Neonatal pain: simultaneous comparison of the scale for use in newborns and the premature infant pain profile

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FINAL APPROVAL OF SCHOLARLY PROJECT
Master of Science in Nursing

Neonatal Pain: Simultaneous Comparison of the Scale for Use in Newborns and the Preterm Infant Pain Profile

Submitted by
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In partial fulfillment of the requirements for the degree of Master of Science in Nursing

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Neonatal Pain:
Simultaneous Comparison of the Scale for Use in Newborns and the Premature Infant Pain Profile

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April 21, 2005
Abstract

Pain is currently a hot topic across all of healthcare. Many research dollars are spent each year on development of means to decrease or eliminate pain. However, much of this research is not used in current practice. This research was designed to help by developing links between existing pain scales. By comparing scores on different scales, the Premature Infant Pain Profile (PIPP) and the Scale for Use in Newborns (SUN), the researchers were able to prove that a correlation between these scales existed ($r = 0.70, p < 0.001$). By establishing this correlation, the research allows nurses the confidence to interpret scores on either scale and thus assess changes in pain. It also substantiates previous research that the SUN accurately assesses pain, by determining convergent validity with the PIPP.
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CHAPTER I

In 1941 McGraw published an article regarding research she had done on neonates. In this article she stated, “it is reasonably certain that the neonate can in no way localize or identify the source of painful peripheral stimulation” (McGraw, 1941, p. 101). This statement launched a campaign of almost half a century of what some may refer to as torturing neonates. For almost fifty years, this research was the benchmark. Nurses and physicians operated and performed painful procedures on countless neonates without use of even a mild analgesic. They medicated them only with substances, such as curare and succinylcholine, for convenience, so that they could not move and then performed painful procedures on them (Zisk 2003). It can be said that this created an atmosphere of torture for our most fragile of patients. After years of neglect, this topic again became an area interest in the late 1980s. By the end of the year 2000, several studies had been done that determined that infants were not only able to feel and localize pain, but that the pain may cause physiological changes that could affect them for the rest of their lives (Glover & Fisk, 2000; Puchalski & Hummel, 2002; Brooks, 1999; Gibbins & Stevens, 2001; Stevens, Johnston & Grunau, 1995).

In 2000, Glover & Fisk noted that the full anatomical pathways necessary for nociception, perception of pain, are in
place at 24 – 28 weeks gestation. Given this new information it is now certain that, for almost half a century, healthcare providers have inflicted pain on our most sensitive patients. With this new information in 1997 the Joint Commission on Accreditation of Health Care Organizations (JCAHO) began requiring that healthcare providers assess and treat pain in neonates. The major difficulty with this requirement is that neonates are unable to verbalize their pain. Several tools, to assess pain have been created for these very sensitive, nonverbal patients. Although several of these tools have been tested and determined to be both valid and reliable, they are not currently being used on a regular basis clinically.

No one tool has been determined to be the gold standard. Therefore, when they are using these tools they are unable to compare results found using the different scales. Research allowing comparison of these tools is currently lacking. Only four studies have done comparative analyses of these tools (Blauer & Gerstmann, 1998; Guinsburg, Almeida, Peres, Shinzato & Kopelman, 2003; Patel, Czerniawski, Gray & Lui, 2003; Sizun, Ansquer, Browne, Tordjman & Morin, 2002). In order to allow comparison of the many available tools more research needs to be done. The current study is a comparative analysis of the Premature Infant Pain Profile (PIPP) and the Scale for Use in
Newborns (SUN) in a population of 20 neonates ranging in gestational age from less than 28 weeks to 36 weeks.

Problem

The neonatal infant is born into a world that brings with it numerous medical procedures that at best are uncomfortable and at worst very painful. Stevens, Johnston, Franck, and Jack (as cited in Coleman, Solarin, & Smith, 2002) demonstrated that in the first two weeks of life premature infants underwent an average of 134 painful procedures. The consequences of these procedures have been shown to trigger physiological and behavioral alterations. Assessment and alleviation of pain and/or distress in preterm infants is, therefore, an important issue. There are currently many pain assessment tools, however little research allowing comparison and evaluation of these tools exist.

Purpose

The purpose of this study is to establish a correlation between scores on the PIPP and scores on the SUN. This correlation will enable the practitioner to determine if the scores using each of these scales are in fact comparable, making pain ratings on each of these scales transcend the confines of the scale. The proposed study will allow us to compare scores established using these different tools and adequately treat the pain associated with that score.
Conceptual Framework

Nursing scholars have primarily employed the concept of energy conservation within a natural science perspective, particularly in regards to physics (Lerdal, 1998). Levine, who formulated her theory of energy conservation in 1969, often refers to the first law of thermodynamics, the Law of Conservation of Energy, and how it relates to the energy in a closed system. This law states that energy can neither be created nor destroyed, but can only be transformed from one state of matter to another. Levine also draws from physics her definition of energy as the "capacity to do work" (Lerdal, 1998, p. 3).

Levine's assessment of the necessity for energy conservation in the healthcare environment relates directly to an individual's capacity for healing. Fatigue is understood, and has been studied, as a condition of low energy. Levine states, "[t]he energy required by alteration in physiological function during illness represents an additional demand on the energy producing systems, and the fatigue so often experienced with illness is the very empirical measure of that additional demand for energy (Lerdal, 1998, p. 4)."

In conjunction with Levine's assessment, the Conservation of Energy Model reflects the belief that the exertion of energy (in this case in response to painful stimuli) can cause a
negative impact on the healing process. Therefore, the aim of this study, using Levine’s conceptual model as a framework, is to test and correlate the currently available neonatal pain assessment tools to help neonates remain free of unnecessary pain or distress and thus retain their energy for healing purposes.

Research Question

Does a correlation exist between the original PIPP score for each heel-stick and scores for the same heel-sticks using the modified SUN in preterm infants ages less than 28 weeks to 36 weeks gestation?

Conceptual Definitions

Preterm infant – any infant born before 36 weeks gestation, for the purposes of this study.

Heel-stick – a procedure performed by lancing the right or left side of the heel of the infant and obtaining a blood sample required for procedures.

Premature Infant Pain Profile (PIPP) – a measure of a neonate’s response to pain. This is accomplished by observing behavioral responses, such as eye squeeze, brow bulge, nasolabial furrow, and state of arousal, and physiological responses, as evidenced by changes in heart rate and oxygen saturation and assigning a numerical score for comparison.
Scale for Use in Newborns (SUN) – a measure of a neonate’s response to pain by observing behavioral responses, such as movement, tone, facial expression, and state of arousal, and physiological responses, as evidenced by changes in heart rate, blood pressure, and rate of respiration.

Operational Definitions

Preterm Infant – one of 80 test subjects born before 36 weeks gestation, videotaped during heel-stick procedures and scored by the original researcher using the PIPP.

