LIBERTY UNIVERSITY

Montview Liberty University Journal of Undergraduate Research

Volume 1 | Issue 1 Article 4

2015

Pain Management in the Neonatal Intensive Care Unit

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A Senior Thesis submitted in partial fulfillment
of the requirements for graduation
in the Honors Program
Liberty University
Spring 2015

Acceptance of Senior Honors Thesis

This Senior Honors Thesis is accepted in partial
fulfillment of the requirements for graduation from the
Honors Program of Liberty University.

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Abstract

While pain management in the Neonatal Intensive Care Unit (NICU) was thought to be useless due to the infants' inabilities to experience pain, research has confirmed that infants can and do experience pain at the same, if not greater, level of intensity as adults experience pain. Painful stimuli cause a system-wide sympathetic nervous system response that can cause damage when prolonged or unmanaged. There are multitudes of ways to treat an infant's pain, but there seems to be a discrepancy between the knowledge that health care workers have regarding pain management in the NICU and the actual implementation of that knowledge. If this canyon between knowledge and action can be bridged, research supports that the overall care and patient outcomes of the infants will improve.

Pain Management in the Neonatal Intensive Care Unit

Pain management in a Neonatal Intensive Care Unit (NICU) is a difficult task to accomplish. As Anand puts it, "the complexity of their inability to verbalize pain and inherent variability of pain dependent on its course and duration adds layers of intricacy to appropriate identification" (Anand, 2007, p. S5). International guidelines for pain management in the NICU suggest that pain is the fifth vital sign, and it should be assessed as such (Gradin & Eriksson, 2011). If pain is not assessed well, it cannot be managed well. If nurses cannot recognize that an infant is suffering, they are unable to do anything about it (Pölkki, Korhonen, Laukkala, Saarela, Vehviläinen-Julkunen, & Pietil, 2010). Therefore, it is imperative that this pain be recognized in order for it to be managed well.

According to the research surrounding this topic, it does not appear that there is a lack of knowledge regarding how to appropriately treat the infants' pain or a lack of skill among health care providers; however, it does seem evident that health care workers struggle to know when to implement this care effectively. As a result, this comprehensive literature review will propose that this problem be remedied in three ways. First, the implementation of pain assessment tools and intervention protocols in each NICU could significantly increase the occurrence of accurate assessment and consistency of pain management among health care providers in the NICU. Second, regular educational seminars presenting the most recent research regarding pain management in the NICU would allow the health care providers to remain current in their knowledge of pain management in a NICU setting. Third, specific education as to which type of pain management to implement in each procedural situation and when is the best time to intervene would allow for increased pain management, better patient care, and improved patient outcomes.

The NICU and Its Inhabitants

The NICU is a specialized intensive care unit (ICU) for infants, often prematurely born, who need concentrated medical attention (Lucile Packard Children's Hospital, 2013). When infants are admitted to the NICU, they undergo an average of fourteen painful experiences each day throughout their stay, including but not limited to venipuncture, intubation, and chest drain insertion—most of which are considered at least moderately painful (Akuma & Jordan, 2011). There are myriad influences that contribute to the risk factors of potentially having an infant who needs the NICU. These influences include maternal factors, such as hypertension or a pregnancy with multiples; delivery factors, such as breech presentation or meconium; and baby factors, such as gestational age at birth or birth weight. All these factors combined play a role in the baby's potential need for expert care. However, the individuals serving in this ICU are specifically trained to work together in caring for the infants in this area of the hospital (Lucile Packard Children's Hospital, 2013).

Neonates' Capacity to Feel Pain

In the past, pain has remained untreated in neonatal patients because it was believed that, due to their immature nervous systems, the infants were unable to feel pain. Moreover, it was believed that administering pain medications to infants was not safe, and the medications would cause unsafe or detrimental side effects. As a result of this thinking, almost all procedures, including surgical procedures such as open-heart surgery, were completed without the use of analgesia until the 1980s (Akuma & Jordan, 2011).

Many advances both in thinking and in practice have occurred. The pain system is actually the only sensory system in the body that is designed to develop naturally without the confrontation of any stimuli during the early time period of the life span (Anand, 2007). In fact,

early stimulation of this sensory system has been found to actually have the potential to damage the system as it develops, especially when painful stimuli are frequent. Specifically, this early stimulation has the ability to cause increased peripheral sensitivity and decreased behavioral reactions. Research has found the opposite; infants are truly more sensitive to pain, and preterm infants are even more sensitive to pain than term infants. Research validates that preterm infants have only 33-50% of the pain threshold that full term infants are born with, specifically regarding tests completed stimulating the dorsal cutaneous flexor reflex reaction to pain (Anand, 2007). Term infants—in comparison to older children and adults—have a lower pain threshold not because their nervous system is immature and therefore unable to transmit the painful stimuli, but because the descending inhibitory fibers have not fully matured. Applying this concept to practice, because the growth of these inhibitory fibers stems from the supraspinal brainstem nuclei, and because the inhibitory fibers have only matured to the cervical spine by 30-32 weeks gestation, when the infant is at this gestational age, he or she actually has a lower pain threshold in the lower extremities than in the upper extremities. Therefore, if a 30-week-old neonate were to experience a finger prick for glucose testing, the infant would actually exhibit less of a physiological response than if the prick had been done in the infant's heel. This phenomenon confirms that neonates' abilities to transmit painful stimuli to the brain are fully intact by approximately thirty weeks gestation. However, the physiological response initiated in the brain traveling back to the periphery has not fully developed at 30 weeks gestation and, therefore, the infant's behavioral response is diminished. It becomes a dysfunction in the infant's ability to express pain (Anand, 2007). Pölkki et al. (2010) also confirms that the reactions of a preterm infant may be less noticeable and even absent in comparison to that of a full term infant.

While both full term and preterm babies can feel pain to the same degree, their reactions may be quite different. Preterm infants often present with less noticeable or even absent reactions to noxious stimuli than those of full term infants. As a result, nurses seem to be using the same methods and tools to assess the pain of all the infants in the NICU, regardless of their gestational age. In a study completed by Pölkki et al. requiring the nurses to view recordings of infants responding to pain, the participants scored the full term infants significantly higher on the pain intensity scale than they did the preterm infants in the videos. This discrepancy causes the nurses' pain assessments to be inaccurate and underscored for the preterm infants, which then results in inadequate treatment and pain management (Pölkki, et al, 2010). Moreover, "pain assessment is the first step toward relieving pain effectively in children: nurses who do not recognize that an infant is suffering pain are unable to alleviate it" (Pölkki, et al, 2010, p. 49). Because there are so many external factors that also affect how an infant reacts to a painful procedure, such as the gestational age of the infant, the health status of the infant, the level of activity in the environment, and other sources of stress, it must be recognized that simply the physiological changes that occur when an infant is exposed to pain do not necessarily give the full picture of the infant's true experience with pain (Pölkki, et al., 2010).

Research has found that even the most premature of neonatal patients has the neural capability to respond to painful stimuli. Also, research has revealed that the combination of pharmacological and additional comfort measures in the relief of an infant's pain is ideal and reduces the risk of adverse outcomes significantly (Akuma & Jordan, 2011). It has also been validated that "unrelieved pain in the neonatal period can have long-term behavioral and physiological consequences, which may lead to long-term functional changes of the pain pathways and maladaptive pain cognitions, contributing to morbidity and mortality" (Akuma &

Jordan, 2011, p. 1289). The potential for long-term negative consequences is arguably the most important consideration when assessing the importance of a change in practice regarding pain management in the NICU.

