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Reducing toxic stress in the neonatal intensive care unit to improve infant outcomes

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ABSTRACT

In 2011, the American Academy of Pediatrics (AAP) published a technical report on the lifelong effects of early toxic stress on human development, and included a new framework for promoting pediatric health: the Ecobiodevelopmental Framework for Early Childhood Policies and Programs. We believe that hospitalization is a specific form of toxic stress for the neonatal patient, and that toxic stress must be addressed by the nursing profession in order to substantially improve outcomes for the critically ill neonate. Approximately 4% of normal birthweight newborns and 85% of low birthweight newborns are hospitalized each year in the highly technological neonatal intensive care unit (NICU). Neonates are exposed to roughly 70 stressful procedures a day during hospitalization, which can permanently and negatively alter the infant's developing brain. Neurologic deficits can be partly attributed to the frequent, toxic, and cumulative exposure to stressors during NICU hospitalization. However, the AAP report does not provide specific action steps necessary to address toxic stress in the NICU and realize the new vision for pediatric health care outlined therein. Therefore, this paper applies the concepts and vision laid out in the AAP report to the care of the hospitalized neonate and provides action steps for true transformative change in neonatal intensive care. We review how the environment of the NICU is a significant source of toxic stress for hospitalized infants. We provide recommendations for caregiving practices that could significantly buffer the toxic stress experienced by hospitalized infants. We also identify areas of research inquiry that are needed to address gaps in nursing knowledge and to propel nursing science forward. Finally, we advocate for several public policies that are not fully addressed in the AAP technical report, but are vital to the health and development of all newborns.

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Toxic Stress in the Neonatal Intensive Care Unit: Transformative Change Is Needed to Improve Infant Outcomes

In 2011, the American Academy of Pediatrics (AAP) published a technical report on the lifelong effects of early "toxic stress" on human development, and introduced a new framework for promoting healthy human development: the Ecobiodevelopmental (EBD) Framework for Early Childhood Policies and Programs. In the technical report, the AAP called for a new paradigm for caring for children and families to promote health, prevent disease, and mitigate sources of early stress that have lifelong consequences for the pediatric patient (Shonkoff, Garner, Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care, & Section on Developmental and Behavioral Pediatrics, 2012). The authors (Shonkoff et al., 2012) differentially define three levels of stress based on their ability to provoke lasting physiologic disruption to the patient: *positive stress*, *tolerable stress*, and *toxic stress* (Table 1). Each level has a different intensity, duration, and/or frequency of the stress response, and thus a different potential to cause irreversible harm. The report also introduced the concept of *buffering*, the socioemotional support provided by a loving caregiver that mitigates the harmful effects of the stress response and confers protection to the child (Table 1). The report defines a caregiver as a caring, responsive adult who can facilitate coping with a stressor, including (but not limited to) parents, family members, nurses, other clinicians, and volunteers.

The AAP report presented the EBD framework to guide the future of pediatric practice, research, and policy in reducing toxic stress for children (Shonkoff et al., 2012). The EBD framework posits that ecology (social and physical environment), biology (physiological adaptations/disruptions), and human development (learning, behavior, well-being) converge to produce lifelong health outcomes. The EBD framework outlines several ecological approaches to significantly decrease the number and severity of adverse events experienced by children and increase the protective buffering of child stress responses that occurs within supportive caregiving relationships. These approaches involve strengthening caregiver and community capacities to promote pediatric health. Caregiver and community capacities are defined as time and commitment to the child, sufficient resources (e.g., economic, emotional, psychological, social, and institutional), and caregiver skills and knowledge. The model posits that innovative policies and programs to increase caregiver and community capacities will lead to adaptive biologic systems in the child that ultimately produce optimal health and development (Shonkoff et al., 2012).

The ecological approach of the AAP report is a useful foundation for examining neonatal care for the hospitalized infant (Shah, Jerardi, Auger, & Beck, 2016). Each year in the United States nearly 4 million newborns are hospitalized (Witt, Weiss, & Elixhauser, 2006), with an incidence of neonatal intensive care unit (NICU) admission at 43.0 per 1,000 normal birthweight infants (2,500–3,999 g), and admission rate for very low birthweight infants (<1,500 g) at 844.1 per 1,000 live births (Harrison & Goodman, 2015). In the highly technological NICU, neonates are exposed to roughly 70 stressful procedures a day (Pereira et al., 2013), which can permanently and negatively alter the infant's developing brain (Pickler et al., 2010). Neurologic deficits are some of the most significant morbidities resulting from the infant conditions requiring NICU admission (Stensvold et al., 2017; Stoll et al., 2010, 2015), such as prematurity and birth defects. These deficits can be partly attributed to the frequent, toxic, and cumulative exposure to stressors during NICU hospitalization (Weber, Harrison, & Steward, 2012). Revolutionary changes in nursing practice, research, and policy will be needed to substantially improve patient outcomes.

