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Article in *Infant Mental Health Journal* · February 2017

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UNPACKING THE BURDEN OF CARE FOR INFANTS IN THE NICU

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ABSTRACT: Infants who begin early life in the medicalized environment of the neonatal intensive care unit (NICU) experience disruption to numerous fundamental expectancies. In the NICU, infants are exposed to chronic, extreme stressors that include painful medical procedures and parental separation. Due to their preverbal stage of development, infants are unable to fully express these experiences, and linking these experiences to long-term outcomes has been difficult. This clinical article proposes the terminology *Infant Medical Trauma in the NICU* (IMTN) to describe the infant experience. Following a discussion of the NICU as an adverse childhood event, the article has three sections: (a) the unique and critical factors that define the newborn period, (b) a review of the IMTN conceptual model, and (c) recommendations for supportive neuroprotective strategies to moderate the intensity of adverse NICU infant experiences.

Keywords: neonatal intensive care, early life trauma, burden of care, health outcomes

* * *

Overall early life provides a roughly ordered sequence of developmental windows of opportunity that, in turn, allow both mundane and extraordinary experiences to get under the skin at strategic time points to alter specific biological functions, which, in turn, have the capacity to alter life course trajectories. (Hertzman, 2012)

High survival rates for infants cared for in the neonatal intensive care unit (NICU) are now commonplace. Application of technologies used in older patients scaled down to accommodate

patients that are smaller and more vulnerable have been the foundation for these advances. Accompanying such advanced technology is the potential for negative environmental/care experiences that may have long-term health and developmental consequences. Despite the dramatic improvements in survival, the morbidities for NICU graduates far exceed the term population (Doyle et al., 2015; Spittle & Orton, 2014). In fact, the increase in survival (decreased mortality) for this vulnerable population has not led to a similar decrease in morbidities (Font & Maguire-Jack, 2016).

Ten to 12% of all newborns require NICU care after birth, and many remain hospitalized for a substantial period of time (Harrison & Goodman, 2015; Kattwinkel et al., 2010). In this highly technical medical environment, infants experience prolonged

There are no conflicts of interest to report for any author.

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INFANT MENTAL HEALTH JOURNAL, Vol. 00(0), 1–11 (2017)

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View this article online at wileyonlinelibrary.com.

DOI: 10.1002/imhj.21636

separation from parents, chronic and extreme stressors, and painful and unpredictable life-saving medical procedures. Although inherited genetic susceptibility and quality of the prenatal uterine environment provide a foundation for the neurodevelopment of the fetus (nature), the context of this article is grounded in providing greater understanding of the NICU experience (nurture or lack thereof). We believe that the infant's interaction with their environment soon after birth is no less critical than is their genetic and prenatal foundation to both short- and long-term development.

Whether the infant is preterm or term, hospitalization in early infancy occurs during a particularly sensitive period of brain development, which includes neuronal migration, forging of synaptic connections, cortical organization, and myelination (Raz et al., 2015). Chronic and intense negative environmental experiences during this time place these infants at risk for poorer long-term health and developmental outcomes such as metabolic syndrome as well as diminished emotional, behavioral, and cognitive well-being (Johnson & Marlow, 2011; Smith et al., 2011; Spittle, Orton, Anderson, Boyd, & Doyle, 2015; Sullivan, Msall, & Miller, 2012). The inability to recognize these poorer health outcomes until later childhood or adulthood compels us to acknowledge and honor the unique perspective of the infant experience as well as to develop models of care that promote infant and family resilience.

Many adults lack an appreciation of the preverbal infant experience, including within the NICU environment. A lack of evidence remains about how the infant experience affects development. Given the deficiency of evolutionary expectant experiences, such as being skin-to-skin after birth, and the superimposed adverse experiences of high-technology NICU care, how do we understand the infant experience? This resultant void challenges our medical lexicon to describe the unique experience of infants who require early life medical care in the NICU. The lack of terminology limits the: (a) assignment of meaning to the infant's personal experience, (b) conceptualization of this infant/human experience by caregivers and others beyond the NICU, (c) development of authentic infant- and family-centered care in the NICU, and (d) discovery as well as further study of innovative interventions regarding these unique phenomena.

