ritchie, Clarke and Gilin (2009) identify a collaborative environment as one of the strong predictors for

implementation of pain management protocols. The 93 nurses who completed the survey documented 170 pain procedures on 2 different shifts. Procedural pain management was more likely to meet the evidence-based criteria, when nurse-physician collaboration was higher (odds ratio, 1.44; 95% confidence interval 1.05-1.98).

## Summary

Extremely premature neonates are at high risk for being exposed to repeated painful procedures especially during the first 14 days of their stay in NICU. Technological and clinical practice improvements have led to increasing survival rates of premature babies, but to improve the clinical outcomes there is a critical need for accurate and efficient neonatal pain management for this highly vulnerable patient population. About one third of infants delivered at 23 weeks' gestation survived to be discharged from neonatal intensive care (McElarath, Robinson, Ecker, Ringer, & Norwitz, 2001). Procedural pain management in extremely premature neonates raises challenging questions for healthcare providers. The literature review shows that preterm neonates are extremely vulnerable to pain and its consequences, and therefore it is important to further explore the current pain management strategies in this population.

Recurrent pain routinely occurs in preterm neonates especially in extremely preterm neonates during their stay in NICU. Compared to older neonates, younger preterm infants are more vulnerable to stress than older preterm infants and are vulnerable to the consequences of pain and chronic reactivity (Lucas-Thompson et al., 2008). From the literature it is evident that innovations in the medical and technology field and standardization of care have improved survival rates for preterm neonates. Though survival rate for preterm neonates has

improved, pain management in this vulnerable population is still a major challenge for the healthcare team. Prior studies and AAP guidelines put forth recommendations for effective pain management during painful procedures in neonates, but not specifically for extremely preterm neonates. Decisions regarding pain management are therefore a decision left to the care team.

This normative case series study of the first 14 days of life in 28 extremely preterm neonates in a level III NICU will contribute additional evidence concerning the pain management in this vulnerable population.

# CHAPTER III

## Methods and procedures

### Introduction

Invasive, painful procedures are a routine aspect of the care in the NICU. From the literature review it is clear that extremely preterm neonates admitted to NICU undergo numerous painful procedures during their stay in the NICU. Pain in extremely preterm neonates is underestimated and undertreated. Pain management in NICU is one of the major aspects of quality care, because untreated pain has both short term and long term consequences on the immature brain. In this study the procedures are categorized as painful based on the ICD-10 Pain –Category G89, (ICD-10-CM Official Guidelines for Coding and Reporting, 2010). Pain management is described under pharmacological and non-pharmacologic measures. The purpose of this study is to understand the frequency and type of painful procedures and to describe both the pharmacologic and non-pharmacologic pain management strategies used in extremely preterm neonates during the first 14 days of NICU stay.

### Design

This research study implements a normative case series methodology, using descriptive, correlational analysis to understand the prevailing practices of pain management in extremely preterm neonates and then compared with the prevailing norm in healthcare that pain should be adequately controlled. The unit of analysis is a critical factor in the case study and it is typically a system of action rather than an individual or group of individuals (Tellis, 1997).

A case series is useful to look into group of similar cases to understand common Occurrences, variations and identify useful information about the phenomena under observation. A descriptive case series is an observation of phenomena in a group of subjects making the sample representative of a common population. Results of case series can generate hypotheses that are useful in designing further studies, including randomized controlled trials **(**Kooistra, Dijkman, Einhorn, & Bhandari, 2009). A descriptive case series often involves the collection and analysis of many variables. In this study the independent variables (painful procedures) are listed in (Appendix H). The 23 painful procedures are categorized in to 3 groups; highly painful, moderately painful and least painful procedures using a 10 point rating scale (Simons et al., 2003). The correlates in this study are pain management interventions listed in (Appendix I) i.e., categorized as pharmacologic and non-pharmacologic interventions. The 3 categories of procedure variables are: highly painful, moderately painful, and least painful. These categories are correlated with the pain management variables describing pharmacologic and non-pharmacologic interventions.

## Logistic Regression

Logistic regression, also called a logit model, is used to model dichotomous outcome variables. In the logit model the log odds of the outcome is modeled as a linear combination of the predictor variables.(Logit Regression, http://www.ats.ucla.edu/stat/spss/dae/logit.htm). Logistic regression was used in this study to determine the likelihood that painful procedure would be managed by either pharmacologic or non-pharmacologic interventions.

The equation that was used estimated was:

Equation: $\text{Log}\ (p/1-p) = \beta 0 + \beta 1 * x1 + \beta 2 * x2 + \beta 3 * x3$

Where:

p=the probability of pharmacologic intervention

$\beta 0$ = constant

x1 = highly painful procedures

x2 = moderately painful procedures

x3 = least painful procedures

## Setting

The setting for this study is a level III neonatal intensive care unit of a nonprofit acute care hospital in mid-Atlantic region with 336-beds. The NICU is located in close proximity to the labor and delivery department of the hospital. Each year the NICU admits approximately over 800 newborns who require care by a broad range of neonatal medical and surgical subspecialties. With 38 beds which include 2 airborne infection isolation rooms (31+ 7 flex beds) and an additional family transition room, this level III NICU is differentiated by their ability to provide care to newborn infants with differing degrees of complexity and risk.

To continually maintain the highest standard of patient care, the NICU voluntarily participates in the Vermont Oxford Network (VON), a non-profit voluntary collaboration of health care professionals dedicated to improving the quality and safety of medical care for newborn infants and their families (http://www.vtoxford.org/about/about.aspx"). As a member of a Patient Safety Center, the NICU also participates in Team STEPPS™ and Neonatal Collaborative initiative with the aim to reduce healthcare-associated infections; decrease neonatal mortality, chronic lung disease, and length of stay through standardized resuscitation and stabilization of the neonate in the first hour of life (Golden Hour); improve

teamwork and communication through the implementation of team behaviors, including the family, into neonatal care.

Equipped with the latest lifesaving technology, and monitoring devices, the NICU is staffed at all times by neonatologists, neonatal nurse practitioners, neonatal nurses, and respiratory therapists to care for the most complex and high risk conditions among newborns. The multi-disciplinary team includes board-certified occupational, physical, speech therapists, pharmacists, dietitians and social workers and board-certified lactation consultants to provide a customized plan of care for each baby and family in the NICU. The NICU promotes individualized developmental care, and kangaroo mother care, with unrestricted parental access and provides family centered care to all neonates.

