



University of Kentucky
UKnowledge

Theses and Dissertations--Nursing

College of Nursing

2013

Barriers to Effective Pain Management in Preterm and Critically Ill Neonates

Sharon W. Lake

University of Kentucky, sharon.lake@uky.edu

[Right click to open a feedback form in a new tab to let us know how this document benefits you.](#)

Recommended Citation

Lake, Sharon W., "Barriers to Effective Pain Management in Preterm and Critically Ill Neonates" (2013).
Theses and Dissertations--Nursing. 7.
https://uknowledge.uky.edu/nursing_etds/7

This Doctoral Dissertation is brought to you for free and open access by the College of Nursing at UKnowledge. It has been accepted for inclusion in Theses and Dissertations--Nursing by an authorized administrator of UKnowledge. For more information, please contact UKnowledge@lsv.uky.edu.

STUDENT AGREEMENT:

I represent that my thesis or dissertation and abstract are my original work. Proper attribution has been given to all outside sources. I understand that I am solely responsible for obtaining any needed copyright permissions. I have obtained and attached hereto needed written permission statements(s) from the owner(s) of each third-party copyrighted matter to be included in my work, allowing electronic distribution (if such use is not permitted by the fair use doctrine).

I hereby grant to The University of Kentucky and its agents the non-exclusive license to archive and make accessible my work in whole or in part in all forms of media, now or hereafter known. I agree that the document mentioned above may be made available immediately for worldwide access unless a preapproved embargo applies.

I retain all other ownership rights to the copyright of my work. I also retain the right to use in future works (such as articles or books) all or part of my work. I understand that I am free to register the copyright to my work.

REVIEW, APPROVAL AND ACCEPTANCE

The document mentioned above has been reviewed and accepted by the student's advisor, on behalf of the advisory committee, and by the Director of Graduate Studies (DGS), on behalf of the program; we verify that this is the final, approved version of the student's dissertation including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Sharon W. Lake, Student

Dorothy Y. Brockopp, PhD, RN, Major Professor

Terrie Lennie, PhD, RN, Director of Graduate Studies

BARRIERS TO EFFECTIVE PAIN MANAGEMENT IN PRETERM AND
CRITICALLY ILL NEONATES

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Nursing
at the University of Kentucky

By
Sharon Wells Lake

Lexington, Kentucky

Director: Dr. Dorothy Y. Brockopp

Lexington, Kentucky

2013

Copyright © Sharon Wells Lake 2013

ABSTRACT OF DISSERTATION

BARRIERS TO EFFECTIVE PAIN MANAGEMENT IN PRETERM AND CRITICALLY ILL NEONATES

The purpose of this dissertation is to explore potential barriers nurses experience in providing effective pain management for preterm and critically ill infants in neonatal intensive care units (NICUs). The specific aims of the study conducted are to examine (a) NICU caregivers' knowledge about pain, (b) scales used to evaluate pain in infants, (c) NICU nurses' documented pain practices, and (d) bias in treating pain of certain types of infants.

This dissertation is comprised of three manuscripts. The first manuscript is an integrated review of the literature describing caregiver knowledge, barriers, and bias in the management of pain in neonates. The second manuscript is a systematic review of multidimensional pain scales developed for use in preterm and critically ill infants. The final manuscript reports a descriptive exploratory study designed to examine nurses' knowledge of pain, knowledge of intensity and appropriate management of procedural pain, bias in treating pain of certain types of infants, and documented pain management practices.

Over the past 25 years, caregiver knowledge of pain in preterm and critically ill infants has advanced from beliefs that neonates do not feel pain, to the knowledge that preterm infants experience more pain than term infants, older children, and adults. Nine multidimensional pain scales with varying levels of reliability and validity have been developed, yet a gold standard for pain assessment in preterm and critically ill neonates has not emerged. In this study, baccalaureate prepared nurses (BSN) and nurses with higher total years of nursing experience had better knowledge of pain in this population than associate degree nurses (ADN). However, pain management was inconsistent, resulting in pain that was untreated as often as 80% of the time. Nurses reported that physician practice was the primary obstacle to providing effective pain management. Additional concerns included knowledge deficits of nurses and physicians, lack of communication and teamwork, and rushed care. Nurses reported biases in managing pain and were less likely to invest time and energy treating the pain of infants experiencing neonatal abstinence syndrome.

KEYWORDS: pain management, nurses' knowledge, barriers, neonates, bias

Sharon Wells Lake

Student's Signature

February 18, 2013

Date

BARRIERS TO EFFECTIVE PAIN MANAGEMENT IN PRETERM AND
CRITICALLY ILL NEONATES

By

Sharon Wells Lake

Dorothy Y. Brockopp, PhD, RN

Director of Dissertation

Terry Lennie, PhD, RN

Director of Graduate Studies

February 18, 2013

*This dissertation is dedicated to my children,
Andrew Wilson Lake,
Allison Rebecca Lake,
and Emily Katherine Lake,
whose encouraging words, “It’ll be ok Mom, just do your best”,
got me through to the end.*

ACKNOWLEDGMENTS

Although an individual work, this dissertation benefitted from the insights and direction of several individuals. First, I would like to acknowledge my committee: Dr. Dorothy Y. Brockopp, Dr. Sherry Warden, Dr. Kristin Ashford, and Dr. John Wilson. You provided guidance, wisdom, focus, encouragement, and a voice of reason at every juncture. I would also like to thank Dr. Julia Costich for agreeing to be my external examiner and provide an objective assessment of this dissertation.

I would like to acknowledge the contributions of my family and friends. Without their love and support, I could not have been successful. My parents, Becky and Doug Wells, instilled in me the love of learning and the belief that I can accomplish anything on which I set my mind and heart. The unwavering encouragement from my dear friend, Pinar Menguc, gave me the confidence to take that first step.

And finally, I am most thankful for the support of my children, Drew, Alli, and Emily. Without your love and understanding, this journey could not have been completed. I am confident the time we spent at the kitchen table doing our homework as a family has set the stage for your lifelong learning.

TABLE OF CONTENTS

ACKNOWLEDGMENTS	iii
LIST OF TABLES	vi
LIST OF FIGURES	vii
CHAPTER ONE Overview of Chapters One, Two, Three, Four, and Five	1
Introduction.....	2
Purpose.....	4
CHAPTER TWO	5
Introduction.....	5
Purpose.....	6
Method	6
Results.....	7
Caregiver Knowledge of Pain in the 1980s	7
Caregiver Knowledge of Pain in the 1990s	7
Caregiver Knowledge of Pain in the 2000s	8
Conclusion	10
CHAPTER THREE	19
Introduction.....	19
Purpose.....	20
Method	20
Results.....	21
Neonatal Infant Pain Scale (NIPS)	21
Pain Assessment Tool (PAT).....	22
Crying, Requires Increased Oxygen Administration, Increased Vital Signs, Expression, and Sleeplessness (CRIES) Scale.....	23
Premature Infant Pain Profile (PIPP)	24
Scale for Use in Neonates (SUN)	25
Pain Assessment in Neonates (PAIN).....	26
Bernese Pain Scale for Neonates (BPSN).....	28
Neonatal Pain, Agitation and Sedation Scale (N-PASS)	29
Crying, Oxygen Requirement, Vital Signs, Expression, Resting, Signaling Distress, (COVERS) Neonatal Pain Scale.....	30
Discussion	31
Conclusion	33
CHAPTER FOUR.....	37
Introduction.....	37
Background	38
Methods.....	40
Design	40
Setting and Sample	41

Measures	41
Neonatal Intensive Care Pain Questionnaire	41
Chart Review	42
Data Analysis	43
Results.....	43
Demographics	43
Knowledge of Neonatal Pain Subscale	44
Pain Intensity and Intervention Subscale	45
Intervention for Procedural Pain.....	46
Bias in Managing Pain Subscale.....	46
Bias in Managing Pain Based on Gender and Gestational Age	47
Self-Reported Barriers to Pain Management	47
Discussion	48
Knowledge Barrier.....	48
Practice Barrier	50
Bias Barrier	50
Self-Reported Barriers	50
Study Limitations.....	51
Conclusion and Recommendation for Future Study	51
 CHAPTER FIVE Conclusions and Discussions.....	 62
References.....	66
Vita.....	88

LIST OF TABLES

Table 2.1	Caregiver Knowledge of Pain in Preterm and Critically Ill Neonates.....	11
Table 3.1	Multidimensional Pain Scales.....	34
Table 4.1	Demographic Characteristics of Nurses.....	53
Table 4.2	Knowledge of Neonatal Pain Subscale	54
Table 4.3	Pain Intensity and Interventions Subscale with Documented Interventions	55
Table 4.4	Bias in Managing Pain Subscale: Ratings of time and energy willing to spend managing pain	57
Table 4.5	Self – Reported Barriers to Pain Management Subscale: Themes and Examples	58

LIST OF FIGURES

Figure 4.1	Total Knowledge Score by Nursing Degree	59
Figure 4.2	Total Knowledge Score by Years' Experience	60
Figure 4.3	Range of Total Bias Scores.....	61

CHAPTER ONE

Overview of Chapters One, Two, Three, Four, and Five

An overview and rationale for the concepts for this dissertation are included in Chapter One. Pain is defined and the importance of pain management and a consistent scale for pain assessment in preterm and critically ill neonates is discussed. The purpose and specific aims guiding this work are presented.

Chapter Two is an integrated review of the literature that critically analyzes and synthesizes caregivers' knowledge, barriers, and bias in the management of pain in preterm and critically ill neonates. The evolution of knowledge about neonatal pain, pain management, and perceived barriers are discussed. Bias in the management of neonatal pain was identified as a gap in the literature. Future directions for research are discussed.

More than 40 pain assessment scales exist, yet a gold standard for pain assessment in preterm and critically ill neonates has not emerged. Failure to use a scale that appropriately evaluates pain based on patient type and condition may present a barrier to effective pain management. Chapter Three is a systematic review of multidimensional pain scales validated for use in preterm neonates. The psychometric properties of each scale along with their strengths and limitations are presented.

While nurses know that preterm and critically ill neonates experience more pain than do older children and adults, a disconnect between knowledge and action continues to prevail. As a result, pain continues to be undertreated. The presence of bias in treating pain in preterm and critically ill neonates is evaluated for the first time in this population. The results of a descriptive exploratory study to evaluate nurses' knowledge of pain, bias

in treating pain of certain types of infants, and perceived barriers to effective pain management are discussed in Chapter Four.

Chapter Five is a summary of the findings in chapters one through four. An analysis of the evolution of knowledge, beliefs, and actual practice of pain management is presented. Directions for future exploration are discussed.

Introduction

Significant advancements in medical management and technology have consistently lowered the threshold of viability for infants born prematurely. The result for preterm infants is protracted exposure to life sustaining medical interventions including painful, invasive procedures (Anand et al., 2006; Anderson, Greve-Isdahl, & Jylli, 2007). Neonatal pain management and pain assessment have been a focus of attention during the past 25 years. Nursing and medical knowledge regarding pain in preterm infants has grown considerably. Research has revealed that even infants born extremely prematurely have the ability to experience and feel pain (Ahn & Jun, 2007; Simons & Tibboel, 2006). Fetuses as early as 20 weeks gestation have ascending pathways for nociception to occur (Anand & Carr, 1989; Evans, 2001; Simons & Tibboel, 2006). However, it is not until 32 weeks gestation or later that the descending pathways necessary to block incoming pain impulses are developed (Anand & Carr, 1989; Evans, 2001; Simons & Tibboel, 2006).

Repetitive and prolonged pain experiences interfere with normal growth and development during the infant's hospitalization and have implications for permanent changes in long-term neurodevelopment (Abdulkader, Freer, Garry, Fleetwood-Walker, & McIntosh, 2008; Anand et al., 2006; Hermann, Hohmeister, Demirakca, Zohsel, &

Flor, 2006). Although caregivers know that pain exists in this population (Anand et al., 2006; Anderson et al., 2007) research has supported that pain continues to be undertreated up to 65% of the time (Ranger, Johnston, & Anand, 2007; Simons & Tibboel, 2006). An infant requiring neonatal intensive care may be exposed to as many as 12 to 16 invasive, painful procedures each day (Anand et al., 2006; Carbajal et al., 2008; Simons & Tibboel, 2006). Therefore, the smallest and most preterm infants are at the greatest risk for adverse outcomes (Anand et al., 2006; Bouza, 2009; Brummelte et al., 2012; Carbajal et al., 2008; Lucas-Thompson et al., 2008).

Pain, as defined by the International Association for the Study of Pain (2001), is “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage” (IASP Newsletter, p. 250). Pain in the neonatal intensive care unit can be categorized as acute procedural pain, acute prolonged pain, or chronic pain (Hummel, Puchalski, Creech, & Weiss, 2008).

Pain assessment is a fundamental precursor to pain treatment (Schollin, 2005). It is only since the mid-1990s that systematic pain assessments have been used for neonates. Since that time, more than 40 pain measurement scales have been developed to evaluate pain in preterm and critically ill infants (Duhn & Medves, 2004; Gibbins et al., 2008). Because the pain cues of relatively healthy newborns differ drastically from those of critically ill and preterm infants (Ahn & Jun, 2007; Anand & Carr, 1989; Gibbins et al., 2007; Lucas-Thompson et al., 2008), choosing one scale to fit all patient situations within a NICU proves quite difficult. Failure to use a pain scale appropriately matched to the patient population may result in ineffective pain management. Most infant pain scales are unidimensional in nature and were developed for use in research (Duhn &

Medves, 2004). Current recommendations indicate that multidimensional scales are preferable to assess the multifaceted nature of pain (Guinsburg et al., 2000; Pereira et al., 1999; Walden, 2001). Clinical application of these scales has not produced a consensus as to which provides the best and most appropriate pain assessment for the entire neonatal population (Anand et al., 2006; Gibbins et al., 2008; Ranger et al., 2007).

Purpose

The purpose of this dissertation is to explore potential barriers nurses experience in providing effective pain management for preterm and critically ill infants in neonatal intensive care units (NICUs). The specific aims of the study conducted are to examine (a) NICU caregivers' knowledge about pain, (b) scales used to evaluate pain in infants, (c) NICU nurses' documented pain practices, and (d) bias in treating the pain of certain types of infants.

CHAPTER TWO

Introduction

In the late 1960s the numbers of neonatal intensive care units grew, and along with them came reports on neonatal pain perception (Carlson, Clement, & Nash, 1996). Early understanding of pain was based on the gate control theory (Melzack & Wall, 1965) and further described in terms of three dimensions. The sensory-discriminative dimension alerts the individual to the duration, intensity, quality, and location of the pain. The affective-motivational dimension identifies pain as unpleasantness and provides the desire to escape that unpleasantness. Finally, cultural values about pain and the ability to use distractions for pain management comprise the cognitive-evaluative dimension (Melzack & Casey, 1968).

For many years, knowledge of neonatal pain was based on four assumptions: (a) the central nervous system is underdeveloped in neonates, (b) neonates do not have pain receptors, (c) for pain perception to occur, nerve fibers must be myelinated, and (d) neonates are unable to remember painful experiences (Rouzan, 2001). These assumptions led the medical community to agree that neonates neither felt pain nor remembered painful events.

In 1979, the International Association for the Study of Pain subcommittee defined pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (IASP Newsletter, p. 250). Additional pain research in the 1980s and 1990s determined that pain perception in neonates is actually based on nociception, the neural process of encoding and processing noxious stimuli (Anand & Carr, 1989; Anand & Hickey, 1987; Stevens & Johnson,

1992). Nociceptive processes are conducted through unmyelinated nerve fibers which, when stimulated, send the signal along the spinal column to the brain. Fetuses as early as 20 weeks gestation have ascending pathways for nociception to occur (Anand & Carr, 1989; Evans, 2001; Simons & Tibboel, 2006). However, it is not until 32 weeks gestation or later that the descending pathways necessary to block incoming pain impulses are developed (Anand & Carr, 1989; Evans, 2001; Simons & Tibboel, 2006). Therefore, preterm infants may actually experience more intense pain because of their inability to blunt the experience.

Purpose

The purpose of this review is to present an integrated analysis of what is known about caregiver knowledge of neonatal pain, barriers to pain management, and bias in the treatment of pain in preterm and critically ill neonates (Table 2.1).