Professional Perceptions and Behaviors Regarding Pain Management

One of the most significant areas of interest is that while the knowledge of medical professionals serving in the NICU has definitely become extensive and sufficient to manage the pain of infants in the NICU well, there seems to be a disconnect between the knowledge doctors and nurses have regarding pain assessment and management and how that knowledge is actually utilized. There is a gap between the knowledge and the practice. To clarify, there is no deficiency in the actual execution of pain management; the execution of skill is sufficient. However, there is a deficit in when that knowledge of assessment and intervention is utilized. For example, when nurses and doctors are tested in their skills of administering analgesia and the knowledge of the effects it will have, they consistently perform well. However, "under-utilization of analgesia for procedural pain relief in neonates is a recurring finding" (Akuma & Jordan, 2011, p. 1289). According to Anand (2007), multiple different research studies revealed extremely poor compliance in the task of administering analgesia to infants before a painful procedure was performed. In Anand's study, an average of fourteen painful procedures a day for 151 neonates was verified by a study in which Anand reported on, and less than 35% of these almost 20,000 painful procedures involved some form of analgesia for the infant (Anand, 2007).

According to Akuma and Jordan, it is internationally recommended that each NICU have specific policies for pain management and that each staff member working in the NICU be fully educated on the use of these pain management policies. It is consistent throughout the research that many NICUs throughout the world do have pain management policies, but few if any of the

staff members are aware that they exist, let alone how they should be implemented (Akuma & Jordan, 2011). It is no wonder that there is very little evidence supporting the implementation of any consistent pain management tools. In an Italian study, it was found that only 66% of the NICUs actually had any kind of written guidelines for pain management, and it was discovered that topical anesthetics overall were drastically underutilized in all the NICUs (Codipietro, Bailo, Nangeroni, Ponzone, & Grazia, 2011). Education about the timing of implementation seems to be a valuable solution that would not only relieve any misconceptions regarding pain assessment and management, but it would also give the doctors and nurses more confidence in caring consistently for the patients in the NICU to the best of their abilities.

The evaluation of pain is subjective, and it becomes extremely difficult to accurately and effectively assess pain in an infant. Because it is recognized that infants experience pain, the experience of pain is quite important in the development of a newborn, especially the further development of their pain sensory system. Studies show there is quite a discrepancy between nurses' understandings of how painful certain procedures actually are. A study surveying the opinions of nurses regarding the level of pain caused by common procedures in the NICU was conducted. The results of the study revealed that the same number of nurses that ranked a venipuncture as 'slightly painful' ranked a venipuncture as 'very painful.' Further, despite these nurses listing the majority of the procedures between 'not painful' and 'moderately painful,' they also reported that they would only use analgesics for pain consistently in procedures such as chest drain insertion, circumcision, or endotracheal intubation. Also in this study, one nurse referred to the consistent use of analgesics as "impractical" (Dodds, 2003). Knowing this, it is important to explore the anatomical pain experience and response in a newborn in order to better understand the infants' experiences of pain.

First, it is important to understand that myriad factors can influence the capacity to which the infant can feel pain. These include but are not limited to the following: sleeping state, gestational age, severity of illness, and previous pain experience (Gradin & Eriksson, 2011). While descending pathways of infants' pain responses have been discussed, it is imperative to explore further the anatomical response of the infants in order to know how to treat them best.

Anatomically, the neural pathways required for pain transmission throughout the body have been found to begin with sensory receptors in the newborn's skin and make a continuous pathway into the cerebral cortex of the brain. While it has been accepted in the past that newborns are unable to feel pain due to a decreased number of sensory receptors in the skin of newborns and the immature neural pathways, it has been found that newborns actually have sensory receptors in their skin that are of equal or greater density than those in adult skin. Before cutaneous sensory receptors begin to form in the skin, synapses are being formed connecting the receptors to interneurons and eventually to the dorsal horn as early as the sixth week of gestation. Cutaneous nociceptive receptors in the skin begin to develop as early as the seventh week of gestation, and the connections made to and in the dorsal horn are completed by thirty weeks gestation. Therefore, while the newborn's nervous system still has room for growth after birth, it is fully intact and capable of transmitting nociceptive responses from the sensory receptors in the skin to the dorsal horn in the brain (Anand & Hickey, 1987).

It is often argued that because there are myriad unmyelinated nerve fibers in the newborn's body, they are unable to feel pain to the same intensity as adults or even feel pain at all (Anand & Hickey, 1987). Studying the adult human body and recognizing that there are areas in the mature adult body through which impulses are carried across unmyelinated or thinly myelinated fibers can nullify this argument. According to Anand and Hickey, "even in the

peripheral nerves of adults, nociceptive impulses are carried through unmyelinated (C-polymodal) and thinly myelinated (A-delta) fibers" (Anand & Hickey, 1987, p. 1322). When nerve fibers are unmyelinated or thinly myelinated, it does not have an effect on the ability of the pain response to pass through the neurons; it simply affects the speed at which the impulse is passed. But, in neonates, this slower conduction velocity is offset by the shorter distance traveled by the impulse. Further, Anand and Hickey's data has evidenced that complete myelination of the nerves traveling in the spinal cord and in the central nervous system itself takes place in the last two trimesters of pregnancy (Anand & Hickey, 1987).

When a person experiences pain, the body recognizes that something is abnormal, and there is a threat to regular function. As a result, the body responds with the sympathetic nervous system's response, known as fight or flight. When this response is activated, every body system plays a role in some way, and the pain affects each system differently but in ways that are intertwined with one another. With only this knowledge about the body's response to pain, it is clear that this is an experience that must be managed well in order to prevent the entire body from distress (Hannibal & Bishop, 2014).

Pain Presentation in the Human Body

Physiologic Alterations in Response to Pain

While each infant's pain response is subjective and individual, there are myriad physiologic changes that occur in the majority of infants regarding the pain response. Each body system is affected in some way to this pain response.

Cardiovascular alterations. The cardiac and respiratory systems consistently respond in similar ways when affected by pain. Because of hormones that are released or inhibited during this response, the physiological changes in the cardiovascular system include increased

heart rate, blood pressure, and breathing efforts in an attempt to try and meet the increased demands of the body and its vital organs for oxygen and nutrients. While this response is effective in the short-term, it can cause damaging effects in the long-term (Middleton, 2003). In a study completed searching the cardiovascular effects of chronic pain, the researchers' results exhibited that those with chronic pain experienced higher baseline heart rates, higher mean arterial pressures, higher systolic blood pressure reactivity to the cold pressor test performed on each subject, and significantly less systolic blood pressure and mean arterial pressure returns to baseline during recovery. The results of this study indicated the classic cardiovascular response when the body experiences a long-term pain reaction, such as a pain response prolonged due to inadequate treatment (Olsen, Bruehl, Nielsen, Rosseland, Eggen, & Stubhaug, 2014).

In addition to these vital sign changes, the cardiovascular system also experiences increases in peripheral vascular resistance, systemic vascular resistance, coronary vascular resistance, and myocardial oxygen consumption. These are all temporary attempts by the cardiovascular system to compensate for the increased demand for oxygen and nutrients in the tissues. Additionally, hypercoagulation and the risk for development of deep vein thrombosis (DVT) result from this systemic response. Because the body is preparing for potential injury, the blood becomes hypercoagulable, thus increasing the patient's risk for DVT. All of these changes result in overall increased workload on the heart. The heart is responsible for circulating oxygen and nutrients and meeting the body's requirements; therefore, when these demands are increased, the heart is responsible to supply enough oxygen to the body (Pasero & McCaffery, 2011).

