Newborn & Infant Nursing Reviews 13 (2013) 82–86

Contents lists available at SciVerse ScienceDirect

Newborn & Infant Nursing Reviews

journal homepage: www.nainr.com

Pain in Premature Infants: What Is Conclusive Evidence and What Is Not

Lina Kurdahi Badr RN, DNSc CPNP, FAAN *

Azusa Pacific University, Azusa, CA

ARTICLE INFO

Keywords:
Pain assessment
Premature infants
Neonatal
Pain assessment tools

ABSTRACT

Premature infants spend much of their early days of life in an environment that is stressful and in many situations painful. Short and long term consequences of pain are not well documented, yet postulated to have a negative impact on stress-response systems and on deployment. To date there is insufficient evidence for the best methods to assess or to effectively treat their pain. Though a variety of uni- and multidimensional assessment tools are available, many lack sufficient psychometric testing, do not incorporate essential developmental cues to premature infants, and do not distinguish between acute and chronic pain. This review paper will discuss the etiology, sources, and manifestations of pain as well as the short and long term consequences of pain. The available assessment tools for pain in premature infants along with reliability and validity will also be presented.

Pain in Premature Infants

Not long ago health professionals believed that neonates, especially premature infants do not feel pain due to the immaturity of the central nervous system. This belief prevailed for decades with small and sick infants subjected to intense pain with no appropriate management. Unfortunately this belief prevails to date in some developing countries. This is despite the fact that over 20 years ago, researchers from Europe and the United States have established the fact that the anatomical, physiological and neurochemical structures that convey pain are well developed in neonates.[1–4]

Number of Painful Procedures

Pain is experienced by all preterm infants in the neonatal intensive care unit (NICU) as they are exposed to many diagnostic and therapeutic procedures that are necessary for their survival.[5] Studies across nations have reported wide variations in the number of painful procedures premature infants are exposed to (see Table 1). For example, a study in France reported that on average, infants in the NICU experience 115 painful procedures in a 2-week period[6] and a study in Switzerland identified 38,626 procedures performed on 120 preterm infants in a 2-week period with 75% of those considered painful (238 painful procedures per child in 2 weeks) with most occurring in infants with the lowest gestational age.[7] Simons et al.[5] followed 151 neonates for the first 14 days of their NICU admission and documented almost 20,000 pain-producing procedures, of which, 31% were due to repeat attempts when the first procedure failed. This averaged 196 procedures per neonate, or between 12 and 15 procedures per day. Three further studies reported an average of two to five painful procedures per day.[8–10] The discrepancy in the numbers of painful procedures among studies could be due to what is considered a painful procedure as well as the different gestational ages of the infants studied and the level of the NICU (see Table 2). For example, the study mentioned above by Cignacco et al.[7] described manipulation of the CPAP prongs or insertion of a nasogastric tube as painful procedures which were not documented as such in other studies. Likewise, a study in Lebanon observed that infants in the NICU were subjected to an average of 14 to 25 procedures per day (280 procedures per child in a 2-week period). Procedures considered as minimally painful such as bathing, and the administration of oral medications and loud noises resulted in significant physiological changes as did more painful procedures such as suctioning and heel sticks.[11]

Sources of Pain

Painful interventions most studied include capillary blood sampling by heel stick, or venipuncture, (e.g.,[5,12–14]) followed by naso- or endotracheal suctioning.[15,16] Other painful procedures assessed include placing a nasogastric tube,[17] removing an adhesive tape or monitoring leads,[18] weighing,[19] and eye examination.[20] Contrary to common practice a Cochrane review of six studies ($n = 478$) found that venipuncture was less painful than the heel stick procedure. The authors conclude that venipuncture should be the preferred mode for blood sampling in term neonates especially if performed by skilled phlebotomist.[21] A study by Goubet and colleagues[22] supports this finding as heel sticks elicited more behavioral distress than venipunctures in a sample of 51 preterm infants. Of interest are two studies that indicated that daily routine activities such as bathing and diaper change can be interpreted as painful to the premature infant as

* Address correspondence to Lina Kurdahi Badr, RN, DNSc CPNP, FAAN, Professor Emerita, UCLA, 4828 Denny Ave., N Hollywood, CA 91601.
E-mail address: lbadr@apu.edu.

1527-3369/1302-0504$36.00/0 – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1053/j.nainr.2013.03.002

Table 1
Number of Painful Procedures Documented in the Literature.

Author (Year), Reference	Subjects, Gestational Age (GA) in Weeks	Number of Painful Procedures*	Most Common Procedure in Order of Frequency
Baker and Rutter (1995)[8]	$N = 54$, GA = 23–41	3000 procedures total in 3 months. No report of LOS†. 74% in infants less than 31 weeks' gestation	56% heel stick; 26% endotracheal suction
Zahr and Balian (1995)[11]	$N = 55$, GA = 23–32	14–25 procedures per infant per day or 273 in 2 weeks (these included daily activities such as diaper change and weighing)	Suctioning‡; heel stick; intravenous starts attempts; positioning/Diaper change
Stevens et al., (2003)[10]	$N = 194$, GA = 27–31; high and low risk	Average 10 procedures per infant per day or 140 in 2 weeks. Most procedures were done on the high-risk infants.	Suctioning; heel sticks; intravenous starts attempts
Simons et al., (2003)[5]	$N = 151$, GA = 25–42	19,674 procedures in 1375 days (14.3 per infant per day or 200 in 2 weeks); 31% due to repeated attempts	63% suctioning followed by heel stick
Johnston et al., (1997)[9]	$N = 239$, GA = 23–42	2134 procedures (1.99 per infant per day or 28 in 2 weeks)	Heel stick followed by insertion of an IV line
Cignacco et al., (2009)[7]	$N = 120$, GA = 24–27	38,626 procedures in the first 14 days (17.3 per day or 242 in 2 weeks)	26% CPAP manipulation; 17% heel stick
Carbajal et al., (2008)[6]	$N = 430$, GA = 24–42	60,969 procedures in 2 weeks (12 per infant per day or 168 in 2 weeks)	28% suctioning; 19% heel stick