Heel-stick – procedure observed on videotape.

PIPP – scoring of the original researcher as found in the database.

SUN – scoring of the neonate’s pain from observing the videotaped heel-stick.

Research Hypothesis

Because of the similarity of the scales, a significant correlation will be found between scores on the PIPP and scores on the modified SUN.

Significance

This study will aide in developing a correlation between the PIPP and SUN scales. It will also help to test the construct validity, reliability, and clinical utility of the SUN scale by comparing scores developed using the SUN to scores using the extensively tested PIPP. However, the most important
development aided by this study will be increased knowledge about the adequate assessment and treatment of pain in preterm infants, as well as, the entire nonverbal population. This advance in knowledge will aid in the development of treatments available to these neonates, thus decreasing energy loss to futile pain responses. This decrease in energy loss will result in decreasing the morbidity and mortality of this vulnerable population. Also, with decreasing morbidity and mortality rates come decreasing costs for treatment.

This also has a great impact on nursing. Nurses are currently struggling to meet JCAHO standards regarding the assessment and treatment of pain in neonates. This research would allow them better access to and understanding of the tools available to perform this duty, helping them better protect this very vulnerable population.

Assumptions

1. The biomedical technology department, according to manufacturer’s guidelines, properly calibrated all machines used.
2. The original researcher scored the neonates properly using the PIPP.
3. Heel-sticks are painful procedures.
4. Pain is a source of stress for a neonate resulting in physiological and behavioral responses.
5. Physiological and behavioral responses expend valuable energy and should be limited in the preterm neonate.

Limitations

1. Not all measures required to score the infants on the SUN scale were available. Therefore, a modified SUN without blood pressure was used.

2. Only one researcher did all the coding on the SUN, and one performed the coding on the PIPP. Several researchers working with these scales and the same infants would create more comprehensive results.

3. Sampling method was another limitation of this study. The sample was a convenience sample. A random sample could further validate the findings of this study.

Summary

In this chapter the problem of lack of research comparing and contrasting tools available to assess neonatal pain was discussed. The goal of this study to provide better information regarding assessment tools used in the assessment of pain in neonates was explained. The conceptual model used in the design of this study, Levine’s conceptual model, was also introduced. The necessary terms used in the creation of the research question were defined using both operational and conceptual definition. The significance of the study to nursing as well as
to the neonatal population and a discussion of the assumptions and limitations of the current study concluded the chapter.
Chapter II

Over the past twenty years, views on neonatal pain have continued to change rapidly. As more time passes and as technology becomes more advanced, many things before deemed impossible to observe are now becoming possible. These advances are making it easier to change the body of nursing knowledge. This study is based on the lack of information in the current literature and was developed using Levine’s Conservation Model (1989). This review of literature will highlight the gaps in the current literature, and show the need for this study in the progression to the ultimate goal that is, providing the best nursing care possible. The focus of this review will be the need for pain assessment and management for the preterm infant, as well as a discussion of Levine’s conceptual framework, used in the development of this study.

A discussion of Levine’s Conservation of Energy Model will highlight the reason why it was chosen as the conceptual framework. After a discussion of the framework, the current literature regarding the physiology of pain in neonates will be discussed. This will be followed by a review of the current literature, which examines the assessment of pain in neonates. The chapter concludes with a discussion of the current literature concerning the two pain scales used in the study, the PIPP and the SUN.
Levine’s Conservation of Energy Model (1989) provides the nursing framework on which this research is constructed. Levine formulated a conceptual model of nursing that focuses on energy and the conservation of the patient's wholeness (Fawcett, 2002). Levine’s model focuses on the individual’s ability to maintain their wholeness, or integrity, through the process of adaptation. However, while Levine alludes to a holistic view of human beings, it should be noted that her concept of energy is based on a purely mechanistic one (Levine, 1989).

Levine defines a person as “an organism dependent upon the inter-relatedness of its component systems. In fact, the organism is a system of systems” (Levine, 1973, pp. 8-9). Additionally, the wholeness of this person is based on the interaction of these component systems and the environment in which that person exists. Affirming that it is possible to explain human beings according to physical laws, she strongly asserted that there is no mystery attached to the phenomenon of energy (Levine, 1989). All of life’s processes are fundamentally dependent on the production and expenditure of energy (Todaro-Franceschi, 2001). Therefore, the ability of any individual to function is based on his or her energy potential and the specific patterns of energy exchange that are available to that person (Todaro-Franceschi, 2001). Levine postulated that energy
resources need to be conserved by nursing intervention in order to ensure the maintenance of individual structural integrity (Todaro-Franceschi, 2001). The nurse’s role within the conservation model is an integral part, and is instrumental in the preservation of energy. It is also the nurse’s responsibility to promote conservation of person’s structural, personal, and social integrity. Levine's model discusses energy in terms of measurable qualities (consumption, expenditure, etc.). Energy resources arise from a causal model in which nurses can control or aid the individual in attaining and utilizing energy (Todaro-Franceschi, 2001).

The internal environment is described as the "integration of bodily functions that resembles a stabilized flow (homeorrhesis) rather than a static state (homeostasis) and is subject to challenges presented by the external environment which always takes the form of energy" (Fawcett, 2002). In other words, the internal environment refers to the "physiological and pathophysiological aspects of the patient with which the nurse deals" (Fawcett, 1997, p. 218).

Levine divides the external environment into the perceptual, operational and conceptual environments (Fawcett, 2002). The perceptual environment refers to that portion of the external environment to which people respond via their sense organs. It includes light, sound, touch, temperature, chemical
change that is smelled or tasted, and proprioception (Fawcett, 2002). The operational environment includes the presence of stimuli and the efforts to manage stimuli. The conceptual environment is defined as the ability of beings to be aware of the past and think about the future.

Another section of Levine’s model structures nursing interventions according to four conservation principles. These are conservation of energy, structural integrity, personal integrity and social integrity (Fawcett, 2002). Conservation of Energy focuses on retaining the individual’s internal energy. Under this principle nursing intervention is based on balancing energy input and output. The next principle, Conservation of Structural Integrity, focuses on healing. Therefore, the nursing intervention is based on limiting the amount of tissue involvement in infection and disease. The third principle, Conservation of Personal Integrity, focuses on the patient as a person. Nursing intervention is based on helping the individual to preserve his or her identity and selfhood. Levine’s final principle, Conservation of Social Integrity, focuses on the individual’s place in his or her family community and society. Nursing intervention is based on helping the individual to preserve his or her place in a family, community, and society (Fawcett, 2002).
Levine's conservation principles all suggest cause-and-effect relationships (Todaro-Franceschi, 2001). The first principle of Levine's model refers to the ability of any person to function and is based on that individual's energy potential and the specific patterns of energy exchange available. Each of these principles combines to form a pragmatic framework in which to view neonates within the neonatal intensive care unit environment.