## Staffing

There are total of 67 nurses in the NICU. Apart from the yearly NICU skills certifications, all NICU nurses are certified with NICU specific certifications such as Neonatal Resuscitation Program (NRP); and **s**ugar, temperature, airway, blood pressure, lab work, and emotional support (S.T.A.B.L.E). Additionally all nurses are required to attend high risk deliveries, and mock codes. Some of the nurses have additional skills and certifications including: "Registered Nurse, Certified (RNC); and International Board Certified Lactation Consultant (IBCLC).

Nurses work 12 hour shifts from 7 a.m. to 7 p.m. and from 7 p.m. to 7 a.m. The nurse- patient staffing pattern is based on acuity level. The acuity level is determined by complexity of care; and other parameters like the type of ventilator support, number of

intravenous lines, intravenous fluids, number of medication, type of investigations, labs, procedures, and surgery, etc.

Medical staff consists of neonatologists and neonatal nurse practitioners. The unit has a 24 hour in-house neonatologist and has additional back up neonatology support for transport and emergency situations.

The unit is supported by resources from throughout the hospital, which includes 24 hour support from respiratory support services, cardiologists, pediatric surgeons, neurologists, and radiologists. The unit is also compliant with the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) recommendation on pain management process. Pain is assessed routinely, when pain medication is given a follow up on the effect of pain relief is documented with a focus on patient safety.

## Subjects

The data were extracted from existing medical records. A retrospective chart data collection procedure has several advantages in this study population. Existing chart data are extremely important for researchers; they most closely resemble what is undertaken in the clinical settings. The study sample was derived from all extremely preterm neonates admitted to the NICU during 2009-2010 for a minimum period of 14 days. The sample was limited by the inclusion, exclusion criteria and study period.

## Sampling Design

Purposive sampling was done based on retrospective chart reviews of all available extremely preterm admitted to a level III NICU of the selected hospital. The data was collected from 2009-2010, until the sample size was attained.

## Sample size

Sample size was calculated using Yamane's formula and was estimated to be 28 subjects.

Yamane's formula for sample size calculation

$$n = \frac{N}{1+N\,(e)^2} = \frac{30}{1+30(.05)^2} = 27.9 = 28$$

Where "n" is the sample size, "N" is the population size, and "e" is the level of precision.

Inclusion criteria

Inclusion and exclusion criteria are defined based on prior studies to include neonates admitted to NICU with extreme prematurity.

Inclusion criteria

Gestational Age <28 weeks on admission

Admitted to NICU for a period of minimum14 days.

Exclusion criteria

Gestational Age >28 weeks on admission

Admitted to NICU for a period of <14 days

## Protection of Human Subjects

Approval was obtained from The Catholic University of America School of Nursing, the Catholic University Committee for the Protection of Human Subjects and from the Institutional Review Board of the participating institution, prior to the initiation of the study. Strict adherence to the policies of the participating institutions for the protection of human subjects and adherence to HIPPA were maintained throughout the study. Procedures were

implemented to ensure the confidentiality and security of all patient data. No identifying patient information is collected on the data collection forms. This study involved collection of data from existing records, therefore, involves minimal risk to the participants.

## Instrumentation

Demographic data, painful procedures and pain management interventions were abstracted from the medical records and entered on to the Demographic Form (Appendix F) and to the chart abstraction tool (Appendix G) which were then entered into computerized data matrix for analysis. Data was extracted to reflect gestational age, day of life, birth weight, gender, care giver, types of procedures, and type of pain management for the first 14 days of NICU stay.

Consistency of the data collection and evaluation of the quality of data abstracted underwent periodic review by comparing consistency and completeness of new data with that of already collected data. Data analysis commenced at regular case intervals of 5, 10, 20, 28, and after all data was collected.

## Data Collection Procedure

After institutional approval, a list of neonates admitted to the NICU during the period of 2009 to 2010 was obtained. An analysis of this information elucidated the patients who met the inclusion criteria of extreme prematurity. These medical records were reviewed to determine if the subject met the inclusion and exclusion criteria. If the subjects met the inclusion and exclusion criteria, data collection procedures were begun as planned in (Appendix E). Data was extracted to reflect the demographic information and the key study

variables using chart abstraction form (Appendix G). Consistency of data collection was maintained by only 1 data collector collecting the data.

All data collection procedures began primarily from the notes of the physician, neonatal nurse practitioners and neonatal nurses. Data review and reliability began after extracting information for the first 5 subjects under the guidance of the dissertation committee faculty. All data collected underwent periodic review as previously described until all data were collected.

The procedure for the research study was as follows:

1. A list of extremely preterm neonates admitted to the Neonatal Intensive Care Unit of the participating institution during 2009 to 2010 was generated from the admission register by a designated hospital staff.
2. The medical records were screened in the medical records department, which is a secure place for all the hospital medical records, and were not taken out of the medical records department or shared with any of the public.
3. Review of medical records to meet the inclusion and exclusion criteria
4. Numeric code numbers were assigned to medical records and care givers.
5. Review of medical records for data collection
6. Obtain demographic data
7. Extract procedure history
8. Extract data on pain management intervention
9. Evaluation of data began after 5 patients are enrolled in the study

10. Data Analysis begin after 5 patients are enrolled in the study

11 Evaluation of data abstraction will then commence at regular case intervals,

10, 20, 28, and after all data is collected.

12 Data analysis will commence at regular case intervals of 5, 10, 20, 28, and after all data is collected.

13. The linkage between the caregiver name and the caregiver numerical codes will be held by Medical Records Department and shredded after data collection is complete.

## Data Analysis

Data analysis was completed using SPSS 18.0 software program. Descriptive and frequency statistics were computed for all study variables, including demographic data. Then correlations, shift by shift were performed between painful procedures and pharmacologic management and likelihood of pharmacologic intervention was estimated using logistic regression analysis.

Equation for analysis:-

Equation: $\text{Log}(p/1-p) = \beta0 + \beta1*x1 + \beta2*x2 + \beta3*x3$

Where: p=the probability of pharmacologic intervention

b0 = constant

x1 = highly painful procedures

x2 = moderately painful procedures

x3 = least painful procedures

The study variables; painful procedures and pain management interventions are dichotomous variable coded as 1 for yes, if there were painful procedures and pain management interventions and 0 for no, if there were no painful procedures and no pain management interventions. Measures of association are calculated using Cramer's V Correlation Coefficient.