Method

Computerized literature searches were performed with limits set for human subjects, English language, and ages: newborn: birth to 1 month. Using the key word pain produced 4,321 references. Adding the term management reduced the references to 2,204. Modifying the approach and using combination key words with pain produced the following results: (a) caregiver knowledge and pain produced six references, (b) nursing knowledge and pain produced 33 references, (c) barriers and pain produced 25 references, and (d) bias and pain produced 47 references. All articles related to caregiver knowledge, nursing knowledge, barriers, and bias were individually reviewed for relevance to preterm and critically ill neonates. Final analysis yielded 19 articles

concerning caregiver knowledge, one regarding barriers to pain management, and no articles addressing bias in managing neonatal pain.

Results

Caregiver Knowledge of Pain in the 1980s

By the late 1980s only 46% of nurses believed that infants felt pain (Franck, 1987). They used a combination of behavioral and physiologic indicators to assess pain (Franck, 1987; Jones, 1989; Pigeon, McGrath, Lawrence, & MacMurray, 1989), but nurses did not consistently use the same indicators (Jones, 1989). Nurses used comfort measures to manage pain because pharmacologic agents were prescribed only during the post-operative period after all other interventions had failed (Franck, 1987).

Caregiver Knowledge of Pain in the 1990s

Ten years later, most nurses (64%) and physicians (59%) believed that infants felt the same amount of pain as adults (Porter, Wolf, Gold, Lotsoff, & Miller, 1997). Nurses continued to use both behavioral and physiologic indicators to assess pain (Dick, 1993), but reported using fewer indicators for intubated infants (Howard & Thurber, 1998). Nurses rated pain experiences of full term infants ($M = 3.73$) significantly higher than those of preterm infants ($M = 2.55$; $t = 8.37$, $df = 8$, $p < .001$; Shapiro, 1993). Physicians and nurses differed in their opinions of the level of pain experienced during procedural interventions, but indicated that 75% of them were at least moderately painful (Porter et al., 1997). Physicians who reported having had a significant pain experience were more likely to rate a procedure as more painful; however this was not observed among the nurses (Porter et al., 1997).

Nurses tended to use comfort measures more often than did physicians (Dick, 1993; Porter et al., 1997), with both groups indicating that comfort measures were not used very often (Porter et al., 1997). The use of anesthetic and analgesic agents was believed to be low. Physicians' ratings of how often pharmacologic agents were used were higher than those of nurses. Both groups agreed that pharmacologic agents should be used more often, but differed regarding which procedures required more intervention (Porter et al., 1997).

Caregiver Knowledge of Pain in the 2000s

As a new century began, nurses and physicians did not feel they had adequate knowledge about pain and pain management in neonates (Halimaa, Vehvilainen-Julkunen, & Heinonen, 2001). Some nurses still believed that infants experienced the same pain as adults (Reyes, 2003), while others now understood that neonates were more sensitive to pain than older children and adults (Byrd, Gonzales, & Parsons, 2009; Schultz, Loughran-Fowlds, & Spence, 2009). Nurses reported that the infant's gestational age affected pain assessments (Reyes, 2003), yet they were not certain whether preterm infants sensed pain as easily as term infants (Halimaa et al., 2001). Infants at risk for neurological impairment were felt to experience less pain (Breau, et al., 2006) and responded differently to comfort measures (Breau et al., 2004) than infants not at risk. They were not consistently aware of pain management guidelines (Akuma & Jordan, 2011; Byrd et al., 2009; Schultz et al., 2009) and received inadequate education regarding pain assessment (Byrd, et al., 2009; Reyes, 2003) and use of pharmacologic agents (Akuma & Jordan, 2011).

Nurses viewed pain as underestimated, difficult to measure, and poorly managed (Dodds, 2003). The majority (70.8%) of nurses agreed that pain scales accurately assess pain (Reyes, 2003) but preferred to rely on their experience or the infant's behavioral and physiologic cues for pain assessment (Akuma & Jordan, 2011; Byrd, et al., 2009; Dodds, 2003). They reported that nurses accurately assessed pain, but performed these assessments inconsistently (Reyes, 2003). Likewise, physicians did not consistently use pain assessment scales because they did not trust the validity and reliability of the scales (Schultz et al., 2009).

While nurses and physicians agreed that the majority of invasive procedures performed in the NICU produced moderate to severe pain, physicians continued to assign lower pain scores than nurses (Akuma & Jordan, 2011; Anderson, Greve-Isdahl, & Jylli, 2007; Cignacco et al., 2008; Simons et al., 2003). Pharmacological interventions and comfort measures were infrequently used before invasive procedures regardless of the perceived level of pain intensity (Anderson et al., 2007; Byrd et al., 2009; Simons et al., 2003). Nurses expressed frustration with inconsistent physician practice patterns for pain management, inappropriate weaning protocols, and inadequate post-operative pain management (Byrd et al., 2009).

Nurses agreed that documentation of pain assessment is important and leads to more effective pain management (Reyes, 2003) and higher quality care (Polkki et al., 2010). Seventy-five percent of nurses reported documenting pain assessments every four hours, every care episode, or more often. However, a review of 100 patient records revealed that a pain assessment was documented 37% of the time on day shift and 44% of the time on night shift. Additionally, of the 289 procedures performed, only 1% had a

documented follow-up pain assessment (Reyes, 2003). This finding was consistent with nurses' opinions that nurses did not routinely document pain assessments (Reyes, 2003).

Conclusion

Nurses and physicians now understand that neonates experience pain. They have demonstrated adequate knowledge of pain intensity caused by procedures and differences in pain cues of preterm and term infants. They have self-reported practices regarding pain assessment and identified appropriate interventions to manage pain. And yet, more than 20 years later, nurses and physicians continue to affirm that pain remains undertreated in this vulnerable population (Akuma & Jordan, 2012).

To date, only one study compared nurses' self-reported behaviors to actual documented practice of pain assessment. The results were not encouraging, indicating a disconnect between knowledge and practice. This knowledge – practice gap in pain management of preterm and critically ill neonates warrants further investigation. Furthermore, potential biases of neonatal intensive care nurses toward patients and pain management have yet to be investigated.

Table 2.1 Caregiver Knowledge of Pain in Preterm and Critically Ill Neonates

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Akuma & Jordan (2011) Purpose: To determine nurses' and physicians' knowledge and reported practice regarding assessment and management of pain in NICUs	Descriptive cross-sectional	Survey	Intensity ranking of painful procedures, infant vs adult pain, current use of comfort measures and analgesia, optimal use of comfort measures and analgesia	N = 199 (44% response rate) RNs and MDs from seven NICUs in the United Kingdom	MDs rated procedures as less painful than RNs; pain scales were available yet rarely used; RNs reported higher use of analgesics than did MDs; both agreed that comfort measures and analgesia were under utilized
Anderson et al. (2007) Purpose: To describe the opinions of Norwegian physicians, nurses, and nurse assistants regarding procedural pain	Descriptive design	Survey	Intensity ranking of painful procedures; current and optimal use of pharmacological agents; current and optimal use of comfort measures	N = 90 (87% response rate) MDs and RNs from two NICUs in Norway	Most rated listed procedures as being more than moderately painful, MDs rated procedures as less painful than RNs, pharmacological agents were rarely used, comfort measures were believed to be underutilized
Breau et al. (2004) Purpose: To determine whether healthcare professionals perceive the pain of infants differently due to their understanding of that infant's risk for neurological impairment (NI)	Descriptive design	Survey for demographic data	Rating of pain, distress, and time to calm from video clips accompanied by descriptions that suggested the infant had mild, moderate, or severe risk of NI	N = 95 (response rate not reported) RNs, MDs, RTs, and others from two NICUs in Canada	Ratings of pain, distress, and time to calm did not vary significantly with level of risk; ratings of the effectiveness of cuddling were significantly lower as risk increased

Table 2.1 (Continued)

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Breau et al. (2006) Purpose: To determine whether healthcare professionals believe the pain of infants at risk for neurological impairment (NI) differs from that of typical infants	Descriptive design	Survey	Beliefs regarding the similarity of pain experienced by infants at mild, moderate, or severe risk of NI relative to those infants without risk.	N = 99 (response rate not reported) RNs, MDs, RTs, and others from three NICUs in Canada	Experienced healthcare professionals have a priori beliefs regarding pain in infants at risk for NI; pain of infants at risk for NI is less than pain of infants not at risk; less pain is more likely as risk for NI increases; there is a greater reduction in aspects reflecting pain response (emotional & behavioral reaction, and communication) than aspects reflecting pain experience (pain sensitivity and incidence)
Byrd et al. (2009) Purpose: To explore barriers that NICU nurses face when attempting to optimally manage newborn pain	Descriptive design	Pilot survey	Newborn pain management, barriers to managing newborn pain	N = 90 (30% response rate) RNs from one NICU in the USA	Fewer than 50% felt that newborn pain was well managed; barriers identified included: MD practice patterns, RN & MD resistance to change, pain assessment tools, inadequate training regarding pain assessment & management, lack of evidence-based protocols

Table 2.1 (Continued)

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Cignacco et al. (2008) Purpose: To gain insights into factors influencing pain intensity assessment of routine procedures in NICU; to develop a ranking and classification intensity of routine procedures	Descriptive exploratory design	Survey	Intensity ranking of painful procedures	N = 321 (74% response rate) RNs and MDs from four NICUs in Switzerland and Germany	RNs rated 19 of the 27 procedures as significantly more painful than did the MDs; 70% of the procedures were assessed as painful and 44% as very painful; gender, age, and professional experience had no influence on pain assessment
Dick (1993) Purpose: To describe and compare the beliefs of NICU nurses and physicians about the existence and treatment of pain in preterm infants	Qualitative	Interviews	Eight major questions with additional probes to elicit information about pain and pain treatment in preterm infants	N = 16 11 RNs and 5 Neonatologists in 2 units in the USA	Themes: Causes of pain experience, behaviors/symptoms recognized as pain, approaches to pain relief, comfort measures to relieve pain, pharmacologic measures to relieve pain, differences between MDs and RNs
Dodds (2003) Purpose: To gain an insight into the nursing assessment and management of neonatal procedural pain	Descriptive exploratory design	Survey	Intensity ranking of procedures, cues for pain assessment, self-reported interventions	N = 21 (26% response rate) RNs in three NICUs in the USA	Intensity ranking similar to prior literature; crying was the most commonly used cue; self-reported use of analgesia and non-pharmacological interventions was very low; 52% of the respondents reported they do not use a pain assessment tool

Table 2.1 (Continued)

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Franck (1987) Purpose: To determine beliefs about neonatal pain and agitation; current methods of assessment, and standards for treatment	Descriptive exploratory design	Survey	Beliefs regarding pain, adequacy of medication used, methods of pain assessment, interventions to manage pain, descriptors of agitated behavior	N = 76 (53% response rate) Head RNs from 36 different states in the USA	Disagreement as to whether infants feel pain; pain medication is under used; cry and activity were primary cues to indicate pain; agitation was identified as a problem in 95% of the NICUs
Halimaa et al. (2001) Purpose: To discover what knowledge caregivers have about pain assessment and the pain experience of premature infants	Descriptive exploratory design	Survey	Knowledge of pain, pain cues, adequate pain education, and self-reported interventions	N = 280 (70% response rate) RNs, LPNs, and lab techs in four NICUs in Finland	Nurses have extensive knowledge about the pain experience and pain assessment and management; behavioral pain cues used primarily for pain assessment; actions used in pain assessment and pain management were not consistent with knowledge

Table 2.1 (Continued)

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Howard & Thurber (1998) Purpose: To identify the indicators used by neonatal nurses to interpret the experience of pain in infants in a NICU	Descriptive exploratory design	Survey	Knowledge of pain cues	N = 72 (response rate not reported) RNs in one NICU in the USA	Pain cues used by > 50% of RNs in decreasing order of frequency were: fussiness, restlessness, grimacing, crying, increasing heart rate, increasing respirations, wiggling, rapid state changes, wrinkling of forehead, and clenching of fist; RNs use fewer pain indicators in the assessment of intubated infants than non-intubated infants
Jones (1989) Purpose: To explore the behavioral and physiological signs that nurses interpret as suggesting the possibility of pain in the newborn	Descriptive exploratory design	Survey	Knowledge of pain cues	N = 81 (76% response rate) RNs in one NICU in the USA	Only three signs were selected with confidence, suggesting difficulty and tentative nature of nursing decisions regarding the assessment of pain in newborns
Pidgeon et al. (1989) Purpose: To examine the perceptions of neonatal nurses as to the indicators and causes of different intensities of pain	Descriptive exploratory design	Survey	Knowledge of pain cues and sources of pain	N = 43 (response rate not reported) RNs in one NICU in the USA	High level of agreement about the behaviors used to assess pain; less discrimination of behaviors on the basis of intensity of pain

Table 2.1 (Continued)

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Polkki et al. (2010) Purpose: To describe nurses' attitudes and perception of pain assessment in the NICU and the demographic factors related to these attitudes and perceptions	Cross sectional descriptive and correlational design	Survey	Attitudes regarding pain assessment and knowledge of pain in preterm infants	N = 257 (71% response rate) RNs in two NICUs in the USA	RNs with higher education agreed more on pain in preterm infants; RNs with less experience disagreed more with pain perception and pain expression
Porter et al. (1997) Purpose: To examine beliefs and self-described behavior of MDs and RNs regarding management of procedural pain	Descriptive exploratory design	Survey	Intensity rating of procedures; use of comfort and pharmacologic interventions	N=374 (80% response rate) RNs and MDs in 11 Level II and 4 Level III NICUs in the USA	9 of 12 procedures rated at least moderately painful; analgesia and comfort measures under used
Reyes (2003) Purpose: To evaluate nursing beliefs as compared to their practice of infant pain assessment	Descriptive exploratory design	Survey and chart audit	Knowledge of pain; documented pain assessments	N = 24 (47% response rate) 100 chart audits RNs in one NICU in the USA	Knowledge results were mixed; 62% of day shift and 56% of night shift without documented pain assessments

Table 2.1 (Continued)

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Shultz et al. (2009) Purpose: To evaluate the beliefs and practices of junior physicians regarding neonatal pain	Descriptive exploratory design	Survey	Knowledge and treatment of pain	N = 33 (77% response rate) Five NICUs in Sydney, Australia	Majority believed: neonates are more sensitive to pain; mortality and morbidity are reduced with pain management; benefits of opioid use outweigh risk; pain results in long term consequences; pain scales are not valid or reliable
Shapiro (1993) Purpose: To examine nurses' judgments of pain intensity in full term and preterm neonates; to describe the cues that NICU nurses use to assess the possible presence of pain.	Descriptive exploratory design	Videotaped infant behavior, written vignettes	Knowledge of pain cues; intensity rating of procedures	N = 45 (82% response rate) RNs in one NICU in the USA	Higher mean pain intensity scores were given to term infants indicating the influence of vigor of pain response; no correlation was found between pain intensity and demographics

Table 2.1 (Continued)

Author(s)/Year Purpose	Design	Measure(s)/ Variable(s)	Variable(s)	Subjects	Findings
Simons et al. (2003) Purpose: To assess the frequency of use of analgesics in invasive procedures in neonates and the associated pain burden in newborns	Prospective chart review	Survey; prospective documentation review	Intensity rankings of procedures, documented analgesics, documented number of procedures including failed attempts	N = 148 (60% response rate) RNs and MDs in two NICUs and one Surgical ICU in the USA	The mean number of procedures per neonate per day was 14.3 ± 4 with the highest exposure occurring on day 1; range of procedures was 0 to 53; RNs scored procedures as more painful than MDs; caregivers who were parents scored procedures lower than those without children

CHAPTER THREE

Introduction

The International Association for the Study of Pain (IASP, 2001) defines pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage” (IASP Newsletter, p. 250). Pain in the neonatal intensive care unit can be categorized as acute procedural pain, acute prolonged pain, or chronic pain. Acute procedural pain is the result of a specific painful event that is self-limited to the performance of the event. Acute prolonged pain has an identified stimulus with a clearly definable beginning and a clearly expected end point which may last a few hours to days. Finally, chronic pain persists beyond normal tissue healing time and may last several months (Hummel, Puchalski, Creech, & Weiss, 2008). Pain assessment is a fundamental precursor to pain treatment (Schollin, 2005).