Two of Levine’s principles are directly applied within the nursing conceptual framework for this research study. The schematic map, Appendix A, is a graphical representation of the conceptual model used for this study involving neonates. The energy input, a heel-stick, was performed resulting in an output, physical and behavioral responses, which were then measured using the two pain scales. With the main goal of this research being the elimination of unnecessary stress on the preterm neonate, Levine’s principles of Conservation of Energy and Conservation of Structural Integrity were integral in designing this study.

Physiology of Pain

Despite differences between adults and infants in their responses to pain, research suggests that newborn neonates, even the extremely premature, are anatomically and physiologically equipped to perceive, react to, and have some understanding of
pain (Puchalski & Hummel, 2002). Pain receptors are found in virtually every tissue of the body and may be aroused by a variety of stimuli (Brooks, 1999). They are able to detect painful stimuli at the periphery and transmit messages throughout the central nervous system (Gibbins & Stevens, 2001). Anand (as cited in Gibbins & Stevens, 2001) suggests that the density of nerve endings in the skin of newborns is similar to or may even be greater than that found in the adult skin.

Pain can be described in the context of several mechanisms. One widely used mechanism, the gate control theory, hypothesizes that there are neural gating channels at the spinal cord level accounting for pain’s association with other sensations (Porth, 2002). As research progresses, it has been found that the original gate control theory, although correct, is only a portion of the process.

Pain is currently a hot spot for research and the knowledge base is growing rapidly. Hummel & Puchalski (2002) describe the pain pathway in terms of noxious stimuli that excite afferent fibers, which transmit information from the periphery to the dorsal horn of the spinal cord. Next, neurotransmitters in the spinal cord amplify the pain information from the periphery, which reaches the thalamus and is distributed throughout the brain (Hummel & Puchalski, 2002). Another study describes nociceptors as the pain receptors or free-nerve endings that
detect and transmit general physical and chemical tissue damage (Jorgensen, 1999). Humphrey, Valman and Pearson (as cited in Stevens, Johnston, & Grunau, 1995) assert that peripheral nociceptive, or pain-sensing pathways begin developing in the fetus at about seven weeks gestation, with sensory nerve endings, and are complete by the twentieth week. One concept that all of these theories have in common is that the pain response requires energy. As was discussed in Levine’s theory, the retention of this energy is necessary for healing and development. Both healing and development are essential in the survival of the preterm neonate.

Puchalski & Hummel (2002) also provide a timeline for fetal nociception. This timeline suggests that sensory nerve endings begin developing in the perioral area during the seventh week of gestation; sensory nerve endings on the face, palms and soles of feet at eleven weeks; followed at twelve weeks by the start of the neural pathway connecting the peripheral nociceptive nerve endings and the spinal dorsal horn cells; then, at fifteen weeks, sensory nerve endings develop on the trunk and proximal extremities.

The twentieth week marks when sensory nerve endings develop on mucous membranes and remaining cutaneous areas. This is followed by the completion of the thalamic track at 24 weeks. At 30 weeks, the brain stem and thalamic track are myelinated
and, finally, at 37 weeks the nociceptive track is completely myelinized (Puchalski & Hummel, 2002). Myelinization is important in the speed at which nerve impulses travel. Because it has been a belief that unmyelinated axons transmit signals slower, this provided support to the idea that neonates were either not affected by pain or less affected by pain. However, Anand & Hickey (as cited in Stevens, Johnston, & Grunau, 1995) note that the shorter distances offset the slower conduction caused by unmyelination traveled by the impulses. This is further supported by Puchalski & Hummel (2002), who state that impulses travel quite well along unmyelinated nerve tracts and that even some mature nerve fibers remain unmyelinated (C-polymodal fibers), or only thinly myelinated (A delta fibers) into adulthood. In adulthood these unmyelinated A and C fibers are responsible for transmitting pain impulses to the CNS (Brooks, 1999).

In addition to the afferent and efferent pain pathways discussed here, there are chemical mediators that play a role in the neonate’s experience of pain. Pain stimulates the release of glucocorticoids. The release of glucocorticoids is naturally catabolic and inhibits cell division and growth, protein synthesis, and neuronal myelination (Puchalski & Hummel, 2002). Jorgensen supports this idea by indicating that pain leads to the release of stress hormones such as cortisol and
catecholamines which affect a newborn’s growth pattern and wound healing and may contribute to an increase in complications and a longer hospital stay (1999). Franck, Greenberg, & Stevens (2000) provide an example that demonstrates the role of chemical mediators. In the example, tissue injury causes release of inflammatory mediators (e.g., potassium, bradykinin, prostaglandins, cytokines, nerve growth factors, catecholamines, and substance P) that sensitize the A-delta and C fibers and recruit other neurons (silent nociceptors) resulting in hyperalgesia. In a healthy neonate, these effects can be detrimental. However, in a pre-term neonate, they could prove an immediate threat on their ability to thrive, as well as a long-term impediment.

Current research is investigating the long-term effects of neonatal pain. Glover & Fisk (2000) describe evidence to suggest that early painful or stressful experiences can have long-term effects. Reynolds and Fitzgerald (as cited in Evans, 2001) suggest that tissue damage in the early neonatal period causes hyperinnervation to that area that can last well into adulthood. Merskey (as cited in Evans, 2001) suggests that repeated tissue damage might extend into adjacent uninjured tissue and cause pain sensations (allodynia) from stimuli that normally would not invoke a pain response. Research has also demonstrated that over stimulation of one pathway (e.g. the
nociceptive pathway) can lead to under stimulation and underdevelopment of another pathway (e.g. the non-pain pathway) (Puchalski & Hummel, 2002). Anand (2000) takes this concept one step further by hypothesizing that the plasticity of the developing pain system in neonates provides a critical window for producing long-term changes in subsequent behavior, responses to stress, and susceptibility to psychosomatic complaints and psychiatric disorders in later life. Stevens, Johnston, & Grunau (1995) also note that the structures needed for long-term memory are well developed in the newborn period. Therefore, painful experiences during that period have the potential to affect long-term outcomes.

Another study, testing formerly extremely low birth weight (ELBW) infants at four months old, found that the formerly ELBW infants displayed a less intense parasympathetic withdrawal during the lance period and a longer sympathetic response during the recovery period (Oberlander, Grunau, Whitfield, Fitzgerald, Pitfield & Saul, 2000). In 2003, Buskila, Neumann, Zmora, Feldman, Bolotin, and Press performed a study with prematurely born adolescents to solidify these claims. Similar to Oberlander et al. (2000), the prematurely born adolescents had more tender points \((6.0 \pm 5.2 \text{ vs. } 3.3 \pm 3.3; \ p = .001)\) and lower tender thresholds \((4.2 \pm 1.5 \text{ vs. } 4.8 \pm 1.6 \text{kg}; \ p = .04)\), when measured with a dolorimeter than their full term counterparts.
It is also noted that although pain may not be specifically remembered, stress related to the event may mediate altered responses later in life (Stevens, Johnston, & Grunau, 1995).