## Limitations

Potential limitation is minimal. The limitations to the research study are that the generalization of the study results is limited to the population sampled for the study. However, with caution the results can be applied to similar populations. The second major limitation of study was the retrospective nature of the study. Medical records possess limitations in depth, range, and scope of data collected. The data is limited to what is documented in the chart. Results of this study may not be completely generalizable because the findings may be affected by observations that were not documented. The medical records reflect the care and assessment provided, however all aspects of care provided are not always fully captured in the medical records.

## Summary

Extremely preterm neonates require prolonged stays in the NICU during which they undergo multiple painful diagnostic and therapeutic interventions. Pain management has an enormous impact on the growth and development of extremely preterm neonates. This chapter outlines the methods that were used in this study, including the protection of human subjects, the setting, the data collection and data analysis procedures.

# Chapter IV: Presentation and Analysis of the Data

## Introduction

Extremely preterm neonates admitted to the NICU experience multiple painful procedures during their stay in NICU. This study explored the type of painful procedures, and prevailing practices of pain management in extremely preterm neonates during the first 14 days of their NICU stay. Using a case series methodology this study collected data on 28 extremely preterm neonates regarding the use of pharmacologic and non-pharmacologic pain management practices during painful procedures in a level III NICU. The study uses a descriptive, correlational, quantitative design based on a normative conceptual framework.

## Data Analysis

Data were analyzed using SPSS version18.0. Descriptive statistics were used to describe the characteristics of the study population (Table-1), care giving environment (Table-2), type of painful procedure (Table-3), correlations ( Table 4& 5) and logistic regression (Table-6) Descriptive data are reported as frequencies, means and percentages.

## Sample Characteristics

A total of 725 charts were reviewed for this study and 28 met the criteria. Twenty – eight subjects were selected based on the inclusion criteria: neonates admitted to NICU with extreme prematurity, Gestational Age <28 weeks on admission; admitted to NICU for a period of a minimum of 14 days. Subjects were excluded if the gestational Age was >28 weeks on admission and admitted to NICU for a period of <14 days. Subject medical records that did not meet the inclusion criterion did not undergo further review and were excluded from the final study.

Data collected from a purposive sample of 28 extremely preterm neonates with gestational age <28 weeks and in the NICU for a minimum of 14 days is summarized in Table.1.

Table: 1

Characteristics of the study sample, n=28

| Characteristics | Number | % |
|---|---|---|
| Gender | | |
| Male | 15 | 54% |
| Female | 13 | 46% |
| Gestational Age at admission | | |
| <26 weeks | 5 | 18% |
| <28 weeks | 23 | 82% |
| Birth weight | | |
| < 750 grams | 4 | 14% |
| 750 <1000 grams | 14 | 50% |
| 1000<1250 | 10 | 36% |

Table 1 summarizes the demographic characteristics of the sample. As shown in table 1, of the total 28, 15(54%) were males, and 13(46%) were females. The gestational age of the cohort 5 (18%) were <26 weeks, 23 (82%) were <28 weeks of gestation. The birth weights within this cohort, 4 (14%) were < 750 grams, 14(50%) were 750 <1000 grams and 10(36%) were 1000<1250.

Table 2

Characteristics of the care giving environment

| Characteristics | Number |
|---|---|
| Total Number of days of care per neonate | 14 days |
| Total Number of shifts per neonate | 28 |
| Total Number of Morning shifts (7:00am- 7:00 pm) | 14 |
| Total Number of Night shifts (7:00pm- 7:00 am) | 14 |
| Number of care of care giver by type by shift per patient | |
| Nurse (individual patient assignment) | 1 |
| Physician (unit assignment) | 1 |
| Neonatal Nurse Practitioner (unit assignment) | 1 |
| Respiratory Therapist (unit assignment) | 1 |

Table 2 describes the care giving environment in the NICU; by the number of days of care, number of shifts, and number of care giver by type. In this study data on painful procedures and pain management interventions were collected on each extremely preterm neonate for the first 14 days of NICU stay. Each day is further divided into 2 shifts, a 12 hour morning shift (7:00am- 7:00 pm) and a 12 hour night shift (7:00pm- 7:00 am). Each infant is taken care by a team:  an on-site physician (neonatologist) nurse practitioner, neonatal nurse and a respiratory therapist. The care is rendered by a team approach.

Table 3

Painful procedures per shift, n=28

| | | Number and type of painful procedures by shift | | | | | |
|---|---|---|---|---|---|---|---|
| Shift | Number | Highly Painful | % | Moderately Painful | % | Least Painful | % |
| 1 | 205 | 81 | 39.51 | 91 | 44.39 | 33 | 16.09 |
| 2 | 348 | 120 | 34.48 | 175 | 50.29 | 53 | 15.23 |
| 3 | 192 | 38 | 19.80 | 123 | 64.06 | 31 | 16.14 |
| 4 | 186 | 39 | 20.96 | 118 | 63.44 | 29 | 15.59 |
| 5 | 195 | 45 | 23.07 | 119 | 61.03 | 31 | 15.89 |
| 6 | 158 | 43 | 27.22 | 88 | 55.70 | 27 | 17.09 |
| 7 | 178 | 70 | 39.33 | 84 | 47.19 | 24 | 13.48 |
| 8 | 184 | 71 | 38.59 | 89 | 48.37 | 24 | 13.04 |
| 9 | 180 | 64 | 35.56 | 90 | 50.00 | 26 | 14.44 |
| 10 | 154 | 62 | 40.26 | 69 | 44.81 | 23 | 14.94 |
| 11 | 170 | 73 | 42.94 | 74 | 43.53 | 23 | 13.53 |
| 12 | 152 | 55 | 36.18 | 75 | 49.34 | 22 | 14.47 |
| 13 | 170 | 67 | 39.41 | 81 | 47.65 | 22 | 12.94 |
| 14 | 165 | 71 | 43.03 | 72 | 43.64 | 22 | 13.33 |
| 15 | 164 | 60 | 36.59 | 83 | 50.61 | 21 | 12.80 |