Systematic pain assessment of neonates began in the mid-1990s. Since that time, more than 40 scales have been developed to evaluate pain in this fragile, non-verbal population (Duhn & Medves, 2004; Gibbins et al., 2008). Because pain cues of relatively healthy newborns differ from those of critically ill and preterm infants (Ahn & Jun, 2007; Anand & Carr, 1989; Gibbins et al., 2007; Lucas-Thompson et al., 2008), selecting one scale to fit all patient situations within a neonatal intensive care unit remains elusive. The majority of infant pain scales has been developed for research and is unidimensional in nature (Duhn & Medves, 2004). Evidence suggests that multidimensional scales assessing both physiologic and behavioral indicators are preferable to assess pain in neonates (Guinsburg et al., 2000; Pereira et al., 1999; Walden, 2001). Of the multidimensional scales currently available, only nine included premature infants in their

development. Two of these nine scales adjust for gestational age as a component of pain assessment (Gibbins et al., 2008). One scale has an additional component to assess pain in infants receiving narcotics for sedation (Gibbins et al., 2008). A gold standard for premature and critically ill neonates has not emerged from clinical application of these scales (Anand et al., 2006; Gibbins et al., 2008; Ranger, Johnston, & Anand, 2007).

Purpose

The purpose of this review is to present an analysis of multidimensional scales used to assess pain in preterm and critically ill neonates (Table 3.1).

Method

A computerized search of MedLine, CINAHL, and PubMed databases was performed to identify all published multidimensional pain scales for use with neonates. Reference lists from appropriate studies were also searched. Inclusion criteria consisted of human subjects, English language, and newborns 0 to 28 days of life. A search using the key phrase pain scale produced 316 references. The key phrase infant pain scale reduced that number to 176. Combining the key phrases of pain scale and preterm infant narrowed the number to 76. Multidimensional pain scale produced 12 citations. All articles were individually reviewed for relevance.

Multidimensional scales (Table 3.1) have been tested against each other as well as with unidimensional scales and visual analog scales. For this discussion, only multidimensional pain scales with initial testing in preterm infants are included. Psychometric properties of each scale are evaluated (DeVon et al., 2007; Nunnally & Bernstein, 1994). The strengths and limitations of each instrument are described.

Results

Neonatal Infant Pain Scale (NIPS)

The NIPS (Lawrence et al., 1993) evaluates five behavioral indicators (cry, state of arousal, facial expression, and position of arms and legs) and one physiologic indicator (breathing pattern) to assess procedural pain. The NIPS is an adaptation of the Children's Hospital of Eastern Ontario Pain Scale developed from a survey of experienced neonatal nurses. Based on defined descriptions, each indicator is scored 0 or 1 with the exception of cry, which is scored 0 to 2, resulting in a total possible score of 0 to 7. In the initial validation study, 38 infants (28 to 38 weeks gestation) requiring capillary, venous, or arterial punctures were videotaped during 90 procedures. The NIPS and the Visual Analog Scale (VAS) were used to score the videotapes in one minute increments before, during, and after the procedures. Inter-rater reliability of the NIPS was high, ranging from .92 to .97 ($p < 0.05$) across successive minutes of observation. Changes in NIPS scores over time were statistically significant with the main effect of time ($F = 18.97$, $df = 2, 42$, $p < .001$) suggesting high construct validity. Cronbach's alphas before (.95), during (.87), and after (.88) the procedures indicated high internal consistency. High concurrent validity was supported by correlations between the NIPS and the VAS at each minute of observation ($r = .53 - .84$; Lawrence et al., 1993).

The validity and reliability of this scale has been supported in subsequent studies of preterm and healthy neonates during venous puncture (Pereira et al., 1999; Serpa et al., 2007), heelstick (Bellieni et al., 2007; Guinsburg et al., 2000), endotracheal intubation (Blauer & Gerstmann, 1998), intravenous catheter insertion (Blauer & Gerstmann, 1998), and endotracheal suctioning (Blauer & Gerstmann, 1998). This scale has also been evaluated in post-operative neonates with the same results (Suraseranivongse et al.,

2006). The NIPS appears to be a highly valid and reliable scale to assess acute pain in neonates. Nurses found it easy to use and practical in application (Blauer & Gerstmann, 1998; Suraseranivongse et al., 2006). Since the scale is heavily weighted with behavioral parameters, infants who are sedated, extremely premature, or too ill to respond may receive a score indicating no or low pain. Therefore the utility in a neonatal intensive care unit may be limited.

Pain Assessment Tool (PAT)

The PAT (Hodgkinson, Bear, Thorn, & Van Blaricum, 1994) was developed by seven experienced NICU nurses and tested in a pilot study of 20 post-operative neonates (27 to 40 weeks gestation). Physiologic indicators (respiratory rate, heart rate, oxygen saturation, and blood pressure), behavioral indicators (posture, tone, facial expression, cry, color, and sleep patterns), and nurse's perception are each scored 0 to 2 or 1 to 2 on a defined scale with a total score of 4 to 20 for the 11 indicators. Data were collected by one of the seven nurses or by a trained associate charge nurse. Scores were recorded for the first 20 infants returning from surgical procedures at time of arrival, every hour for six hours, then every three hours for 18 hours. Three of these infants were excluded from data analysis because they were receiving paralytic agents post operatively. The authors reported that in general, the PAT scores coincided with nursing judgment and subsequent interventions used to treat pain, suggesting content validity. Psychometric properties for the scale were not reported (Hodgkinson et al., 1994). One additional study supported moderate inter-rater reliability and construct validity. However, PAT score reliability was found to be lower at higher PAT score values (Spearman's rank $r = .17$, $p < .05$),

suggesting that the scale does not accurately assess moderate to severe pain (Spence, Gillies, Harrison, Johnston, & Nagy, 2005).

Although this scale was used in preterm and term infants, the actual range of gestational ages was not identified. Extremely low birthweight infants were not included. Subjective assessment of pain is included as a scored element in this scale. Despite these limitations, the PAT was found to be easy to use in the clinical setting (Spence et al., 2005).

Crying, Requires Increased Oxygen Administration, Increased Vital Signs, Expression, and Sleeplessness (CRIES) Scale

The CRIES scale (Krechel & Bildner, 1995) consists of three behavioral indicators (crying, facial expression, and sleep behavior) and three physiologic indicators (heart rate, blood pressure, and oxygen requirement) to measure post-operative pain. Indicators are scored from 0 to 2 on a defined scale. The score for heart rate and blood pressure is combined; therefore, total scores range from 0 to 10. Initial validation and reliability testing occurred in a group of 24 postoperative infants ranging from 27 to 40 weeks gestation. Infants were observed and scored hourly by two nurses for a total of 1,382 observations. Nurses scored the infants using three criteria: (a) nurse's subjective assessment of pain or no pain, (b) the Objective Pain Scale (OPS; Hannallah, Broadman, Belman, Abramowitz, & Epstein, 1987) from the Children's Medical Center in Washington, and (c) the CRIES. A third nurse evaluated the assessments of the first two (Krechel & Bildner, 1995).

Inter-rater reliability was moderate at .72. A strong positive correlation was found between the CRIES and OPS ($r = .73, p < .0001$). Discriminant validity was

evaluated using a Wilcoxon sign rank test to detect the differences between scores at the time of analgesia and scores one hour post analgesia. A significant mean post medication decrease of 3.0 units ($p < .0001$) was observed in the CRIES and 3.4 units ($p < .0001$) in the OPS. When asked to indicate their preference for the scales, 73% of nurses in this study chose the CRIES (Krechel & Bildner, 1995). Support for concurrent validity, convergent validity, and inter-rater reliability was found in additional studies of postoperative preterm and term neonates (McNair, Ballantyne, Dionne, Stephens, & Stevens, 2004; Spence et al., 2005; Suraseranivongse et al., 2006).

While the nurses in the initial validation study preferred the CRIES scale, other clinicians expressed that it was difficult to use and questioned the utility of some items (Suraseranivongse, 2006). When compared with other scales, the statistical correlation of the CRIES was not as strong (Suraseranivongse, 2006). The CRIES has reduced utility at the bedside as it cannot be used to assess infants who are intubated or receiving narcotic analgesia (Krechel & Bildner, 1995; McNair et al., 2004; Suraseranivongse et al., 2006). A limitation of this study was the comparison of the CRIES to the OPS, since the OPS was developed for pain assessment in older preverbal children rather than neonates.

Premature Infant Pain Profile (PIPP)

The PIPP (Stevens, Johnston, Petryshen, & Taddio, 1996) was initially developed to evaluate two physiologic and 13 behavioral indicators. The scale was tested in a sample of 237 infants (27 to 34 weeks in gestation) during circumcision or a heelstick procedure. The results led to condensing the scale to include four behavioral indicators (behavioral state, brow bulge, eye squeeze, and nasolabial furrow), two physiologic

indicators (heart rate and oxygen saturation) and a gestational age adjustment score. These seven indicators are scored on a defined scale of 0 to 3 for a total score of 0 to 21. The seven-item scale was then evaluated in 124 infants (32 to 34 weeks gestation) during a heelstick procedure. The standard item Cronbach's alpha was .71, indicating acceptable internal consistency. Construct validity was evaluated using a heelstick (pain) and a handling (non-pain) situation. Scores between the pain ($M = 12.9$, $SD = 3.4$) and non-pain ($M = 6.0$, $SD = 2.7$) situation were significantly different (paired $t = 12.24$; two-tailed $p < .0001$; Mann-Whitney $U = 765.5$, $p < .00001$) suggesting that the scale accurately discriminated between the two situations (Stevens et al., 1996).

Additional studies supported the construct validity (Ballantyne, Stevens, McAllister, Dionne, & Jack, 1999; Cignacco, Denhaeryncscalek, Nelle, Buher, & Endberg, 2009) and inter-rater reliability (Ballantyne et al., 1999; Bellieni et al., 2007; Cignacco et al., 2009) of this scale during non-pain as well as tissue damaging events such as heelstick, intravenous sticks, and venous punctures. Convergent validity was supported in post-operative neonates when compared to the CRIES (McNair et al., 2004).

There has been more reliability and validity testing of the PIPP than other infant pain measurement scales (Duhn & Medves, 2004). Generally, nurses find the scale easy to use and are able to independently use the scale after only a brief explanation (Ballentyne et al., 1999). An additional strength of this scale is that it adjusts for degree of prematurity.

Scale for Use in Neonates (SUN)

The SUN (Blauer & Gerstmann, 1998) is comprised of three behavioral (tone, facial expression, and movement) and four physiologic (heart rate, mean arterial pressure,

central nervous system state, and respiratory rate) indicators. Defined scores range from 0 to 4, with a total score of 0 to 28. Thirty-three infants (24 to 40 weeks gestation) were assessed for acute pain during three painful procedures: intravenous (IV) insertion, endotracheal intubation, and endotracheal suctioning. Diaper changes, which are not considered painful, were included in this study as a control. Sixty-eight procedures were evaluated by one of the researchers using the SUN, NIPS, and Comfort scale in a randomized order, for a total of 1,428 individual pain scores. Discriminant validity was demonstrated by significant changes in scores (mean differences not reported; $p < 0.01$ to $p < 0.001$) between baseline to intervention and back to baseline for each procedure. However, when each procedure was compared within each scale and rank ordered according to change in score, diaper changes were scored as more painful than endotracheal tube suctioning when using the SUN and Comfort scale (Blauer & Gerstmann, 1998).

One of the aims of this study was to determine the sensitivity of the scale to detect state changes with various procedures. The scores for diaper change were higher than the scores for endotracheal suctioning. This raises the question of whether the scale measured the intended construct. While the symmetry of the SUN was convenient, the gradations for central nervous system state, tone, and facial expression were difficult to distinguish (Blauer & Gerstmann, 1998). Inter-rater reliability and other psychometric properties were not reported.

Pain Assessment in Neonates (PAIN)

The PAIN scale (Hudson-Barr et al., 2002) was developed by combining indicators selected from the NIPS and the CRIES to measure acute pain. The scale is

comprised of five behavioral (extremity movement, facial expression, state of arousal, cry, and breathing pattern) and two physiologic (heart rate and oxygen required to maintain saturations > 95%) indicators. Cry, heart rate, and oxygenation are measured on a defined 3-point scale (0 to 2) while the others are scored on a defined 2-point scale (0 or 1). The total score ranges from 0 to 10. The PAIN scale was tested in 196 infants ranging from 26 to 47 weeks gestation. The PAIN score was compared to the NIPS score during a painful procedure selected by the nurse. The scales were randomly ordered for each assessment. Scores on the PAIN and NIPS were significantly higher in infants who experienced a painful procedure (PAIN M = 3.41, SD = 2.60; NIPS 3.14, SD = 2.30) in the prior 30 to 60 minutes than for infants who had not experienced a painful procedure (PAIN M = 1.13, SD = 1.70; NIPS M = 1.03, SD = 2.30; PAIN $t = -7.11$, $p < .001$; NIPS $t = -6.85$, $p < .001$), supporting construct validity. The two scales were highly correlated ($r = .93$; $p < .001$), supporting criterion validity (Hudson-Barr et al., 2002).

Several limitations were identified. Clinicians were instructed on the use of both scales at the time of use without an opportunity to practice and become proficient. Inter-rater reliability was not assessed. The majority of the infants scored ≤ 3 out of 10 on both the PAIN and the NIPS, indicating that the sample was not experiencing pain; therefore, the scale may not have represented the continuum of no pain to worst pain. The strong correlations between the two scales may have been the result of items included in the PAIN scale that were directly derived from the NIPS scale. All of these limitations may have produced results that may not be reliable (Hudson-Barr et al., 2002).

Bernese Pain Scale for Neonates (BPSN)

The BPSN (Cignacco, Mueller, Hamers, & Gessler, 2004) was developed to assess acute pain in preterm and term infants. A group of 12 infants ranging from 27 to 41 weeks gestation were evaluated on seven behavioral (skin color, posture, duration of crying, alertness, eyebrow bulge with eye squeeze, breathing pattern, and time to calm) and two physiologic (heart rate and oxygen saturation) indicators. Each item was rated on a defined 4-point scale (0 to 3) with a total score of 0 to 27. Each infant was observed and videotaped in the following situations: (a) after feeding, (b) while a foot was being warmed, (c) during routine capillary blood draw, and (d) 15 minutes after blood draw.

The infants were stratified into two groups based on gestational age (< or > 32 weeks). Six healthcare workers (two at the bedside and four additional watching the videotapes) in each of the situations mentioned above performed pain assessments using the BPSN, the PIPP, and the Visual Analog Scale (VAS; n = 288). Moderate to high inter-rater reliability was noted at baseline (.86), during heel warming (.92), during lance (.98), and post blood draw (.97). Intra-rater reliability was high, ranging from .98 to .99. Construct validity was supported by significant differences in pain (M = 15.96, SD = 5.7) and no pain (M = 2.32, SD = 1.6; F = 41.27, p < .0001) between the four situations. Comparison of the BPSN to the VAS indicated a moderate correlation (r = .85, p < .0001). A comparison of the BPSN to the PIPP demonstrated high convergent validity (r = .907, p < .0001). While the number of infants enrolled in the study was small (n = 12), the number of pain scores evaluated was large (n = 288; Cignacco et al., 2004). An additional study supported inter-rater and intra-rater reliability in nine preterm infants during a heelstick procedure (Cignacco et al., 2009).

Inter-rater reliability between the observed state and videotaped state was moderate to high suggesting this scale is useful at the bedside. The sample did not include critically ill neonates requiring mechanical ventilation. Therefore, this scale may not be appropriate for use in all NICU patients.

Neonatal Pain, Agitation and Sedation Scale (N-PASS)

The N-PASS (Hummel et al., 2008) was developed to assess acute pain, prolonged pain, and sedation in preterm and term infants. The scale defines four behavioral (facial expression, extremities/tone, behavioral state, and crying/irritability) and four physiologic (heart rate, blood pressure, respiratory rate, and oxygen saturation) indicators. Each indicator is scored 0 to 2 for pain/agitation or 0 to -2 for sedation. Modeled after the PIPP, 0 to 3 points are added to the pain/agitation portion of the scale to adjust for degree of prematurity. Total scores range from -10 to 0 for the sedation component of the scale and 0 to 13 for the pain/agitation component. Many of the cues for agitation and pain are the same, thereby making it clinically difficult to distinguish the difference in this non-verbal population.

To validate the scale in the assessment of prolonged pain, the N-PASS was compared to the PIPP in 46 ventilated or post-operative preterm and term infants (23 to 40 weeks gestation). A group of 10 nurses were trained for data collection. Simultaneous assessment of infants by two data collection nurses before and after pharmacologic interventions for pain or sedation produced 72 observations. Inter-rater reliability was high at .90. Internal consistency was moderate for raters one and two ($\alpha = .82$ and $.72$ respectively for pain scores; $\alpha = .89$ for sedation scores). Comparison of N-PASS scores pre and post-pharmacologic intervention supported construct validity

(Wilcoxin signed-rank test: pain scores 4.86 (3.38) and 1.81 (1.53), $p < .0001$; sedation scores -0.85 (1.66) and -2.78 (2.81), $p < .0001$). Spearman's Rank correlations indicating high convergent validity were .83 and .81 for raters one and two pre-intervention and .61 for both raters post-intervention (Hummel et al., 2008).