Although the AAP report provides a useful framework from which to launch interventions, the report does not offer specific action steps necessary to substantially improve patient outcomes in the NICU and to realize the new vision for pediatric health care. Therefore, the purpose of this paper is to apply the concepts and vision laid out in the AAP report to the care of the hospitalized neonate, and to propose action steps for true

Table 1 – Stress Response Definitions

Level of Stress Response	Definition	Buffering
Positive stress*	A mild-moderate stress response that quickly resolves in the presence of a supportive caregiver and contributes to normal, healthy child development	Yes
Tolerable stress*	A severe stress response to extremely adverse or threatening experiences that contributes to physiologic harm and long-term health consequences. In the presence of a supportive caregiver, harm to the child is greatly reduced and the stress response can be brought back to baseline.	Yes
Toxic stress*	A severe, frequent, and/or prolonged stress response to adverse events in the absence of a supportive caregiver. The toxic stress response has the ability to disrupt brain circuitry, organ systems, metabolism, and normal physiology of the child's biological systems. The physiologic disruption caused by toxic stress results in lifelong health impairments.	No

* As described in the AAP technical report (Shonkoff et al., 2012).

transformative change in neonatal intensive care. First, we review how the early environment of the NICU is a significant source of toxic stress for hospitalized infants. Second, we provide recommendations for caregiving practices that could significantly buffer the toxic stress experienced by hospitalized infants. Third, we identify areas of research inquiry needed to address gaps in nursing knowledge and to propel nursing science forward. Finally, we advocate for several public policies that are not fully addressed in the AAP technical report but we feel are vital to the health and development of all newborns.

Levels of Stress in the NICU

The most common infant stress responses provoked by the NICU environment constitutes that of the most dangerous form of stress, toxic stress. While the AAP report provided several examples of stressors capable of inducing a toxic stress response (e.g., parental neglect, abuse, and maternal depression), others have expanded on the AAP's examples to include childhood hospitalization (Franke, 2014; Shah et al., 2016). Specifically, NICU hospitalization is a significant source of toxic stress for infants due to the nature, timing, and buffering of infant stress within the NICU environment.

Nature of Stressors

Infants in the NICU are exposed to complex, multisensory, and painful stimuli and frequently deprived of developmentally supportive stimuli. Both the presence of negative stimuli and the lack of positive stimuli constitute significant stressors that are physiologically disruptive to the infant (Carbajal et al., 2008; Hatfield & Polomano, 2012; Weber et al., 2012). Stressors can originate from the physical NICU environment (e.g., bright lighting, loud noises, noxious smells), the psychosocial NICU environment (e.g., lack of developmentally supportive social interactions, noncontingent caregiver responses to infant cues), or the clinical NICU environment (e.g., clinical procedures necessary for the health and safety of the infant).

The physical NICU environment is an overwhelming source of stressful stimuli, similar to many ICU settings (Shoemark, Harcourt, Arnup, & Hunt, 2016). NICUs exhibit high volumes of background noise stemming from alarms, equipment, acute patient events, and staff conversations (Byers, Waugh, & Lowman, 2006; Szymczak & Shellhaas, 2014). The intensity, frequency, and characteristics of ICU sounds invoke toxic stress responses from infants as ICU sounds are mainly comprised of abrasive sounds whose pitch, pattern, and tone are difficult to predict (Bremmer, Byers, & Kiehl, 2003). Similarly, excessive lighting in the NICU environment is frequently experienced by infants during clinical procedures, acute patient events, and infant assessments (Ozawa, Sasaki, & Kanda, 2010). Bright light invokes physiologic dysregulation in NICU infants and can contribute to poor visual development (Watanabe et al., 2013). Finally, noxious smells from disinfectants, adhesives, lubricants, skin care products, and hand hygiene products induce pain responses in NICU infants (Frie, Bartocci, Lagercrantz, & Kuhn, 2017; Kuhn, Astruc, Messer, & Marlier, 2011; Lipchock, Reed, & Mennella, 2011).

The psychosocial environment of the NICU provides an exemplar for infant stress exposure derived from deprivation of positive sensory stimuli and an overabundance of negative stimuli that are physiologically disruptive to the infant. For example, NICU infants are commonly deprived of positive touch experiences, such as hand containment, kangaroo care, and swaddled holding (Hubbard & Gattman, 2017; Torowicz, Lizanti, Rim, & Medoff-Cooper, 2012). Critically ill infants are held during kangaroo care on average only twice a week by parents in the NICU (Gonya & Nelin, 2013). Our previous work support these findings, as many infants in our studies went entire weeks without being held (Weber, Harrison, Sinnott, Shoben, & Steward, 2018). Several studies have shown that due to serious time constraints, nurses must ration care and are most likely to omit or skip developmental activities; parental support, teaching, and involvement; and infant comfort care (Hendricks-Muñoz & Prendergast, 2007; Rochefort, Rathwell, & Clarke, 2016; Tubbs-Cooley, Pickler, Younger, & Mark, 2015). Time constraints can also significantly impair a nurse's ability to provide care based on developmentally supportive, contingent responses to infant cues. Noncontingent responses include caregivers not responding to cues provided by the infant signaling a specific need (e.g., infant crying due to hunger or the need to be held) or implementing caregiving procedures without regard to infant cues (e.g., changing the infant's diaper when the infant is asleep). For example, a case study of a hospitalized infant documented nearly 100 interruptions during sleep per day and caregiving interruptions spaced less than 30 minutes apart 90% of the time (Daniels & Harrison, 2016). Noncontingent responses to infant cues communicating the need for sleep, feeding, social interaction, or a break from clinical procedures significantly impair infant physiologic regulation during these activities (Chuang et al., 2018; Kirk, Alder, & King, 2007; Levy et al., 2016; Whetten, 2016).