To date, there is no single term that describes the infant's combined physical, environmental, and relational stresses associated with an NICU hospitalization. Terminology for the infant experience, such as *extreme stress*, *early life stress*, *toxic stress*, *developmental stress*, or *developmental adversity*, may be less provocative; however, each of these terms do not fully capture the true intensity of the infant experience. We acknowledge the potential for controversy in labeling an infant experience in the NICU as a *trauma*. Yet, we believe it is the best term for truly capturing what the infant in the NICU is experiencing.

The goal of this article is to examine the NICU experience from the infant's perspective and propose the model of *Infant Medical Trauma in the NICU* (IMTN) as a framework for understanding the needs of infants in this clinical setting. Following a discussion of long-term developmental outcomes, three sections structure this article. First explored are the unique and critical factors that define

the newborn period. The next section is a discussion of the IMTN conceptual model. The third section provides recommendations for neuroprotective strategies to moderate the intensity of adverse NICU infant experiences.

CASE FOR NEWBORN ADVERSE CHILDHOOD EVENTS

There is compelling scientific evidence of lifelong health problems following early life adversity (Font & Maguire-Jack, 2016; Link & Phelan, 1995). For example, adverse childhood experiences (ACEs) have been shown to result in poor mental and physical health in adulthood (Felitti et al., 1998; Monnat & Chandler, 2015), with worse outcomes associated with cumulative exposure and younger age of exposure (Putnam, Harris, & Putnam, 2013). Preterm infants may very well be more vulnerable to early negative exposures because of both their NICU experience and their health-related morbidities that may enhance vulnerability to abuse and neglect (Finkelhor et al., 2013; U.S. DHHS, 2013). In fact, numbers of days in the NICU is more likely to result in poorer long-term outcomes despite the medical diagnosis that led to the NICU admission or subsequent length of hospital stay (Jarjour, 2015).

In addition to stressors such as parental divorce, incarceration, parental mental illness, and abuse and neglect, medical trauma is a unique source of potential childhood traumatic stress (Greeson et al., 2014; Kazak et al., 2006). Following injury or illness, some children are susceptible to traumatic stress symptoms that may become disruptive to functioning, leading to poorer health outcomes and quality of life (Kassam-Adams, Marsac, Hildenbrand, & Winston, 2013). Knowledge of the impact of traditional ACEs and evolving information on medical trauma in childhood suggests that preverbal infants also may be vulnerable to trauma from intensive early life medical care.

Evidence also has suggested that the immature and vulnerable brain of an infant is at risk for alterations resulting from adverse experiences (Smith et al., 2011). Brain volume, alterations in microstructure, and white matter injury are all associated with diminished neurodevelopmental outcomes in preterm infants (Bora, Pritchard, Chen, Inder, & Woodward, 2014; Chau et al., 2013; Kidokoro et al., 2014; Munakata et al., 2013; Smyser et al., 2013; Thompson et al., 2014; Wisnowski et al., 2014). Smith et al. (2011) demonstrated that increased stress exposures in the NICU were associated with decreased brain size and alterations in the brain microstructure and functional connectivity. Abnormal brain maturation identified during NICU care has been associated with poor neurodevelopmental outcomes at 18 months corrected age (Chau et al., 2013). These data suggest a need to shift our brain injury paradigm from a fixed lesion model (i.e., related to intracranial hemorrhage or ischemic insults) to a dynamic model that emphasizes the continued vulnerability of the newborn brain to microstructural or functional injuries occurring over the course of a prolonged hospitalization.

Normal maturation of the central nervous system (CNS) ensues based on a developmental trajectory unaltered by premature

birth. Early born infants are neurologically ill-prepared for increased risk from negative sensory experiences, as opposed to more predictable and controllable experiences (Kuhn et al., 2013; Zores et al., 2015). Furthermore, brain development for the NICU infant does not occur independent of other organ systems. For many preterm infants, the immaturity of their respiratory, digestive, and thermal regulatory systems influences the availability of oxygen, nutrients, and other essential elements necessary for healthy brain development. This also may influence the perception of experiences as manageable.