* Number of procedures calculated per day or week when possible.
† LOS = length of hospital stay.
‡ Actual percent not reported.

manifested by significant decreases in oxygen saturations (SO_2) and increases in heart rates (HR).[11,23] In contrast, Cignacco et al.[7] listed diaper change as a non-painful procedure. In this latter study, 27 procedures common in the NICU were recorded, some procedures (eg. intubation, eye examination, heel stick) were considered to be very painful, some were considered painful (e.g., CPAP prong insertion, extubation, tape removal) and some were labeled as not painful (e.g., diaper change, X-ray, insertion of an umbilical line). Thus, it remains unclear as to what constitutes a painful experience for premature infants. It is also uncertain which factors heighten or dampen responses to pain. The influence of circumstantial factors on the expression of pain, such as the gestational age (GA) of the infant, the severity of illness, the level of sedation or the amount of noise or light in the NICU has not yet been adequately explained.[24]

Potential Short- and Long-Term Consequences of Pain

Because premature infants cannot manifest pain as well mature infants due to lack of inhibitory control they may be at an increased risk for negative brain alterations in both structure and function.[25] Studies have documented and postulated several neurodevelopmental consequences such as learning and behavioral difficulties observed in later infancy and childhood and reduced brain white matter.[26–29] In contrast, a new longitudinal study with 90 infants who were given either continuous morphine or placebo while in the NICU and followed up at 5 years showed minimal differences between groups. After correcting for contextual variables, children at 5 years were tested for intelligence, visual motor integration, behavior, chronic pain, and health-related quality of life with no difference between groups except for scores on one IQ subtest, "visual analysis."[30] Thus, the long-term effects of treating pain with morphine or not treating were not any different in this study. The inconsistencies in results could be due to many factors that contribute to the long-term effects of pain such as developmental maturity of the infant at the time pain occurred, GA, illness severity, length of exposure to pain, and contextual variables factors at the time and after the pain exposure.

A recent study using EEG recordings during noxious stimuli found that infants who are born prematurely, and who have experienced at least 40 days of intensive or special care, have an increased neuronal response to noxious stimuli compared to healthy newborns at the

Table 2
Commonly Used Pain Assessment Tools for Premature Infants.

Neonatal Infant Pain Scale (NIPS) (6 items coded 0–1), behavioral and 1 item breathing	Lawrence et al., (1993)[55]	Inter-rater $r = .92$–$.97$ Cronbach's $\alpha = .87$–$.95$	Concurrent With VAS* r = .53–.84 Construct	Procedural pain Limited clinical use Preterm and full-term
Neonatal Facial coding System (NFCS) (9 items coded 0–1), behavioral and physiologic	Granau and Craig (1997)[56]	Inter-rater, $r = .85$–$.95$ Kappa $r = .67$ Cronbach's $\alpha = .83$	Predictive Discriminate Convergent $r = .89$	Mostly for research as videotape is needed Procedural pain 25 weeks to full-term
The Bernese Pain Scale for Neonates (BPSN) (9 items coded 0–3), Behavioral	Cignacco et al., (2004)[57]	Inter-rater, $r = .86$–$.97$	Construct $F = 41.3$, $p < .001$ Concurrent with VAS† $r = .85$ and with PIPP $r = .91$	Pain Preterm and full-term
Premature Infant Pain Profile (PIPP) (6 Items coded 1–4), behavioral and physiologic and GA	Stevens et al., (1996)[58]	Inter-rater $r = .85$–$.95$ Cronbach's $\alpha = .82$	Discriminate validity $t = 2.4$, $p < .01$ Construct $r = .85$	Procedural pain (most commonly used tool in research) 28–40 weeks
Neonatal Pain Agitation and sedation scale (N-PASS) (8 Items coded −2 to +2), behavioral and physiologic and GA	Hummel et al., (2003)[59]	Inter-rater = .85– .95 Cronbach's $\alpha = .87$–$.91$	Concurrent with PIPP, $r = .83$ Discriminate, $t = .2.78$, $p < .001$	For ongoing pain Includes sedation 23–40 weeks
CRIES (5 items coded 0–2), behavioral and physiologic	Krechel and Bildner (1995)[60]	Inter-rater, $r = .72$– $.98$ Kappa $r = .93$	Concurrent with NIPS $r = .84$	Mostly for postoperative pain 32–60 weeks
The Douleur Aigue Nouveau-ne (DAN) (13 items coded 0–4), behavioral	Carbajal (1997)[61]	Inter-rater, $r = .59$–$.97$ Cronbach's $\alpha = .88$	Face Concurrent with FANS‡ $r = .88$	Procedural and prolonged pain Research and clinical use 26–36 weeks

* GA: gestational age.
† VAS: visual analogue scale.
‡ FANS: Faceless Acute Neonatal Pain Scale.