*Continued*

Table 3 *(Continued)*

Painful procedures per shift, n=28

| | | Number and type of painful procedures by shift | | | | | |
|---|---|---|---|---|---|---|---|
| Shift | Number | Highly Painful | % | Moderately Painful | % | Least Painful | % |
| 16 | 157 | 54 | 34.39 | 83 | 52.86 | 20 | 12.74 |
| 17 | 145 | 47 | 32.41 | 78 | 53.79 | 20 | 13.79 |
| 18 | 132 | 47 | 35.61 | 69 | 52.27 | 16 | 12.12 |
| 19 | 142 | 52 | 36.62 | 73 | 51.41 | 17 | 11.97 |
| 20 | 131 | 41 | 31.30 | 74 | 56.49 | 16 | 12.21 |
| 21 | 127 | 32 | 25.20 | 80 | 62.99 | 15 | 11.81 |
| 22 | 127 | 41 | 32.28 | 72 | 56.69 | 14 | 11.02 |
| 23 | 111 | 31 | 27.93 | 65 | 58.56 | 15 | 13.51 |
| 24 | 114 | 39 | 34.21 | 60 | 52.63 | 15 | 13.16 |
| 25 | 104 | 28 | 26.92 | 60 | 57.69 | 16 | 15.38 |
| 26 | 102 | 25 | 24.51 | 62 | 60.78 | 15 | 14.71 |
| 27 | 107 | 35 | 32.71 | 57 | 53.27 | 15 | 14.02 |
| 28 | 123 | 51 | 41.46 | 58 | 47.15 | 14 | 11.38 |
| Total | 4,423 | 1,482 | 33.30 | 2,322 | 52.88 | 619 | 13.91 |

Table 3 presents a summary of the number of painful procedures per shift (n=28) for the 28 extremely preterm neonates in the study sample. The painful procedures are categorized as highly painful, moderately painful and least painful procedures quantified using a 10 point rating scale (Simons et al., 2003).

A total of 4,423 painful procedures were performed in 28 shifts in these extremely preterm neonates during the first 14 days of their NICU stay. Of these 4,423 painful procedures, 1482(33.30%) were highly painful, 2322(52.88%) were moderately painful, and 619(13.91%) were least painful procedures. The mean painful procedures for (n=28) were 158, with mean of 53 highly painful, 83 moderately painful and 22 least painful procedures.

Of the 28 shifts, each shift had a mean of 5.7 painful procedures. Out of these 5.7 mean painful procedures in each shift,1.9 were highly painful procedures, 3 were moderately painful procedures and 0.8 were least painful procedures. This results show that majority of the procedures (52.88%) done in extremely preterm neonates during the first 14 days of NICU stay are moderately painful procedures followed by highly painful procedures (33.30%).

Shift 1&2 represents the largest number of procedures done compared to other shifts, 205 & 348 respectively. In normal term neonates, transition to extra uterine life takes place within minutes of delivery with spontaneous breathing and adjustments in the cardiopulmonary system. Extremely preterm neonates are not capable of this transition, they require assistance with breathing and sustaining life especially in the initial period of this extra uterine adaptation. In the present study the reason for a large number of procedures especially in shift 1& 2 represents this stabilization process.

Table: 4

Shift by shift Correlation of painful procedures with pharmacologic intervention, n=28

| | Pharmacologic Intervention by shift | | |
|---|---|---|---|
| Shift | Highly Painful | Moderately Painful | Least Painful |
| 1 | _ _ | _ _ | _ _ |
| 2 | 0.855* | 0.610 | 0.245 |
| 3 | 0.801** | 0.519 | 0.096 |
| 4 | _ _ | _ _ | _ _ |
| 5 | _ _ | _ _ | _ _ |
| 6 | _ _ | _ _ | _ _ |
| 7 | 0.413 | 0.590 | 0.213 |
| 8 | _ _ | _ _ | _ _ |
| 9 | 0.855** | 0.403 | 0.466 |
| 10 | _ _ | _ _ | _ _ |
| 11 | 0.464 | 0.366 | 0.093 |
| 12 | 0.471 | 0.239 | 0.101 |
| 13 | 0.702* | 0.427 | 0.089 |
| 14 | 0.902** | 0.039* | 0.570 |
| 15 | 0.638 | 0.545 | 0.201 |
| 16 | 0.772** | 0.313 | 0.132 |
| 17 | 0.556 | 0.369 | 0.143 |
| 18 | 1.000** | 0.369 | 0.167 |
| 19 | 0.635 | 0.624 | 0.103 |
| 20 | 0.369 | 0.556 | 0.201 |
| 21 | 0.207 | 0.556 | 0.207 |
| 22 | 0.471 | 1.000** | 0.192 |
| 23 | 0.239 | 0.694* | 0.207 |
| 24 | _ _ | _ _ | _ _ |
| 25 | 0.413 | 0.280 | 0.207 |
| 26 | _ _ | _ _ | _ _ |
| 27 | _ _ | _ _ | _ _ |
| 28 | _ _ | _ _ | _ _ |

* = significant correlation at p=<.05

** = significant correlation at p=<.01

_ _ = No statistics were computed because pharmacologic intervention is a constant

Table 4 describes shift by shift correlation of painful procedures with pharmacologic interventions (n=28). Cramer's V Correlation Coefficient is used to measure the degree of relationship between painful procedures and pharmacologic intervention. Of the total 28 shifts 9 shifts (2, 3, 9,13,14,16, 18, 22 &23) had significant correlation between highly painful procedures and pharmacologic intervention. Shift 2, 13, 14 & 23 were significant at ($p<0.05$); shift 3,9,14, 16, 18 &22 were significant at ($p<0.01$).

Of the total 28 shifts, only 7 shifts (2, 3, 9, 13, 14, 16&18) had pharmacological interventions for highly painful procedures. Three shifts (14, 22 & 23) had pharmacologic intervention for moderately painful procedures. None of the 28 shifts had pharmacologic intervention for least painful procedures.