It is known that physiological signs of painful stimuli are present in neonates, whether there is a behavioral response or not. Painful stimuli solicit stress responses from the autonomic nervous system such as increased respirations, increased ventilation, increased heart rate, increased systolic and diastolic blood pressure, pupil dilation, inhibition of gastrointestinal motility, decreased oxygen saturation, hyperglycemia, changes in transcutaneous oxygen and carbon dioxide levels, intracranial pressure, measures of vagal tone, skin blood flow, and palmar sweat (Brooks, 1999; Franck & Miaskowski, 1997). Along with the proposed physiological effects of pain, one can also look at the energy drain caused by this response. Levine (1989) discusses the necessity of conservation of energy and conservation of structural integrity. Both of these principles are broken when we elicit unnecessary stress responses from an already struggling preterm neonate. Although the possibility of long term disability may exist, if the neonate’s energy is not conserved there may not be a future about which to worry. It is hopeful that the boom of research in this area will lead to widespread understanding and acceptance of the reality of neonatal pain and the need to take
actions toward properly assessing and treating pain and distress in this population.

Assessment of Pain

Many hospitals currently assess pain using a verbal rating on a pain scale, which for neonates is impossible. When this scale does not work, as is the case for neonates, they rely on either the judgment of a nurse or on their ability to distinguish a pain cry from many other cries related to the needs of the neonate.

Several studies aimed at the development and validation of pain assessment tools have been done and are currently underway. For example, Johnston, Stevens, Yang and Horton (1995) conducted a multidimensional assessment of preterm neonate’s responses to real and sham heel-sticks. The study consisted of 48 neonates between 26 and 31 weeks gestational age. The purpose of the study was to observe the real or sham heel-stick with preterm neonates and focus on behavioral and physiological aspects that are present. The heel-stick procedure consisted of heel warming, lancing of the heel, and heel squeezing until an adequate blood sample was obtained. From this study, it was concluded that young very low birth weight neonates are capable of experiencing a full multidimensional response to pain. The neonates responded differently to the sham and real heel-stick procedures, with the real heel-stick creating a greater
response. Throughout the procedure, the neonate’s responses also increased, with increased heart rate and brow bulge becoming the most evident. Inclusion of gestational age revealed that older neonates showed a more vigorous response.

Lindh, Wiklung, Sandman, and Hankanson (1997) conducted a study of 10 preterm neonates, ranging in age from 27-35 weeks, who had a heel-stick procedure performed. Similar to Johnston et al. (1995), this study concluded that all neonates responded with facial expression, such as brow bulge, and had an increase in heart rate. Lindh et al. (1997) also found that blood sampling was a definite cause of distress in the preterm neonate, expressed by the facial activity in all of the participants. As in Johnston et al. (1995), Lindh et al. (1997) concluded that the most premature neonates did not respond as robustly to pain when compared to the older neonates. However, this study did note a limited number of participants, making definitive conclusions difficult.

Another study performed by Hadjistavropoulos, Craig, Grunau, and Whitfield (1997) consisted of 56 preterm neonates ranging in gestational age from 25 to 41 weeks. The study focused on facial and body activity. This study concluded that a specific order to the neonate’s responses to pain. They found that the pain response occurred in an orderly fashion starting with facial expressions and then proceeded to body movements.
Similar to Lindh et al. (1997) and Johnston et al. (1995), Hadjistavropoulos et al. (1997) concluded that neonates older in gestational age showed a more pronounced response to the heel-stick. These neonates were judged to be experiencing the most pain as evidenced by facial activity, which was again noted to be the most observed variable. The study also concluded 71% of the variance in pain ratings could be predicted using facial activity alone.

Johnston, Stevens, Franck, Jack, Stremler, and Platt (1999) conducted a study consisting of 120 preterm neonates with an average gestational age of 28 weeks. The purpose of the study was to use the PIPP scale and medical records to determine what might cause a lack of response to a heel-stick procedure. In contrast to Lindh (1997), not all of the participants responded to the heel-stick. Only 80% of the participants responded. In contrast to Lindh et al. (1997), Johnston et al. (1995), and Hadjistavropoulos et al. (1997), Johnston et al. (1999) could not rule out the possibility that some neonates may not perceive pain. With available research, stating that preterm neonates can feel pain, this is an unlikely conclusion. A better explanation would be that the preterm neonate endured the pain, but was unable to express it.

After twenty years of research, Franck (2002) acknowledges that we still do not have “standard” pain assessment scales that
guide treatment of neonatal pain. A study by Bishop (2003) also noted that assessment inaccuracies in using a scale for pain assessment and management were considered a low priority by hospitals. In order to evaluate and reduce the pain and stress experienced by neonates, assessment tools must be accurate, reliable, and clinically utilizable. Research by Dodds (2003) states that in order for a tool to be successful in the clinical setting, it needs to be introduced along with education about its importance and how to use it.

The necessity for the development and validation of neonatal pain assessment scales that are easily applicable in the clinical setting is a very real nursing concern. Over the past several years, many pain scales have been created to assess various nonverbal pain indicators. However, no one scale has emerged as the gold standard. Thus, research into the applicability and validity of the currently available tools is necessary in order to establish standards of care for the assessment and subsequent treatment of pain in neonates.

Premature Infant Pain Profile (PIPP)

The PIPP was developed in 1995 by a group of researchers in an attempt to create a pain scale that was designed exclusively for preterm neonates. Their initial review of literature sparked a new thinking process in the field of pain scale research. Although several pain scales were currently in use,
no one tool encompassed all dimensions of the pain phenomenon. They decided that since pain itself was multidimensional, the tools used to rate pain should also be multidimensional. Therefore, they began by reviewing symptoms of pain. Their initial findings include the following:

Physiological indicators (heart rate, vagal tone, respiratory rate, blood pressure, oxygen saturation, intracranial pressure, catecholamine levels, corticosteroid levels, growth hormone levels, glucagon levels, and behavioral indicators), facial activity (brow bulge, eye squeeze, nasolabial furrow, open lips, vertical and horizontal mouth stretch, and taut tongue), crying (acoustical characteristics, temporal characteristics, peak spectral energy, harmonic structure, and duration), body activity and movements (arms, legs, torso), modifying factors (behavioral state, health status, and gestational age). Their list was quite extensive. They knew however, that not all of these factors could be included in one scale if it was to ever be used clinically. Their next step was to determine which indicators were critical and available for use in the clinical and research setting. Several measures were discarded because of the unavailability of equipment to measure them. Others were eliminated because of lack of use in the setting and for high correlation to the disease state. Biochemical and hormonal indicators were
discarded because of the required invasive procedure needed to procure their results. Many other similar decisions had to be made on other indicators.