Specifically, there are distinct elevations in blood pressure and heart rate as well as palmar sweating and changes in partial pressures of oxygen have been observed during and after procedures such as circumcision and heel lancing. The length and intensity of the stimulus and

the temperament of the infant determine the extent of the changes in heart rate and blood pressure. Decreases in the partial pressures of oxygen have been observed during and after surgical procedures and circumcisions; however, these changes were prevented when local anesthetics were utilized. In another example, neonatal patients who were intubated without the use of anesthetics experienced substantial decreases in the partial pressure of oxygen and significant increases in both blood pressure and intracranial pressure (Anand & Hickey, 1987). However, "the increases in intracranial pressure with intubation were abolished in preterm neonates who were anesthetized," and when opiate-induced analgesia was used, the cardiovascular responses of the intubated infants responding to tracheal suctioning was eliminated (Anand & Hickey, 1987, p. 1326). When local anesthesia was actually used on full term infants experiencing circumcision, the changes in heart rate and blood pressure were actually prevented. Simply providing the infant with a pacifier during or after these procedures was not sufficient to prevent or lower the increase in heart rate or blood pressure (Anand & Hickey, 1987). It seems that the solution to pain management in a NICU setting is the correct and timely administration of appropriate analgesia; however, the problem seems to lie in the medical staff's ability to discern when the administration of such medication is necessary and beneficial.

Respiratory alterations. The respiratory system also experiences myriad changes in order to respond to the pain the patient experiences. Because pain causes the patient to refrain from movement, the respiratory system becomes increasingly more at risk for infection and dysfunction. The experience of unrelieved pain can cause the patients to limit the movement of their thoraxes and abdomens in order to minimize the pain. As a result, they become reluctant to cough, and the sputum and any other secretions that are formed become trapped in the

respiratory system, potentially leading to atelectasis, pneumonia, decreased cough, decreased oxygen flow and volumes, sputum retention, infection, and hypoxemia. The pain caused by utilizing the diaphragm and expanding the chest wall and abdomen decrease the patients' vital lung capacities, as they are unable to breathe deeply and cough adequately. This results in increased inspiratory and expiratory pressures and reduced ventilation at the alveolar level. This decrease in oxygen availability can lead to cardiovascular problems, changes in level of consciousness, and possibly delayed wound healing. This becomes an even greater problem when the body's systemic response is requiring more and more oxygen to function fully. When the tissues are increasing their demand for oxygen, and when the respiratory system is not able to supply what the body is chronically demanding, the long-term effects on the patient become overwhelming. This is when the patient begins to develop infection and some of the other complications that result from a dysfunctional respiratory unit. Not to mention, because the respiratory system is not able to supply the tissues with adequate oxygen, ischemia and hypoxemia can result in a widespread manner (Middleton, 2003; Pasero & McCaffery, 2011).

Hormonal and metabolic alterations. The endocrine system can be labeled as the cause, of sorts, for the domino reaction that occurs when the body experiences pain. Myriad hormones are released that travel to their target organs, causing the systems to respond in the way they do to the pain. Cortisol is a primary participant in the pain response, and this hormone causes the majority of the inflammatory consequences that are seen when the sympathetic nervous system is activated. Cortisol is a hormone that has catabolic responsibilities, causes arousal in the morning, and when stimulated more heavily, it has potent anti-inflammatory effects. Moreover, cortisol is responsible for releasing glucose that has been stored away in order to utilize it for energy during the pain reaction. In regard to normal daily activity, cortisol

is excreted in a diurnal pattern, allowing it to maintain blood glucose levels and suppress the function of non-vital organ systems in order for the brain and neuromuscular system to be sustained. Moreover, cortisol works on a regular basis to prevent damage from occurring to the tissues and nerves during the inflammatory process. In addition to its role in daily function, cortisol also plays a vital role in the stress response that takes place when pain is experienced. The surge of cortisol that occurs during this reaction to pain is the body's way of compensating for the new energy demand it is experiencing. While this response is adequate and beneficial in the short-term, it becomes damaging when prolonged, hence the importance of pain management (Hannibal & Bishop, 2014).

Another response of the endocrine system during this sympathetic nervous system reaction is an increase in the release of catecholamines, such as norepinephrine and epinephrine. This release of adrenergic catecholamines causes an increase in heart rate, blood pressure, and respirations as the body tries to compensate for the negative stressors it is experiencing. These reactions are specifically targeted at moving more oxygen throughout the body as a result of the increased oxygen demand. Increased catecholamines are also responsible for vasoconstriction of the arterioles, the stimulation of sweat secretion, and dilation of the pupils (Hannibal & Bishop, 2014). These compensatory mechanisms are helpful when executed in the short-term; when pain is not controlled, these mechanisms become long-term experiences, and they then become detrimental to the patient's health.

Additionally, the endocrine system responds with an increase in acetylcholine, a cholinergic hormone that acts on sweat glands and the end plates of skeletal muscle, except that of the heart and esophagus. Increases in acetylcholine in the short-term assist in sweat production and skeletal muscle contraction during the sympathetic nervous system response

stimulated by the experience of pain (Carroll & Curtis, 2009). The activation of this system also causes an increase in antidiuretic hormone (ADH), renin, angiotensin II, and aldosterone. All of these hormones play a role in the body's ability to retain fluid and sodium in order to increase blood pressure and allow more oxygen to be circulated throughout the circulatory system during a time of higher demand (Middleton, 2003). These specific hormones will be discussed in further detail later.

The endocrine response is also comprised of an increase in CRH—corticotropin-releasing hormone. The secretion of this hormone stimulates the secretion of adrenocorticotropic hormone (ACTH), which then stimulates the sympathetic nervous system, causing the pain response and even more cortisol to be released into the vasculature. Further, glucagon—a polypeptide produced by the pancreas—increases, causing an increase in the body's metabolic rate. As a result, insulin levels are decreased, and hyperglycemia, impaired tolerance of glucose, and the destruction of carbohydrates, proteins, and fats commence (Middleton, 2003).

The endocrine system also responds by increasing growth hormone and decreasing testosterone levels. In summation, all of these hormone shifts result in gluconeogenesis, hepatic glycogenolysis, hyperglycemia, glucose intolerance, insulin resistance, muscle protein catabolism, and increased lipolysis. While all of these endocrine reactions are beneficial in the short-term, they become damaging when experienced on a long-term level. As a result, it is extremely important to manage patients' pain in order to prevent this system from overreacting to the stimulus (Pasero & McCaffery, 2011).

While there is limited research data on the metabolic changes of infants undergoing non-surgical procedures, there is significant validated information on their pain response to surgical procedures specifically. For example, in a study completed by Anand and Hickey, the plasma

renin activity of infants was measured five minutes after a venipuncture procedure was performed, and the infants received sedating medication prior to the initiation of the procedure. Five minutes post-venipuncture in full-term infants in the NICU, there was a significant increase in plasma renin activity, which did return to normal levels within an hour after the procedure. There were no observed changes in the levels of epinephrine, norepinephrine, or cortisol after the venipuncture. Moreover, in preterm infants who did not receive sedating medications who underwent endotracheal suctioning, chest physiotherapy, and ventilation therapy, there were significant increases measured in both epinephrine and norepinephrine; however, this elevation was significantly decreased when the infants were sedated prior to the procedures. Massive increases in serum cortisol were measured in infants who experienced circumcision. This increase occurred during the procedure and remained after the procedure for a marked amount of time. When the cortisol levels were measured during circumcisions in which the infant was simply given a local anesthetic, the changes in the cortisol levels were almost identical to what they were when the procedure was performed with no pain medication at all (Anand & Hickey, 1987). These findings reiterate that no education is specifically needed among health care providers regarding the skill of correctly administering pain management interventions. However, much education is needed on what interventions are necessary for specific procedures and when the interventions should be implemented. While health care providers likely mean well when they attempt to initiate pain management interventions, their efforts are unsuccessful if they do not adequately manage the infants' pain.

