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# An Ounce of Prevention: Decreasing Painful Interventions in the NICU

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**Scenario:** *The patient is a near-term infant with bilateral chest tubes who requires neither oxygen or ventilator support.*

*The NICU care team is gathered at the bedside for morning rounds.*

*Near the end of rounds, one team member asks, "What are we doing for pain control?" The nurse indicates there is a standing order for "as needed" fentanyl, which is controlling pain well. Another team member questions the need for opiate pain treatment, citing the risk of respiratory depression with the resultant need for ventilator support. The fentanyl order is discontinued, and no other pain medications are ordered.*

*The following morning, the patient chart is reviewed. Despite elevated pain assessment scores through the night, the infant received no further pain medications. The night nurse had requested an order for pain medications; the request was denied because of "risk of respiratory depression." The infant was treated with nonpharmacologic pain interventions, which did not bring the pain scores into acceptable ranges.*

This clinical case occurred, not 20 or even 10 years ago, but in 2008. Despite greater knowledge about pain physiology

and treatment, the development of numerous neonate-specific pain assessment tools, and the availability of a variety of pharmacologic and nonpharmacologic pain interventions, many neonates still must endure undertreated or untreated pain. Much has been written about pain assessment and pain treatment in the NICU; unfortunately, pain prevention in the neonatal population receives much less attention. Anand and colleagues, reporting on proceedings of the American Academy of Pediatrics' Neonatal Pain-Control Group, noted that intervention for pain is used infrequently, partly because of a lack of appreciation for the need for pain control and also because the long-term effects of pain in the neonatal population are not

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## ABSTRACT

Despite a proliferation of literature relative to pain physiology, assessment, and treatment, pain management in NICUs remains inconsistent—most often focused on assessment and treatment rather than prevention. The acceptance of pain as an inevitable part of NICU hospitalization is part of the culture in many NICUs. This article is intended to encourage discussion of pain prevention in the NICU, with a goal of creating a new "minimal-pain" NICU culture. The focus of NICU pain management programs should be on decreasing the number of painful events the NICU patient experiences. Areas for consideration include assessing the performance of procedures by novice versus experienced NICU personnel, reevaluating the role of pediatric residents in the treatment of NICU patients, evaluating the use of umbilical lines and peripherally inserted central catheters to reduce the frequency of peripheral punctures, and evaluating the admission process for ways to reduce neonatal pain and stress. This article discusses the physiology of pain in the neonate, identifies adverse outcomes related to repeated pain, and proposes practice changes that can prevent unnecessary pain in neonatal care.

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## Disclosure

*The author discloses no relevant financial interests or affiliations with any commercial interests.*

Accepted for publication October 2009. Revised November 2009.

recognized.<sup>1</sup> In practice, pain relief measures are commonly provided after surgery, but are often not provided for the multiple minor interventions that are part of the neonate's daily life in the NICU.<sup>2</sup> Pain is often considered to be an inevitable component of NICU hospitalization.

Similar issues exist in the treatment of pediatric patients. In the late 1990s, several pediatric emergency rooms adopted the concept of the "ouchless" or "painless" emergency room.<sup>3,4</sup> Dr. William Zempsky suggested that with the implementation of cultural change, education, changes in policy, and new technology, a "painless" emergency department could be achieved.<sup>4</sup> More recently, Dr. Neil Schechter suggested that the complete elimination of pain is an unrealistic goal. He described a new emergency room designed using a model called "comfort central"; the goal of this program is to assure families that the hospital staff will provide the highest level of comfort possible.<sup>5</sup>

The purpose of this article is to encourage discussion about pain prevention in the NICU, with a goal of creating a "minimal-pain" culture in the NICU. Health care providers recognize that there are moral, ethical, and physiologic reasons for preventing, assessing, and adequately treating pain. The first-line approach of a successful pain management program should be to prevent pain whenever possible. A minimal-pain culture in the NICU hinges on establishing pain prevention as a top priority among NICU health care providers. Pain prevention must become a responsibility of all health care providers, with families as part of the team. Emphasis on pain prevention does not, however, minimize the need for pain assessment and treatment.