With their indicators chosen, the researchers went to a group of experts on pain from several disciplines. They asked these experts to examine their list of indicators. The experts all agreed that these indicators were a good representation of pain indicators displayed by neonates.

The next step was pilot testing. Four existing data sets were used for the initial tests. The initial test helped the researchers remove a few more indicators because of lack of specificity and/or sensitivity. The indicators that remained were: brow bulge, eye squeeze, nasolabial furrow, heart rate, oxygen saturation, behavioral state, and gestational age. Once the indicators had been determined, a way to rate the indicators on a number scale was needed. So, categories for all the indicators were determined and each was given a number score.

With the number ratings in place, testing for the consistency and validity of the scores could begin. The findings were as follows: generally scores of six or less were non-pain scores, while scores of 12 were related to moderate to severe pain. As with adults and verbal pain scales, it was found that the score did not necessarily determine pain, but
that the difference between the pre and post procedure scores was much more effective at determining pain.

The results of the tests on the four pilot groups were then statistically tested to reveal Cronbach’s alpha coefficients ranging from 0.76 of eye squeeze to 0.59 for behavioral state. These alpha scores were representative of a moderate correlation. However, in order for these results to be confirmed as anything other than a correlation between behavioral, physiological, or contextual factors, another test was needed. The standardized alpha confirmed their results with a score of 0.71, which suggested internal consistency.

With these results, testing of construct validity could begin. The method was to test two opposite situations. The PIPP would be used to score one painful situation, a heel-stick, and one non-painful situation, handling similar to heel-stick procedure but without the actual heel-stick. The mean PIPP score for the painful situation was 10.3 (SD 4.5) and the non-painful situation PIPP score was 6.3 (SD 3.2). The difference of the scores was significant (t = 2.4, two-tailed p < 0.02).

They also performed similar tests on full term neonates and had the same result (Stevens, Johnston, Petryshen, & Taddio, 1996). Now that the scale had been statistically validated, all that was needed was to test the tool clinically.
In 1998, Ballantyne, Stevens, McAllister, Dionne, and Jack performed research to validate this tool clinically. The design for this study included using the PIPP to measure pain in three situations. The first was referred to as a baseline event and included no contact with the neonate. The second situation was diapering. The final situation was a tissue damaging event, heel-lance, venous blood draw, or IV insertion. The neonates were then separated into gestational age groups.

While the procedures were being performed, two nurses observed and rated the neonates on the PIPP. Nurse one was the individual caring for the patient, and varied depending on the day and the patient load. The second nurse was an expert rater and was present for all the procedures. The procedures were also videotaped and reviewed by two expert raters at a later time.

The scores ranged from 9.1 to 13.3 with a mean of 11.0 (SD = 1.3) for the pain event. The scores for the non-pain event ranged from 7.8 to 10.9 with a mean of 9.0 (SD = 0.8). Scores from the baseline event ranged from 2.5 to 6.6 with a mean of 4.9 (± 1.0). Repeated Measures ANOVA gave statistical significance to the PIPP by establishing that it was able to statistically differentiate between pain and non-pain events (F = 48, p = 0.0001). These results were further stabilized by the fact that no significant effects were found between gestational
groups \( F = 0.10, p = 0.96 \) or between raters \( F = 0.73, p = 0.534 \) (Ballantyne 1999). The PIPP now had construct validity along with intra- and interrater reliability and was ready for the clinical arena.

Because of the extensive research completed using and testing the PIPP, it was determined to be the gold standard for the purposes of this study. The SUN scores will, therefore, be compared to the original researchers PIPP for the sake of establishing convergent validity. The comparison will also allow for the examination of the relationship between these two scales and their attempts to quantify the multidimensional experience that is pain.

*Scale for Use in Newborns*

The SUN scale contains seven behavioral and physiologic categories. The seven categories are: CNS state, breathing, movement, tone, face, heart rate, and mean blood pressure (Blauer & Gerstmann, 1998). Developed by Blauer and Gerstmann in 1998, it was designed to improve neonatal pain scoring design. In their original research the SUN was tested against a unidimensional tool, the Neonatal Infant Pain Scale (NIPS), and a multidimensional pain scale, the Comfort Scale. It was found that the unidimensional tool was the easiest and fastest to use, but only focused on behavioral characteristics. Therefore, neonates too sick to mount a behavioral response would not
benefit from this tool. It was also determined that the Comfort Scale was the most difficult to use, and that it was very difficult to distinguish between categories. From their research, the Comfort Scale was deemed impractical in the clinical setting. The findings reported that the SUN fell within these two scales. It was not as easy to use as the NIPS, but it was not as difficult to use as the Comfort Scale. In examining the SUN, it was found that although it was easier to use than the Comfort scale, it still had similar drawbacks when attempting to score certain categories. For example, the score in the CNS category consists of determining whether the neonate was deeply asleep, drowsy, or lightly asleep. This led to a belief that some of the gradations were difficult to determine. Problems were also found that were similar to that of the Comfort Scale, when attempting to monitor blood pressure.

By comparing scores on the SUN to scores on the NIPS and Comfort Scale, concurrent validity was established. All scores displayed statistically significant results from before the procedure to during the procedure as well as during the procedure to after the procedure. The coefficient of variation was also calculated for each of the tools, and, as would be expected, the NIPS had a much higher score (188% ± 99%) than the SUN (33% ± 8%) or the Comfort Scale (27% ± 5%). The researchers determined that the large degree of variation in the NIPS
cancels out its ease of use, therefore making it a less desirable tool. This research led to making the suggestion that out of these three tools the SUN was the best choice for the clinical setting. However, it was noted that some small changes to the SUN (combining CNS state and breathing, and researching other physiologic measures to replace blood pressure) could be made that would most likely increase the effectiveness of the tool without sacrificing the tool's symmetry or descriptive capability.

To this point, the SUN has only content validity. This study will compare scores on the SUN to scores on the PIPP. This will allow the researchers not only to assess the correlation between the two scales, it will also allow for testing the convergent validity of the SUN with a well researched and widely utilized tool, the PIPP.

Summary

In this review recent studies involving research in the areas of neonatal pain physiology, assessment of pain in neonates, and development and testing of the PIPP and SUN scales were discussed. Also examined were the immediate and long-term effects of pain in neonates. These studies have shown that pain in neonates is a very real issue and deserves attention. Many of these studies discussed the use of pain scales in the clinical setting, but few were directly aimed at researching the
One of the only clinical trials in this area, research utilizing the PIPP, was discussed. However, more research in this area must be done in order to assure the best quality of care for neonates. Until pain scales with supported reliability and validity are used in all settings where neonatal pain is an issue, research in this field cannot cease.