Health outcome data (discussed next) include categorical outcomes of concern for preterm infants. In addition to the major morbidities for NICU-surviving infants (cerebral palsy, intellectual disabilities, vision and hearing difficulties), preterm and late-term infants are at increased risk for more nuanced abnormalities in brain development, such as increased risk for autism, learning difficulty, attention and behavioral issues, anxiety, and depression.

Neurodevelopmental Disorders

Preterm infants are at greater risk for a host of neurodevelopmental disorders, influenced by their early care experiences. Recent studies have reported a prevalence of autism spectrum disorder (ASD) for preterm infants at 2 to 8%, a risk inversely related to gestational age (Abel et al., 2013; Johnston & Stevens, 1996). For example, among the estimated 1 in 68 children diagnosed with ASD, the risk for autism is as much as three times higher for former preterm infants, particularly those born small for gestational age, those with low birth weight, and those with all grades of intracranial hemorrhage (Centers for Disease Control and Prevention, 2014; Gardener, Spiegelman, & Buka, 2011; Kuzniewicz et al., 2014; Pinto-Martin et al., 2011).

Learning and Behavioral Impairments

For many former preterm infants, learning does not come easily. Relative to term peers, former preterm cohorts perform significantly worse on all cognitive and academic domains, and display more severe responses on many behavior problem scales (Hutchinson, De Luca, Doyle, Roberts, & Anderson, 2013). A linear relationship exists between gestational age and cognitive ability; indicating that as gestational age decreases, so does long-term cognitive ability (Poulsen et al., 2013). Decreased cognitive ability, compared to term infants, is present in late preterm infants and early term infants (Poulsen et al., 2013). Even with maturation, former late preterm infants continue to have cognitive and behavioral challenges well into adolescence and adulthood (Lahat, Van Lieshout, Saigal, Boyle, & Schmidt, 2014; Sullivan et al., 2012).

Mental Health Concerns

Preterm birth is a risk factor for future psychiatric disorders, with higher prevalence rates of depression and anxiety found in young adults born extremely preterm (Grunau, 2013; Johnson et al., 2010;

Raikkonen et al., 2008; Sullivan et al., 2012). Furthermore, when compared to term peers, children born extremely preterm have four times greater risk for anxiety disorders (Raikkonen et al., 2008).

An increased prevalence of attention deficit hyperactivity disorder also is a risk among former preterm infants, up to two times that of control groups (Hack et al., 2009; Lindström, Lindblad, & Hjern, 2011; Scott et al., 2012). Moreover, researchers have found that 20 to 30% of preterm, very low birth weight, or moderately low birth weight infants have at least one mental health issue. By comparison, in the general U.S. population, 15.5% of children have mental health problems. In addition, statistically significant findings of increased rates of depression, anxiety, and behavioral conduct problems have been reported (Singh, Kenney, Ghandour, Kogan, & Lu, 2013).

THE UNIQUE NEWBORN PERIOD

Overlaid onto the stresses of the NICU environment are critical periods of an immature and rapidly developing CNS (Moore, Persaud, & Torchia, 2015). Following embryonic development, Gestational Weeks 9 to 40 represent the fetal period of brain development. Evolutionarily, the fetal period of neurodevelopment relies upon systematic brain maturation, through both gross anatomical and microscopic cellular processes (Hruby, Maas, & Fedor-Freybergh, 2013). In the developing brain, activity-dependent synaptic connections allow for the natural pruning of less active or developed neurons (Hua & Smith, 2004). The enduring synaptic connections result from repeated activity, forming neuronal pathways, which allow for the development of memory, learning, and behavior (Hua & Smith, 2004). Neural pruning is normal in the prenatal period and is easily altered by infant experiences. Over time, development may be altered, as pathways are not easily righted (Samaso, Tomasi, & Vaccarino, 2014; for a detailed review, see Stiles & Jernigan, 2010).

Developmentally unexpected sensory experiences may influence subsequent CNS function by alteration of the brain microstructure (Fitzgerald, 2005; Ranger & Grunau, 2014). Thus, until neural circuitry maturation, infants in particular may be at risk for overexposure to multiple sensory stimuli or stressors. Furthermore, the duration of endured stress, typically defined as a week or more in the animal model, may evoke a state of chronic stress with potential to impact early and long-lasting neuronal development (Joëls, Karst, Krugers, & Lucassen, 2007; McEwen, 2007).