## PAIN AND NOXIOUS STRESSORS IN THE NEONATE

Approximately 300,000 infants, or 8 percent of the newborn population, are admitted to NICUs annually. Neonates admitted to NICUs, especially preterm infants, are subjected to many procedures, each resulting in varying degrees of pain. Commonly recognized painful procedures include endotracheal intubation, suctioning, insertion of needles into peripheral veins to obtain laboratory samples and/or venous access, nasogastric or orogastric tube placements, tape removal, central vascular line placements, intramuscular or subcutaneous injections, lumbar puncture, eye exams, arterial blood draws, and chest tube placement.<sup>6</sup> Examples of common noxious stimuli in the NICU include bright lights, noise, and frequent handling by a variety of caregivers.<sup>7</sup>

Several studies have documented the frequency of painful procedures in the NICU. Simons and coworkers reported that in the first 14 days of an NICU admission, neonates were subjected to a mean of 14 painful procedures per day. In this study, 39.7 percent of all neonatal subjects did not receive any analgesia during the 2-week study period.<sup>8</sup> Carbajal and associates reported that neonates at 33 weeks gestational age admitted to the NICU experienced an average of 10 painful

procedures per day, and 79.2 percent of them were performed without any type of analgesia.<sup>9</sup>

In addition to procedural events that are easily recognized as painful, infants in the NICU are exposed to many other situational stressors that may increase their sensitivity to pain. As mentioned earlier, these include frequent handling by multiple caregivers, bright lights, and high noise levels. Although these stimuli are not normally considered sources of pain, research has shown that in ill or preterm infants, these stimuli may readily be processed along the same nerve pathways and perceived in the same manner as more obvious pain signals.<sup>2,10</sup> Researchers have recognized that preterm neonates have an increased sensitivity to pain and develop prolonged periods of hyperalgesia in response to acutely painful stimuli; stimuli that do not normally cause pain may, because of this hyperalgesia, expose the premature infant to prolonged periods of pain.<sup>11</sup> Differences in anatomic, physiologic, and biochemical structure and function may cause infants to feel pain more intensely than adults.<sup>12</sup>

## KNOWLEDGE AND MISCONCEPTIONS ABOUT NEONATAL PAIN

Historically, many misconceptions existed regarding the ability of the neonate to experience pain and about the safety/efficacy of both pharmacologic and nonpharmacologic interventions to alleviate pain. As recently as the 1980s, it was uncommon for neonates undergoing surgical procedures to be anesthetized.<sup>13</sup> Misconceptions regarding pain in the neonate have traditionally included the following beliefs:

- Neonates have an underdeveloped nervous system, resulting in inability to perceive and/or process pain signals.<sup>7,13</sup>
- Unmyelinated nerve fibers, present in the fetus/neonate until approximately 37 weeks gestation, are incapable of transmitting pain signals.<sup>7,14</sup>
- Neonates are unable to remember painful experiences and therefore lack the situational and emotional functions required to interpret/experience pain.<sup>13</sup>

Several important research articles published in the late 1980s and the 1990s challenged these beliefs about the neonate's ability to perceive and process painful experiences.<sup>14,15</sup> Anand and colleagues discussed the fact that neonatal physiologic responses to pain are reflected in biochemical and cardiorespiratory changes that are similar in character to, but more pronounced than, those in adults. Anand and colleagues further presented evidence that both anatomic and neurochemical systems begin to develop early in the fetal period and are capable of perceiving, transmitting, and processing even in the preterm newborn. Physical nerve and receptor cells are present and functional in even the tiniest preterm infants.<sup>14</sup>

Important differences exist between adult and fetal/neonatal pain structures and functions:

- In the fetus, nerve fibers that transmit pain are nonmyelinated, resulting in somewhat slower transmission of pain than in adults. Contrary to earlier beliefs, however,

these nonmyelinated fibers *do* transmit pain. Slower conduction times could potentially result in a prolonged pain experience in the premature infant.<sup>14</sup>

- The fetus/neonate has a higher concentration of peripheral receptor cells than the adult.<sup>16</sup>
- The neonate's central nervous system pain pathways and endocrine response systems are sufficiently anatomically and functionally developed to allow transmission of painful stimuli.<sup>14</sup>
- Fetal/neonatal sensory nerve cells are more excitable than adult sensory nerve cells, resulting in a greater reflex response in newborns.<sup>17</sup>
- Transmission of sensory input along the spinal cord is less specific in the fetus and neonate than in the adult, creating the potential for newborns to sense normally pleasurable sensory input (for example, touch) as painful or to sense normally noxious but nonpainful stimuli (lights, noise) as pain.<sup>16</sup>
- Descending nerve tracts responsible for modulation or dampening of pain signals are immature and ineffective in the neonate, resulting in prolongation of pain.<sup>16</sup>

These differences raise the concern that newborns, and especially premature newborns, may perceive pain more intensely than adults and for a more prolonged period of time.