A subsequent study supported inter-rater reliability, convergent validity, and internal consistency. Test-retest reliability was established using recorded video of an acute pain situation. Validity and reliability between groups stratified for gestation age supported reducing the number of categories from four (scored 0 to 3) to two (scored 0 or 1) to compensate for prematurity (Hummel, Lawlor-Klean, & Weiss, 2009).

This scale was initially tested in the clinical setting rather than in a controlled setting or by videotape; therefore the findings may be biased. However, this approach is critical in developing a scale that is easy for the bedside clinician to use. These two studies provide beginning evidence of the validity and reliability of this scale to assess pain across the spectrum of gestational ages. Further testing with larger sample sizes in various clinical situations is warranted to support the construct of assessing acute procedural pain, acute prolonged pain, and sedation in the same scale.

Crying, Oxygen Requirement, Vital Signs, Expression, Resting, Signaling Distress, (COVERS) Neonatal Pain Scale

The COVERS scale (Hand, Noble, Geiss, Wozniak, & Hall, 2010) is based on three physiologic (heart rate, oxygen requirement, and blood pressure) and four behavioral (resting state, body movements, facial expression, and crying) indicators. The indicators are defined and scored from 0 to 2 for a total score of 0 to 12. Twenty-one infants (27 to 40 weeks gestation) were evaluated by a single observer during a heelstick

procedure and a diaper change at baseline, during the procedure, and post recovery. Both observations occurred within a 12-hour period. Each observation was evaluated using a composite scale made up of indicators from the NIPS, CRIES, PIPP, and COVERS scales. The indicators were later separated and analyzed according to the individual scales. To establish concurrent validity, scores for the COVERS scale and the NIPS were compared for term infants (Spearman's $r = .95$) while scores for the COVERS scale and the PIPP were compared for preterm infants (Spearman's $r = .84$). Both were found to be high. Construct validity was established by comparing the mean COVERS scores between diaper change and the heelstick observations at baseline (heelstick 0.1; diaper change 0.4, $p > .05$), from baseline to procedure (heelstick 7.3; diaper change 4.9, $p < .05$) and from procedure to recovery (heelstick 1.3; diaper change 2.0, $p > .05$). Comparisons between the COVERS scale and CRIES were not reported (Hand et al., 2010).

The sample studied did not include extremely preterm infants. Using a single observer and a composite assessment scale eliminated the ability to assess inter-rater reliability and ease of use. It is unclear whether every indicator from the NIPS, CRIES, and PIPP was included in the composite assessment scale along with the COVERS scale, or only select items. Since three pain assessment scales were combined into one instrument, bias in scoring may have occurred. Therefore the reliability of the statistical analysis is questionable.

Discussion

Each of the nine scales is multidimensional in nature and was used to measure pain in preterm and term neonates. Using a multidimensional scale in this population is

important for two reasons. First, pain expression varies with gestational age. Extremely low birthweight infants may have dampened responses to pain (Gibbins et al., 2008; Slater et al., 2009). Secondly, most critically ill infants require mechanical ventilation. The presence of an endotracheal tube prevents assessment of some behavioral parameters (Gibbins et al., 2008; Krecher & Bildner, 1995). A multidimensional approach helps account for these variations in clinical situations (Guinsburg et al., 2000; Pereira et al., 1999; Walden, 2001).

Advancements in technology and medical management have progressively lowered the limits of viability of prematurely born infants to as early as 23 weeks gestation. Therefore, it is crucial that the scale used for pain assessment in a neonatal intensive care unit be sensitive to pain cues across all gestational ages and severity of illness. The reliability and validity of each scale varied. With the exception of the SUN and CRIES, the bedside nurses reported the scales as easy to use. In their initial validation, the NIPS, PAT, and CRIES were compared to scales not intended for use in preterm or non-verbal populations, potentially confounding the results. The PAT included a scored component based on the nurse's subjective perception of the infant's pain, which may bias the final score. The N-PASS and COVERS scales are the most recently developed and warrant additional validity and reliability testing. The N-PASS is the only scale that has attempted to measure multiple categories of pain as well as sedation. The PIPP is the most tested scale to date; yet it has not emerged as the gold standard (Duhn & Medves, 2004). Because this population is unable to verbalize pain, the task of finding the ideal scale to assess every neonate across the continuum of prematurity, severity of illness, and sedation remains elusive.

Since this review was restricted to multidimensional pain scales reported in the English language, it may not be entirely inclusive. Pain scales which did not include preterm infants in their initial development were not considered for review. It is possible that a scale subsequently tested and appropriate for preterm infants was not considered.

Conclusion

Adequate pain management begins with effective pain assessment (Schollin, 2005). In the United States, one in eight infants is born prematurely; 13 million worldwide (March of Dimes). There is an obligation to this fragile population to continue working diligently to find the pain assessment scale that allows the clinician to quickly assess and successfully manage the pain experiences of preterm and critically ill infants. In a period of less than 25 years, more than 40 pain assessment scales have been developed. The answer is not in producing scale after scale that is tested specifically in one or two situations and then forgotten. A better solution may be a concerted effort to identify a promising scale which is then extensively evaluated across multiple conditions and multiple sites before making a decision that it does not have the qualities to become the gold standard and moving on.

Table 3.1 Multidimensional Pain Scales

Pain Scale	Behavioral Indicators	Physiologic Indicators	Gestational Age Tested	Psychometric Properties Tested	Adjusts for Gestational Age	Assesses Sedation	Nature of Pain Assessed
Neonatal Infant Pain Scale (NIPS), 1993	Facial expression, cry, arm movement, leg movement, state of arousal	Breathing pattern	28 - 38 weeks	Concurrent validity Construct validity Content validity Internal consistency Inter-rater reliability	No	No	Acute pain
Pain Assessment Tool (PAT), 1994	Sleep patterns, facial expression, color, cry, tone, posture	Heart rate, respiratory rate, oxygen saturation, blood pressure	27 - 40 weeks	Content validity Construct validity Inter-rater reliability	No	No	Acute pain
Crying, Requires increased oxygen administration, Increased vital signs, Expression, Sleeplessness (CRIES), 1995	Facial expressions, crying, sleeplessness	Heart rate, oxygen saturation	27 - 40 weeks	Concurrent validity Construct validity Convergent validity Discriminant validity Inter-rater reliability	No	No	Acute pain
Premature Infant Pain Profile (PIPP), 1996	Brow bulge, eye squeeze, nasolabial furrow	Heart rate, oxygen saturation	27 - 34 weeks	Construct validity Content validity Convergent validity Internal consistency Inter-rater reliability	Yes	No	Acute pain

Table 3.1 (Continued)

Pain Scale	Behavioral Indicators	Physiologic Indicators	Gestational Age Tested	Psychometric Properties Tested	Adjusts for Gestational Age	Assesses Sedation	Nature of Pain Assessed
Scale for Use in Newborns (SUN), 1998	Movement, tone, facial expression	Heart rate, mean blood pressure, central nervous system state, respiratory rate	24 - 40 weeks	Discriminant validity	No	No	Acute Pain
The Pain Assessment in Neonates (PAIN), 2002	Facial expression, breathing pattern, cry, extremity movement, state of arousal	Heart rate, oxygen saturation	26 - 47 weeks	Criterion validity Construct validity	No	No	Acute Pain
Bernese Pain Scale for Neonates (BPSN), 2004	Grimacing, crying, body movements, skin color, sleeping patterns, consolation	Heart rate, oxygen saturation, respiratory rate	27 - 41 weeks	Construct validity Convergent validity Intra-rater reliability Inter-rater reliability	No	No	Acute Pain
Neonatal Pain Agitation, and Sedation Scale (N-PASS), 2008	Behavioral state, tone, irritability, cry	Heart rate, blood pressure, respiratory rate, oxygen saturation	23 - 40 weeks	Construct validity Convergent validity Discriminate validity Internal consistency Inter-rater reliability Test-retest reliability	Yes	Yes	Acute pain, prolonged pain, agitation & sedation

Table 3.1 (Continued)

Pain Scale	Behavioral Indicators	Physiologic Indicators	Gestational Age Tested	Psychometric Properties Tested	Adjusts for Gestational Age	Assesses Sedation	Nature of Pain Assessed
Crying, Oxygen requirement, Vital signs, Expression, Resting, Signaling distress, (COVERS) Neonatal Pain Scale, 2010	Crying, facial expression, behavioral state, signaling distress	Heart rate combined with blood pressure, oxygen requirement with breathing pattern	27 - 40 weeks	Construct validity Convergent validity	No	No	Acute pain

CHAPTER FOUR

Introduction

Since the 1980s, substantial advancements in technology and medical management in the fields of perinatology and neonatology have consistently lowered the threshold of viability for preterm infants. The result for preterm infants is prolonged exposure to medical interventions including painful, invasive procedures necessary to sustain life (Anand et al., 2006; Anderson, Greve-Isdahl, & Jylli, 2007). Simultaneously, pain assessment and pain management in neonates have received increased attention during the past 20 years. The body of knowledge in both nursing and medicine has expanded considerably in terms of evidence and acknowledgement that infants, including those born extremely prematurely, have the capacity to feel pain (Ahn & Jun, 2007; Simons & Tibboel, 2006). Although ascending pathways for nociception to occur are present in fetuses by 20 weeks gestation, descending pathways necessary to block incoming pain impulses are not developed until at least 32 weeks gestation (Anand, & Carr, 1989; Evans, 2001; Simons & Tibboel, 2006). Therefore preterm infants may actually experience more intense pain responses because of their inability to blunt the experience (Anand & Carr, 1989; Evans, 2001; Simons & Tibboel, 2006).

Repetitive, prolonged pain interferes with normal growth and development during hospitalization and has implications for permanent alterations in long-term neurodevelopment (Abdulkader, Freer, Garry, Fleetwood-Walker, & McIntosh, 2008; Anand et al., 2006; Hermann, Hohmeister, Demirakca, Zohsel, & Flor, 2006). Given that a neonate requiring intensive care may be exposed to as many as 12 to 16 invasive, painful procedures each day (Anand et al., 2006; Carbajal et al., 2008; Simmons et al.,

2003), the smallest and most preterm infants are at the greatest risk for suffering long-term effects.

The new catch phrase “pain, the fifth vital sign”, has emerged from a push by healthcare providers for consistent pain assessment and management for patients of all ages, coupled with requirements from accreditation bodies such as The Joint Commission (Latimer, Johnston, Ritchie, Clarke, & Gilin, 2009). Research suggests that pain is treated approximately 35% of the time (Ranger, Johnston, & Anand, 2007; Simons et al., 2003) despite caregiver knowledge that pain exists in this fragile population (Anand et al., 2006; Anderson et al., 2007; Dodds, 2003). Explanations for failure to adequately treat pain from a pharmacologic standpoint include: fear of over medicating, respiratory depression, hypotension, toxicity, and creating dependency (Dodds, 2003; Simons & Tibboel, 2006; Stevens, Gibbins, & Frank, 2000). Addiction has also been cited as a concern (Byrd, Gonzales, & Parsons, 2009; Dodds, 2003; Simons & Tibboel, 2006; Stevens et al., 2000) even though addiction is not possible in neonates (Byrd et al., 2009). In addition, 80% of analgesic medications used in NICUs are not licensed for neonatal use (Conroy, McIntyre, & Choonara, 1999).

Background

In the earliest studies of infant pain, there was disagreement as to whether infants actually feel pain (Franck, 1987). According to the literature from the past 10 years, nurses now have an acceptable level of knowledge regarding pain in preterm and term infants (Breau et al., 2006; Byrd et al., 2009; Halimaa, Vehvilainen-Julkunen, & Heinonen, 2001; Polkki et al., 2010; Porter, Wolf, Gold, Lotsoff, & Miller, 1997; Reyes, 2003).

Nurses consistently identified behavioral cues as the most frequently associated indicators for pain in critically ill infants (Breau et al, 2004; Dick, 1993; Dodds, 2003; Franck, 1987; Pidgeon, McGrath, Lawrence, & MacMurray, 1989; Shapiro, 1993; Young, Barton, Richardson-Dawson, & Troutman, 2008) and used fewer pain indicators in the assessment of intubated than non-intubated infants (Howard & Thurber, 1998). Nurses were in general agreement about the intensity of pain associated with the most common pain producing procedures (Anderson et al., 2007; Dodds, 2003; Reyes, 2003) and typically rated those procedures as more painful than their physician counterparts (Breau et al., 2004; Cignacco et al., 2008; Porter et al., 1997; Simons et al., 2003). Furthermore, nurses gave higher mean pain intensity scores to term infants, suggesting that the differences in vigor of the pain response between preterm and term infants influenced their nursing care (Shapiro, 1993).

Several investigators studied self-reported pain management interventions (Anderson et al., 2007; Byrd et al, 2009; Dick, 1993; Franck, 1987; Halimaa et al., 2001; Porter et al., 1997; Reyes, 2003). To date, only one study compared self-reported assessments to actual practice. Findings indicated that nurses do not consistently document use of a pain scale for pain assessment nor reassess the infant's response to pain interventions (Reyes, 2003). In one study, only 35% of infants received preemptive analgesics prior to painful procedures, and 39.5% of infants did not receive any analgesic therapy during their entire NICU stay (Simons et al., 2003).

NICU nurses have reported problems they perceived as barriers to effectively managing neonatal pain. These barriers included: (a) unclear unit and organizational policies and procedures, (b) uncertainty about the safety of pharmacologic agents, (c)

inadequate staff knowledge of pain, (d) pain scales which do not accurately assess infant pain, (e) inconsistent pain management practices, and (f) physicians beliefs about pain (Byrd et al., 2009). Knowledge deficits and perceived barriers to pain management have the potential to impact openness to changes in practice.

Pain inherently involves a degree of subjectivity (Bernhofer, 2011). Therefore, assessment and decisions regarding pain management can be influenced by biases and personal values of caregivers (Bernhofer, 2011). Bias and disparities in the treatment of neonatal pain have not been documented in the literature. However, in the adult population, pain management has been biased by age (Green & Hart-Johnson, 2010; Motov & Kahn, 2009), gender (Green & Hart-Johnson, 2010; Motov & Kahn, 2009; Safdar et al., 2009), and certain patient diagnostic groups (Brockopp, Ryan, & Warden, 2003).

The purposes of this study were to examine NICU nurses' (a) knowledge about pain in neonates, (b) knowledge of pain intensity produced by procedural interventions and actions taken to manage procedural pain, (c) bias in pain management of certain types of infants, and (d) self-reported barriers in managing pain.

Methods

Design

An exploratory descriptive design was used for this study. Responses to a 36-item questionnaire including an open-ended question were collected. A retrospective chart review was also conducted. Approval was obtained from the Institutional Review Board.

Setting and Sample

All nurses (n = 117) employed at a full time equivalent of 0.5 or greater in the 66 bed Level III NICU at a tertiary academic medical center in the Midwest were invited to complete a questionnaire. Pediatric pool nurses and traveling contract nurses were excluded. Forty-three nurses (37%) responded. This NICU had an average daily census of 55 patients. Total yearly admissions ranged between 800-850 patients (deGraaff & Bada, 2008; deGraaff & Bada, 2009). Electronic medical records were reviewed retrospectively for 40 consecutive admissions from November 2, 2010 to December 14, 2010. Records of infants who died at less than 24 hours of age were excluded.

Measures

Neonatal Intensive Care Pain Questionnaire

The Neonatal Intensive Care Pain Questionnaire was developed for this study. Demographic data collected from the nurses include age, nursing degree, years of nursing experience, years of NICU nursing experience, and prior personal experience with pain. The questionnaire contains a series of 36 items with four subscales to assess NICU nurses' knowledge of pain in neonates, knowledge of pain intensity of procedures and interventions to manage procedural pain, bias in pain management of certain types of infants, and self-reported barriers in managing pain. The items and expected responses for the first two subscales were derived from a comprehensive review of the literature. Scenarios to assess bias in pain management were adapted from the Clinical Decision-Making Questionnaire for Pain Management in adult populations (Brockopp et al., 2003). The final subscale consisted of one open ended question to assess nurses' self-reported barriers in managing neonatal pain. To test for face validity and content

validity, the questionnaire was administered to a panel of nine clinical experts.