Adverse events in the NICU occur concurrently with key periods of critical brain development and maturation. In addition, the experience is in violation of the infant evolutionary expectancy of connectedness to the parents by transition from the womb to the mother's chest and breast. This concurrence highlights the critical importance of appreciating a unique perspective of the infant experience in the life-sustaining, but unnatural, environment of the modern NICU.

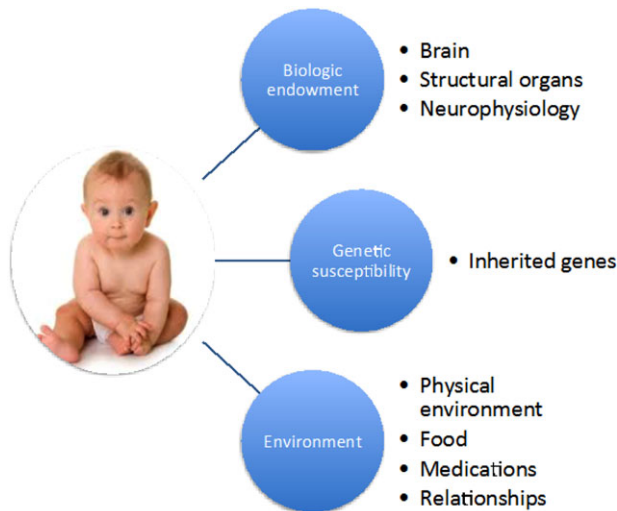


FIGURE 1. The human template.

INFANT MEDICAL TRAUMA IN THE NICU

Trauma is a word of Greek origin, defined as “a wound.” The trauma of infant medical care in the NICU represents early life experiences (e.g., stress, pain, and parental separation) common to the NICU. Both physical and socioemotional aspects may compromise infant neurodevelopment. We operationally define *Infant Medical Trauma in the NICU* (IMTN) as the integrated and embedded cumulative early life experiences of stress, pain, and parental separation occurring in conjunction with or because of medical care that may affect short- and long-term neurobiological-neurophysiological responses and developmental outcomes.

Infants enter the NICU with their inherent and unique biologic endowment, genetic susceptibility, and experiences with the fetal environment present (Figure 1). The biologic endowment expresses the brain morphology and structural foundation as well as neurobiological and neurophysiological responsiveness. Genetic susceptibility alters the brain’s response to stressors throughout the life span.

These formative components are very important to the developing infant. While biologic and genetic endowments are not modifiable, per se, the environment is a heavy influencer. Because the dynamic infant template is in constant interaction with and modified by experiences within the NICU environment, the focus of care must shift toward factors that caregivers can modify and change. Our framework for IMTN (Figure 2) illustrates significant adverse exposures that infants encounter in the NICU that may place them either on a trajectory toward risk or resilience. As discussed in D’Agata and McGrath (2016), although healthy newborns experience some of these exaggerated stressors, the prolonged nature of stressor exposure is most detrimental to NICU infants. Next, we outline the critical aspects of the framework in Figure 2.

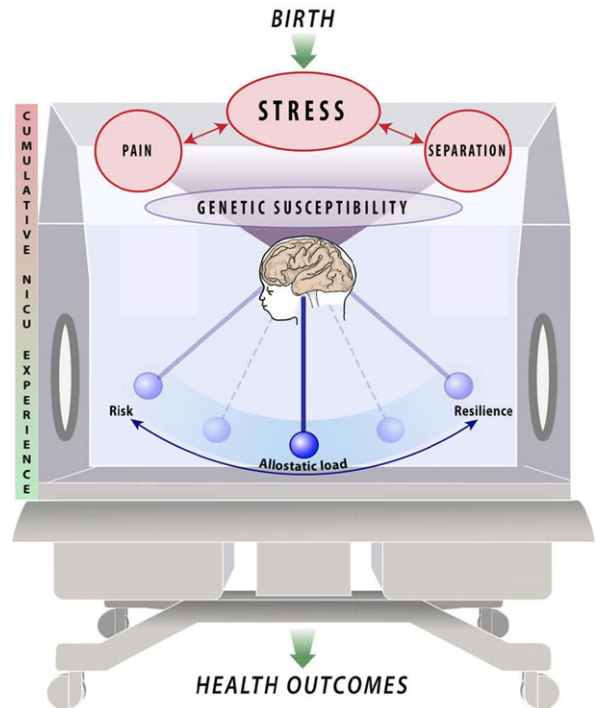


FIGURE 2. Conceptual model of Infant Medical Trauma in the NICU.