Common distressing stimuli in the NICU required for the infant's clinical care include mechanical ventilation, nasogastric tube insertion, heelsticks, intravenous catheter insertions, handling, and suctioning (Newnham, Inder, & Milgrom, 2009). One study found that infants were manipulated with clinical procedures an average of 38 times over a 24-hour period in the NICU (Pereira et al., 2013). Another study found that NICU infants are exposed to as many as 16 painful procedures a day (Carbajal et al., 2008). Our previous work is consistent with these findings, as premature infants in the NICU experienced the equivalent of about 12 severely stressful events with an 8-hour observation period

(Weber, Harrison, Sinnott, Shoben, & Steward, 2018). These studies are testimonies to relentless infant stress exposure in the NICU.

Timing of Stressors

Infants are hospitalized in the NICU during a critical and sensitive period in their brain development (Feldman, 2015). During the first few months of life, neuronal plasticity, neuronal pruning, and brain growth occur at the highest rate of any other period in the human lifespan. Structures in the infant brain are actively organizing and integrating into functional neuronal networks (Clouchoux et al., 2011; Smyser et al., 2010; Smyser, Snyder, & Neil, 2011). Thus, distressing stimuli in the NICU have a heightened ability to permanently alter infant brain development by augmenting neuronal cell death (Bhutta & Anand, 2002), reducing brain volume, and impairing brain structure and function (Smith et al., 2011).

Buffering of Stressors

The absence of a supportive caregiver to buffer severe infant stress responses is a common phenomenon in the NICU. Less than a third of parents visit the NICU 6 or more days per week, with parental presence constituting only 5% of the time the infant is hospitalized (Reynolds et al., 2013). Other studies have found that parents visit roughly 4 days out of each week during the infant's entire NICU hospitalization (Greene et al., 2015). Thus, infants spend the majority of NICU hospitalization without their parents present to buffer infant stress responses to noxious stimuli.

Nurses play a pivotal role as the primary supportive caregiver when parents are not present at the bedside. Hand containment, facilitated tucking, nonnutritive sucking, cue-based care, bundled care, and swaddled holding are a few of the many evidence-based interventions that nurses implement to buffer infant stress responses in the NICU (Pillai Riddell et al., 2015). At the same time, these stress-buffering interventions are the first activities to be missed or skipped by nurses due to time and staffing constraints (Hendricks-Muñoz & Prendergast, 2007; Rochefort et al., 2016; Tubbs-Cooley et al., 2015). So while nurses can be supportive caregivers at the bedside, nurses cannot replace parents and the comfort and consistency of care they provide their infants. Therefore, parental absence from the bedside places the infant at high risk for experiencing toxic, as opposed to tolerable, stress.

In summary, the nature and timing of stressors in the NICU predispose the infant to toxic stress in the absence of a supportive caregiver to help regulate the infant. We, along with others, believe that NICU hospitalization constitutes a significant, toxic stressor for infants (Sanders & Hall, 2017; Shah et al., 2016). The longer the NICU hospitalization, the greater chance for prolonged and cumulative exposure to toxic stress. Furthermore, because parental visitation decreases with increased NICU length of stay (Gonya & Nelin, 2013; Greene et al., 2015), the steadily reduced presence of parents at the bedside places the infant at additional risk for experiencing toxic, as opposed to tolerable, stress. In the next section, we provide practice, research, and policy approaches to decrease toxic infant stress responses and increase social buffering in the NICU.

Implications for Neonatal Research, Practice, and Policy

The concepts described in the EBD framework can be easily applied to infant experience in the NICU. Over the past several decades, neonatal scholars have made their own recommendations to increase caregiver and community capacities (i.e., time and commitment to the infant, resources, caregiving skills and knowledge) and buffer infant stress. Successful efforts include providing institutional resources for family accommodations in the hospital (Franck, Ferguson, Fryda, & Rubin, 2015, 2017), socioemotional resources such as peer-to-peer parental support for NICU parents (Hall, Ryan, Beatty, & Grubbs, 2015; Hynan & Hall, 2015; Macdonell et al., 2013; Rossman, Greene, & Meier, 2015), psychological resources from mental health professionals (Hynan & Hall, 2015; Hynan et al., 2015), and even financial resources to promote optimal infant nutrition through breastfeeding in the NICU (Johnson et al., 2018; Morgan et al., 2015; Relton et al., 2018). Well-established parent education programs increase caregiver skills and knowledge; reduce parental distress, depression, and anxiety; and strengthen the parent–infant relationship in the NICU (Chertok, McCrone, Parker, & Leslie, 2014). Single-family rooms, when designed to promote the psychosocial needs of all users (i.e., infants, families, and clinicians), not only improve infant developmental outcomes (Lester et al., 2014, 2016; Shahheidari & Homer, 2012; Vohr et al., 2017), but also invite parental visitation (Raiskila et al., 2017), reduce noise (Liu, 2012), control infection (Sadatsafavi, Niknejad, Shepley, & Sadatsafavi, 2017), increase kangaroo care and breastfeeding rates (Jones, Jones, & Feary, 2016), and promote bonding and parental independence (Toivonen, Lehtonen, Löyttyniemi, & Axelin, 2017). The provision of human milk is critical to the optimal nutrition, health, and development of NICU infants (Crenshaw, 2014; Section on Breastfeeding, 2012), and breastfeeding support interventions significantly improve breastfeeding outcomes (Gharib, Fletcher, Tucker, Vohr, & Lechner, 2017; Haroon, Das, Salam, Imdad, & Bhutta, 2013; Relton et al., 2018; Renfrew et al., 2009).