Modifications in content and phrasing were made based on their recommendations.

The first subscale contains 10 true/false questions to assess general knowledge of pain in neonates. Expected responses were combined to generate a total knowledge score of 0 to 10. In the second subscale, nurses rated pain intensity as none, mild, moderate, or severe for 10 procedures commonly performed in NICUs. Participants then selected the best intervention to manage the resulting pain for each of the 10 procedures. Expected responses were combined to generate a total procedure knowledge score of 0 to 20.

Higher scores for each of these subscales indicated better knowledge of pain in neonates.

The bias subscale consisted of five scenarios experienced in NICUs. Using a 5-point Likert scale, nurses rated the time and energy they were willing to spend in managing the pain of the infant in each scenario (1 = little time and energy; 5 = maximum time and energy). Scores for the 5 items were combined to generate a total bias score of 0 to 25. Lower scores indicated higher bias.

Chart Review

Pain assessment, intervention, and reassessment data were collected by retrospective review of the electronic medical record for the first 24 hours post admission. This time interval was selected based on the work of Simmons et al. (2003), which identified the highest exposure of painful procedures occurred on day one of admission. Pain intervention data were also collected for the following procedures performed during the same time period: chest tube insertion, endotracheal tube (ETT) intubation, ETT suctioning, peripherally inserted central catheter (PICC) insertion, peripheral intravenous (IV) insertion, lumbar puncture, intramuscular (IM) injection, heel

lance, nasogastric (NG) tube insertion, and tape removal. Gestational age and gender were also collected.

Data Analysis

Data were analyzed using IBM SPSS Statistics 20.0 (Armonk, NY). Both descriptive and inferential statistics were used to analyze the data. The level of effectiveness of pain management based on gestational age groups was performed using a Kruskal-Wallis test. Bias in pain management interventions based on gender was assessed using a Chi square test. Significance was set at $p < .05$. Self-reported barriers to pain management were transcribed and categorized into reoccurring themes using qualitative analysis.

Results

Demographics

The average age of the nurse participants was 33.7 years (range 22 to 58). The majority (66.7 %) were BSN prepared with an average of 8.58 years (range 0 to 34 years) of nursing experience of which 7.6 years (range 0 to 33 years) was in neonatal intensive care. Most (62.8%) of the nurses reported that at some point they had experienced significant pain that required medical management (Table 4.1).

Two hundred and twenty procedures were documented in the 40 infant records reviewed. The most frequently occurring procedure was heel lance (36.4%), followed by ETT suctioning (24.6%), IV insertion (15.9%), IM injection (10%), NG tube insertion (9.1%), ETT intubation (1.8%), lumbar puncture (1.8%), and PICC insertion (0.5%). Chest tube insertion and tape removal were not present in this sample (Table 4.3). The

mean gestational age was 35 weeks (range 24 to 41 weeks). The majority (52.5%) of infants was male.

Knowledge of Neonatal Pain Subscale

Nurses in this study were not aware that neonates experience more pain than older children and adults (88.4%) or that preterm infants experience more pain than term infants (74.4%). Three fourths incorrectly believed that pain pathways are completely developed at birth. More than half (55.8 %) responded that neonates can easily become addicted to narcotics. Nurses were cognizant that preterm infants express pain differently than full term infants (72.1%) and that gestational age affects how pain is expressed (76.7%) in this population. They were also aware that pain may alter the neurodevelopment of preterm infants (95.3%). Nurses unanimously agreed that neonates require analgesics for pain management and that pain is undertreated in NICUs across the country (Table 4.2). Total knowledge scores ranged from 4 to 9 ($M = 6.51$, $SD = 1.369$).

A two-way between-groups analysis of variance was conducted to explore the impact of nurses' age, education, years of NICU experience, total years of nursing experience, and prior pain experiences on total knowledge scores. The main effect for age $F(6, 23) = .487$, $p = .81$, years of NICU experience, $F(2, 23) = 1.57$, $p = .23$, and prior pain experiences, $F(1, 23) = 1.54$, $p = .23$ did not reach statistical significance. The interaction effect between education and total years of nursing experience was not statistically significant $F(5, 27) = 1.85$, $p = .14$. There was a statistically significant main effect for education, $F(1, 32) = 7.48$, $p = .01$ (Figure 4.1) and for total years of nursing experience, $F(8, 32) = 2.34$, $p = .04$ (Figure 4.2). The effect size was large for both education (partial eta squared = .19) and total years of nursing experience (partial eta

squared = .37). The results indicate that BSN prepared nurses ($M = 6.92$, $p = .01$) and nurses with more total years of nursing experience ($M = 8.58$, $p = .04$) have better knowledge about pain in neonates.

Pain Intensity and Intervention Subscale

Ninety-three percent of the nurses correctly reported that chest tube insertion results in severe pain. Procedures identified as causing moderate pain included PICC insertion (51.2%), lumbar puncture (61.9%), and ETT intubation (67.4%). Procedures identified as producing mild pain were tape removal (93%), ETT suctioning (58.1%), IV insertion (67.4%), IM injection (60.5%), heel lance (76.7%), and NG tube insertion (67.4%; Table 4.3).

Narcotics were recommended to treat the pain of chest tube insertion (100%) and ETT intubation (83.7%). Sucrose with or without the addition of a pacifier was recommended for PICC insertion (76.7%), IV insertion (88.4%), IM injection (67.4%), and heel lance (74.4%). Swaddling/containment was selected for NG tube placement (53.5%). Managing the pain from lumbar puncture was equally divided between sucrose (37.2%) and narcotic administration (37.2%). Sucrose and swaddling/containment were each recommended 41.9% of the time for treating the pain from tape removal. Just over half (51.2%) of the nurses reported that endotracheal tube suctioning did not require pain management (Table 4.3).

Mean scores were 4.42 ($SD = 1.592$) for pain intensity of procedures, 8.02 ($SD = 1.371$) for best interventions to manage procedural pain, and 12.44 ($SD = 2.025$) for total procedure knowledge. The results of a two-way between-groups analysis of variance conducted to explore the impact of nurses' age, education, years of NICU experience,

total years of nursing experience, and prior pain experiences on total pain intensity with intervention scores were not significant.

Intervention for Procedural Pain

The most frequently reported procedure was heel lance (n = 80) followed by ETT suctioning (n = 54), IV insertion (n = 35), IM injection (n = 22), NG insertion (n = 20), lumbar puncture (n = 4), ETT insertion (n = 4), and PICC insertion (n = 1). Of the 220 procedures performed, pain was treated only 20% (n = 45) of the time. The most commonly reported intervention was swaddling/containment used during ETT suctioning (n = 13), IV insertion (n = 5), heel lance (n = 3), IM injection (n = 2), and NG tube insertion (n = 2). Sucrose with or without a pacifier was used for NG tube insertion (n = 1). Five infants receiving narcotic analgesics experienced a combination of ETT suctioning (n = 10), heel lance (n = 3), NG tube placement (n = 3), and IV insertion (n = 2) and ETT intubation (n = 1; Table 4.3).

Bias in Managing Pain Subscale

Total bias scores ranged from 19 to 25 (Figure 4.3). None of the items were rated at one or two, suggesting that nurses were willing to spend at least a moderate amount of time and energy treating the pain of infants in each of the circumstances. The scenario depicting a baby with neonatal abstinence syndrome received the lowest score (M = 4.42, SD = .731) indicating the highest level of bias. The second lowest score (M = 4.65, SD = .573) described an infant with Down Syndrome. Two scenarios, one describing an extremely preterm infant born to a very young mother and one in which a very preterm infant was born to a young mother and an elderly father were rated the same (M = 4.77, SD = .480). The highest rating, indicating the least bias, involved a term infant with

multiple congenital anomalies born to closely related Mennonite parents ($M = 4.79$, $SD = .412$; Table 4.4). There was a significant difference between at least two of the bias scenarios with the difference most notably between the infant experiencing neonatal abstinence syndrome and the infant of related parents ($F(2, 212) = 3.482$, $p = .009$). The results of a two-way between-groups analysis of variance conducted to explore the impact of nurses' age, education, years of NICU experience, total years of nursing experience, and prior pain experiences on total bias scores were not significant.

Bias in Managing Pain Based on Gender and Gestational Age

A Kruskal-Wallis test was conducted comparing the effectiveness of pain interventions to groupings of gestational age. No significant difference was found ($H(3) = 3.452$, $p = .327$) indicating the effectiveness of pain management did not differ based on degree of prematurity. A Chi-Square test was calculated comparing the effectiveness of pain management based on gender. No significant difference was found ($\chi^2(2) = 2.115$, $p = .347$), suggesting the effectiveness of pain management did not differ based on the gender of the infant.

Self-Reported Barriers to Pain Management

Most often, nurses reported physician pain management practices as the principal barrier to managing pain for their patients (66.7 %). They stated that physicians in this unit did not have a standardized approach to pain management. Resident physicians in particular were hesitant to order narcotics and frequently undermanaged pain with small intermittent doses rather than continuous infusion for post-operative patients (Table 4.5).

Inadequate knowledge among physicians and nurses was the second theme identified (14.3%). Nurses suggested that physicians had a knowledge deficit regarding

pain experiences of neonates, recounting that some physicians believe that neonates have a diminished capacity to feel pain. Nurses identified themselves as having difficulty recognizing pain cues in post-operative infants receiving paralytic agents, resulting in untreated pain, which was then difficult to manage (Table 4.5).

Poor communication and teamwork (9.5%) emerged as the third barrier to effective pain management. Nurses reported that physicians' undervalued the bedside nurse's assessment of pain and were many times unwilling to work toward resolution for the patient. Nurses stated that they were advocates for their patients despite the constant struggle it presented. They believed inadequate communication among the medical team and between physicians and nurses resulted in less than optimal outcomes for the patient (Table 4.5).

The final barrier reported was rushed care (9.5%). Nurses identified that when they or their physician counterparts were in a hurry, pain was not managed effectively. One nurse shared that at times, the effect from a painful procedure was perceived to be shorter than the effects from medication, resulting in her selecting a less effective, shorter acting pain intervention, which may not have provided adequate pain management. Nurses shared that because they were rushing, physicians did not want to order or wait for pain medication to take effect before performing a painful procedure (Table 4.5).

Discussion

Knowledge Barrier

Nurses in this study understood that gestational age and prematurity affects the expression of pain in neonates, and pain may change neurodevelopmental pathways. They were unaware that preterm infants experience more pain than their full term

counterparts, or that neonates experience more pain than older children and adults. Nurses prepared at the baccalaureate level and nurses with higher years of total nursing experience had better knowledge of neonatal pain. This was consistent with findings reported by Polkki et al. (2010).

In general, nurses' rankings of the intensity of painful interventions were lower than findings reported in prior studies (Akuma & Jordan, 2012; Anderson et al., 2007; Cignacco et al., 2008; Dodds, 2003; Shapiro, 1993; Simons et al., 2003). Yet, interventions identified to manage painful procedures were more often consistent with the literature. This finding was reflected in the subscales comprising the total procedure knowledge score. The mean score for best intervention to treat pain ($M = 4.42$) was nearly half that of the pain intensity score ($M = 8.01$). These findings suggest that despite underestimating the amount of pain caused by procedures, nurses would still use effective interventions to manage pain.

Consistent with the literature, nearly all nurses in this study agreed that chest tube insertion produces severe pain necessitating narcotic analgesia (Anderson et al., 2007; Cignacco et al., 2008; Dodds, 2003; Porter et al., 1997). Other consistencies included a moderate pain rating for PICC insertion and mild pain ratings for NG tube placement and tape removal (Cignacco et al., 2008; Dodds, 2003; Porter et al., 1997; Simons et al., 2003). The remaining procedures were consistently ranked one level below that which was supported in the literature. With the exception of pain management for ETT suctioning, best interventions were consistent with reports in prior studies. Endotracheal tube suctioning is understood to cause pain. Yet the majority of nurses in this study reported that pain management for ETT suctioning was not indicated.

Practice Barrier

In this study, procedural pain was treated only 20% of the time. This finding was much lower than the 35% reported in earlier studies (Ranger et al., 2007; Simons & Tibboel, 2006). Consistent with the literature, comfort measures were employed more often than pharmacologic agents, but were still underused (Anderson et al., 2007; Byrd et al., 2009; Simons et al., 2003).

Bias Barrier

Bias in pain management was reported in each of the case scenarios. Nurses were least likely to expend energy managing the pain of infants with neonatal abstinence syndrome (Table 4.4). This is particularly concerning as the rate of neonatal abstinence syndrome has tripled since 2000 (Patrick et al., 2012). Brockopp, Ryan, and Warden (2003) reported similar findings among nurses and nursing students who were least likely to expend time and energy managing pain in substance abusing adults. Gender and age bias have also been reported in the adult literature (Green & Hart-Johnson, 2010; Motov & Kahn, 2009; Safdar et al., 2009) but were not a significant finding in this study. Because the failure to treat rate was 80%, it is possible that there were not enough interventions to detect differences.

Self-Reported Barriers

Nurses reported that the physicians' pain management practices were the primary barrier to effective pain management in their unit. Prior studies documented that physicians repeatedly ranked the intensity of procedural pain lower than nurses did (Akuma & Jordan, 2011; Anderson et al., 2007; Cignacco et al., 2008; Simons et al., 2003), which may influence their willingness to treat with analgesics. Additional barriers

included knowledge deficits of nurses and physicians, poor communication and teamwork, and rushed care. Byrd et al. (2009) reported similar findings in physician practice patterns and knowledge deficits of caregivers in NICUs.

Study Limitations

The response rate was just below the recommended 40% necessary to yield data which may be considered representative of the entire sample (Kramer et al., 2009). Additionally, nurses who chose to respond may represent those who had a heightened interest in neonatal pain. Protecting the anonymity of the participants eliminated the possibility of correlating knowledge and bias to documented practice.

Conclusion and Recommendation for Future Study

Knowledge deficits among nurses and physicians, nursing education, total years of nursing experience, and nurses' bias toward certain types of infants appeared to have affected pain management in this NICU. Self-reported barriers of physician pain management practices, lack of communication and teamwork, and rushed care may also have contributed to poor pain management practices. Based on the findings of this study, continued exploration of the gap between knowledge and the practice is warranted. Since nurses are not solely responsible for pain management, an interdisciplinary approach may reveal additional insights and findings. Surveys have been the primary approach to examine caregiver knowledge and self-reported pain management practices. Over time little change in pain management practices has occurred. A qualitative approach specifically exploring the knowledge-practice gap may identify the supports or triggers that lead to the decision to treat or not, thereby effecting change. To date, this was the

first study to explore and report bias in the treatment of neonatal pain. This finding may be important and merits continued exploration on an interdisciplinary level.