Stress

For infants, and to an even greater extent, preterm infants, stress can be difficult to differentiate from pain. This discussion will not analyze infant perception of each but rather focuses on a stressor as an actual or potential disturbance to one’s environment (Joëls & Baram, 2009). In the NICU, stressors may include environmental factors such as extreme light and loud noises as well as unpredictable caregiving, multiplicity of care providers, and prolonged separation from parents. Intertwined with NICU stress is the unpredictability of many aspects of caregiving. For example, infants may be unable to discriminate between painful and nonpainful touch until 35 to 37 weeks’ postmenstrual age (Fabrizi et al., 2011). While touch is inherent to physical interactions, as well as the developing infant’s physiological stress response system, a newborn’s inability to anticipate touch makes it an unpredictable phenomenon (Fabrizi et al., 2011; Feldman, Singer, & Zagoory, 2010). This also suggests that intrusive caregiving disruptions may not be easily discriminated by the infant from nurturing touch. Thus, the infant may at times experience many invasive and noninvasive caregiving tasks, including parental touch, as stressful.

Pain

Pain is the unpleasant sensory and/or emotional experience associated with actual or potential tissue damage or described in such terms as *damage* (International Association for the Study of Pain, 1994). The historical challenges in recognizing infant pain has led to many false assumptions. Many did not believe that infants,

especially preterm infants, experienced pain due to their neurologic immaturity (McGraw, 1941; Rodkey & Pillai Riddell, 2013). Others have suggested that if infants did feel pain, it was to a lesser degree than do older children and adults. Current research has indicated that preterm infants often suffer hypersensitivity to pain (Slater et al., 2010; Valeri, Holsti, & Linhares, 2014). Based on animal models, this may occur due to cutaneous hyperinnervation, which retracts postnatally, resulting in hyperexcitability or hypersensitivity in pain-processing pathways (Fitzgerald, 2005).

Many procedural interventions in the NICU are painful. The unpleasant and unpredictable nature of pain in the NICU results in infant disengagement behaviors and poorer autonomic responsiveness (Grunau et al., 2005). Biological embedding describes experiences during sensitive periods of development that “get under our skin” (Fox, Levitt, & Nelson, 2010; Hertzman, 2012). These influential sensory experiences activate genes in areas of the brain that commit differentiating neurons to sensory functions, and establish sensory pathways ultimately leading to neural and biologic pathway determination (Hruby et al., 2013). Adverse experiences may thus shape brain development, potentially resulting in abnormal neurodevelopment (National Scientific Council on the Developing Child, 2005/2014). For example, the experience of pain in the NICU may have implications for the development of biological stress systems. Given the frequency and potential duration of painful procedural encounters, an average of 12 painful procedures per hospitalized day, the opportunity exists for long-term effects (Carabajal et al., 2008).

Parent–Infant Separation

Early life human connectedness lays the foundation of social and emotional development and mental health throughout the life span (Bowlby, 2005). Infants have an array of intrinsic behaviors to maintain proximity to later attachment figures, typically parents (Bowlby, 1988). Proximity seeking both supports and protects the infant, with successful accomplishment of proximity and safety ultimately resulting in secure attachment (Mikulincer, Shaver, & Pereg, 2003). All infants admitted to the NICU experience some degree of separation from their parents for receipt of lifesaving care. Moreover, admission to the NICU results in a spectrum of barriers that separate the family, barriers that include technology, health status of the infant, hospital protocols and routines, and so on. For infants born very early or with other significant medical concerns who may require weeks or months of hospitalization, this separation may be prolonged. The implications of this separation have received limited investigation to date, yet necessitate exploration to understand the long-term impact to socioemotional health and brain development. In doing so, interventions to minimize separation will be identified and implemented as important standards of care.