Hopefully, the proposed study will aid in the development of “the” neonatal pain tool. The proposed study will allow researchers to be able to reference the PIPP and SUN scales against one another to help in determining best scale for use in the clinical arena. Once use of a tool is established as a standard of care and nursing is delivering the highest quality care to neonates, research in this area will have fulfilled its goal.
Chapter III

This chapter contains the methodology of this study aimed at establishing a correlation between the Premature Infant Pain Profile (PIPP) and the Scale for Use in Newborns (SUN). It begins with a discussion of the research design. A description of the setting and participants in this study follow. Next, the assessment tools and other materials used in the study are presented. Chapter III concludes with a description of the methods used for collection and analysis of the data.

Design

The study design was a comparative analysis of two neonatal pain scales, the PIPP and the SUN. By using these tools simultaneously on the identical population, not only can the scores be compared, but it will also be possible to draw a correlation between these two tools allowing for comparison of scores.

Subjects

Eighty one preterm infants, gestational ages ranging from less than 28 weeks to 36 weeks, were recruited as part of the original study (Evans, McCartney, and Lawhon, 2002). A nurse outside the research group, using a number system, coded all of the infants with an identifier. They were then entered into a database. The neonates were videotaped during heel-stick procedures. The original researchers observed videotaped footage
of each of the 344 heel-sticks (recognized by only identification number) and entered the PIPP scores as well as the time and date of each of the heel-sticks into the database. The database provides the time, date, and the original researchers PIPP score (see Appendix B for score sheet). This information enables the current researcher to compare the scores found during the current research with the results from the original researchers data.

The setting for this study was the research office of a midwestern school of nursing. Twenty neonates were chosen from the original population of 81. These 20 neonates include five from each gestational age group (less than 28 weeks, 28 to 30 weeks, 31 to 33 weeks, and 34 to 36 weeks). The neonates were chosen at random by drawing numbered pieces of paper out of a hat. The researchers believed that scoring neonates across the gestational ages allowed for the greatest amount of variance and provided the most accurate comparison of the tools. A larger sample would increase the generalizability of the findings, but time and budget constraints only allowed for the study of 20 neonates.

Material

The original study used the PIPP. The PIPP is a multidimensional pain assessment tool. This means that it not only assesses the physiological responses to the stimuli, but it
also assesses the more subjective behavioral responses. The tool consists of six categories for scoring (heart rate, oxygen saturation, eye squeeze, brow bulge, nasolabial furrow, and interactive state). It has been tested for content validity; construct validity; intra- and interrater reliability; internal consistency; and clinical utility (Stevens et al., 1996).

The SUN, which is also a multidimensional pain assessment tool, is made up of seven categories for scoring (heart rate, blood pressure, respiration rate, movement, muscle tone, facial expressions, and interactive state), of which the researcher only had six.

In the original study (Evans, McCartney, & Lawhon, 2002) blood pressure was not collected, because it was not needed for the PIPP and believed to be a source of unneeded stress for the neonates. Therefore, in this study the researcher was unable to observe changes in blood pressure. The SUN uses blood pressure for one scoring variable. For the purposes of this study, the modified SUN, did not include blood pressure. This left the researchers with six variables instead of seven and a possible high score of 24 instead of 28 (Appendix B).

The SUN is a much more recent development in the field of neonatal pain assessment. Because of its recent development, it has currently only been tested for content validity (Blauer & Gerstmann 1998).
Using the PIPP scores, the current researchers were able to cut out much of the time consuming and costly initial steps of videotaping and scoring the infants using the PIPP.

The choice of the SUN stemmed from an article written by Blauer and Gerstmann (1998). In this study, it was determined that the SUN “was the preferable tool because of its ease of use, scale symmetry, and scoring consistency (p. 47).” Because of these findings, the current researcher decided to use the modified SUN, not only to test it on its own merits but also to test it against a tool that has been tested for all aspects of validity, reliability, and clinical utility regarding pain assessment tools.

Data Collection

Using the existing research database, the time of the heel-stick was found. The heel-stick was observed on videotape and scored using the modified SUN. The scores were then entered into the database for statistical comparisons.

Data Analysis

The data analysis consisted of descriptive statistics of the PIPP and modified SUN and Pearson’s Product Moment correlation.
Assumptions

1. The biomedical technology department, according to manufacturer’s guidelines, properly calibrated all machines used.
2. The original researcher scored the neonates properly using the PIPP.
3. Heel-sticks are painful procedures.
4. Pain is a source of stress for a neonate and therefore, would result in physiological and behavioral responses.
5. Physiological and behavioral responses expend valuable energy and thus should be limited in the preterm neonate.

Limitations

1. Not all measures required to score the infants on the SUN scale were available. Therefore, a modified SUN was used.
2. Only one researcher did all the coding on the SUN, and one performed the coding on the PIPP. Several researchers working with these scales and the same infants would create more comprehensive results.
3. Sampling method was a limitation of this study. The sample was a convenience sample. Therefore, a larger, more diverse sample may further validate the findings of this study.
Summary

This chapter discussed the methodology of the current study researching the correlations between the PIPP and the modified SUN pain assessment tools. The setting and the subjects were also discussed. It also provided relevant background information about the initial study (Evans et al., 2002) from which the observations for this study were collected. The SPSS database used to accommodate the initial researchers data was also described. The means of data collection and data analysis concluded the discussion.
Chapter IV

This chapter presents the results of the statistical analyses that will allow the researchers to establish a correlation between the PIPP and the SUN. Characteristics of the 20 neonates chosen will be described next. The chapter concludes with a discussion of the research question and the research hypothesis.

Sample

The research sample for this study consisted of 20 neonates, seventy-percent male (N = 14) and thirty-percent female (N = 6). Three ethnic groups were present. Seventy percent of the participants were Caucasian (N = 14), one-fourth were African American (N = 5), and the final category, Other, contained five percent (N = 1). These neonates ranged in gestational age from 24 to 35 weeks with a mean gestational age of 30.30, and a standard deviation of 3.57. Their birth weights ranged from 630 grams to 2270 grams with a mean weight of 1405.75 grams and a standard deviation of 587.03. Eleven heel-sticks were rejected due to the subjects wearing UV masks. The masks did not allow for the scoring of the subjects facial movements. Because of the size of the sample, which was 83 original heel-sticks, it was determined that these heel-sticks would be deleted from the study. Each neonate received an
average of 3.6 heel-sticks, the range lying between 1 and 8 heel-sticks per neonate.

This sample was not completely representative of the entire population because of its lack of variation in ethnicity and slightly skewed sex percentage. However, the current research does not require a representative sample. The purpose of this study is to compare scores using the Scale for Use in Newborns with scores previously recorded using the Premature Infant Pain Profile.