In addition, "further detailed hormonal studies in preterm and full term neonates who underwent surgery under minimal anesthesia documented a marked release of catecholamines, growth hormone, glucagon, cortisol, aldosterone, and other corticosteroids, as well as

suppression of insulin secretion" (Anand & Hickey, 1987, p. 1327). Carbohydrate and fat stores were consequently broken down, causing a multitude of other problems cascading into even further alterations in the metabolic balance of the infant's body. Interestingly, these responses were abolished in studies completed in which potent anesthetics, such as halothane and fentanyl, were utilized. The responses were decreased with the use of halothane, and they were completely eliminated with a low dose of fentanyl (Anand & Hickey, 1987).

Genitourinary effects. The genitourinary system is also affected by chronic or untreated pain. As mentioned earlier, the increase in pain causes the release of a multitude of hormones. An increase in the release of aldosterone, ADH, renin, and angiotensin II all play a role in the physiological response of the genitourinary system to pain. Because these hormones are responsible for fluid and electrolyte balance, urinary output, and blood volume and pressure, when they are altered, the fluid and electrolyte status of the body is also altered. Further, the patients could experience fluid overload, hypokalemia, and decreased urinary output. These physiological responses affect the cardiovascular system, as well, by increasing the preload on the heart and the vascular resistance it experiences as it pumps blood throughout the body. When these hormones are released, they signal to the kidneys to retain sodium and water, thus increasing the body's fluid volume and blood pressure and causing urinary retention (Middleton, 2003; Pasero and McCaffery, 2011). Also, "A decrease in extracellular fluid occurs as fluid moves to intracellular compartments, causing fluid overload, increased cardiac workload and hypertension" (Middleton, 2003). Because sodium and potassium have an inverse relationship within the body, when sodium is retained, potassium is excreted; therefore, these patients often experience hypokalemia (Middleton, 2003). Slight hypokalemia can result in cardiac dysrhythmias, constipation, fatigue, muscle damage, numbness, or tingling. While a low

potassium level for a short time might not result in any clinical manifestations, a low potassium level for a prolonged period or a potassium level increasingly becoming low can cause extreme damage and even death (Dugdale, III, 2014).

Gastrointestinal effects. Physiological changes in the gastrointestinal (GI) system can include but are not limited to decreased gastric and bowel motility and effects on nutrition. When the sympathetic nervous system is stimulated, the GI system is temporarily put on hold because other body systems, such as the cardiovascular system, need the available oxygen and nutrients to overcome the stimulus. However, when the stimulus is prolonged, such as in unmanaged pain, the GI system is dysfunctional for a long period of time. This results in delays in emptying of the gastric system and reduced overall motility of the bowel. If prolonged significantly, this reduced motility could lead to paralytic ileus. All of this, in combination with the rest, can result in decreased nutritional status, as well. When bowel function is placed on hold, the body does not have the opportunity to digest and absorb the nutrients needed from patient's intake. This nutritional status imbalance can lead to myriad other problems, including but not limited to delayed wound healing and increased recovery time (Middleton, 2003). When discussing the importance of nutrition in terms of healing, Mary Ellen Posthauer states, "complications such as pain, infection, and surgery increase the length of hospitalization and rehabilitation, decrease the individual's quality of life and contribute to the increased cost of care" (Posthauer, 2012, p. 15). This is a perfect representation of how pain can be a complication to nutritional status, and therefore, overall healing. Especially in neonatal patients, adequate nutrition is essential to their continued growth and development.

Musculoskeletal system effects. The musculoskeletal system also experiences physiological effects of the stimulation of the sympathetic nervous system. First, it must be

understood that this system is definitely one in which the presentation in the short-term experience is drastically different from the presentation in a long-term experience. For example, in a short-term situation, when the fight or flight response is activated, the musculoskeletal system utilizes the increased amounts of mobilized glucose in order to fight the stimulus or flee from the situation. However, in a prolonged situation when the stimulus remains for an extended period of time, the musculoskeletal system does not respond this way. It is incapable of maintaining the short-term response for a long period of time. Therefore, the patient begins to experience muscle spasms, impaired muscle function, fatigue, and even immobility. When the body involuntarily experiences noxious stimuli repeatedly, reflex muscle spasms can result where the tissue is actually being damaged (Middleton, 2003; Pasero & McCaffery, 2011). According to Middleton, "impaired muscle function and muscle fatigue can also lead to immobility, causing venous stasis, increased blood coagulability and, therefore, an increased risk of developing DVT" (Middleton, 2003, p. 1). Further, as mentioned when discussing the respiratory system, prolonged pain can result in splinting—the patient's lack of movement to expand the thoracic cavity or exercise the abdominal or thoracic muscles. This can lead to reduced respiratory function (Middleton, 2003).

Immune system effects. The immune system is also affected by this prolonged sympathetic nervous system response to pain. Unrelieved pain can result in depression of the immune system. As if the patient was not already at risk for complications, this can even further put the patient at risk for infection, impaired wound healing, pneumonia, and eventually the possibility of sepsis could become a reality. When the body experiences stimulation of the sympathetic nervous system, it attempts to decrease the function of the less necessary body systems in order to maximize the function of those necessary to survive the stimulus. Therefore,

the immune system is temporarily suppressed in order to maintain adequate function of the other more vital body systems. Unmanaged pain can result in a prolonged suppression of the immune system, placing the patient at an increased risk for multiple complications (Middleton, 2003; Pasero & McCaffery, 2011).

Cognitive effects. Cognitively, untreated pain can cause a reduction in overall cognitive functions and mental confusion. The widespread inflammatory response and hypercortisolism mirror the response the body exhibits when anxiety is experienced, and when the body experiences either pain or anxiety, both experiences have a positive correlation to one another. Because the acute stress response releases numerous hormones at an unnatural rate, the patient's anxiety and depression levels are also increased. Moreover, the extensive release of cortisol further increases the patient's anxiety toward the stimuli (Middleton, 2003; Pasero & McCaffery, 2011). As a result, "the stressor effects of unrelieved pain have the potential to increase anxiety levels further and interfere with activities of daily living, such as diet, exercise, work or leisure activities and to interrupt normal sleep patterns causing varying degrees of insomnia" (Middleton, 2003). When pain goes unrelieved, it can result in cognitive impairment, mental confusion, and a lowered ability to concentrate on the task at hand (Middleton, 2003). While concentration is not necessarily applicable to infants, cognitive impairment or mental status changes are applicable. Chronic pain definitely has a significant effect on the patient's cognitive functioning, and if we strive to give holistic nursing care, this aspect of the patient cannot be overlooked.

In a study highlighted by Hannibal and Bishop, they found that no matter whether the stressor was pain related or non-pain related, "cortisol is likely to contribute to the consolidation of fear-based emotional memories that are readily recruited by nonthreatening stimuli and

conditioned to reactivate the stress response" (Hannibal & Bishop, 2014, p. 1820). This study solidified that the release of cortisol does play a role in cognitive functioning, especially that of the stress response, which is also positively correlative to the experience of anxiety in patients experiencing chronic or unmanaged pain.