Table 4.1 Demographic Characteristics of Nurses

	Frequency	%
Age (n = 43)		
≤ 25 years	14	32.6
26 – 30 years	8	18.6
31 – 35 years	6	14.0
36 – 40 years	7	16.3
41 – 45 years	1	2.3
46 – 50 years	3	7.0
51 – 55 years	2	4.7
56 – 60 years	2	4.7
Degree (n = 42)		
ADN	14	33.3
BSN	28	66.7
Years NICU Experience (n = 43)		
< 1 year	2	4.7
1 – 5 years	22	51.1
6 – 10 years	8	18.6
11 – 15 years	4	9.3
16 – 20 years	2	4.7
21 – 25 years	2	4.7
26 – 30 years	2	4.7
31 – 35 years	1	2.3
Total Years of Nursing Experience		
< 1 year	2	4.7
1 – 5 years	22	51.1
6 – 10 years	6	14.0
11 – 15 years	4	9.3
16 – 20 years	4	9.3
21 – 25 years	1	2.3
26 – 30 years	1	2.3
31 – 35 years	3	7.0
Prior Painful Experience		
Yes	27	62.8
No	16	37.2

Table 4.2 Knowledge of Neonatal Pain Subscale

	Correct Response	
	n	%
Pain medication is over used in NICUs	43	100
Neonates have immature nervous systems and do not need analgesics for pain management	43	100
Pain can cause long term neurodevelopmental changes in preterm infants	41	95.3
Pain assessment leads to more effective pain management	38	88.4
Gestational age affects the expression of pain in neonates	33	76.7
Preterm infants express pain the same as term infants	31	72.1
Neonates can easily become addicted to narcotics	24	55.8
Development of pain pathways is complete at birth	11	25.6
Preterm infants experience more pain than term infants	11	25.6
Neonates feel the same pain as older children and adults	5	11.6

Table 4.3 Pain Intensity and Interventions Subscale with Documented Interventions

	Chest Tube Insertion		PICC Insertion		Lumbar Puncture		ETT Intubation		ETT Suctioning		IV Insertion		IM Injection		Heel Lance		NG Tube Insertion		Tape Removal	
	n	%	n	%	N	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
	Pain Intensity (n = 43)																			
No Pain	0	0	0	0	0	0	0	0	17	39.5	0	0	0	0	1	2.3	11	25.6	0	0
Mild	0	0	20	46.5	2	4.8	5	11.6	25	58.1	29	67.4	26	60.5	33	76.7	29	67.4	40	93
Moderate	3	7	22	51.2	26	61.9	29	67.4	0	0	14	32.6	14	32.6	9	20.9	3	7	3	7
Severe	40	93	1	2.3	14	33.3	9	20.9	1	2.3	0	0	3	7	0	0	0	0	0	0
Best Intervention to Manage Pain (n = 43)																				
None Needed	0	0	0	0	0	0	1	2.3	22	51.2	0	0	1	2.3	2	4.7	6	14	7	16.3
Swaddle/Containment	0	0	1	2.3	0	0	4	9.3	19	44.2	3	7	2	4.7	8	18.6	23	53.5	18	41.9
Sucrose ± Pacifier	0	0	33	76.7	16	37.2	1	2.3	2	4.7	38	88.4	29	67.4	32	74.4	14	32.6	18	41.9
Tylenol	0	0	6	14	11	25.6	1	2.3	0	0	2	4.7	11	25.6	1	2.3	0	0	0	0
Morphine/Fentanyl	43	100	3	7	16	37.2	36	83.7	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.3 (Continued)

	Chest Tube Insertion		PICC Insertion		Lumbar Puncture		ETT Intubation		ETT Suctioning		IV Insertion		IM Injection		Heel Lance		NG Tube Insertion		Tape Removal	
	n	%	n	%	N	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
	Documented Intervention for Performed Procedures (n = 220)																			
Procedure Frequency	0	0	1	0.5	4	1.8	4	1.8	54	24.6	35	15.9	22	10	80	36.4	20	9.1	0	0
None	0	0	1	100	4	100	3	75	31	57.4	28	80	20	90.9	74	92.5	14	70	0	0
Swaddle/Containment	0	0	0	0	0	0	0	0	13	24.1	5	14.3	2	9.1	3	3.8	2	10	0	0
Sucrose ± Pacifier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0
Tylenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Morphine/Fentanyl	0	0	0	0	0	0	1	25	10	18.5	2	5.7	0	0	3	3.8	3	15	0	0

Bolded entries represent consensus of correct response based on literature review

Table 4.4 Bias in Managing Pain Subscale: Ratings of time and energy willing to spend managing pain

	3		4		5		Mean	SD
	n	%	n	%	n	%		
Isaiah is a term infant born to Mennonite parents who are first cousins. He has multiple congenital anomalies including osteogenesis imperfecta. Isaiah has multiple fractures from the birth process.			9	20.9	34	79.1	4.79	.412
Kahlia was born at 23 4/7 weeks gestation to a 14 year old G ₁ P ₁ single black female. She has bilateral grade IV intraventricular hemorrhages. Kahlia is on maximum ventilator support, has bilateral chest tubes, and is having one of them replaced.	1	2.3	8	18.6	34	79.1	4.77	.480
Nevaeh was born at 28 weeks gestation to a 22 year old mother and a 60 year old father. She developed NEC with bowel perforation. Bilateral abdominal drains were placed at the bedside to manage her condition until she is stable enough to go to the OR.	1	2.3	8	18.6	34	79.1	4.77	.480
Turner is a term infant born with Down Syndrome. He had surgery for duodenal atresia earlier today.	2	4.7	11	25.6	30	69.8	4.65	.573
Carly was born at 35 weeks gestation to a 28 year old G ₆ P ₆ single white female. Mom self-reports using crack cocaine, marijuana, and alcohol. Carly is exhibiting symptoms of Neonatal Abstinence Syndrome.	6	14	13	30.2	24	55.8	4.42	.731

Scored on a Likert scale from 1 to 5; 1 = little time and energy managing pain, 5 = maximum time and energy managing pain

Table 4.5 Self – Reported Barriers to Pain Management Subscale: Themes and Examples

	Frequency	
	n	%
Physician’s Pain Management Practices	28	66.7
<i>Physician’s reluctant to order pain management</i>		
<i>Doctors seem to be hesitant to order pain meds even when it is obvious that it is needed</i>		
Knowledge Deficit	6	14.3
<i>Doctors and surgeons outside of NICU misunderstand pain in neonates</i>		
<i>Patients return from the OR paralyzed and nurses do not see “symptoms” of pain & therefore do not give pain medication</i>		
Poor Communication and Teamwork	4	9.5
<i>Lack of communication with providers</i>		
<i>Frequently physicians undervalue the bedside nurses’ assessment of a patient’s pain. It can often be a struggle to get med orders for pain management.</i>		
Rushed Care	4	9.5
<i>Physicians sometimes do not want to wait until pain meds are given and take effect before starting non-emergent procedures.</i>		
<i>Lack of time because MD in a hurry; nurse in a hurry</i>		

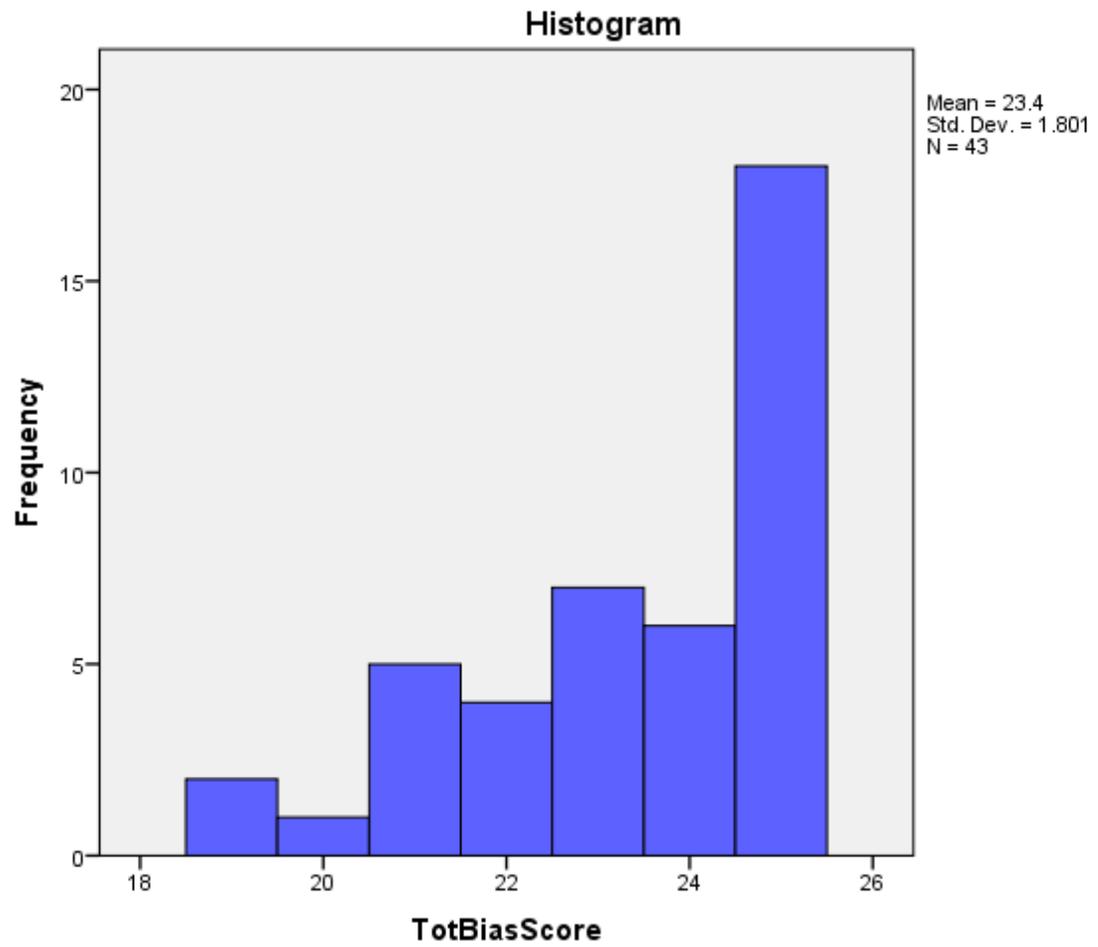
Figure 4.1 Total Knowledge Score by Nursing Degree



Figure 4.2 Total Knowledge Score by Years' Experience



Figure 4.3 Range of Total Bias Scores



CHAPTER FIVE

Conclusions and Discussions

The purpose of this dissertation was to explore potential barriers nurses experience in providing effective pain management for preterm and critically ill infants in neonatal intensive care units (NICUs). The specific aims of the study conducted were to examine (a) NICU caregivers' knowledge about pain, (b) scales used to evaluate pain in infants, (c) NICU nurses' documented pain practices, and (d) NICU nurses' bias in treating pain of certain types of infants. Three manuscripts were presented.

The first manuscript presented an integrated review of published literature that reported data on caregiver knowledge, barriers, and bias in treating the pain of preterm and critically ill neonates in the past 25 years. The review revealed that over time, knowledge of pain in this fragile population evolved from the belief that infants do not feel pain (Rouzan, 2001), to the knowledge that neonates are more sensitive to pain than older children and adults (Byrd, Gonzales, & Parsons, 2009; Schultz, Loughran-Fowlds, & Spence, 2009) and conclusions that preterm infants may actually experience more intense pain responses because of their inability to blunt the experience (Anand & Carr, 1989; Evans, 2001; Simons & Tibboel, 2006).

Over time, caregivers demonstrated adequate knowledge of pain and pain cues (Reyes, 2003). Physicians consistently rated procedural pain lower than nurses did (Akuma & Jordan, 2011; Anderson Greve-Isdahl, & Jylli, 2007; Cignacco et al., 2008; Simons et al., 2003). While the majority of nurses agreed that pain scales accurately assess pain (Reyes, 2003), they preferred to rely on personal experiences or observed infant cues for pain assessment (Akuma & Jordan, 2011; Byrd et al., 2009; Dodds, 2003).

An evaluation of documented practice revealed that pain assessments were performed only 37 to 44% of the time (Reyes, 2003). Throughout the decades, caregivers consistently reported that pain is undertreated (Anderson et al., 2007; Byrd et al., 2009; Simons et al., 2003). Self-reported barriers to effective pain management included knowledge deficits regarding pain assessment and management, inconsistent physician practice patterns, and inappropriate pharmacologic weaning protocols.

To date, bias in the management of neonatal pain has not been investigated and represents a gap in the literature. A body of knowledge exists regarding age (Green & Hart-Johnson, 2010; Motov, & Kahn, 2009) and gender bias in the management of pain in adult patients (Green & Hart-Johnson, 2010; Motov, & Kahn, 2009; Safdar et al., 2009). Nurses' willingness to expend time and energy managing adult pain based on certain diagnostic groups has been reported (Brockopp, Ryan, & Warden, 2003).

The second manuscript is a systematic review of nine multidimensional pain scales developed for use in preterm and critically ill infants. Variation in the reliability and validity of these scales is noted. Except for the CRIES and the SUN, bedside nurses reported that each of the scales were easy to use. The PAT, CRIES, and NIPS were compared to scales not intended for use in non-verbal or preterm populations. Scores for the PAT may be biased since the scale contains a scored component that is based on the clinician's subjective assessment of pain. The COVERS and the N-PASS are the newest of the nine scales and warrant additional validity and reliability testing. The PIPP is the most tested scale to date, yet has not emerged as the gold standard.

The final manuscript presents the findings from an exploratory study of potential barriers and biases, which may influence nurses' ability to effectively manage pain in

preterm and critically ill neonates. Nurses in this study were unaware that preterm infants experienced more pain than their term counterparts, or that neonates experience more pain than older children and adults. Nurses prepared at the baccalaureate level ($M = 6.92$, $p = .01$), and nurses with higher years of total nursing experience ($M = 8.58$, $p = .04$) had better knowledge of neonatal pain.

In general, nurses ranked the intensity of painful interventions lower than findings reported in prior studies, yet interventions identified to manage that pain were more often consistent with reported findings. The mean score for best intervention to treat pain ($M = 8.01$) was nearly double that of the pain intensity score ($M = 4.42$) suggesting that despite underestimating the amount of pain caused by procedures, nurses would use effective interventions to manage pain. Two hundred and twenty procedures were performed during the first 24 hours of admission in 40 neonates. Of these, only 20% ($n = 45$) had a documented intervention to manage pain indicating that the gap between knowledge and practice still exists in this NICU.

The amount of time and energy nurses were willing to invest in managing pain of certain types of infants suggested a bias in care does exist. Nurses were least willing to invest time managing the pain of infants with neonatal abstinence syndrome. Further investigation is warranted, as this was the first study to report nurses' bias in managing neonatal pain. Bias toward gender and gestational age were not found to be significant and may have been the result of the high rate of failure to treat.

Nurses self-reported that physician practice was the primary barrier to effective pain management in their unit. They also identified knowledge deficits among physicians and nurses, poor communication and teamwork, and rushed care as barriers

affecting their ability to effectively manage pain. Similar findings regarding physician practice patterns and knowledge deficits had been identified in prior work (Byrd, 2009).

Based on the findings of this dissertation work, continued exploration of bias and a qualitative examination of the gap between knowledge and pain management practices are warranted. Because nurses are not solely responsible for pain management, an interdisciplinary approach may reveal additional insights and findings. Bias may exist among other healthcare providers as well.

References

Chapter One

- Abdulkader, H. M., Freer, Y., Garry, E. M., Fleetwood-Walker, S. M. & McIntosh, N. (2008). Prematurity and neonatal noxious events exert lasting effects on infant pain behaviour. *Early Human Development*, 84, 351-355. doi: 10.1016/j.earlhumdev.2007.09.018
- Ahn, Y. & Jun, Y. (2007). Measurement of pain-like response to various nicu stimulants for high-risk infants. *Early Human Development*, 83, 255-262. doi: org/1016/j.earlhumdev.2006.05.022
- Anand, K. J., Aranda, J. V., Berde, C. B., Buckman, S., Capparelli, E. V., Carlo, W., ... Walco, G. A. (2006). Summary proceedings from the neonatal pain-control group. *Pediatrics*, 117(3) S9-S22. doi: 10.1542/peds.2005-06200
- Anand, K. J. S. & Carr, D. B. (1989). The neuroanatomy, neurophysiology, and neurochemistry of pain, stress, and analgesia in newborns and children. *Pediatric Clinics of North America*, 36, 795-822.
- Anderson, R. D., Greve-Isdahl, M. & Jylli, L. (2007). The opinions of clinical staff regarding neonatal procedural pain in two Norwegian neonatal intensive care units. *Acta Paediatrica*, 96(7), 1000-1003. doi: 10.1111/j.1651-2227.2007.00190.x
- Bouza, H. (2009). The impact of pain in the immature brain. *The Journal of Maternal-Fetal and Neonatal Medicine*, 22(9), 722-732. doi: 10.3109/14767050902926962
- Brummelte, S., Grunau, R. E., Chau, V., Poskitt, K. J., Brant, R., & Vinall, J., ... Miller, S. P. (2012). Procedural pain and brain development in premature newborns. *American Neurological Association*, 71, 385-396. doi: 10.1002/ana.22267

- Carbajal, R., Rousset, A., Danan, C., Coquery, S., Nolent, P. & Ducrocq, S., ...Breart, G. (2008). Epidemiology and treatment of painful procedures in neonates in intensive care units. *Journal of the American Medical Association*, 300(1), 60-70.
- Duhn, L. I. & Medeves, J. M. (2004). A systematic integrative review of infant pain assessment tools. *Advances in Neonatal Care*, 4(3), 126-140. doi: 10.1016/j.adnc.2004.04.005
- Evans, J. C. (2001). Physiology of acute pain in infants. *Newborn and Infant Nursing Reviews*, 1(2), 75-84. doi: 10.1053/nbin.2001.25302
- Gibbins, S., Stevens, B., Beyene, J., Chan, P. C., Bagg, M. & Asztalos, E. (2008). Pain behaviours in extremely low gestational age infants. *Early Human Development*, 84, 451-458. doi: 10.1016/j.earlhumdev.2007.12.007
- Gibbins, S., Stevens, B., McGrath, P. J., Yamda, J., Beyene, J. & Breau, L., ...Ohlsson, A. (2007). Comparison of pain responses in infants of different gestational ages. *Neonatology*, 93(1), 10-18. doi: 10.1159/000105520
- Guinsburg, R., Peres, C., Almedia, M., Balda, R., Berenguel, R. & Tonelotto, J., ...Kopelmann, B. I. (2000). Differences in pain expression between male and female newborn infants. *Pain*, 85, 127-133. doi: org/10.1016/S0304-3959(99)00258-4
- Hermann, C., Hohmeister, J., Demirakca, S., Zohsel, K. & Flor, H. (2006). Long-term alteration of pain sensitivity in school-aged children with early pain experiences. *Pain*, 125, 278-285. doi: org/10.1016/j.pain.2006.08.026