Researchers have demonstrated that preterm infants have a lower pain threshold than term infants. These studies support the contentions of neonatal experts that preterm infants experience a more intense transmission of pain signals and that these signals become more intensified with repeated painful experiences (hyperalgesia).<sup>6,18</sup>

## ASSESSMENT OF NEONATAL PAIN

In the past decade, much attention has been paid to assessment of pain in the neonate. Pain behaviors are easily identifiable, particularly in term and near-term infants. However, the most acutely ill or tiniest preterm infants may become lethargic and nonresponsive to painful stimuli. In 2001, the International Association for the Study of Pain acknowledged the inability of pediatric and neonatal patients to clearly communicate pain and revised its classic definition of pain to state that "the inability to communicate in no way negates the possibility that an individual is experiencing pain" (p. 2).<sup>19</sup>

The Joint Commission on the Accreditation of Healthcare Organizations requires pain assessment at regular intervals and in response to known painful interventions and pain relief measures, regardless of the time interval.<sup>20</sup> Professional organizations and consensus groups have also issued statements on management and treatment of neonatal pain.<sup>2,21</sup> Most NICUs have been successful in implementing the assessment of pain as the fifth vital sign.

Numerous neonate-specific pain scales have been developed and validated through appropriate research methodologies. However, pain assessment is only one part of a successful pain management program. A 2002 educational

module published by the Association of Women's Health, Obstetric and Neonatal Nurses highlights several important points regarding the use of pain assessment tools, including the following:

1. Pain measurement is only one tool in a pain management program.
2. Lack of response to a painful intervention does not mean the infant is not experiencing pain.
3. Selected pain tools should be multidimensional (measure physiologic and behavioral elements) and should have established reliability and validity.
4. No pain assessment tool is perfectly suited to all circumstances.<sup>22</sup>

Merely assessing pain is of limited value; the value of assessment lies in the ability to then apply evidence-based intervention to decrease or eliminate the pain.

Research shows that assessment of pain is not consistent. A 2006 survey of 105 Australian neonatal units reported that only 6 percent of the units routinely used pain assessment tools, and 15 percent of the units identified that they had a pain management program in place.<sup>23</sup> Reporting on a study conducted in 12 U.S. NICUs, Dunbar and colleagues noted that pain assessments were done in less than 20 percent of painful interventions.<sup>24</sup> These studies suggest that although pain assessments might be completed as a routine part of vital sign assessments, pain inflicted during procedures and follow up of pain levels after intervention are not regularly assessed. Despite an increased understanding of the physiology of neonatal pain and the development and implementation of numerous pain assessment tools specific to the neonate, treatment of neonatal pain remains inconsistent.

## COMPLICATIONS OF UNTREATED PAIN

Multiple studies report that untreated, frequent, and/or chronic pain in the neonate may be related to a variety of adverse outcomes in later life.<sup>1,6,10</sup> Frequent exposure of the neonate to pain, especially the preterm neonate, occurs at a time of neurologic development when it is "developmentally unexpected."<sup>9</sup> Puchalski and Hummel discussed the concept of "neural plasticity," which is defined as the potential for change in the normal structural development or formation of the neonatal brain as the result of exposure to unexpected stimuli; such stimuli include exposure to pain and stress.<sup>25</sup> The neonatal brain is in a period of rapid physical growth and development; the more premature the infant, the higher the risk that external stimuli can cause changes in that normal development.