Findings

The combined scores on the PIPP ranged from 2 to 18 with a mean of 9.29 and a standard deviation of 4.02, see Figure 1. The combined scores on the modified SUN ranged from 7 to 23 with a mean of 16.03 and a standard deviation of 3.50, as shown in Figure 2. See Tables 1 through 4 for scores by age group.

The research question that was used to develop this study, does a correlation exist between the original PIPP score for each heel-stick and scores for the same heel-sticks using the modified SUN in preterm neonates ages less than 28 weeks to 36 weeks gestation? To answer the research question a Pearson Product Moment Correlation coefficient was computed using the scores on the modified SUN and scores on the PIPP. The Bonferroni approach was used to control for Type I error, therefore a p-value of less than 0.025 (.05/2 = .025) was
required for significance. The resulting 0.70 Pearson Correlation coefficient with a p-value = 0.01 signifies a high positive correlation between the scales, as illustrated in Figure 3.

The original hypothesis was that because of the similarity of the scales, a fairly significant correlation will be found between scores on the PIPP and scores on the SUN. Because of the high degree of correlation shown during this study the null hypothesis, that no correlation exists, can be rejected.

Summary

In this chapter the research sample characteristics were described. The Pearson Correlation Coefficient of 0.70 was reported along with descriptive statistics of the scores on the PIPP and SUN. The research question was addressed by determining that the Pearson Correlation Coefficient was large enough to signify a high positive correlation between the two scales. Rejection of the null hypothesis concluded the chapter.
Table 1

**Group 1 Scores (less than 28 weeks)**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPP</td>
<td>25</td>
<td>3</td>
<td>18</td>
<td>8.36</td>
<td>3.57</td>
</tr>
<tr>
<td>SUN</td>
<td>25</td>
<td>7</td>
<td>22</td>
<td>15.48</td>
<td>3.96</td>
</tr>
<tr>
<td>Valid N (List wise)</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2

**Group 2 Scores (28 to 30 weeks)**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPP</td>
<td>16</td>
<td>3</td>
<td>10</td>
<td>6.81</td>
<td>1.94</td>
</tr>
<tr>
<td>SUN</td>
<td>17</td>
<td>13</td>
<td>18</td>
<td>14.71</td>
<td>1.72</td>
</tr>
<tr>
<td>Valid N (List wise)</td>
<td>16</td>
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<td></td>
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</tr>
</tbody>
</table>

Table 3

**Group 3 scores (31 to 33 weeks)**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPP</td>
<td>19</td>
<td>3</td>
<td>17</td>
<td>11.79</td>
<td>3.78</td>
</tr>
<tr>
<td>SUN</td>
<td>19</td>
<td>13</td>
<td>23</td>
<td>17.47</td>
<td>3.50</td>
</tr>
<tr>
<td>Valid N (List wise)</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4

**Group 4 scores (34 to 36 weeks)**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPP</td>
<td>12</td>
<td>2</td>
<td>17</td>
<td>10.58</td>
<td>4.96</td>
</tr>
<tr>
<td>SUN</td>
<td>12</td>
<td>11</td>
<td>23</td>
<td>16.75</td>
<td>3.72</td>
</tr>
<tr>
<td>Valid N (List wise)</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1

Frequency of Combined Scores - PIPP

Std. Dev = 4.02
Mean = 9.3
N = 72.00
Figure 2

Frequency of Combined Scores - SUN

Std. Dev = 3.50
Mean = 16.0
N = 73.00
Figure 3

PIPP/SUN Pearson Correlation Scatter Plot

PIPP

SUN
Chapter V

The assessment and treatment of pain in the neonatal population have long been overlooked. In the final chapter of this research study an analysis and comparison of the findings will begin to focus on new data that will allow the nurse to more quickly and accurately assess alterations in pain status of neonates. This will be followed by a discussion of the conclusions derived from the research data. Implications from the information derived from this study affect all aspects of nursing and are discussed next. The limitations and recommendations for future research will conclude the chapter.

Findings

The research question for this study, does a correlation exist between the PIPP and the modified SUN, was answered in the previous chapter. A 0.70 Pearson correlation ($p = .01$) was the result of a comparison of scores on the PIPP and modified SUN. Therefore, it can be said from the results of this research that a strong positive correlation does exist.

Another research question that was not asked when beginning this research, but that has been assessed by this research is the question of validity of scores when using the modified SUN scale. This scale has not been studied in great detail. Therefore, questions of the validity of the scale have yet to be answered. This research, while assessing the correlation
between the modified SUN and the PIPP, has also been able to test the convergent validity of the modified SUN by comparing it to the PIPP. The 0.70 Pearson correlation coefficient not only is useful in comparing scores on the two scales, it also allows the researchers to show the validity of scores using the modified SUN. Because of the strong correlation, it can be determined that this research confirms the research of Blauer and Gerstmann (1998), in which the validity of the original SUN was confirmed.

The results also aided in confirming the researcher’s theoretical framework. In the framework it was determined that heel-sticks were painful, and would elicit behavioral and physiological responses. A score of greater than 6 on the PIPP was considered to be painful (Stevens et al, 1996), and our average PIPP score was 9.29, standard deviation 4.02. A score of 10 to 14 on the SUN was considered baseline and scores above this mark were considered painful (Blauer & Gerstmann 1998). This study’s mean SUN score was 16.03, standard deviation 3.50. This data suggests that the theoretical framework was correct in determining that heel-sticks are painful, and causes expenditure of energy that would be better used for healing.

Conclusions

After careful analysis of the data established by this research a comparison of scores on the PIPP and the modified SUN
can be performed when assessing pain in neonates. By showing convergent validity with the PIPP, the modified SUN has also been determined to be a reliable pain scale. According to Blauer and Gerstmann (1998) scores between 10 and 14 on the SUN are considered baseline with all scores above this signifying pain responses. In the current research the average score of 16.03 (SD = 3.50) was established following the findings of the PIPP and again establishing that heel-sticks are painful.

**Limitations**

1. The major limitation was that this study was a secondary data analysis. Therefore, some aspects of the SUN were not available to be measured or observed; therefore, a modified SUN was used.

2. Another limitation, lack of environmental controls, resulted in the rejection of 11 heel-sticks. These were rejected because the neonates were wearing UV masks at the time of the heel-stick making facial coding impossible.

3. Differences in the routine followed before and after the procedure also limited this study’s results.

4. As is always true in research, a larger sample would increase variability, therefore, increasing the generalizability of this study’s findings.
Implications

Yet another pain scale has been shown to be a reliable judge of pain in nonverbal patients. As more scales are tested and deemed to be clinically reliable, it is the duty of the practicing nurse to utilize these scales when assessing pain in these most vulnerable of patients.