BRINGING INFANT EXPERIENCE INTO THE FOREFRONT

Currently, there is no adequate medical terminology describing the potential negative health outcomes from adverse early life infant

experiences. The traumatic experience and sequelae of preterm birth as experienced from the parental perspective (Forcada-Guex, Borghini, Pierrehumbert, Ansermet, & Muller-Nix, 2011; Lefkowitz, Baxt, & Evans, 2010) has been described; however, little attention has been paid to describe the experiences of the infant, who receives the medical care. The absence of a framework to describe this experience limits conceptualization and advocacy for improvements in care provision acknowledging the infant’s unique experience. Since infants are preverbal, we rely on the science of understanding infant behavior to guide us.

In the 1970s, Als and Brazelton described infant behavioral cues, shedding light on the infant experience; yet, the translation of their pioneering work as a guiding force to caregiving remains inconsistently implemented across NICUs (Als, Tronick, Lester, & Brazelton, 1977; Brazelton, 1973). Both the interpretation of the preverbal infant’s “language” and delivery of developmental care are variable practices (Coughlin, 2014; Coughlin, Gibbins, & Hoath, 2009). Both Als Tronick, Lester, and Brazelton (1977) and Brazelton (1973) noted that preverbal infants communicate their adaptation of stress exposure through behavioral and physiologic mechanisms into general categories of autonomic, motor, and state organization. Unfortunately, most neonatal clinicians do not receive training to decode communication from the preverbal infant. For example, the ability to discriminate a quiet awake state from hypervigilance requires training, as these two states have very different meanings for an infant. Interpreting this language requires both a commitment to closely listen and observe as well as to develop new skills beyond those typically taught in medical or nursing training.

HOW CAN WE PROVIDE POSITIVE EARLY EXPERIENCES FOR THE INFANT AND FAMILY?

Care in the NICU, while focused on promoting survival, represents an interruption to many beginnings for both infants and parents. Knowing that a healthy infant’s extrauterine life does not typically include intense and prolonged experiences of separation, pain, and stress, strategies for improvement are discussed next.

Recognize Infant Medical Trauma in the NICU

The purpose of proposing the IMTN concept is to articulate the NICU infant experience. Developmentally, this experience is critically important when considering long-term health trajectories. Pausing to envision oneself in the role of the NICU patient—an ill or preterm infant—and the various adverse experiences of pain, stress, and separation that occur repeatedly over a protracted time frame and with no means of self-advocating or halting offending care, likely evokes a sense of helplessness. Currently, we do not have terminology for this experience. Without language to identify the infant experience, work cannot progress toward optimizing care. Inclusion of such language will call to action those who can influence the NICU model of care, including clinicians, parents, administrators, and organizations, to redesign care to be truly neuroprotective and infant- and family-centered.

Support the Primary Infant–Parent Relationship

There is an interruption to the innate proximity-seeking behaviors of an infant to his or her parents for protection and nurturance during an NICU hospitalization by hospital routines, technology, and infant health status. Despite the numerous benefits of skin-to-skin holding, including physiologic stability for infants and stress reduction for parents, skin-to-skin holding continues to be inconsistently implemented (Luong, Long Nguyen, Huynh Thi, Carrara, & Bergman, 2016; Nyqvist, 2016). Often cited as the reason for inconsistency is the lack of support in the NICU for caregivers to facilitate this intervention (Chan, Labar, Wall, & Atun, 2016). As a result, infant holding may be considered as a stressful interference to medical care rather than as facilitative and beneficial to both infant and parent. Of more concern are the results of a recent study by Hendricks-Muñoz et al. (2013), who found a significant difference between nurses' and mothers' perceptions of the importance of parental presence in the NICU. Of the nurses surveyed, only 21% reported parental presence to be important versus 67% of the mothers. In addition, 90% of mothers saw themselves as needed care members while only 40% of nurses agreed with this statement (Hendricks-Muñoz et al., 2013).