Table 5 shows shift by shift correlation of painful procedures with non-pharmacologic interventions (n=28). Cramer's V Correlation Coefficient is used to measure the degree of relationship between painful procedures and non- pharmacologic interventions. Out of 28 shifts, 16 shifts had non-pharmacologic interventions. For highly painful procedures 7 shifts had significant correlation with non-pharmacologic interventions, shift 2& 3 were significant at ($p<0.05$), shifts 14,16,18,24 & 28 were significant at ($p<0.01$)

For moderately painful procedures 5 shifts had non-pharmacologic interventions. Shift 14 & 20 were significant at ($p<0.01$). Shift 22, 24 & 28 were significant at ($p<0.05$). Of the 28 shifts 4 shifts had significant correlations with non-pharmacologic interventions. Shift 9& 27 were significant at ($p<0.05$) and shift 14 & 28 were significant at ($p<0.01$)

Table: 5

Shift by shift Correlation of painful procedures with non-pharmacologic intervention, n=28

| | Non- Pharmacologic Intervention by shift | | |
|---|---|---|---|
| Shift | Highly Painful | Moderately Painful | Least Painful |
| 1 | _ _ | _ _ | _ _ |
| 2 | 0.642 | 0.609 | 0.224 |
| 3 | 0.673* | 0.462 | 0.253 |
| 4 | 0.222 | 0.413 | 0.037 |
| 5 | 0.032* | 0.605 | 0.247 |
| 6 | 0.207 | 0.304 | 0.090 |
| 7 | 0.478 | 0.519 | 0.236 |
| 8 | 0.304 | 0.413 | 0.079 |
| 9 | 0.504 | 0.468 | 0.447* |
| 10 | 0.413 | 0.562 | 0.162 |
| 11 | 0.646 | 0.564 | 0.201 |
| 12 | 0.442 | 0.561 | 0.412 |
| 13 | 0.410 | 0.347 | 0.209 |
| 14 | 0.864** | 0.650** | 0.546** |
| 15 | 0.545 | 0.523 | 0.191 |
| 16 | 0.792** | 0.404 | 0.304 |
| 17 | 0.392 | 0.501 | 0.309 |
| 18 | 0.000** | 0.509 | 0.170 |
| 19 | 0.594 | 0.492 | 0.316 |
| 20 | 0.292 | 0.809** | 0.196 |
| 21 | 0.358 | 0.646* | 0.392 |
| 22 | 0.487 | 0.772 | 0.000 |
| 23 | 0.381 | 0.423 | 0.072 |
| 24 | 0.712** | 0.754* | 0.258 |
| 25 | 0.254 | 0.364 | 0.175 |
| 26 | 0.300 | 0.642 | 0.322 |
| 27 | 0.577 | 0.572 | 0.461** |
| 28 | 0.697** | 0.727* | 0.712** |

* = significant correlation at p=<.05.

** = significant correlation at p=<.01

_ _ = No statistics were computed because non-pharmacologic intervention is a constant

Table 6

Logistic Regression

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Highly painful Procedures | .311 | .068 | 20.812 | 1 | .000 | 1.365 |
| Moderately Painful | -.017 | .092 | .034 | 1 | .855 | .983 |
| Least Painful | -.178 | .296 | .364 | 1 | .546 | 837 |
| Constant | -3.526 | .300 | 138.122 | 1 | .000 | .029 |

Table 6, the logistic regression table describes the aggregate measure of the likelihood of having a pharmacologic intervention given the following independent variables: highly painful procedures, moderately painful procedures, and least painful procedures + a constant.

$\text{Log } (p/1-p) = \beta 0 + \beta 1 * x1 + \beta 2 * x2 + \beta 3 * x3$

Where:

p=the probability of pharmacologic intervention

$\beta 0$ = constant

x1 = highly painful procedures

x2 = moderately painful procedures

x3 = least painful procedures

## Logistic regression results

In terms of the variables used in this equation

Log (p/1-p) = -3.561 + .311 * highly painful + -.017*moderately painful + -.178 least painful

Logistic regression assumes that the outcome variable is binary (i.e., coded as 0 and 1). In the case of moderately painful and least painful the coefficients are not significantly different from zero, therefore it cannot be assumed that there is any significant effect on pharmacologic intervention given the presence of moderately or least painful procedures. However there is a significant increase in the log odds of a pharmacologic intervention if a highly painful procedure occurs. If a highly painful procedure occurs there is a 1.3 increase in the probability of a pharmacologic intervention.

## Generalizability

Generalizability of the current study is limited by the small sample size. The study describes the existing situation in the NICU.

## Summary

In conclusion, the data provides an informative summary about the nature of painful procedures and the type of pain relieving interventions undertaken currently in the NICU for managing procedural pain in extremely preterm neonates. The data provides insight into current practice. Understanding what is happening in the clinical setting with pain management in extremely preterm neonates can suggest modifications of care patterns to align more closely to normative practices of pain management. The conceptual framework of this study is based on normative theory; therefore, the categories of interactions observed this study have clinical relevance and can lead to important recommendations and further studies.

# Chapter V

## Findings and Discussion

This chapter discusses the study findings regarding current pain management practices in extremely preterm neonates in a level III NICU. Pain controls in these extremely preterm neonates are less than optimal and problematic especially during the first 14 days of life. Data were collected on painful procedures and aspects relating to utilization of pharmacologic and non –pharmacologic pain relief interventions specifically linked to painful procedures. The analysis of results is presented in the context of the literature described in Chapter II and the results obtained in Chapter IV which presents significant findings with regard to pain management in extremely preterm neonates. The major findings of this study are supported by the evidence collected and indicate that improvements could be made in both pharmacologic and non-pharmacologic pain management interventions in extremely preterm neonates.

## Findings

Most painful procedures in this study were performed without any analgesia. There was minimal use of pharmacologic pain medications. In fact, pharmacologic pain medication was used only during the insertion of peripherally inserted central catheter (PICC). In this study a total of 4,423 painful procedures were performed and 1482 (33.30%) were highly painful procedures. But pharmacologic pain medication was given specifically only 40 times revealing that only 2.7% of the highly painful procedures received specific pharmacologic pain relief. The highly painful procedure was PICC line insertion and specific pharmacologic agent used was fentanyl.

A previous study by Carbajal, et al, (2008) in 430 neonates between the gestational ages 24 - 42 weeks during the first 14 days of their admission to NICU, reports that only 2.1% of the procedures were performed with pharmacological pain management. The present study has a similar finding, only 2.7% received pharmacologic intervention for painful procedures in this study. Prior research show that the most common painful procedures performed in preterm neonates during the first 14 days of NICU stay are heel sticks and suctioning. The results of the present study also show that heel sticks and suctioning were the most common painful procedures done in extremely preterm neonates during the first 14 days of NICU stay and confirm the findings of earlier studies.