In summary, the response exhibited by the human body when a painful stimulus is introduced and unmanaged truly involves every body system. When intervention is not initiated to control the person's response to the pain, the body attempts to compensate in a way that turns into quite the cascade of events. This unmanaged response causes much damage and stress to the body. This further supports the need for aggressive pain management, especially in an environment with the most fragile of patients. Again, while health care providers are fully capable of executing the skills necessary to manage these infants' pain, there is a lack in the knowledge of when to initiate this intervention and which intervention to use with individual procedures and painful experiences. This discrepancy must be remedied in order to provide the best care and achieve the best patient outcomes possible.

Behavioral Alterations in Response to Pain

Simple motor responses. While the infants' motor responses to pain are not always consistent, studies have shown that full term infants respond to a pinprick in both their upper and lower extremities by flexing and adducting the affected limb. Sometimes, crying, grimacing, or both accompanied the motor response (Anand & Hickey, 1987). A similar study was completed in premature infants, and the response of the infants was relatively equal to that of the full term infants (Anand & Hickey, 1987). Anand and Hickey noted, "premature neonates (<30 weeks) not only had lower thresholds for a flexor response but also had increased sensitization after repeated stimulation" (Anand & Hickey, 1987, p. 1328).

Facial expressions. The facial expressions of infants have been studied significantly, and it has been found that there are specific facial expressions that are associated with certain emotions, including but not limited to happiness (pleasure), sadness, pain, and surprise. The recognition of facial expression was reported to be one of the most commonly reported behavioral responses to pain (Dodds, 2003). Recently, the facial expressions of infants experiencing pain during immunizations was studied and quantified. The researchers found that when the technique used to lance the heel or administer the immunization was altered even slightly, the infant's pain response was different, as well. It was concluded that there are myriad factors that play into an infant's pain response, and each infant may respond slightly differently to the same painful procedure. Things such as the mood can alter this response or affect the infant or environment at the time the infant is stimulated (Anand & Hickey, 1987).

Crying. While infants cry for more reasons than just pain, it has been validated that infants have specific cries for specific needs and levels of discomfort. For example, the cry that Infant A elicits when she is hungry often differs from the cry she elicits when she is in pain. Further, the cry Infant A elicits when she is hungry is also often different from the cry Infant B elicits when she is hungry. As a result, researchers have been able to study and identify the different cries for distress that infants elicit (Anand & Hickey, 1987). They found that "cries due to pain, hunger, or fear can be distinguished reliably by the subjective evaluation of trained observers and by spectrographic analysis" (Anand & Hickey, 1987, p. 1328). Consequently, infants' cries have been successfully used to analyze the level of the pain they experience and how it differs in distinctive situations and procedures (Anand & Hickey, 1987). Further, Dodds found that crying was the most commonly reported behavioral indicator of pain, which was identified by 86% of her study participants (Dodds, 2003).

Because pain cries are so telling of the intensity of the pain infants are experiencing, studying these cries is extremely helpful in learning about the way in which infants respond to pain. In full term infants, the pain cry seems to be different than the pain cry in preterm infants. Infants experiencing conditions that affect the nervous system, such as hyperbilirubinemia, meningitis, or neurological impairment, were found to elicit a different cry than healthy preterm or healthy full term infants. Because each of these types of infants has a different level of cortical functioning, the cry is slightly altered, and the results of the spectrographic analysis confirm this (Anand & Hickey, 1987).

In a study by Anand and Hickey, highly trained adults were taught how to recognize the differentiation of these cries, and they observed and listened to the cries of infants experiencing circumcision (Anand & Hickey, 1987). The adult listeners were able to effectively distinguish between the different types of cries the infants were presenting with. When other painful procedures were performed, the infants responded differently, but the adult listeners noticed most the difference in the cries of the full term infants and those of the preterm infants. The cries of the preterm infants were found to reveal their heightened sensitivity to the painful procedures at hand, but both the full term and preterm infants elicited almost identical latency periods—the time between when the noxious stimulus was actually elicited and when the crying or the motor response was observed. This is consistent with the claim that preterm infants are still fully capable of feeling pain to the same degree as full term infants, but the conduction time is a bit slower in preterm infants, which is even slightly offset due to the short distance between neurons (Anand & Hickey, 1987).

Complex behavioral response. Observing the more complex behaviors of infants as they experience painful stimuli is also extremely telling of their experience. For example,

"alterations in complex behavior and sleep-wake cycles have been studied mainly in newborn infants undergoing circumcision without anesthesia…[researchers found] that painful procedures were followed by prolonged periods of non-rapid-eye-movement sleep in newborns" (Anand & Hickey, 1987, p. 1328). These results have also been confirmed in neonatal patients. In studies of the same nature completed in an adult population, similar results were observed when the adults were exposed to long periods of stress or pain. Similar studies have confirmed that for the hour following the circumcision, infants often experience an increase in wakefulness, irritability, altered sleep-wake cycle, and altered arousal levels. In a study completed to validate these thoughts, neonates were observed for a more significant period of time after the circumcision, and 90% of the infants exhibited alterations in their behavioral states after the procedure while only 16% of infants that did not experience circumcision exhibited this same type of behavioral change (Anand & Hickey, 1987).

An almost identical study was completed in which the neonates were given local anesthetics prior to the circumcision. The behavioral changes that were observed in the infants that had not received anesthetics were completely absent in the infants who had received anesthetics (Anand & Hickey, 1987). Additionally, "for two days after circumcision, neonates who had received anesthetics were more attentive to various stimuli and had greater orientation, better motor responses, decreased irritability, and a greater ability to quiet themselves when disturbed," and as a result of these studies, "intervention designed to decrease the amount of sensory input and the intensity of stressful stimuli during intensive care or preterm neonates was associated with improved clinical and developmental outcomes" (Anand & Hickey, 1987, p. 1329). Researchers have validated that the pain response these infants elicit is not simply a reflex; it is truly a response to pain they are experiencing (Anand & Hickey, 1987).

Long-Term Effects of Unmanaged or Poorly Managed Pain

Although there is little research regarding the long-term developmental effects of unmanaged or poorly managed pain in a premature infant, a small amount of information is available. When an infant, child, or adolescent experiences these physiological effects for a long period of time, they can cause developmental delays. As the child's nervous system continues to grow and develop, it needs a healthy environment in which to do that. When it is chronically stimulated by the pain response, it can cause increased behavioral and physiologic responses to pain, which can further exacerbate the problem. This chronic pain can manifest itself through altered temperaments, increased infant distress behavior, and higher somatization. It can also result in altered development of the pain system and increased vulnerability to stress disorders, and it can lead to increased anxiety states and addictive behavior. All of these responses are potential developmental delays that could be avoided with the close management of pain (Pasero & McCaffery, 2011). Gyland (2012) proposes that pain assessment that is both consistent and effective will result not only in improved pain management but also in patient outcomes. Gyland found that when pain assessment and management is consistent and effective, preterm infants have decreased long-term consequences, including but not limited to stress disorders, decreased pain sensitivity, impaired social and cognitive abilities, attention deficit disorders, and behaviors exhibiting self-destruction.

Other studies propose that term infants that experience pain early in life can cause exaggerated behavioral responses to painful stimuli later in life (Prevention and management of pain and stress in the neonate, 2000). Also, "neonates who were exposed to numerous painful and noxious stimuli between post-conceptual weeks 28 and 32 showed different behavioral and

physiological responses to pain compared with neonates of a similar post-conceptual age who had not had such experiences" (Prevention and management of pain and stress in the neonate, 2000, p. 455). Parents of toddlers who had spent much time in the NICU related to low birth weight reported that the toddlers exhibited a diminished response to painful stimuli in comparison to children who were born full term. Also, in another study, children ages 8-10 were asked to describe their pain based on pictures of hypothetically painful situations. The children who were extremely low birth weight rated their psychological pain significantly lower than their medical pain, which was the opposite in the children who were born with normal birth weights. While this research is by no means comprehensive, it does indicate that there seems to be long-term effects to excessive painful stimuli early in life, especially in neonatal infants (Prevention and management of pain and stress in the neonate, 2000).