As a mechanism to increase parent involvement in the care of their infants, a model of family-integrated care (FICare) has recently gained attention. Initial results from these studies have strongly endorsed the health benefits of supporting the NICU infant–parent dyad. In the FICare model, parents of recovering preterm infants provide care beyond the simple tasks commonly allowed (e.g., diaper changes, temperature measurement, feeding, etc.) (O'Brien et al., 2013). Participation in the intervention required parents to (a) spend extended time spent in the NICU, (b) attend structured education sessions to learn how to provide direct care to their infant, and (c) document their learning. The outcomes of this model of care include increased infant weight gain and increased incidence of breast-feeding at discharge (O'Brien et al., 2013). FICare researchers have reported that by engaging, assisting, and educating parents to care for their infant, even during semi-acute stages of illness, infants experienced improved short-term health outcomes, and parents reported that they felt supported in their role development. Furthermore, facilitation of parent hands-on care promotes infant–parent proximity and supports the primacy of the infant–parent dyad in the journey to health and wellness (Jiang, Warre, Qiu, O'Brien, & Lee, 2014).

Measure Cumulative Stress Exposure

The development of a stress-measurement score, similar to pain-measurement scores, will allow us to quantify environmental stressors and further enhance clinician and parent awareness of an infant's stress exposure. We now utilize pain-measurement scales to assist with physiological and behavioral signs and symptoms of infant pain (Cong, McGrath, Cusson, & Zhang, 2013). The development of a comprehensive infant stress scale would capture a critical component of an infant's experience. In turn, allowing for

clinicians and parents to assess infant response to both acute and cumulative stressors and the opportunity to modify the environment or timing of procedures will facilitate neuroprotection.

Learn From Other Research

The socioemotional experience of early life in medicalized environments shares similarities to orphaned children placed in early life institutional-rearing environments. While associations between NICU care and institutionalized care are not commonly discussed, parallels exist between these caregiving environments (e.g., multiple caregivers, rotating shifts of caregivers, ratio of child-to-caregiver, and limited individualized care (Bick, 2015). Health-outcome deficits for children reared within institutional environments in physical growth, cognitive, emotional, and behavioral domains are demonstrable and significant (Bakersman-Kranenburg et al., 2011; Smyke et al., 2007). While the infant participants in these studies did not experience the painful procedures typical of a medical environment, they still suffered significant psychosocial deficits. These results caution us that infants or children cared for in any institutional environment need significant attention to provision of positive early life caregiving experiences as well as environmental care modifications to support their development (Drury et al., 2012; McGoron et al., 2012).

SUMMARY AND DIRECTIONS FOR FUTURE RESEARCH

Important considerations for future research include further investigations of NICU environmental factors influential to long-term health (Kuhn et al., 2013; White, 2016; Zores et al., 2015). Presently, many NICUs have chosen single-room designs to support both infants and families. More research is required to understand the long-term neurodevelopmental outcomes of infants cared for in these units. Using a stress-measurement instrument, is infant stress in a single-room design different from open-bed designs? What are the long-term differences in outcomes? Can we measure meaningful parental presence in the NICU? Using biobehavioral measures, do positive parent interventions moderate the stress experience? Moreover, what is meaningful parental presence, and how can it be best be encouraged and supported?

At this time, within NICU caregiving, a comprehensive measurement of an infant's experience does not exist. In addition, not all factors influencing the health of an NICU infant (stress, pain, and separation) are included in current assessment methodologies. While in clinical practice the perception of infant pain is measurable—using pain scores, stress, and parent–infant separation is not. As can often occur in clinical practice, unmeasurable outcomes are dismissed as unimportant. However, given the breadth of research presented in this article, lack of attention to the NICU infant's risk factors may place infants at risk for negative long-term health outcomes. The development of mechanisms to measure influencing factors may be critically important to improving the neurodevelopmental health of infants.

Infants are unable to articulate to caregivers the extent of their pain and stress burden or their need for human connection. This lack of communication may result in experiences that would not occur if the patient were verbal and able to self-advocate. In addition, repeated negative exposure for infants in the NICU may influence their long-term development. Universally, clinician focus in the NICU is on providing the best care possible to support infant health and development; however, improvements to clinical care typically occur when science demonstrates evidence of a better way to practice. The time has come for clinicians and researchers to focus on the multidisciplinary science of understanding IMTN and to conduct research focused on the neurodevelopmental implications of care. The acceptance of a term to describe the NICU infant experience will allow for common language in practice and research as well as a critical avenue for scientific inquiry appropriate to the profound importance for infants, families, and public health.

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