Table 4 and 5 that show the shift by shift correlation of painful procedures with pharmacologic and non-pharmacologic interventions. All correlation calculations depend on variance for the computation of the correlation coefficient. No values were calculated in cells that represent shifts with no variance (n= 28) that is, for shifts where no pain medications were administered for any study subject (the pharmacologic interventions were therefore a constant). In this case, the correlation formula Cramer's V cannot be calculated because there is no variance in one or more of the parameters.

## Painful procedures

In this study, a total of 4,423 painful procedures were performed in these extremely preterm neonates during the first 14 days of their NICU stay. Of these 4,423 painful procedures, 1482(33.30%) were highly painful, 2322(52.88 %) were moderately painful, and 619(13.91 %) were the least painful procedures. The mean painful procedures for (n=28)

were 158, with mean of 53 highly painful, 83 moderately painful and 22 least painful procedures.

Endotracheal intubation is one of the frequently performed painful procedures in the NICU. This procedure has potential adverse changes such: as laryngospasm, hemodynamic changes, rise in intracranial pressure, and risk of hemorrhage and airway injury. These adverse changes can be attenuated by using premedication with analgesic, sedative and muscle-relaxant drugs (Lago, 2010). In this study, 48 intubations were performed; however none of the subjects were pre-medicated for intubations. A study by Feltman, Weiss, Nicoski and Sinacore (2011) reports rocuronium as an effective premedication for non-emergent intubation in preterm neonates. Thirty-five percent (7) of intubations in rocuronium group vs. 8% (2) of controls were successful on first attempt ($P$=0.057). In a survey conducted in UK by Lago (2010), 90% of tertiary neonatal units reported the routine use of sedation prior to intubation with a combination of atropine plus an opioid (morphine or fentanyl), while 82% of such units routinely use a muscle-relaxant.

In this study there were 3 chest drain insertions, which are highly painful procedures (Anderson et al., 2007) and none of them was accompanied by any pain reliving interventions. According to the AAP (2006) guidelines[1] for reducing pain from other major procedures; analgesia for chest-drain insertion comprises all of the following: general non-pharmacologic measures; slow infiltration of the skin site with a local anesthetic before

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[1] See pain management guidelines from the American Academy of Pediatrics: Committee on Fetus and Newborn and Section on Surgery, Canadian Pediatric Society and Fetus and Newborn Committee. (2006). Prevention and management of pain in the neonate: An Update. *Pediatrics, 108*(5), 2231-2241. Doi:10.1542/peds.2006-2277.

incision unless there is life-threatening instability. Insertion of chest drains are considered to be an emergency procedure in extremely preterm neonates: but the AAP (2006) further highlights that if there was inadequate time to infiltrate before insertion of the chest tube, local skin infiltration after achieving stability may reduce later pain responses and later analgesic requirements. Additionally the AAP suggests systemic analgesia with a rapidly acting opiate such as fentanyl. Analgesia for chest-drain removal comprises the following: general non-pharmacologic measures and short-acting, rapid-onset systemic analgesic. But none of the 3 chest drain insertions and removal in this study was accompanied by any pain relief measures.

Throughout the study findings it is apparent that no pain medications were used for procedures other than PICC line insertion. There were a total of 8 lumbar punctures in this study, lumbar puncture is a non-emergency highly painful procedure (Anderson et al., 2007) and none of these were accompanied by any pain reliving interventions.

## Prematurity

Gestational age is a crucial factor in the care of extremely preterm neonates and one of the issues in caring for the extremely preterm neonates is the fragility of these individuals. In patients with very low gestational age the acuity and the complexity of care increase proportionately. The literature shows that extremely preterm neonates are different and very fragile, and are particularly vulnerable to the effects of repeated episodes of handling whether they are invasive or not (Holsti et al., 2007). Along with the issue of providing intensive care for extremely preterm neonates, one of the crucial challenges for the NICU team is providing appropriate pain management during the care process given the fragility of the patient.

Premature birth is a crisis and creates unique challenges in case management for all health care providers. Preterm infants' behavior is also affected by their underlying physiologic status. Extremely premature neonates are often very unstable with compromised physiology and immature organ systems. A major challenge the caregivers face is the dilemma of extreme fragility and the need to support life versus the need to control pain. The uncertainty the caregivers feel is reflected in this care dilemma. The care givers are pulled in two directions as they seek to sustain life as well as trying to provide interventions to control pain. There are also difficulties in choosing the right type of pain medication for pain in extremely preterm neonates. Dose requirements vary based on the gestational age. The care givers are not certain about the efficacy of certain pain medications and therefore are not comfortable with providing pharmacologic interventions. In addition, the side effects of some pain medications are not well understood. For this reason many care givers may choose to err on the safe side by not medicating for pain.

## Pharmacologic interventions

Gestational age plays a large part in treatment decisions in NICU, similarly there may be some other reasons for not using pharmacologic pain medications in extremely preterm neonates. Reasons for not using pain medications for the extremely preterm neonates in this study may be attributed to the care givers concern for potential unwanted side effects such as hypotension, inadequate time for administration of medications such as in emergency situations like resuscitations. Finally there may be also a care giver perception of greater risk than benefit in the use of pain medications in extremely preterm neonates.

In this study analgesic therapy specifically for painful procedures was focused on PICC line insertion. Procedure specific analgesia (fentanyl) was given to all peripherally inserted central catheterization (PICC). This is the reason that multivariate analysis indicated a significant increase in the likelihood of receiving pharmacologic intervention in the case of highly painful procedures such as PICC lines, while showing no likelihood of pharmacologic intervention for moderately or least painful procedures.

## Type of pharmacologic pain medications

NICU's use medication based on gestational age, acuity, type of painful procedures and the unit protocol. Pharmacologic agents were used infrequently in this study setting. When used, the pharmacologic intervention was generally fentanyl. On two occasions midazolam was used in combination with fentanyl for PICC line insertion.

## Non-pharmacologic interventions

The fragile nature, acuity and frequent medical interventions of the extremely pre-term neonate may prevent the healthcare team from using some of the indicated non-pharmacologic interventions. This is true because the neonate has to be medically stable for interventions like non-nutritive sucking, sweet solutions, skin–skin contact, and breastfeeding analgesia, sucrose, massage, and kangaroo care particularly in these medically complex, highly acute infants.

The non –pharmacologic interventions in this study included nonnutritive sucking, swaddling, nesting, containment, kangaroo care (skin-to-skin contact). These interventions were not procedure-specific in this study. Facilitated tucking and swaddling was one of the consistent non-pharmacologic pain relief measures provided in this level III NICU. This level

III NICU did not use any sucrose/sweet solutions as non-pharmacologic pain relief measures in extremely preterm neonates.