Pain Assessment Tools and Staff Attitudes

There are multiple evidence-based tools available to both doctors and nurses regarding the assessment of infants' pain. These include but are not limited to the Premature Infant Pain Profile (PIPP), the Neonatal Pain, Agitation, and Sedation Scale (N-PASS), the Newborn Infant Pain Score (NIPS), Astrid Lindgren Children's Hospital Pain Score 0 for infants below 37 gestational weeks (ALPS 0), ALPS 1 (for full-term infants up to one month of age), and Cry, Requires oxygen, Increased vital signs, Expression, Sleeplessness (CRIES). Of these pain assessment tools, the PIPP, the CRIES tool, and the NIPS are the most common. However, only the PIPP scale includes an adjustment for gestational age (Anand, 2007). While these tools are useful, they should not be used alone. According to the Pediatric Nursing Journal, "the use of behaviorally based pain assessment tools alone should be considered with caution to avoid underestimating pain responses…[and] we might need to consider preventative and reductive

interventions where we predict painful episodes rather than await scientific evidence to improve assessment techniques" (Pediatric Nursing Journal, 2009). This point regarding prophylactic pain management is an incredible thought that must be entertained in pain treatment circles.

In a study completed by Elizabeth Dodds (2003), she surveyed a group of nurses and found that 52% of them do not use pain assessment tools at all during their pain assessments. Those not using assessment tools reported to rely on behavioral and physiological responses by the infants and their experience to estimate their pain; however, when these same nurses were asked to report the indicators they looked for, a multitude of different, inconsistent assessment techniques were reported (Dodds, 2003).

In a fifteen-year follow up assessment completed in 2011, national surveys revealed there have been systematic pain assessment guidelines and awareness methods communicated, yet there is an extremely wide range of compliance with these guidelines, ranging from 6-60% reporting the use of any assessment tools at all. The nurses reported that pain assessment tools were important in the accurate assessment of pain; however, it was clear in the nurses' documentation that no pain assessment tools were used. This study revealed that even though the participating units had been informed of the national guidelines suggesting a structured pain assessment method, the units were investigated for a second time in 2008, and over half of the units involved had still failed to adopt such a structured method. The result was that simply circulating the guidelines was not sufficient to promote a change in behavior; moreover, the attitudes of the staff members and levels of leadership in the participating units played a large role in action change (Gradin & Eriksson, 2011).

Pölkki, et al., completed a study observing the attitudes that nurses have in regard to the pain assessment and intervention in a NICU setting. They found that nurses consistently

reported on the importance of utilizing pain assessment in order to effectively relieve the pain of the infants; however, they also continually discovered that nurses rarely choose to use any kind of pain assessment tool or method of keeping records of the pain evaluations they make. After assessing the nurses' academic knowledge of pain assessment tools and the way premature infants feel pain, it was found that nurses have extensive knowledge of these tools and painful stimuli reactions. But, the nurses' actions consistently contradicted the knowledge they displayed. There is quite the discrepancy between what the nurses verbally claim to be important and what their actions reveal they believe about the importance of pain assessment in the process of relieving that pain (Pölkki, et al., 2010).

At the conclusion of the study, a survey regarding the nurses' attitudes toward pain assessment was completed, and they discovered that the nurses with more experience were the ones who disagreed the most regarding the necessity of using pain scales to ensure the accuracy of a pain rating for an infant. While the participants responded saying that the use of pain scales is essential for accurate and adequate pain management, over half of them also believe that they are capable of assessing an infant's pain in a reliable manner without the use of any pain scale (Pölkki, et al., 2010). Pölkki, et al., accurately shares that while the findings "may disclose deficiencies in nursing practice: pain assessment is still ineffective in children, and related to unsuccessful improvement in the quality of nursing care; enhancing pain management through accurate pain assessment can improve caring for this vulnerable and less studied population" (Pölkki, et al., 2010, p. 53). Thankfully though, the respondents displayed wonderful knowledge of the overall topic of pain assessment and intervention in a NICU setting (Pölkki, et al., 2010).

Surprisingly, one reason that pain assessment in infants is not being completed adequately and accurately is due to the professional experience the nurses have: Pölkki, et al., found their work experience had the strongest correlation with the way the participants responded to the survey questions, revealing their attitudes and perceptions of pain assessment. The nurses with the least amount of experience caring for infants displayed the highest number of misconceptions regarding a premature infant's ability to feel pain and express it. However, the nurses with the highest level of work experience reported that pain scales are unnecessary in the assessment of a premature infant's pain level. This finding clearly exposes the need for more evidenced-based research and guidelines for practice in this area of nursing (Pölkki, et al., 2010).

Non-Pharmacological Forms of Pain Management

There are a multitude of different non-pharmacological forms of pain management available for the health care providers to utilize in order to most effectively manage the pain of the infants. Some of the most commonly used forms of non-pharmacological pain management tools are pacifiers, non-nutritive sucking (NNS), non-nutritive sucking with the use of a sucrose solution, swaddling, containment, breastfeeding, and skin-to-skin contact. Each of these tools has proven useful in different situations and for different painful procedures. Success in pain management is often achieved when the use of pharmacological pain management and non-pharmacological methods are paired and used in synchrony (Codipietro, et al., 2010; Dodds, 2003; Huang, Tung, Kuo, & Chang, 2004).

For minor procedures, Codipietro et al. discovered that the most frequently used methods of pain management are pacifiers alone (69%) and sucrose solutions (58%). During a heel lance procedure, 43% of the participants utilized breast-feeding and 73% used the sucrose solutions, specifying that they either used these methods often or always during the procedure. In regard to

a venipuncture, breast-feeding was almost never used, but NNS and sucrose solutions were almost always the methods adopted (Codipietro et al., 2010). The interesting finding remains that while most doctors and nurses reported to Dodds that non-pharmacological approaches to pain control should be used, their use is still limited. Dodds' study only found that 50% of nurses and doctors ever use NNS during their painful procedures (Dodds, 2003).

The most research exists on the comparison and contrast of swaddling and containment during a heel stick procedure. Containment refers to "restricting premature infants' reflex motions by holding or using an arm to place the neonate's arms and legs near its trunk to maintain a flexed in-utero posture" (Huang et al., 2004, p. 32). Swaddling refers to the tight wrapping of an infant in a blanket or other cloth article to provide a sense of security during the painful procedure. Huang et al. discovered that as the infants in the study were being weighed, those who were swaddled demonstrated less physiological responses to stress and a better ability to self-regulate the stressful stimuli than those who were not swaddled. Further, during the heel stick procedure, swaddled infants scored lower on the PIPP than contained infants. No statistically significant difference was found between these two methods, but both were proven to increase the infant's ability to self-regulate the response to the stressor and decrease the infant's physiological response to the stressor (Huang et al., 2004).