- Hummel, P., Puchalski, M., Creech, S. D. & Weiss, M. G. (2008). Clinical reliability and validity of the n-pass: Neonatal pain, agitation and sedation scale with prolonged pain. *Journal of Perinatology*, 28, 55-60. doi: 10.1038/sj.jp.7211861
- International Association for the Study of Pain Task Force on Taxonomy (2001). Announcement: modification of pain definition. *IASP Newsletter*, 2, 2.
- Lucas-Thompson, R., Townsend, E. L., Gunnar, M. R., Georgieff, M. K., Guiang, S. F. & Ciffuentes, R. F., ... Davis, E. P. (2008). Developmental changes in the responses of preterm infants to a painful stressor. *Infant Behavior and Development*, 31, 614-623. doi: 10.1016/j.infbeh.2008.07.004
- Pereira, A., Guinsburg, R., Almeida, M., Monteiro, A., Santos, A. & Kopelman, B. (1999). Validity of behavioral and physiologic parameters for acute pain assessment of term newborn infants. *Sao Paulo Medical Journal*, 117(2), 72-80. doi: org/10.1590/S1516-31801999000200005
- Ranger, M., Johnston, C. & Anand, K. J. (2007). Current controversies regarding pain assessment in neonates. *Seminars in Perinatology*, 31(5), 283-288. doi: 10.1053/j.semperi.2007.07.003
- Schollen, J. (2005). Can cry in the newborn be used as an assessment of pain? *Acta Paediatrica*, 94(10), 1432-1436. doi: 10.1111/j.1651-2227.2005.tb01803.x
- Simons, S. H. & Tibboel, D. (2006). Pain perception development and maturation. *Seminars in Fetal & Neonatal Medicine*, 11, 227-231. doi: 10.1136/pmj.79.934.438
- Walden, M. (2001). Pain assessment and management-guideline for practice. Glenview, IL: National Association for Neonatal Nurses. Document 1222.

References

Chapter Two

- Akuma, A. O. & Jordan, S. (2011). Pain management in neonates: A survey of nurses and doctors. *Journal of Advanced Nursing*, 68(6), 1288-1301. doi: 10.1111/j.1365-2648.2001.05837.4
- Anderson, R. D., Greve-Isdahl, M. & Jylli, L. (2007). The opinions of clinical staff regarding neonatal procedural pain in two Norwegian neonatal intensive care units. *Acta Paediatrica*, 96(7), 1000-1003. doi: 10.1111/j.1651-2227.2007.00190.x
- Anand, K. J. S. & Carr, D. B. (1989). The neuroanatomy, neurophysiology, and neurochemistry of pain, stress, and analgesia in newborns and children. *Pediatric Clinics of North America*, 36, 795-822.
- Anand, K. J. S. & Hickey, P. R. (1987). Pain and its effects in the human neonate and fetus. *New England Journal of Medicine*, 317, 1321-1329.
- Breau, L. M., McGrath, P. J., Stevens, B., Beyene, J., Camfield, C. S. & Finley, G. A., ... Ohlsson, A. (2004). Healthcare professionals' perceptions of pain in infants at risk for neurological impairment. [Electronic version]. *BMC Pediatrics*, 4(23), 1-9. doi: 10.1186/1471-2431-4-23
- Breau, L. M., McGrath, P. J., Stevens, B., Beyene, J., Camfield, C. S. & Finley, G. A., ... O'Brien, K. (2006). Judgments of pain in the neonatal intensive care setting: A survey of direct care staffs' perceptions of pain in infants at risk for neurological impairment. *The Clinical Journal of Pain*, 22(2), 122-129.
- Byrd, P., Gonzales, I. & Parsons, V. (2009). Exploring barriers to pain management in newborn intensive care units: A pilot survey of nicu nurses. *Advances in Neonatal Care*, 9(6), 299-306. doi: 10.1097.ANC.06013e3181c1ff9c

- Carlson, K. L., Clement, B. A. & Nash, P. (1996). Neonatal pain: From concept to research questions and a role for the advanced practice nurse. *Journal of Perinatal and Neonatal Nursing*, 10(1), 64-71.
- Cignacco, E., Hamers, J. P., Stoffel, L., van Lindgen, R. A., Schultz, N. & Muller, R., ... Nelle, M. (2008). Routine procedures in NICUs: Factors influencing pain assessment and ranking by pain intensity. *Swiss Medical Weekly*, 138(33-34), 484-491.
- Dick, M. J. (1993). Preterm infants in pain: Nurses' and physicians' perceptions. *Clinical Nursing Research*, 2(2), 176-187. doi: 10.1177/105477389300200207
- Dodds, E. (2003). Neonatal procedural pain: A survey of nursing staff. *Paediatric Nursing*, 15(5), 18-21.
- Evans, J. C. (2001). Physiology of acute pain in infants. *Newborn and Infant Nursing Reviews*, 1(2), 75-84. doi: 10.1053/nbin.2001.25302
- Franck, L. S. (1987). A national survey of the assessment and treatment of pain and agitation in the neonatal intensive care unit. *Journal of Obstetrics, Gynecology and Neonatal Nursing*, 16(6), 387-393. doi: 10.1111/j.1552-6909.1987.tb01599.x
- Halimaa, S. L., Vehvilainen-Jukumen, K. & Heinonen, K. (2001). Knowledge, assessment and management of pain related to nursing procedures used with premature babies: Questionnaire study for caregivers. *International Journal of Nursing Practice*, 7, 422-430. doi: 10.1046/j.1440-172X.2001.00322.x
- Howard, V. A. & Thurber, F. (1998). The interpretation of infant pain: Physiological and behavioral indicators used by nicu nurses. *Journal of Pediatric Nursing*, 13(3), 164 -174. doi: org/10.1016/S0882-5963(98)80075-4

- International Association for the Study of Pain Task Force on Taxonomy (2001).
Announcement: modification of pain definition. *IASP Newsletter*, 2, 2.
- Jones, M. A. (1989). Identifying signs that nurses interpret as indicating pain in newborns. *Pediatric Nursing*, 15(1), 76-79.
- Melzack, R. & Casey, K. L. (1968). Sensory, motivational and central control determinants of pain: A new conceptual model. In D. Kenshalo (Ed), *The Skin Senses* (pp. 423-439). Springfield, Illinois: Charles C. Thomas.
- Melzack, R. & Wall, P. D. (1965). Pain mechanisms: A new theory. *Science*, 150(3699), 971-979.
- Pidgeon, H. M., McGrath, P. J., Lawrence, J. & MacMurray, S. B. (1989). Nurses' perceptions of pain in the neonatal intensive care unit. *Journal of Pain and Symptom Management*, 4(4), 179-183. doi: org/10.1016/0885-3924(89)90040-7
- Polkki, T., Korhonen, A., Laukkala, H., Saarela, T., Vehvilainen-Jukunen, K. & Peitila, A. M. (2010). Nurses' attitudes and perceptions of pain assessment in neonatal intensive care. *Scandinavian Journal of Caring Sciences*, 24, 49-55. doi: 10.1111/j.1471-6712.2008.00683.x
- Porter, F. L., Wolf, C. M., Gold, J., Lotsoff, D. & Miller, J. P. (1997). Pain and pain management in newborn infants: A survey of physicians and nurses. *Pediatrics*, 100(4), 626-632. doi: 10.1542/peds.100.4.626
- Reyes, S. (2003). Nursing assessment of infant pain. *Journal of Prenatal and Neonatal Nursing*, 17(4), 291-303. doi: 10.1542/peds.100.4.626

- Rouzan, I. A. (2001). An analysis of research and clinical practice in neonatal pain management. *Journal of the American Academy of Nurse Practitioners*, 13(2), 57-60. doi: 10.1111/j.1745-7599.2001.tb00218.x
- Schultz, M., Loughran-Fowlds, A. & Spence, K. (2009). Neonatal pain: A comparison of the beliefs and practices of junior doctors and current best practice. *Journal of Paediatrics and Child Health*, 46, 23-28. doi: 10.1111/j.1440-1754.2009.01612.x
- Shapiro, C. R. (1993). Nurses' judgments of pain in term and preterm newborns. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 22(1), 41-47. doi: 10.1111/j.1552-6909.1993.tb01781.x
- Simons, S. H. & Tibboel, D. (2006). Pain perception development and maturation. *Seminars in Fetal & Neonatal Medicine*, 11, 227-231. doi: 10.1136/pmj.79.934.438
- Simons, S. H., vanDijk, M., Anand, K. S., Roofthoof, D., van Lindgen, R. A. & Tibboel, D. (2003). Do we still hurt newborn babies? A prospective study of procedural pain and analgesia in neonates. *Archives of Pediatric and Adolescent Medicine*, 157, 1058-1064.
- Stevens, B. & Johnston, C. (1992). Assessment and management of pain in infants. *Canadian Nurse*, 88, 31-34.

References

Chapter Three

- Ahn, Y. & Jun, Y. (2007). Measurement of pain-like response to various nicu stimulants for high-risk infants. *Early Human Development*, 83, 255-262. doi: org/1016/j.earlhumdev.2006.05.022
- Anand, K. J., Aranda, J. V., Berde, C. B., Buckman, S., Capparelli, E. V., Carlo, W., ... Walco, G. A. (2006). Summary proceedings from the neonatal pain-control group. *Pediatrics*, 117(3) S9-S22. doi: 10.1542/peds.2005-06200
- Anand, K. J. & Carr, D. B. (1989). The neuroanatomy, neurophysiology, and neurochemistry of pain stress, and analgesia in newborns and children. *Acute Pain in Children*, 36(4), 795-822.
- Ballantyne, M., Stevens, B., McAllister, M., Dionne, K. & Jack, A. (1999). Validation of the premature infant pain profile in the clinical setting. *The Clinical Journal of Pain*, 15(4), 297-303.
- Bellieni, C. V., Cordelli, D. M., Caliani, C., Palazzi, N. F., Perrone, S. & Bagnoli, F., ... Buonocore, G. (2007). Inter-observer reliability of two pain scales for newborns. *Early Human Development*, 83, 549-552. doi: org/10.1016/j.earlhumdev.2006.10.1006
- Blauer, T. & Gerstmann, D. (1998). A simultaneous comparison of three neonatal pain scales during common nicu procedures. *The Clinical Journal of Pain*, 14(1), 39-47.
- Cignacco, E., Denhaerynck, K., Nelle, M., Buher, C. & Endberg, S. (2009). Variability in pain response to a non-pharmacological intervention across repeated routine pain

- exposure in preterm infants: A feasibility study. *Acta Paediatrica*, 98(1), 1-5. doi: 10.1111/j.1651-2227.2008.01203.x
- Cignacco, E., Mueller, R., Hamers, J. P. & Gessler, P. (2004). Pain assessment in the neonate using the bernese pain scale for neonates. *Early Human Development*, 78, 125-131. doi: 10.1016/j.earlhumdev.2004.04.001
- DeVon, H. A., Block, M. E., Moyle-Wright, P., Ernst, D. M., Hayden, S. J., Lazzara, D. J., ...Kostas-Polston, E. (2007). A psychometric toolbox for testing validity and reliability. *Journal of Nursing Scholarship*, 39(2), 155-164. doi: 10.1111/j.1547-5069.2007.00161x
- Duhn, L. I. & Medeves, J. M. (2004). A systematic integrative review of infant pain assessment tools. *Advances in Neonatal Care*, 4(3), 126-140. doi: 10.1016/j.adnc.2004.04.005
- Gibbins, S., Stevens, B., Beyene, J., Chan, P. C., Bagg, M. & Asztalos, E. (2008). Pain behaviours in extremely low gestational age infants. *Early Human Development*, 84, 451-458. doi: 10.1016/j.earlhumdev.2007.12.007
- Gibbins, S., Stevens, B., McGrath, P. J., Yamda, J., Beyene, J. & Breau, L., ...Ohlsson, A. (2007). Comparison of pain responses in infants of different gestational ages. *Neonatology*, 93(1), 10-18. doi: 10.1159/000105520
- Guinsburg, R., Peres, C., Almedia, M., Balda, R., Berenguel, R. & Tonelotto, J., ...Kopelmann, B. I. (2000). Differences in pain expression between male and female newborn infants. *Pain*, 85, 127-133. doi: org/10.1016/S0304-3959(99)00258-4

- Hand, I. L., Noble, L., Deiss, E., Wozniak, L. & Hall, C. (2010). Covers neonatal pain scale: Development and validation. *International Journal of Pediatrics*, 2010, 1-5. doi: 10.1155/2010/496719
- Hannallah, R. S., Broadman, L. M., Belman, A. S., Abramoqitz, M. D. & Epstein, B. S. (1987). Comparison of caudal and ileo-inguinal/ileo-hypogastric nerve blocks for control of post orchiopexy pain in pediatric ambulatory surgery. *Anesthesiology*, 66, 832-834.
- Hodgkinson, K., Bear, M., Thorn, J. & Van Blaricum, S. (1994). Measuring pain in neonates: Evaluating an instrument and developing a common language. *Australian Journal of Advanced Nursing*, 12(1), 17-22.
- Hudson-Barr, D., Capper-Michel, B., Lambert, S., Palermo, T. M., Morbeto, K. & Lombardo, S. (2002). Validation of the pain assessment in neonates (pain) scale with the neonatal infant pain scale (nips). *Neonatal Network*, 21(6), 15-21. doi: 10.1891/0730-0832.21.6.15
- Hummel, P., Lawlor-Kelan, P. & Weiss, M. G. (2009). Validity and reliability of the n-pass assessment tool with acute pain. *Journal of Perinatology*, 30, 474-478. doi: 10.1038/jp.2009.185
- Hummel, P., Puchalski, M., Creech, S. D. & Weiss, M. G. (2008). Clinical reliability and validity of the n-pass: Neonatal pain, agitation and sedation scale with prolonged pain. *Journal of Perinatology*, 28, 55-60. doi: 10.1038/sj.jp.7211861
- International Association for the Study of Pain Task Force on Taxonomy (2001). Announcement: modification of pain definition. *IASP Newsletter*, 2, 2.