## Implications for practice

The complexity and acuity of these extremely preterm neonates create tremendous challenges for the clinical practice. The implications for pain management are clearly grounded in the significance section of Chapter I and the results presented in Chapter IV. Using a normative conceptual framework the implications for practice are expressed in terms of current findings in the study, available literature and tangible improvements with regard to development of unit wise protocols and guidelines for pain management for this vulnerable patient population.

In the unit selected for this study there were written pain management guidelines for PICC insertion, therefore all the neonates who underwent PICC insertion received pain medication in the form of fentanyl. This confirms the findings of Gharavi et al. (2007) that units with written guidelines for pain management, pain assessment and documentation performed better on use of opioid analgesics and sucrose solution. This finding highlights the need to develop specific practice guidelines and protocols regarding procedural pain management for each painful procedure in the extremely preterm neonates since such guidelines remove caregiver uncertainty and assure some level of pain management for this vulnerable population.

One of the crucial questions here is how clinical practice can be improved for this patient group. The results of this study suggest that significant improvements in pain

management are possible with a normative approach provided that neonatal intensive care units have consistent resources and pain management protocols and policies.

## Additional findings

The findings of this study suggest that repeated procedural attempts were made with one dose of pain medication. In this study there were 50 PICC insertions, but pharmacologic interventions were provided on 40 occasions. This suggests that Multiple PICC line insertions were attempted with one dose of fentanyl. Prior research shows that preterm neonates undergo approximately 10 to 15 painful procedures per day during their first two days of life. This study shows that extremely preterm neonates underwent 8 procedures per day during the first 2 days of NICU stay. Carbajal et al., (2008) reported that some neonates experienced as many as 62 procedures per day. In this study the maximum number of painful procedures reported per day on an extremely preterm neonate was 41 painful procedures. Barker and Rutter (1995) in their study recorded that an extremely preterm neonate was exposed to 500 painful procedures, in this study the highest number of painful procedures an extremely preterm neonate was exposed is 271 painful procedures.

## Study limitations

Pain management decisions in extremely preterm neonates are determined by a number of factors, such as gestational age, physiological stability, acuity of illness, type of interventions, unit protocol and the care team. Factors like physiological stability and acuity of illness were not evaluated in this study. The second limitation is the accuracy and adequacy of documented data, since the study used retrospective data collection method, completeness of documentation is questionable. The findings were not compared to any

existing data base, because no exclusive data on pain management in extremely preterm neonates were available for comparison. This study used a small sample size; therefore generalization has to be made to similar population with much caution.

## Recommendations for future research

Further studies are required to delineate issues in pain management in extremely preterm neonates (between gestational ages 23- 28 weeks). The literature shows substantial variations in the use of pharmacologic pain management across various NICUs. Therefore additional research is needed to understand the reasons for this variation in practice. Future studies should cover areas of lack of evidence in terms of safety and efficacy of pharmacologic and non-pharmacologic pain relief measures in extremely preterm neonates. Additional studies are needed to evaluate the feasibility, safety and efficacy of non – pharmacologic interventions like use of sucrose or massage in extremely preterm neonates. NICU care is a team based approach and in this study some teams appear to be providing more pain relief measures than other teams. Therefore the team composition and decision-making practices also need closer examination.

This level III NICU monitors the type of pain medication used, number of pain medications given to each neonate in the unit, the dose of pain medications, and documentations on post medication pain relief effectiveness. From this study it is evident that additional thought in the form of further research is needed to understand how and what pharmacological and non-pharmacological pain relief can be applied for other painful procedures.

The data show that some shifts correlate with pain medications and other do not, one of the underlying factors may be the care team assigned during the shift. Therefore, an interesting analysis for the future is to look at the team members working on the shifts where no infants were medicated to see if there was any consistency in personnel or other reasons why no pain medications were used during these shifts.

## Conclusion

Pain and its management are of crucial importance to all concerned with the care of extremely preterm neonates but it is a constant struggle to provide the right kind of procedural pain relief in extremely preterm neonates. Although much has been achieved in the past few decades, this study adds to our understanding of the current pain management practices in extremely preterm neonates and the results highlight that there remains much more to be learned to achieve adequate pain management in this population.

The findings show that adequate pain management was often not provided to these extremely preterm neonates during painful procedures. In the NICU context, especially in absence of the parents, nurses play a vital role where care decisions are concerned and nurses act as advocates for this vulnerable population. Nurses are constantly at the bedside providing care, assessing, and documenting pain levels. Pain management decisions in the NICU are mostly nurse driven; therefore, pain management becomes an advocacy issue. Prevention of pain in extremely preterm neonate is a standard and failing to meet the standard raises ethical concerns.

The normative conceptual framework used in this study highlights that the current pain management scenario in this vulnerable population is suboptimal and should not be the

norm in this population. Some of the reasons for this less-than-optimal pain management could be that the caregivers are uncertain about the use of some pain reliving interventions, especially pain medications, due to the potential side effects. Some of these uncertainties can be reduced by drawing attention to conducting further research and developing guidelines and policies for creating an optimal standard for pain management in this vulnerable population. Such evidence would remove some of the uncertainty caregivers have about managing pain, and result in less fear about using pain management interventions in this population. Care in this NICU involves a team based collaborative approach. The normative conceptual framework of this study suggests that at the unit level a clear collaborative interdisciplinary approach based on protocols for pain management should be in place. At the organizational level, policies should exist that mandate updated pain assessment tools and an ongoing commitment to supporting the care environment with the best possible evidence to achieve the goal of optimal management with minimal suffering.

# APPENDIX A

## Sample size determination formula

Yamane's formula for sample size calculation

$$n = \frac{N}{1+N\,(e)^2} = \frac{30}{1+30(.05)^2} = 27.9 = 28$$

Yamane's formula and was estimated to be 28 subjects.

Where "n" is the sample size, "N" is the population size, and "e" is the level of precision.