Discrepancy between Doctors and Nurses

While the American Academy of Pediatrics states, "pain is managed most effectively by preventing, limiting, or avoiding noxious stimuli and providing analgesia," there are many different options available for the treatment and relief of neonatal pain (p. 455). However, a significant discrepancy exists between the comfort measures employed by doctors and those employed by nurses (Akuma & Jordan, 2011). According to Anand, one recent study discovered

that when the physicians and nurse practitioners evaluated the infants' pain, the infants' likelihood of receiving analgesia post-operation was four times that of when the nurse completed the pain assessment. Analgesia seems to only be utilized by the nurses to relieve pain during the more invasive procedures, such as intubation or chest drain insertion, and nurses have shown to use analgesia less often than doctors (Anand, 2007). In fact, doctors do not seem to consistently employ comfort measures for any procedure, while nurses normally utilized some type of comfort measure in each of the procedures, except a heel prick, even if that comfort measure is only the use of a pacifier (Akuma & Jordan, 2011). Additionally, it is interesting to note, "clinicians agreed that both medicines and comfort measures should be used more frequently than they currently are" (Akuma & Jordan, 2011, p. 1292). While the most cited reason for not administering analgesia was performing the procedure in an emergency situation, a small minority group in the study (20%) felt there was no reason to not use analgesia in a procedure or situation in which analgesia would be used in an adult (Akuma & Jordan, 2011).

When an adult is admitted to the ICU and is unable to verbalize his or her pain, it is often common practice to provide either sedation or consistent pain management. The potential for improved patient outcomes in the ICU when pain is managed well has proven to be successful, and systematic pain assessments are often used to accomplish the task of pain management in these settings. This strategy has proven to reduce both the level of pain and the gravity of the pain, decrease the length of time a mechanical ventilator is needed, and decrease the incidence of nosocomial infections (Rose, Haslam, Knechtel, McGillion, & Dale, 2013). If adults in the ICU who are unable to verbalize their pain are being treating with this type of prophylaxis, the same interventions and preventative care should be given in the NICU.

Further, the doctors and nurses surveyed in the study completed by Akuma and Jordan demonstrated a high knowledge of the pain experience in infants. However, when asked to rank the procedures most commonly performed in the NICU in order of their levels of pain, nurses consistently ranked every procedure higher on the pain intensity scale than doctors (Akuma & Jordan, 2011). Moreover, "despite acknowledging that all neonates feel pain to a similar or higher intensity than adults, respondents reported that medicines are not usually administered for procedural pain relief, except during elective endotracheal intubation and chest drain insertion" (Akuma & Jordan, 2011, p. 1295). Even though nurses seem to be significantly more likely to employ comfort measures, nurses are still inconsistent to employ them each time the procedure is done, and they are more unlikely to employ a comfort measure that successfully manages the complete level of pain the infant is likely experiencing. To further drive the point of the discrepancy not only between doctors and nurses but also between the knowledge and the action, intubation that is done without the use of analgesia is known to be associated with severe pain and other side effects, including increased stress, prolonging the first attempt to intubate, sudden vital sign alterations, increased need for multiple attempts, and potential damage to the tissue above the glottis and the trachea. This procedure without analgesia is only suggested in a life threatening, emergent situation. Additionally, the use of opioids and sedatives prior to performing this procedure has proven to decrease the hemodynamic changes associated with this process as well as the risk of damaging the upper airway and the time required to perform the procedure successfully on the first attempt. Therefore, it comes as quite the surprise to recognize that research reports that some medical professionals never employ analgesia for this procedure, and less than 55% use analgesia on a consistent basis for endotracheal intubation (Akuma & Jordan, 2011). There is an incredible discrepancy between the knowledge clinicians have and

the actions they perform, and this discrepancy must be overcome if these patients are going to receive the best care possible.

These discrepancies between doctors and nurses and among the use of pharmacological and non-pharmacological pain management interventions further drives the point that while it is not evident that there is a deficiency in the knowledge health care providers have of how pain should be managed, there is a disconnect between that knowledge and the implementation of it. If the doctors, nurses, and other members of the health care team utilize the same pain management protocols for their patients, the quality of the patients' care would significantly increase, and research supports that the patients' short-term and long-term outcomes would improve.

Pain Management in End of Life Care

Assessing the pain of patients in the hospital is a process that is critical to their healing and overall health. Most of the time, pain is assessed either verbally through a numerical rating system or through a rating system consisting of faces that gradually become more descriptive of the level of pain the patient is feeling (FACES system). These systems work quite well for the purpose they serve; however, the use of these systems includes one incredibly important assumption: they assume the patients are able to comprehend the system and express their corresponding level of pain. While the numerical and the FACES systems work well for adults and older children, they are not compatible with infants. Therefore, it is imperative that an alternative pain assessment method is developed and implemented for the youngest of patients in the hospital setting (Raeside, 2011).

Neonatal patients are one of the most unique patient groups within the hospital. They are so fragile, yet so strong in their fight for life. Just as any other patient in the hospital, they feel

pain, too. They have the ability to sense and perceive painful stimuli similar to the way adults and children do, and their future health is partially dependent upon their pain management during the early stages of life (Anand & Hickey, 1987). As stated by Martin, "[just] as pain is a subjective experience, there is a recognized difficulty in assessing it in patient populations who cannot verbalize, describe, or draw attention to their pain" (Martin, 2013, p. 253). The truth of this is evident as the ability of nurses to manage pain in the NICU is researched further, especially in an end-of-life care setting.

Neonatal patients can be admitted to the Neonatal Intensive Care Unit (NICU) for numerous different reasons. Maternal, newborn, and labor and delivery factors all play a role in determining the health of the baby and, therefore, the level of the baby's need for special care (Lucile Packard Children's Hospital, 2013). Neonates born with terminal conditions are admitted to the NICU for observation and end-of-life care. Interestingly, nurses caring for infants with terminal illnesses often report a moral dilemma between whether technological intervention is necessary in a patient who will die; many feel the majority of efforts to keep a patient alive who is likely to not survive are futile. But, the expectation placed on them by the parents, and the orders by the doctors they report to, often force the nurses to implement invasive procedures they feel are unnecessary. Participants in a recent study by Dr. Victoria Kain felt, "technology was often used just because it was there, describing a sense of powerlessness that technology was not used judiciously" (Kain, 2011, p. 12). This affects the way nurses implement their care to these infants. If they are not in agreement with whether the care is even necessary, their employment of that care will reflect that inconsistency. Regardless of their gestational age, preventing or treating pain effectively and efficiently is imperative to the infants' comfort and quality of life in an end-of-life care setting (Anand & Hickey, 1987). Therefore, it seems that

there is a significant lack of communication between all three parties—the doctors, the nurses, and the parents. Communication is vital to providing these patients with the best care, especially when the care is palliative.

The anatomy of the Central Nervous System (CNS) is not only fascinating but also extremely complex. The CNS begins forming at the early age of 8 gestational weeks and continues to form through the 37th gestational week (Anand & Hickey, 1987). Many tools have been developed to assess, treat, and prevent pain in neonatal patients. Physiologically, heart rate, respiratory rate, oxygen saturation, blood pressure, salivary cortisol levels, and serum cortisol levels can all be measured and utilized in the assessment of a neonatal patient's pain level (Raeside, 2011). The Neonatal Infant Pain Scale (NIPS) and the Premature Infant Pain Profile (PIPP) can be used to score the pain level of a neonatal patient using different observations and assessment skills. Alternative methods such as breastfeeding have proven to be incredibly effective in the control of infants' pain (Shah, Herbozo, Aliwalas, & Shah, 2012).