Although it is difficult to extract specific mechanisms for adverse outcomes from the many other risk factors the NICU patient experiences, more and more researchers are focusing on links between untreated neonatal pain and both short- and long-term adverse outcomes. Short-term effects of pain for the preterm infant are related to the infant's clinical status and overall outcome.<sup>26</sup> The immediate pain response results in increased heart and respiratory rates, increased blood

pressure, decreased oxygen saturation, and changes in cerebral blood flow.<sup>6,10</sup> Additionally, the infant secretes increased amounts of adrenal stress hormones. This increase in physiologic parameters can result in the expenditure of energy resources that are needed for healing and growth.<sup>10</sup>

Research has shown that continued secretion of stress hormones in response to untreated pain can result in increased infections, poor healing, prolonged hospitalization, and increased mortality.<sup>27</sup> Anand and colleagues demonstrated a relationship between repetitive and long-term pain in the neonatal period and changes in pain sensitivity and pain processing in later life.<sup>1</sup> McClain and Kain reported that exposure to poorly controlled pain may result in increased pain sensitivity (hyperalgesia) and potentially to chronic pain conditions in later life.<sup>28</sup> Other long-term adverse outcomes that have been suggested in the literature include anxiety disorders; hyperactivity/attention deficit disorders; impaired social skills; self-destructive behaviors; and other neurodevelopmental, cognitive, and behavioral disorders.<sup>1,6,10</sup>

#### TOWARD A "MINIMAL-PAIN" NICU: CREATING AN EXPECTATION OF PAIN PREVENTION

There has been a dramatic increase in research and review articles directed at neonatal pain over the past decade, but most of these discussions focus on physiology, assessment, and treatment of pain. Treatment of pain in the neonate presents its own challenges and concerns. Analgesics may have short-term adverse effects such as hypotension or respiratory depression. Long-term effects of analgesic use in the neonate, and especially in the preterm infant, are not well known. Additionally, there remains the issue of how to wean infants effectively and safely from long-term opiate use.

These issues should not prevent treatment of pain, but they do highlight the importance of preventing pain whenever possible. Strategies to minimize the number of painful procedures are an essential piece—indeed, the most essential piece—of a comprehensive pain management program in the NICU.

Authors have addressed avoiding or eliminating unnecessary laboratory tests and other interventions. Dunbar and associates discussed reducing the number of painful procedures as one "potentially better practice" intervention in the NICU.<sup>24</sup> Urso emphasized prevention of pain whenever possible and the use of all available means of nonpharmacologic and pharmacologic interventions when prevention is not possible.<sup>13</sup> Reducing the frequency of neonatal pain experiences remains of paramount importance. While acknowledging their inability to completely eliminate painful experiences in the NICU, health care practitioners need to recognize that prevention is the most effective way to manage pain.

#### DECREASING PAINFUL EXPERIENCES IN NEONATAL CARE

The most difficult step in decreasing painful interventions may well be changing the NICU culture as it relates to pain prevention. Despite health care professionals' increased awareness of the importance of pain prevention, NICU patients continue to be exposed to numerous routine painful procedures every day.<sup>2,24</sup> Establishing pain prevention as an expectation requires a multidisciplinary team approach, as well as extensive education for all groups of health care providers.<sup>29</sup> Preventing and/or reducing the incidence of painful interventions in the NICU is an interdisciplinary process that requires input and cooperation from every health care provider who directly or indirectly cares for the neonate, including medical directors and medical resident supervisors; nursing administrators; and educators and clinical specialists responsible for policies, education, and process improvement/patient outcome programs.

#### Eliminating Unnecessary Procedures

The literature contains many discussions of eliminating unnecessary procedures and grouping procedures whenever possible.<sup>1,2,9,10</sup> For example, infants newly admitted to the NICU may require blood to be drawn to monitor glucose levels every four hours; infants who have been stable on a given glucose infusion for two to three days may not need them. Too often NICU policies fail to acknowledge differences between patients; these same detailed policies also often fail to allow for independent nursing judgment in assessing patient needs. Chronic feeding-growing infants who are stable rarely require weekly complete blood counts and/or hematocrits or routine metabolic panels. It is important to identify when an order for a laboratory test is merely routine or customary rather than necessary. This distinction reinforces the need for an NICU culture in which the expectation of pain prevention is key.

Other methods of reducing the frequency of pain events in the NICU are less obvious—and in some cases are controversial. These include drawing blood from a vein rather than doing a heelstick, reviewing the risk/benefit assessment of central line placement, assessing procedures (both medical and nursing) performed by novice versus skilled personnel, and assessing the number of interventions (particularly assessments) performed by novice practitioners for "learning" purposes.