The recommendations above highlight the applicability of the AAP report to current movements in neonatal health care: *trauma-informed care* and *family-centered care*. Trauma-informed care of the hospitalized infant emphasizes the need for health care providers to realize that (1) NICU hospitalization can be seen as a form of trauma for our infants and their families, (2) to recognize the signs and symptoms of trauma and its impact on infants and families, and (3) to prevent additional trauma by reducing

toxic stress to tolerable stress in the NICU (Coughlin, 2014; D'Agata, Young, Cong, Grasso, & McGrath, 2016; Sanders & Hall, 2017). Family-centered care (FCC) advocates for the comprehensive and holistic care of infants and their families, with emphasis on family participation; respect for families preferences, needs, and differences; and transparent communication and knowledge sharing (Ramezani, Hadian Shirazi, Sabet Sarvestani, & Moattari, 2014). In the NICU, the pillars of FCC include family-centered developmental care, staff education and support, peer-to-peer family support, palliative/bereavement care, discharge education and follow-up, and mental health support (Craig et al., 2015; Lee, Carter, Stevenson, & Harrison, 2014; Verma et al., 2017).

Unfortunately, like the recommendations proposed in the AAP report, the interventions prescribed by the trauma-informed and FCC movements are not new (Glass & McAtee, 2006; Link & Phelan, 1995; McEwen, 1998; Schor & American Academy of Pediatrics Task Force on the Family, 2003; Schore, 1996). Trauma-informed care has a rich history of over 30 years in the mental health professions (Wilson, Pence, & Conradi, 2013), while FCC and its subcomponents have been evolving since the 1980s (Als, 1977; Als et al., 1994; Anderson, Marks, & Wahlberg, 1986). Despite decades of research, dissemination and implementation of these evidence-based recommendations in the United States is lagging. In the following sections, we summarize current recommendations for neonatal practice, identify much needed areas of research inquiry, and advocate for public policies necessary to reduce toxic stress in US NICUs.

Clinical Strategies to Buffer Stress

Given that buffering is the differentiating factor between tolerable and toxic stress, what would the ideal "buffering" environment look like in clinical practice? We propose that through alternative approaches to caregiving, nurses can reduce toxic stressors in the NICU. Many caregiving activities that are stressful, such as diapering (Comaru & Miura, 2009; Lyngstad, Tandberg, Storm, Ekeberg, & Moen, 2014), are also necessary to infant health. However, the nature, timing, and level of support in which activities are executed can be altered to buffer infant responses.

Nature of Caregiving

The physical, psychosocial, and clinical environment in which caregiving is performed can be modified by NICU nurses and other health care clinicians to reduce infant toxic stress. For example, the AAP states that background noise in the NICU should not exceed a volume of 45 to 50 decibels, with transient sounds not to exceed 65 to 70 decibels (White, Smith, Shepley, & Committee to Establish Recommended Standards for Newborn ICU Design, 2013). Similarly, the AAP recommends that lighting in the NICU reach not more than 600 lx (White, Smith, & Shepley, 2013), and a Cochrane meta-analyses support cycled lighting to promote the development of NICU infants (Morag & Ohlsson, 2016). Products used in the NICU setting should be assessed for noxious odors and replaced with milder, yet equally effective products. In addition to reducing noxious noise, lights, and smells in the physical environment, NICU nurses can also encourage families to provide positive sounds, sights, and smells for their infants. Maternal odors from breastmilk and scent cloths provide comfort and physiologic stability to NICU infants (Badiee, Asghari, & Mohammadizadeh, 2013; Baudesson de Chanville et al., 2017; Welch et al., 2013). Recordings of parents' singing, womb sounds, and voices enhance infant sleep, feeding, and physiologic stability (Chirico et al., 2017; Doheny, Hurwitz, Insoft, Ringer, & Lahav, 2012; El-Dib & Glass, 2015; Filippa et al., 2017). Importantly, parent-scented cloths and voice recordings can be administered by nurses when parents are absent.