Although there are several assessment tools, pharmacological treatment options, and non-pharmacological treatment options available for treating and preventing pain, studies consistently show that the knowledge of assessment and correct intervention among nurses is not necessarily deficient, but the timing of implementation of that knowledge is quite lacking, especially in the context of end-of-life care. To clarify, neonatal nurses have been found to implement well the care they have been taught when they choose to actually intervene with the goal of controlling the patient's pain; however, in the context of end-of-life care, there seems to be a lack of knowledge of *when* to implement this care and how often to continue it. The knowledge of the best care and the actual skill of implementing it are not problematic; the nurses simply seem to lack the knowledge of *when* is most effective to employ this care in order for it to be most

effective in a palliative care setting (Anand, 2007). Pain management in this setting only differs in that the goal is to maximize the patient's comfort and quality of life, and the nurses are responsible to initiate pain management, ensure it is effective, and continue that management until the end of the patient's life. The knowledge deficit among health care providers of when and how often to implement pain management in this end-of-life care setting is consistent with a procedural or non-end-of-life care setting.

A multitude of studies have been performed examining both the knowledge and the implementation of these assessment tools and interventions, and the research shows the nurses know how to correctly assess a neonatal patient and intervene when he or she is in pain; however, when the level of implementation has been studied, analysis has shown that the majority of nurses are not adequately or consistently employing the comprehension they have of assessment and intervention, especially in the context of palliative care (Anand, 2007; Pölkki et al., 2010).

In a study recently completed to investigate the experiences with death of infants and educational needs of neonatal nurses in regard to palliative care, 97.4% of participants agreed that palliative care education was important and necessary in the NICU setting; however, only 13% reported having received any neonatal palliative care education. Only 19.1% of the participants shared that they provide symptomatic care to dying neonates, and only 8.7% provide pain management. Half of the nurses agreed that pain control in palliative care was the number one area in which they needed education (Peng, Chen, Huang, Liu, Lee, & Sheng, 2013). This evidences the aforementioned finding—knowledge of when to implement this care is vital.

According to Martin, there are two main reasons, or categories of reasons, as to why pain management is not successful or adequate in the neonatal end-of-life setting. First, barriers to

symptom management can prevent success in administering adequate treatment. As more studies are being done to investigate the reason behind a lack of education in when to implement pain management in end-of-life situations for these infants, one group of researchers hypothesizes that it might be due to an inability of the nurses to understand the difference between evaluating the pain response in smaller neonates as opposed to larger, more developed infants. In more developed babies, the pain response is more pronounced physiologically—the facial expressions are more distinct, and the overall response is easier to recognize. However, in the smaller neonates, because the physiological response is less pronounced, it is harder for the nurse to know when pain medications are necessary. In the palliative care setting, it is better to err on the side of caution and provide the baby with comfort than to refrain from acting due to a fear of inadequate education (Martin, 2013). The nurses know how to provide pain management, but they are not well educated in when this intervention should be accomplished.

Second, often there is conflict between the members of the neonatal team in regard to the implementation of correct palliative care. As found in recent studies, "from the beginning of their training, nurses and physicians have a different focus: nurses are taught to provide holistic care to the whole patient, whereas physicians' training is focused on diagnostic skills that may enable a patient to be cured" (Martin, 2013, p. 254). In fact, some studies even show that there is a fairly large separation between the methods of assessment and intervention used by nurses and those used by doctors. The doctors and the nurses are both using different methods to assess the pain of their patients, and their results are not equivalent. While the nurses often use the pain scales, the doctors rely more on the physiological response changes to estimate the pain level of the infant. Moreover, while the doctors prefer the pharmacological methods of pain management, the nurses often select the physiological methods first and then move to

pharmacological methods, if necessary (Anand, 2007; Pölkki et al., 2010). Further, neonatal nurses consistently reported that they felt unsupported in the decisions they made in regard to end-of-life care. These feelings are escalated when members of the medical team disagree with the care that should be given. As it relates to pain management, this causes hesitation and frustration for the nurse when deciding how and when to provide treatment of pain during the end of the infant's life. In addition, the nurses reported feelings of moral distress were alleviated when the medical care team agreed on the care that should be given to their patients (Martin, 2013).

In a different study conducted by Kathy Ahern, the research supported that "the best approach to neonatal palliative care is informed collaboration among staff members and parents…[this is] a process by which multidisciplinary researchers, practitioners, and other stakeholders collaboratively share their work as equals to make progress on central problems of mutual concern" (Ahern, 2013). The researchers found that there is a significant need for education in neonatal care on the topic of palliative care of infants. The literature undoubtedly supported the importance of palliative care to these patients; however, it showed that educational in-services would be the best methods of educating the staff on this essential part of their care (Ahern, 2013). This need for further education was consistent throughout each research article investigated; therefore, it can be safely concluded that the number one problem in palliative care in neonates, and specifically pain management during end-of-life care, is not the implementation of care or the need for more training. Rather, it is the need for more education focused on when intervention is appropriate. The nurses examined in these studies showed a high level of competency in implementing the skills they had been taught. Research even supports that nurses, midwives, neonatologists, and other professional caregivers are consistent in prioritizing

care needs. However, the nurses' knowledge of the skills available to remedy those needs and when they should be implemented was quite lacking, resulting in inadequate nursing care in the end stages of the infants' lives (Ahern, 2013).

In-service educational seminars focusing on when to implement end-of-life care interventions would be extremely beneficial. It would be of utmost benefit for the nurses, doctors, and all other professional caregivers to be a part of the same educational events in order to ensure consistent treatment across the board. That would eliminate some of the disparities between treatment opinions and disagreements regarding care. This would also likely increase the overall care of the patient and allow the families of the patients to be more relaxed, as well. As a result, the expectations the families place on the caregivers, especially the nurses, would likely subside a bit, and this would give the nurses more confidence in their treatment. Most importantly, though, this would allow the dying patients to receive the best treatment, even in the end stages of their lives, which is the ultimate goal in palliative care—even in the smallest of patients.

Solutions

Consistently, research regarding pain management in the NICU has revealed that health care providers are not deficient in their knowledge of assessment or their knowledge of appropriate intervention. The incongruity lies in their knowledge of when to intervene with these mediations. It is imperative that this deficit between knowledge and action be bridged. There are three solutions that could significantly remedy this problem.

First, the implementation of multiple pain tools and pain assessment and intervention protocols in all NICUs is necessary. Only 58% of nurses and 29% of doctors who were surveyed were aware of whether or not their unit had a pain assessment tool, and even fewer were able to

identify the name of the assessment tool used on their unit. Consistent pain management protocols—with the support of the leadership staff on the unit—have proven to increase pain management effectiveness in the NICU. When health care workers were asked what kinds of suggestions they had regarding the improvement of pain relief, they responded with the following suggestions: development of pain tools and unit policy, staff education, more education regarding current research, assistance in empowering the nurses to be advocates for the infants, updated prescriptions such as PRN sucrose for all infants, education on how to empower the parents, and a change in staff attitudes toward analgesia use (Akuma & Jordan, 2011).

Second, the need for further education seems to be a constant theme throughout all of the research. According to Anand (2007), "A comprehensive knowledge base and familiarity with current research related to pain assessment and management are paramount, to help the clinician treating neonates in the NICU" (p. S10). Monthly seminars presenting the most recent research in regard to pain management in the NICU would be extremely helpful in improving this education.

Third, according to Dodds, regarding the nurse respondent's claim that certain aspects of pain management are impractical, Dodds replies, "this implies a need for further education regarding timing of procedures and [the] use of pharmacological methods of management available, as giving analgesia to relieve procedural pain need not be impractical" (Dodds, 2003, p. 21). Further education regarding appropriate pain management and the timing of which to use it would improve patient outcomes by improving overall pain management. This education needs to be the same for all health care providers working on the units.

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