Research has demonstrated that drawing venous specimens may be less painful than heel lancing in term infants. In less acutely ill infants, where preservation of peripheral veins may not be as critical, drawing blood for "sepsis workup" laboratory tests and for glucose blood levels from a vein can result in fewer and/or less painful punctures than the customary heel lances.<sup>30,31</sup> In more acutely ill infants, short-term use of umbilical lines and early placement of peripherally inserted central catheter (PICC) lines, may allow nurses to feel more comfortable drawing venous blood for laboratory tests. Early

placement of an umbilical line can reduce the number of venous and peripheral blood samples needed. Early placement of PICC lines can also reduce the number of times intravenous (IV) access is needed over the course of a neonate's hospitalization.<sup>2</sup> Central lines have associated risk factors, the most common being infection, thrombus formation, and arterial spasm; these are clinically significant in less than 10 percent of patients.<sup>32</sup> Taking this into consideration may lead us to revisit the risk/benefit of central lines, factoring in the risks of frequent, painful needle insertions for peripheral IVs and heel lancing for glucose screens and lab draws.

### Novice versus Experienced Providers and NICU Procedures

Although new nurses and resident physician staff need opportunities for learning, the primary focus should always be on the well-being of the neonate. This statement seems straightforward, but too often the number of procedure attempts or the number of physical exams an infant is subjected to is overlooked in the quest to provide educational experiences for practitioners. The number of disciplines seeking teaching experiences in the NICU (e.g., medical residents, staff nurses, nurse practitioner staff, respiratory therapists) may exacerbate an already difficult situation.

The question has been raised in the literature as to the appropriateness of allowing less-experienced health care providers to perform procedures on neonates, especially unstable ones. For example, when an extremely preterm infant who will most likely need immediate intubation and line placement is being delivered, who should perform the necessary procedures: a skilled performer with known ability to complete them quickly and most likely on the first try or the novice who "needs the experience"? Is this the appropriate teaching experience for the new respiratory therapist, nurse, or first-year resident? Too often the person who "needs" the experience gets the first try, and the experienced care provider intervenes only after the novice is unsuccessful. Simons and colleagues documented that a substantial number of painful interventions were the result of failed attempts at procedures. The researchers reported failure rates of 45.6 percent for central venous catheters, 37.5 percent for peripheral arterial catheters, and 34.6 percent for umbilical catheter placement. They did not report on who performed these failed procedures (i.e., novice or experienced personnel).<sup>8</sup> There is no question that new staff need opportunities to learn, which means that at some point they have to do the first procedure (IV start, intubation, line placement) on a patient. What NICU pain-prevention teams may need to reassess is how and when those "firsts" take place. A newborn delivered at 23 weeks or a "crashing" infant with sepsis is probably not the best choice for the novice learner—nor is the novice the best choice for the patient. The acuity of the patient and the fast-paced, high-anxiety atmosphere accompanying it are not conducive to learning—or to success at an unfamiliar procedure.

### NICU Admission

Admission to the NICU involves handling of the infant by many caregivers, physical examinations by at least the nurse and one physician, bright lights, noise, injections of vitamin K, eye prophylaxis, heel lances for blood collections for laboratory assessment, and one or more attempts to place a peripheral IV. A preterm infant has additional stressors, including intubation, surfactant administration, and line placements. Developmental care may not start until after the infant has been subjected to the very nondevelopmentally appropriate admission process.

### SUMMARY

The knowledge base regarding neonatal pain, stress, and the potential adverse outcomes of repeated pain exposure has evolved significantly over the past decade. Despite increased knowledge about the physiology of neonatal pain, the development of valid neonatal pain assessment tools, and statements from professional organizations regarding the need to treat pain in the newborn, there is still considerable confusion and many differences in practice among health care providers in NICUs.

The current challenge is to move beyond intellectual knowledge about pain issues to clinical application of proven methods to reduce painful stimuli in the NICU. Preventing pain should be as high a priority as preventing ventilator-induced lung damage or hypoxia-related central nervous system damage. Effective pain management programs depend on the knowledge, critical thinking skills, and advocacy skills of every neonatal health care provider. Attaining a "minimal-pain" NICU environment is the responsibility of every health care provider as well.

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Dr. Mountcastle gratefully thanks Estelle (Nellie) Mountcastle, RN, for her continual encouragement and support in every step of her nursing education and practice.

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