The psychosocial environment, specifically with regards to the positioning, developmental support, and contingent responsiveness provided to the infant, can have a profound impact on the ability of the infant to self-regulate (Chang, Anderson, & Lin, 2002; Grenier, Bigsby, Vergara, & Lester, 2003; Jarus et al., 2011). We recommend that, whenever possible, all caregiving be completed by two people: one person to perform care, and the other to contingently respond to infant cues and assist the baby in self-regulation during care. Numerous studies have shown the ability of "Two-Person Techniques," such as hand containment, facilitated tucking (Hartley, Miller, & Gephart, 2015; Herrington & Chiodo, 2014; Hill, Engle, Jorgensen, Kralik, & Whitman, 2005; Obeidat, Kahalaf, Callister, & Froelicher, 2009; Pillai Riddell et al., 2015; Ward-Larson, Horn, & Gosnell, 2004), and kangaroo care (Cho et al., 2016; Dezhdar, Jahanpour, Firouz Bakht, & Ostovar, 2016; Johnston et al., 2014) to significantly lower infant physiological and behavioral responses to stress during caregiving. Parents, whenever possible, should be part of the Two-Person Technique to promote bonding and encourage management of their baby's care. If parents are not present at the bedside, then respiratory, occupational, physical, or massage therapists could assist the nurse in regulating the infant. Even trained volunteers, under the direct supervision of a nurse, could be guided in providing hand containment for the infant (Fritsch-deBruyn, Capalbo, Rea, & Siano, 1990). The second person could assist in positioning the infant side-lying or prone during caregiving for infants who do not tolerate the supine position. While many studies have demonstrated the effectiveness of Two-Person Techniques in buffering infant stress responses to single episodes of caregiving (Hartley et al., 2015; Herrington & Chiodo, 2014; Hill et al., 2005; Obeidat et al., 2009; Pillai Riddell et al., 2015; Ward-Larson et al., 2004), consistent, serial use of Two-Person Techniques on the neurobiological, structural, and functional brain development of NICU infants has not been studied. Sustained touch, talking with the infant, and making eye contact are effective

techniques that nurses and other clinicians can use for interacting socially with the infant when parents are not able to be present (Welch et al., 2014). Such social interventions delivered by professional staff will be more effective when the professionals caring for that infant are consistent, primary caregivers (Mefford & Alligood, 2011).

Finally, the frequency of clinical procedures and caregiving is excessive in NICUs and should be tailored to the infant's unique developmental and health care needs. Each activity should be scrutinized for necessity to the infant's care. For example, measuring abdominal girth and gastric residual can be deferred in many infants (Dutta et al., 2015). Vital signs should be taken from the monitor when able, and blood pressures can be performed once a shift in infants with a consistent clinical course. Suctioning can be performed only when clinically indicated by a decline in respiratory status or oxygenation, as opposed to a routine schedule (Mann, Sweet, Knupp, Buck, & Chipps, 2013). Tailoring the frequency of caregiving to the infant is a strategy that requires strong nursing judgment, specifically in the ability of the nurse to weigh the risks and benefits of lowering the infant's stress levels versus the need for monitoring of the infant. However, this strategy also highlights the critical importance of the nurse in reducing the infant's exposure to toxic stress.

Timing of Caregiving

Although we cannot change the timing of critical brain development during which infants receive care, we can change the timing of caregiving to minimize the stress infants experience during hospitalization. Caregiving activities should revolve around the infant's sleep/wake cycles, arousal cues, and unique developmental needs. How this is actually implemented into practice may differ based on the infant's corrected gestational age and medical status. For stable infants who are not able to nipple feed (e.g., infants less than 32 corrected gestational age), most routine caregiving activities can be deferred until the infant awakens. Tube feedings can be given while the infant is sleeping after merely checking tube placement, thus minimally disturbing the infant. If the infant is too immature to independently awaken, then caregiving activities can be performed after it is necessary for the nurse to disturb the infant (e.g., an oxygenation desaturation episode requiring stimulation). Using this strategy, it is possible to provide the infant with as much as 6 hours of rest before changing the diaper to maintain skin integrity and monitor for adequate urine output. For infants who are learning to nipple feed and beginning to awaken every 3 to 4 hours, cue-based caregiving activities, as well as cue-based feeds, can be implemented. Using this strategy, both caregiving activities and oral feeds would be deferred if the infant does not awaken, resulting in a gastric feed. And finally, for infants who consistently awaken every 3 to 4 hours, waiting until the infant shows signs of arousal can promote smooth transitions from sleep to awake states, while enhancing the infant's readiness and engagement for feeding (Kirk et al., 2007; Shaker, 2013).