As part of evidence based practice JCAHO should mandate as a standard of care that neonates be scored using one of these valid and reliable scales. The time has come to stop guessing and use a tool designed and tested for this application.

Nursing administration with the evidence presented in this must make pain in neonates a priority. With the knowledge that neonates can feel pain and that heel-sticks are painful, it is the opinion of this researcher that at a minimum comfort measures prior to heel-sticks should be required. Therefore, hospital administrators need to establish new protocols using this information.

Along with clinical use of these scales, the schools of nursing should include the use of these scales in the clinical setting and the classroom. If more new nurses knew how to use these pain scales, better pain management in the non-verbal population could be facilitated. Pain has become such a hot topic in the literature more discussion and understanding of
pain and pain management must be included in nursing course work.

Recommendations for Further Research

1. A larger, more diverse sample would allow for more generalizable conclusions.
2. Better controls on the environment, including the nurses, would yield better results.
3. Utilization of a broad range of scales would aid in the nurse’s ability to use results from different scales to assess changes in pain level.

Summary

A discussion of the findings revealing the high degree of correlation of scores using the PIPP and the SUN began this chapter. Conclusions drawn from the data also warranted an evaluation of the convergent validity of the modified SUN. The major limitation of the study, limited available data, was then cited. Implications for practice, education, and administration were discussed, and it was determined that a non-verbal/neonatal pain scale should be used, taught, and mandated respectively. The researcher’s recommendations for future research included larger, more diverse sample, better experimental controls, and utilization of a broader range of scales.

With this research, we are one step closer to ending the unnecessary pain and suffering of our most fragile patients.
Many steps are still necessary, but in time with continued research in this area this vulnerable population will be able to flourish by redirecting their energy from displays of pain and suffering to promote continued growth of their bodies. The purpose of this study is therefore complete. The scores can now be transferred between the PIPP and the SUN with the confidence of knowing that research has shown that a high positive correlation exists between these scales. Therefore, patients that would normally require extra time to be scored twice using the same scale can immediately benefit from the nurses new ability to compare scores on different scales.
References


Appendix A

Schematic Map: Levine’s Conservation of Energy Model Adapted for the Neonatal Infant

Levine’s Conservation Principles

Internal Environment - Neonatal Intensive Care Unit

Energy Conservation

Structural Integrity

External Environment - Neonatal Intensive Care Unit

Nursing Care/Interventions (Heel-Stick)

Physical/Behavioral Response (Video Observation)

Comparison of Scales

PIPP Score

SUN Score
# Appendix B

## Premature Infant Pain Profile scoring sheet

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>INDICATOR</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chart</td>
<td>Gestational Age</td>
<td>36 weeks and more</td>
<td>32-35 weeks, 6 days</td>
<td>28-31 weeks, 6 days</td>
<td>Less than 28 weeks</td>
<td></td>
</tr>
<tr>
<td>Observe infant 15 seconds</td>
<td>Behavioral State</td>
<td>Active/awake Eyes open Facial movements</td>
<td>Quiet/awake Eyes open No facial movements</td>
<td>Active/sleep Eyes closed Facial movements</td>
<td>Quiet/sleep Eyes closed No Facial movements</td>
<td></td>
</tr>
<tr>
<td>Oxygen Saturation</td>
<td>Eye Squeeze</td>
<td>None 0-9% of time</td>
<td>Minimum 10-39% of time</td>
<td>Moderate 40-69% of time</td>
<td>Maximum 70% of time or more</td>
<td></td>
</tr>
<tr>
<td>Observe infant 30 seconds</td>
<td>Heart Rate Max</td>
<td>0-4 beats/min increase</td>
<td>5-14 beats/min increase</td>
<td>15-24 beats/min increase</td>
<td>25 beats/min or more increase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxygen Saturation Min</td>
<td>0-2.4% decrease</td>
<td>2.5-4.9% decrease</td>
<td>5.0-7.4% decrease</td>
<td>7.5% or more decrease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brow Bulge</td>
<td>None 0-9% of time</td>
<td>Minimum 10-39% of time</td>
<td>Moderate 40-69% of time</td>
<td>Maximum 70% of time or more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nasolabial Furrow</td>
<td>None 0-9% of time</td>
<td>Minimum 10-39% of time</td>
<td>Moderate 40-69% of time</td>
<td>Maximum 70% of time or more</td>
<td></td>
</tr>
<tr>
<td>TOTAL SCORE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

Scoring Sheet for Modified SUN

CNS State:
0 = Deeply asleep
1 = Drowsy, lightly asleep
2 = Awake, quiet alert, calm
3 = Anxious, fussy
4 = Hyper-alert, panicked

Score: ________

Breathing:
0 = No spontaneous breathing
1 = Shallow, intermittent breathing
2 = Quiet respiration, relaxed, usual pattern
3 = Increased rate and work of breathing, change from baseline
4 = Fights ventilator, coughs, chokes

Score: ________

Movement:
0 = No movement
1 = Decreased activity, infrequent movements
2 = Occasional movement, usual movements
3 = Increased activity, flexion and extension of extremities
4 = Vigorous movements of extremities, torso, and head

Score: ________

Tone:
0 = Flaccid, no tone
1 = Decreased tone
2 = Normal tone
3 = Increased tone, some finger/toe flexion
4 = Rigidity, limb extension, finger/toe flexion

Score: ________

Face:
0 = Totally relaxed, no tone or expression
1 = Reduced facial tone or expression
2 = Normal, neutral, no tension
3 = Increased tension, furrowed brow
4 = Contortion, grimace, vigorous cry

Score: ________

Heart rate:
0 = Depressions > 15% below baseline
1 = Depressions to 15% below baseline
2 = Baseline
3 = Elevations to 15% above baseline
4 = Elevations > 15% above baseline

Score: ________

Total: ________
Acknowledgments

First of all, I must thank Dr. Jane Evans for her time and patients in helping my colleagues and I through this process. We would not have made it without her guidance. I would also like to thank Joan Moon. Her APA expertise, although taxing at times, was critical to the success of this paper and my successful graduation. Dr. Cathy Kleiner was also an integral part of the process. Although she was not directly involved in my research, her guidance was often the driving force to its completion. I would also like to thank the rest of Dr. Evans’ research team; Barb Crenshaw, Beth Syzmanski, Monica Slattman, Joel Simmons, and Carrie Riley. We put many hours into completing our own projects, but none of them would be the same without the constant input and support from each other. Last, but certainly not least I must thank my wife. Nicole was my rock. She gave me the love and support I needed to get out of a profession that I had grown to hate and go back to school full-time. She was also a great motivator when I needed a little encouragement to complete papers or study for tests. Without her support none of this would have been possible! Thanks to all that have supported me through the last few years. You have made them successful.