- Krechel, S. W. & Bildner, J. (1995). Cries: A new neonatal postoperative pain measurement score. Initial testing of validity and reliability. *Paediatric Anaesthesia*, 5, 53-61. doi: 10.1111/j.1460-9592.1995.tb00242.x
- Lawrence, J., Alcock, D., McGrath, P., Kay, J., MacMurray, S. & Dulberg, C. (1993). The development of a tool to assess neonatal pain. *Neonatal Network*, 12(6), 59-66.
- Lucas-Thompson, R., Townsend, E. L., Gunnar, M. R., Georgieff, M. K., Guiang, S. F. & Ciffuentes, R. F., ... Davis, E. P. (2008). Developmental changes in the responses of preterm infants to a painful stressor. *Infant Behavior and Development*, 31, 614-623. doi: 10.1016/j.infbeh.2008.07.004
- March of Dimes. Retrieved September 18, 2012, from <http://www.marchofdimes.com>.
- McNair, C., Ballentyne, M., Dionne, K., Stephens, D. & Stevens, B. (2004). Postoperative pain assessment in the neonatal intensive care unit. *Archives of Disease in Childhood: Fetal & Neonatal*, 89, F537-F431. doi: 10.1136/adc.2003.032961
- Nunnally, J. C. & Bernstein, I. H. (1994). *Psychometric Theory* (3rd Ed). New York, New York: McGraw-Hill, Inc.
- Pereira, A., Guinsburg, R., Almeida, M., Monteiro, A., Santos, A. & Kopelman, B. (1999). Validity of behavioral and physiologic parameters for acute pain assessment of term newborn infants. *Sao Paulo Medical Journal*, 117(2), 72-80. doi: org/10.1590/S1516-31801999000200005

- Ranger, M., Johnston, C. & Anand, K. J. (2007). Current controversies regarding pain assessment in neonates. *Seminars in Perinatology*, 31(5), 283-288. doi: 10.1053/j.semperi.2007.07.003
- Schollen, J. (2005). Can cry in the newborn be used as an assessment of pain? *Acta Paediatrica*, 94(10), 1432-1436. doi: 10.1111/j.1651-2227.2005.tb01803.x
- Serpa, A., Guinsburg, R., Balda, R., dos Santos, A., Areco, K. & Peres, C. (2007). Multidimensional pain assessment of preterm newborns at the 1st, 3rd, and 7th days of life. *Sao Paulo Medical Journal*, 125(1), 29-33. doi: org/10.1590/S1516-31802007000010000
- Slater, R., Cantarella, A., Yoxen, J., Patten, D., Potts, H. & Meek, J., ...Fitzgerald, M. (2009). Latency to facial expression change following noxious stimulation in infants is dependent on postmenstrual age. *Pain*, 146, 177-182. doi: org/10.16/j.pain.2009.07.022
- Spence, K., Gillies, D., Harrison, D., Johnston, L. & Nagy, S. (2005). A reliable pain assessment tool for clinical assessment in the neonatal intensive care unit. *Journal of Obstetric Gynecologic and Neonatal Nursing*, 33(5), 80-86. doi: 10.1177/0884217504272810
- Stevens, B., Johnston, C., Petryshen, P. & Taddio, A. (1996). Premature Infant Pain Profile: Development and initial validation. *The Clinical Journal of Pain*, 12(1), 13-22.
- Suraseranivongse, S., Kaosaard, R., Intakong, P., Pornsiriprasert, S., Karnchana, Y. & Kaopinpruck, J. et al. (2006). A comparison of postoperative pain scales in neonates. *British Journal of Anaesthesia*, 97(4), 540-544. doi: 10.1093/bja/ae1184

Walden, M. (2001). Pain assessment and management-guideline for practice. Glenview,
IL: National Association for Neonatal Nurses. Document 1222.

References

Chapter Four

- Abdulkader, H. M., Freer, Y., Garry, E. M., Fleetwood-Walker, S. M. & McIntosh, N. (2008). Prematurity and neonatal noxious events exert lasting effects on infant pain behaviour. *Early Human Development*, 84, 351-355. doi: 10.1016/j.earlhumdev.2007.09.018
- Ahn, Y. & Jun, Y. (2007). Measurement of pain-like response to various nicu stimulants for high-risk infants. *Early Human Development*, 83, 255-262. doi: org/1016/j.earlhumdev.2006.05.022
- Akuma, A. O. & Jordan, S. (2011). Pain management in neonates: A survey of nurses and doctors. *Journal of Advanced Nursing*, 68(6), 1288-1301. doi: 10.1111/j.1365-2648.2001.05837.4
- Anand, K. J., Aranda, J. V., Berde, C. B., Buckman, S., Capparelli, E. V., Carlo, W., ... Walco, G. A. (2006). Summary proceedings from the neonatal pain-control group. *Pediatrics*, 117(3) S9-S22. doi: 10.1542/peds.2005-06200
- Anand, K. J. & Carr, D. B. (1989). The neuroanatomy, neurophysiology, and neurochemistry of pain stress, and analgesia in newborns and children. *Acute Pain in Children*, 36(4), 795-822.
- Anderson, R. D., Greve-Isdahl, M. & Jylli, L. (2007). The opinions of clinical staff regarding neonatal procedural pain in two Norwegian neonatal intensive care units. *Acta Paediatrica*, 96(7), 1000-1003. doi: 10.1111/j.1651-2227.2007.00190.x

- Bernhofer, E. (2011). Ethics: Ethics and pain management in hospitalized patients. *OJIN: The Online Journal of Issues in Nursing*, 17(1). doi: 10.3912/OJIN.
Vol17No01EthCo101
- Breau, L. M., McGrath, P. J., Stevens, B., Beyene, J., Camfield, C. S. & Finley, G. A., ... Ohlsson, A. (2004). Healthcare professionals' perceptions of pain in infants at risk for neurological impairment. [Electronic version]. *BMC Pediatrics*, 4(23), 1-9.
doi: 10.1186/1471-2431-4-23
- Breau, L. M., McGrath, P. J., Stevens, B., Beyene, J., Camfield, C. S. & Finley, G. A., ... O'Brien, K. (2006). Judgments of pain in the neonatal intensive care setting: A survey of direct care staffs' perceptions of pain in infants at risk for neurological impairment. *The Clinical Journal of Pain*, 22(2), 122-129.
- Brockopp, D. Y., Ryan, R. & Warden, S. (2003). Nurses' willingness to manage the pain of specific groups of patients. *British Journal of Nursing*, 12(7), 409-415.
- Byrd, P., Gonzales, I. & Parsons, V. (2009). Exploring barriers to pain management in newborn intensive care units: A pilot survey of nicu nurses. *Advances in Neonatal Care*, 9(6), 299-306. doi: 10.1097.ANC.06013e3181c1ff9c
- Carbajal, R., Rousset, A., Danan, C., Coquery, S., Nolent, P. & Ducrocq, S., ... Breart, G. (2008). Epidemiology and treatment of painful procedures in neonates in intensive care units. *Journal of the American Medical Association*, 300(1), 60-70.
- Cignacco, E., Hamers, J. P., Stoffel, L., van Lindgen, R. A., Schultz, N. & Muller, R., ... Nelle, M. (2008). Routine procedures in NICUs: Factors influencing pain assessment and ranking by pain intensity. *Swiss Medical Weekly*, 138(33-34), 484-491.

- Conroy, S., McIntyre, J. & Choonara, I. (1999). Unlicensed and off label drug use in neonates. *Archives in the Diseases of Children: Fetal and Neonatal Edition*, 80, F142-F145.
- deGraaff, S. & Bada, H. (2008). *Annual Neonatal Intensive Care and Newborn Data: 2008*. Lexington, KY: Albert B. Chandler Medical Center.
- deGraaff, S. & Bada, H. (2009). *Annual Neonatal Intensive Care and Newborn Data: 2009*. Lexington, KY: Albert B. Chandler Medical Center.
- Dick, M. J. (1993). Preterm infants in pain: Nurses' and physicians' perceptions. *Clinical Nursing Research*, 2(2), 176-187. doi: 10.1177/105477389300200207
- Dodds, E. (2003). Neonatal procedural pain: A survey of nursing staff. *Paediatric Nursing*, 15(5), 18-21.
- Evans, J. C. (2001). Physiology of acute pain in infants. *Newborn and Infant Nursing Reviews*, 1(2), 75-84. doi: org/10.1053.nbin.2001.25302
- Franck, L. S. (1987). A national survey of the assessment and treatment of pain and agitation in the neonatal intensive care unit. *Journal of Obstetrics, Gynecology and Neonatal Nursing*, 16(6), 387-393. doi: 10.1111/j.1552-6909.1987.tb01599.x
- Green, C. R. & Hart-Johnson, T. (2010). The adequacy of chronic pain management prior to presenting at a tertiary care pain center: The role of patient socio-demographic characteristics. *The Journal of Pain*, 11(8), 746-754. doi: 10.1016/j.oain.2009.11.003
- Halimaa, S. L., Vehvilainen-Jukumen, K. & Heinonen, K. (2001). Knowledge, assessment and management of pain related to nursing procedures used with

- premature babies: Questionnaire study for caregivers. *International Journal of Nursing Practice*, 7, 422-430. doi: 10.1046/j.1440-172X.2001.00322.x
- Hermann, C., Hohmeister, J., Demirakca, S., Zohsel, K. & Flor, H. (2006). Long-term alteration of pain sensitivity in school-aged children with early pain experiences. *Pain*, 125, 278-285. doi: org/10.1016/j.pain.2006.08.026
- Howard, V. A. & Thurber, F. (1998). The interpretation of infant pain: Physiological and behavioral indicators used by nicu nurses. *Journal of Pediatric Nursing*, 13(3), 164 -174. doi: org/10.1016/S0882-5963(98)80075-4
- Kramer, M., Schmalenberg, C., Brewer, B. B., Verran, J. A. & Keller-Unger, J. (2009). Accurate assessment of clinical nurses' work environments: Response rate needed. *Research in Nursing & Health*, 32, 229-240. doi: 10.1002/nur.20315
- Latimer, M. A., Johnston, C. C., Ritchie, J. A., Clarke, S. P. & Gilin, D. (2009). Factors affecting delivery of evidence-based procedural pain care in hospitalized neonates. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 38, 182-194. doi: 10.1111/j.1552-6909.2009.01007.x
- Motov, S. M. & Kahn, A. N. (2009). Problems and barriers of pain management in the emergency department: Are we ever going to get better? *Journal of Pain Research*, 2, 5-11.
- Patrick, S. W., Schumacher, R. E., Bennyworth, B. D., Krans, E. E., McAllister, J. M. & Davis, M. M. (2012). Neonatal abstinence syndrome and associated health care expenditures: United States, 2000-2009. *Journal of the American Medical Association*, 307(18), 1934-1940. doi: 10.1001/jama.2012.3951

- Pidgeon, H. M., McGrath, P. J., Lawrence, J. & MacMurray, S. B. (1989). Nurses' perceptions of pain in the neonatal intensive care unit. *Journal of Pain and Symptom Management*, 4(4), 179-183. doi: org/10.1016/0885-3924(89)90040-7
- Polkki, T., Korhonen, A., Laukkala, H., Saarela, T., Vehvilainen-Jukunen, K. & Peitila, A. M. (2010). Nurses' attitudes and perceptions of pain assessment in neonatal intensive care. *Scandinavian Journal of Caring Sciences*, 24, 49-55. doi: 10.1111/j.1471-6712.2008.00683.x
- Porter, F. L., Wolf, C. M., Gold, J., Lotsoff, D. & Miller, J. P. (1997). Pain and pain management in newborn infants: A survey of physicians and nurses. *Pediatrics*, 100(4), 626-632. doi: 10.1542/peds.100.4.626
- Ranger, M., Johnston, C. & Anand, K. J. (2007). Current controversies regarding pain assessment in neonates. *Seminars in Perinatology*, 31(5), 283-288. doi: org/10.1053/j.semperi.2007.07.003
- Reyes, S. (2003). Nursing assessment of infant pain. *Journal of Prenatal and Neonatal Nursing*, 17(4), 291-303. doi: 10.1542/peds.100.4.626
- Safdar, B., Heins, A., Homel, P., Miner, J., Neighbor, M., DeSander, P. & Todd, K. H. (2009). Impact of physician and patient gender on pain management in the emergency department: A multicenter study. *Pain Medicine*, 10(2), 364-372. doi: 10.1111/j.1526-4637.2008.00524.x
- Shapiro, C. R. (1993). Nurses' judgments of pain in term and preterm newborns. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 22(1), 41-47. doi: 10.1111/j.1552-6909.1993.tb01781.x

- Simons, S. H. & Tibboel, D. (2006). Pain perception development and maturation. *Seminars in Fetal & Neonatal Medicine*, 11, 227-231. doi: [org/10.1016/j.siny.2006.02.010](https://doi.org/10.1016/j.siny.2006.02.010)
- Simons, S. H., vanDijk, M., Anand, K. S., Roofthoof, D., van Lindgen, R. A. & Tibboel, D. (2003). Do we still hurt newborn babies? A prospective study of procedural pain and analgesia in neonates. *Archives of Pediatric and Adolescent Medicine*, 157, 1058-1064.
- Stevens, B., Gibbins, S. & Franck, L. S. (2000). Treatment of pain in the neonatal intensive care unit. *Pediatric Clinics of North America*, 47(3), 633-650. doi: [org/10.1016/S0031-3955\(05\)70230-3](https://doi.org/10.1016/S0031-3955(05)70230-3)
- Young, J., Barton, M., Richards-Dawson, M. A. & Trotman, H. (2008). Knowledge, perception and practices of healthcare professionals at tertiary level hospitals in Kingston, Jamaica, regarding neonatal pain management. *West Indian Medicine*, 57(1), 28-32.

References

Chapter Five

- Akuma, A. O. & Jordan, S. (2012). Pain management in neonates: a survey of nurses and doctors. *Journal of Advanced Nursing*, 68(6), 1288-1301. doi: 10.1111/j.1365-2648.2001.05837.4
- Anand, K. J. S. & Carr, D. B. (1989). The neuroanatomy, neurophysiology, and neurochemistry of pain, stress, and analgesia in newborns and children. *Pediatric Clinics of North America*, 36, 795-822.
- Anderson, R. D., Greve-Isdahl, M. & Jylli, L. (2007). The opinions of clinical staff regarding neonatal procedural pain in two Norwegian neonatal intensive care units. *Acta Paediatrica*, 96(7), 1000-1003. doi: 10.1111/j.1651-2227.2007.00190.x
- Brockopp, D. Y., Ryan, R. & Warden, S. (2003). Nurses' willingness to manage the pain of specific groups of patients. *British Journal of Nursing*, 12(7), 409-415.
- Byrd, P., Gonzales, I. & Parsons, V. (2009). Exploring barriers to pain management in newborn intensive care units: A pilot survey of nicu nurses. *Advances in Neonatal Care*, 9(6), 299-306. doi: 10.1097.ANC.06013e3181c1ff9c
- Cignacco, E., Hamers, J. P., Stoffel, L., van Lindgen, R. A., Schultz, N. & Muller, R., ... Nelle, M. (2008). Routine procedures in NICUs: Factors influencing pain assessment and ranking by pain intensity. *Swiss Medical Weekly*, 138(33-34), 484-491.
- Dodds, E. (2003). Neonatal procedural pain: A survey of nursing staff. *Paediatric Nursing*, 15(5), 18-21.

- Evans, J. C. (2001). Physiology of acute pain in infants. *Newborn and Infant Nursing Reviews*, 1(2), 75-84. doi: org/10.1053.nbin.2001.25302
- Green, C. R. & Hart-Johnson, T. (2010). The adequacy of chronic pain management prior to presenting at a tertiary care pain center: The role of patient socio-demographic characteristics. *The Journal of Pain*, 11(8), 746-754. doi: 10.1016/j.oain.2009.11.003
- Motov, S. M. & Kahn, A. N. (2009). Problems and barriers of pain management in the emergency department: Are we ever going to get better? *Journal of Pain Research*, 2, 5-11.
- Reyes, S. (2003). Nursing assessment of infant pain. *Journal of Prenatal and Neonatal Nursing*, 17(4), 291-303. doi: 10.1542/peds.100.4.626
- Rouzan, I. A. (2001). An analysis of research and clinical practice in neonatal pain management. *Journal of the American Academy of Nurse Practitioners*, 13(2), 57-60. doi: 10.1111/j.1745-7599.2001.tb00218.x
- Safdar, B., Heins, A., Homel, P., Miner, J., Neighbor, M., DeSander, P. & Todd, K. H. (2009). Impact of physician and patient gender on pain management in the emergency department: A multicenter study. *Pain Medicine*, 10(2), 364-372. doi: 10.1111/j.1526-4637.2008.00524.x
- Schultz, M., Loughran-Fowlds, A. & Spence, K. (2009). Neonatal pain: A comparison of the beliefs and practices of junior doctors and current best practice. *Journal of Paediatrics and Child Health*, 46, 23-28. doi: 10.1111/j.1440-1754.2009.01612.x

Simons, S. H. & Tibboel, D. (2006). Pain perception development and maturation.

Seminars in Fetal & Neonatal Medicine, 11, 227-231. doi:

org/10.1016/j.siny.2006.02.010

Simons, S. H., vanDijk, M., Anand, K. S., Roofthoof, D., van Lindgen, R. A. & Tibboel,

D. (2003). Do we still hurt newborn babies? A prospective study of procedural pain and analgesia in neonates. *Archives of Pediatric and Adolescent Medicine*,

157, 1058-1064.

Vita

Place of Birth Ashland, KY

Educational Background

Year	Degree	Institution
1984	BA Biology	Transylvania University
1986	BSN	University of Kentucky
1990	MSN	University of Kentucky

Professional Positions Held

Year	Employer	Title
1986-1991	University of Kentucky Hospital	Staff Nurse
1991-2001	UK Children's Hospital	Case Manager
2001-2009	Kentucky Children's Hospital	Patient Care Manager
2009-2013	UK HealthCare	Director, Nursing Practice & Support Services

Scholastic and professional honors

Year	Honors	Institution
1986	Sigma Theta Tau	University of Kentucky

Sharon Wells Lake
Signature