Buffering During Caregiving

While it is the responsibility of all NICU caregivers (i.e., nurses, other clinicians, parents, family members, and volunteers) to buffer infant toxic stress responses in the NICU, nurses should teach, encourage, and support parents in being the primary buffer to their infant's stress. Nothing can completely replace the invaluable comfort and consistency of care that parents provide their infants. Family-integrated care (FICare) needs to be promptly implemented as a standard of care in US NICUs. With FICare, parents assume nursing care of their infants with the bedside nurse as coach and mentor and become adept at identifying and buffering early signs of their infant's toxic stress responses (Craig et al., 2015; Hall et al., 2017; O'Brien et al., 2015). Continuous kangaroo care (i.e., as early as possible, for as long as possible) needs to be another standard of care in US NICUs (Mörelius, Örtenstrand, Theodorsson, & Frostell, 2015), because kangaroo care is a powerful nonpharmacologic treatment that greatly buffers the infant's response to pain and stress (Cong, Ludington-Hoe, & Walsh, 2011; Kostandy et al., 2008; Lyngstad et al., 2014; Mitchell, Yates, Williams, Chang, & Hall, 2013; Pillai Riddell et al., 2015). A recent paper provides action steps for NICUs to transform into neonatal intensive parenting units (NIPUs) (Hall et al., 2017). These steps include FICare, continuous skin-to-skin care, and the provision of extensive psychosocial resources, such as paid parent support coordinators, dedicated mental health professionals, telemedicine services, and structured parent orientation and education sessions (Hall et al., 2017). All of these recommendations are standard and known to be effective at reducing toxic stress and enhancing outcomes in NICU infants. However, these standards will not and cannot be implemented if parents are not present at the bedside.

We firmly believe that parents want to be good parents and be present for their infant. Yet, multiple barriers to parent engagement exist. Parents may stay away because they perceive judgment rather than support from nursing staff, feel overwhelmed in the ICU setting, are frightened and uncertain about providing care or even touching their infant, see nursing staff as "better" caregivers for their sick infant, and feel unneeded or in the way (Cleveland & Gill, 2013; Obeidat, Bond, & Callister, 2009; Williams et al., 2018). Other parents may have severe mental health issues, substance use disorders, or are not developmentally mature enough (e.g., a young adolescent) to independently take on the responsibilities of parenting. Parents who are visibly impaired or lack the maturity to adequately provide care for their infant need appropriate intervention on behalf of the infant. However, nurses need to acknowledge and act on their critical role of advocating for the family as a unit and not only the infant. Welcoming, supporting, encouraging, and teaching these parents when they are able to be

present and ensuring that these families have access to the resources they need are critical nursing interventions that can have a huge impact.

Parental stress, depression, and anxiety also contribute to lack of visitation and engagement with infant care in the NICU and are significant comorbidities in high-risk parent populations (Gonya & Nelin, 2013). Several evidence-based strategies assist mothers in coping with mental health complications during NICU hospitalization and increase parent visitation and engagement. These strategies include free community classes during pregnancy and NICU hospitalization to address the stressors of parenting in the NICU (Puthussery, Chutiyami, Tseng, Kilby, & Kapadia, 2018), scheduling peer advisors to have frequent meetings with NICU parents to address concerns (Bourque et al., 2018; Hall et al., 2015; Levick, Quinn, & Vennema, 2014; Rossman et al., 2015), and universal screening for mental health complications (e.g., acute stress disorder, post-traumatic stress disorder, depression, and anxiety) upon NICU admission, 14 days of life, and sequentially thereafter with trained mental health professionals (Cherry et al., 2016; Cole, Olkkola, Zarrin, Berger, & Moldenhauer, 2018; Hynan et al., 2015; McCabe-Beane, Stasik-O'Brien, & Segre, 2018).

Every parent should be assessed daily for barriers to visiting and to remaining involved in their infant's care. Common barriers to parental presence in the NICU include transportation issues, long commutes to the hospital, inability to pay for parking/lodging/meals, financial imperatives to return to work, and lack of resources for sibling care (Blomqvist, Frölund, Rubertsson, & Nyqvist, 2013; Greene et al., 2015; Heinemann, Hellström-Westas, & Hedberg Nyqvist, 2013). Neonatal health care teams need to work daily to remove these barriers. Hospital systems need to proactively develop innovative solutions for promoting and supporting parental presence. These solutions include providing a place for parents to stay and take care of their basic needs, such as eating, bathing, laundry, and sleep (Edéll-Gustafsson, Angelhoff, Johnsson, Karlsson, & Mörelius, 2015). Ideally, private rooms would offer these amenities at the bedside, but if not possible, facilities on the unit or at the very least on-site within the hospital system (e.g., Ronald McDonald House) would allow parents with long commutes to have a space in close proximity to their baby. Vouchers for lodging and meals would significantly reduce the financial burden of staying long periods in the NICU. Providing on-site childcare facilities for siblings would remove the barrier of securing and paying for sibling childcare. Providing transportation services through hospital-provided shuttles, volunteer agencies, and reimbursement vouchers for parking, gas, bus passes, or taxi services can help remove transportation barriers.

Furthermore, technology-based interventions offer significant promise in improving provider–family communication and increasing parent engagement remotely, but require further testing (Epstein et al., 2017). Examples of technology-based interventions that have been implemented to supplement parents' physical presence include text messaging updates (Globus et al., 2016), webcam footage of infants (Rhoads, Green, Gauss, Mitchell, & Pate, 2015), FaceTime and Skype updates (Epstein, Sherman, Blackman, & Sinkin, 2015; Lindberg, Axelsson, & Ohrling, 2009), virtual rounding (Yager, Clark, Cummings, & Noviski, 2017), and virtual visitation (Gray et al., 2000; Yeo, Ho, Khong, & Lau, 2011). Although these interventions cannot provide direct physiologic buffering to infant stress responses, they may indirectly buffer infant stress by improving interaction when parents are physically present.