APPENDIX B

Inclusion and Exclusion Study Criteria

Inclusion Criteria

———— Gestational Age <28 weeks on admission

———— Admitted to NICU

Exclusion Criteria

———— Gestational Age >28 weeks on admission

———— Admitted to NICU for <14 days

APPENDIX C

Data collection protocol

1. A list of extremely preterm neonates admitted to the Neonatal Intensive Care Unit of the participating institution during 2009 to 2010 was generated from the admission register by a designated hospital staff.
2. The medical records were screened in the medical records department, which is a secure place for all the hospital medical records, and were not taken out of the medical records department or shared with any of the public.
3. Review of medical records to meet the inclusion and exclusion criteria
4. Numeric code numbers were assigned to medical records and care givers.
5. Review of medical records for data collection
6. Obtain demographic data
7. Extract procedure history
8. Extract data on pain management intervention
9. Evaluation of data began after 5 patients are enrolled in the study
10. Data Analysis begin after 5 patients are enrolled in the study
11 Evaluation of data abstraction will then commence at regular case intervals, 10, 20, 28, and after all data is collected.
12 Data analysis will commence at regular case intervals of 5, 10, 20, 28, and after all data is collected.
13. The linkage between the caregiver name and the caregiver numerical codes will be held by Medical Records Department and shredded after data collection is complete.

APPENDIX D

Demographic form

| | |
|---|---|
| Day of life | _____ |
| Gestational age on admission | Weeks ____ Days ____ |
| Birth weight | _____ Grams |
| Gender | 1=male; 2=female |

APPENDIX E

Chart abstraction form

Date: (of data collection)

Time period I: 7:00am-7:00 pm ☐

Time period II: 7:00pm-7:00 am ☐

Chart Code Number _____

Care giver (RN) Code Number _____

Physician Code Number _____

Neonatal Nurse Practitioner Code Number _____

Day of life _____

Gestational age Weeks ____ Days ____

Birth weight _____ Grams

Gender 1=male; 2=female

Procedures:

Intubation ___ Number of times performed; 99=missing

Ventilation ___ Number of times performed; 99=missing

Endotracheal suctioning ___ Number of times performed; 99=missing

Nasopharyngeal Suctioning ___ Number of times performed; 99=missing

Venipuncture ___ Number of times performed; 99=missing

Heelstick ___ Number of times performed; 99=missing

Intra Muscular Injections ___ Number of times performed; 99=missing

Eye Examination ___ Number of times performed; 99=missing

NCPAP —— Number of times performed; 99=missing

Insertion Umbilical Venous Line —— Number of times performed; 99=missing

Insertion Umbilical Arterial Line —— Number of times performed; 99=missing

Insertion Peripheral Arterial Line —— Number of times performed; 99=missing

Insertion Percutaneous central line —— Number of times performed; 99=missing

Insertion Chest Tube —— Number of times performed; 99=missing

Needle Aspiration —— Number of times performed; 99=missing

Lumbar puncture —— Number of times performed; 99=missing

Broviac Line Insertion —— Number of times performed; 99=missing

Insertion Urinary Catheter —— Number of times performed; 99=missing

Extubation —— Number of times performed; 99=missing

Removal Peripheral Lines —— Number of times performed; 99=missing

Removal of Central Line —— Number of times performed; 99=missing

Removal chest tube —— Number of times performed; 99=missing

Dressing change —— Number of times performed; 99=missing

Other Name of the procedure ————————

Pain Assessment 1=yes; 0=no, 99=missing

Pain Relief Measures

Pharmacologic 1=yes; 0=no, 99=missing

Fentanyl 1=yes; 0=no, 99=missing

Morphine 1=yes; 0=no, 99=missing

Midazolam 1=yes; 0=no, 99=missing

| | |
|---|---|
| Other | Name of the drug ———— |
| Non Pharmacologic & Behavioral | |
| Sucrose | 1=yes; 0=no, 99=missing |
| Pacifier | 1=yes; 0=no, 99=missing |
| Kangaroo Care | 1=yes; 0=no, 99=missing |
| Swaddling | 1=yes; 0=no, 99=missing |
| Other | Name of the intervention ———— |

APPENDIX F

Painful procedures

| | |
|---|---|
| Intubation+++ | —— Number of times performed; 99=missing |
| Ventilation+ | —— Number of times performed; 99=missing |
| Endotracheal suctioning++ | —— Number of times performed; 99=missing |
| Nasopharyngeal Suctioning++ | —— Number of times performed; 99=missing |
| Venipuncture+++ | —— Number of times performed; 99=missing |
| Heelstick+++ | —— Number of times performed; 99=missing |
| Intra Muscular Injections+++ | —— Number of times performed; 99=missing |
| Eye Examination+ | —— Number of times performed; 99=missing |
| NCPAP+ | —— Number of times performed; 99=missing |
| Insertion Umbilical Venous Line++ | —— Number of times performed; 99=missing |
| Insertion Umbilical Arterial Line++ | —— Number of times performed; 99=missing |
| Insertion Peripheral Arterial Line+++ | —— Number of times performed; 99=missing |
| Insertion Percutaneous central line+++ | —— Number of times performed; 99=missing |
| Insertion Chest Tube+++ | —— Number of times performed; 99=missing |
| Needle Aspiration+++ | —— Number of times performed; 99=missing |
| Lumbar puncture+++ | —— Number of times performed; 99=missing |
| Broviac Line Insertion +++ | —— Number of times performed; 99=missing |
| Insertion Urinary Catheter++ | —— Number of times performed; 99=missing |
| Extubation++ | —— Number of times performed; 99=missing |
| Removal Peripheral Lines++ | —— Number of times performed; 99=missing |
| Removal of Central Line++ | —— Number of times performed; 99=missing |
| Removal chest tube++ | —— Number of times performed; 99=missing |
| Dressing change++ | —— Number of times performed; 99=missing |

+++ = Highly painful procedures
++ = Moderately painful procedures
+ = Least painful procedures
(Quantified using a 10 point rating scale. Simons et al., 2003).

APPENDIX G

Pain Relief Measures

| | |
|---|---|
| Pharmacologic | 1=yes; 0=no, 99=missing |
| Fentanyl | 1=yes; 0=no, 99=missing |
| Morphine | 1=yes; 0=no, 99=missing |
| Midazolam | 1=yes; 0=no, 99=missing |
| Other | Name of the drug _____ |
| Non-Pharmacologic & Behavioral | |
| Sucrose | 1=yes; 0=no, 99=missing |
| Pacifier | 1=yes; 0=no, 99=missing |
| Kangaroo Care | 1=yes; 0=no, 99=missing |
| Swaddling | 1=yes; 0=no, 99=missing |
| Other | Name of the intervention _____ |

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