Finally, decreasing length of stay would necessarily decrease the toxic exposure of NICU hospitalization. Several interventions that promote parental presence and engagement in the NICU have been associated with significant decreases in length of stay, such as kangaroo care (Conde-Agudelo & Díaz-Rossello, 2016), Continuous Opportunities for Parent Empowerment (COPE; Melnyk et al., 2006), and the Auditory, Tactile, Visual, and Vestibular intervention (ATVV; White-Traut et al., 2002). Although the interventions mentioned in this section can increase hospital costs due to time and resources needed for implementation, the savings incurred would undoubtedly pay for the expenses of these and other interventions (Conde-Agudelo & Díaz-Rossello, 2016; Melnyk et al., 2006; Ortenstrand et al., 2010; White-Traut et al., 2002).

Implementation into Practice

Although it is easy to make recommendations for clinical practice, implementation is much more difficult given the changes required in health care staffing, training, and culture to transform NICUs into NIPUs (Bracht, O'Leary, Lee, & O'Brien, 2013; Galarza-Winton, Dicky, O'Leary, Lee, & O'Brien, 2013; Macdonell et al., 2013). While health care professionals philosophically agree with FCC principles, US NICUs have not been able to shift even basic infant care to the parents. Implementing the principles of FCC as described above would be a major step forward in reducing toxic stress in the NICU. Neonatal leadership in nursing, medicine, and the allied health disciplines must make FCC a top priority in their strategic plans, as evidenced by providing training, support, and feedback to neonatal staff at orientation; including FCC in required yearly competencies; and assessing practice of FCC during employee evaluations and as a criteria for promotions. In order for a paradigm-shifting, cultural revolution to occur, elements of FCC must be seen as key quality improvement metrics (Tzelepis, Sanson-Fisher, Zucca, & Fradgley, 2015), which are continuously measured, just like rates of infection, pressure injuries, and medication errors. The National Perinatal Association has published a 61-item checklist detailing gold-standard components of FCC (Hynan & Hall, 2015), which can be used to track an individual NICU's progress. Including FCC in quality improvement metrics communicates the hospital system's investment in providing optimal

care for infants and families (Groene, 2011; Groene et al., 2009; Pluut, 2016).

Implications for Research

The EBD framework incorporated into the AAP report was intended as a guide for pediatric researchers in the design, testing, and implementation of new interventions to improve pediatric health (Shonkoff et al., 2012). However, the framework's concepts were derived from dialogues over half a century old and are not radically different from previous work in stress or neonatal research (Als, 1977; Als et al., 1986; Brazelton, Tronick, Adamson, Als, & Wise, 1975; Minde, Whitelaw, Brown, & Fitzhardinge, 1983; Tessier et al., 1998; Zeskind & Iacino, 1984). As such, this framework is unlikely to catalyze the development and implementation of new policies and programs necessary to revolutionize pediatrics.

For example, the three delineations of stress responses presented in the AAP report (i.e., positive stress, tolerable stress, and toxic stress) have been presented previously throughout the decades using different terminology (McEwen, 1972, 1980, 1998). *Positive stress* is conceptually similar to *eustress* and *allostasis*: the body's natural, physiologic response to stress that maintains homeostasis and healthy, short-term adaption to stressors (McEwen & Wingfield, 2010). *Tolerable stress* is conceptually similar to *distress* and *dysregulation of allostatic processes*: maladaptive physiologic responses to stress that are repeatedly induced, prolonged, not rapidly terminated, and/or inadequate with the potential to cause damage (Danese & McEwen, 2011; Hatfield & Polomano, 2012). Finally, *toxic stress* is a severe form of dysregulated allostatic processes that induce damage (i.e., wear and tear, known as *allostatic load*) on the brain and body, resulting in poor health outcomes (McEwen, 1998). In other words, toxic stress responses contribute to allostatic load in the hospitalized neonate.

Notice that the difference between tolerable and toxic stress is the presence of buffering (Table 2). While the concept of buffering may distinguish between dysregulated stress responses that contribute to allostatic load and those that do not, the concept of buffering is also well established. Social support as a buffer to the stress response has also been reported from at least the 1970s (Bell, LeRoy, & Stephenson, 1982; Dean & Lin, 1977; Hennessy, Kaiser, & Sachser, 2009; Levine, 1993).

Perhaps the newer designations for levels of stress (i.e., positive, tolerable, and toxic) are more intuitive and understandable descriptions of the concepts. However, continuing to generate new terminology without a subsequent pairing in action creates an illusion of progress, without any meaningful change in outcomes. The illusion of progress generates real harm for our patients by equating advancements in theory as actual improvements in health care and pediatric health. An example of this is AAP's claim that the EBD framework will revolutionize pediatrics by increasing multidimensional research (i.e., research that includes biological, genetic, ecological, neurological, and developmental domains) for a more comprehensive investigation of pediatric health (Shonkoff et al., 2012). Significant advancements in multidisciplinary research are important and innovative, but will not directly and most efficiently address the social determinants of health, which are well documented as the largest contributors to toxic stress in the United States (Braveman & Gottlieb, 2014; Tilden, Cox, Moore, & Naylor, 2018). Instead, a specific and unique set of research questions will be more fruitful in producing research and policy recommendations that will address the social determinants of health and transform pediatric care.

We propose that the first step is to study the following questions related to defining levels of stress and identifying best designs for intervention delivery.

- How do we measure and differentiate between the three levels of stress, enabling accurate identification of risk and measurement of intervention effectiveness?
- What components are needed in an intervention toolkit tailored to an individual family's needs?
- How can we best time, coordinate, and package stress-reducing interventions (clinical practice and social programs) to maximize likelihood of prevention or reduction of physiologic harm?

We believe that the mechanisms, relationships, and measures described in the adult allostatic load model should be adapted to apply to developing infants and children (Johnson, Bruce, Tarullo, & Gunnar, 2011; Weber, Harrison, & Steward, 2012) and used to define positive, tolerable, and toxic stress. An allostatic load panel of pediatric-specific biomarkers could be monitored as an integrated neurobiological network contributing to infant brain structure, function, and development. Examples of these markers include heart rate variability from the parasympathetic nervous system (Porges, 2009); skin conductance and norepinephrine from the sympathetic nervous system (Harrison et al., 2006); dopamine from reward circuits (Hassan et al., 2018), corticotropin-releasing hormone, adrenocorticotropic hormone, and cortisol from the hypothalamic–pituitary–adrenal axis (Gunnar & Hostinar, 2015); and oxytocin as the social buffering hormone (Weber,

Table 2 – Levels of Stress Responses Previously Delineated by Different Stress Terminology

Level of Stress Response Positive Stress	Eustress	Allostasis
Tolerable stress	Distress with buffering	Dysregulated allostatic processes
Toxic stress	Distress without buffering	Allostatic load (result of toxic stress)

Harrison, Sinnott, Shoben, & Steward, 2018). Aberrant response patterns in individual markers or in the network of markers, including significant, prolonged deviations from the child's baseline, could indicate tolerable or toxic responses to stress, depending on the level of social buffering hormones like oxytocin. In addition, evidence-based interventions could be implemented in the NICU at the first indication of physiologic dysregulation or deviation from baseline, potentially preventing toxic stress responses and subsequent allostatic load. An allostatic load panel could confirm the effectiveness of new and innovative interventions that downgrade toxic stress responses to tolerable stress responses, thus minimizing effects of NICU stressors on the developing infant brain. In the community, normative and high-risk infant populations could be compared for differences in developmental trends over time. Results could inform the timing of programs and policies aimed at addressing the social determinants of health to improve pediatric health outcomes.

A wealth of evidence already exists in support of a wide range of family-centered and developmental care interventions in reducing toxic stress. Yet, implementation of well-established, evidence-based interventions remains infrequent, inconsistent, or nonexistent in clinical practice (Callen, Pinelli, Atkinson, & Saigal, 2005; Hendricks-Muñoz & Prendergast, 2007; Raffray, Semenic, Osorio Galeano, & Ochoa Marín, 2014; Seidman et al., 2015). The concepts, principles, and theories of implementation science offer numerous strategies for enhancing uptake of evidence-based interventions (Curtis, Fry, Shaban, & Considine, 2017; Kaplan, Provost, Froehle, & Margolis, 2012; Rapport et al., 2017). Implementation science research will assist us in moving from a scattered range of family-centered developmental care interventions to a comprehensive, coordinated intervention toolkit that is sequentially, strategically, and personally designed for each family.

The ability of the nurse to implement these toolkits heavily depends on the communication, coordination, and resource allocation of the entire health care team. Nurse scientists therefore must begin to examine the factors that contribute to inadequate implementation of these clearly evidence-based recommendations (Geerligs, Rankin, Shepherd, & Butow, 2018). Focused efforts directed at implementation and dissemination science are required to generate pediatric research that is strategic in addressing barriers to adoption, customizable to benefit broad populations, and tailored to the real-world settings in which improvement is directed (Curtis et al., 2017; Rapport et al., 2017). Furthermore, innovative solutions to staffing, team communication, and resource allocation can help address the most commonly cited barriers to implementation (Geerligs et al., 2018). Now, more than ever, pediatric scientists in the United States need to design studies with focused consideration of the end users and key stakeholders of their interventions to promote translation and dissemination of their work (Geerligs et al., 2018).

Simultaneously, research is needed to identify the best ways to communicate our science in support of policy change that will influence population health and reduce health care costs.

- How do we operationalize and measure the concepts outlined in the EBD framework (ecologic, biologic, and human development) to more clearly communicate our science to policymakers and to the public? For example, do data demonstrating structural and functional improvement in infants' brains have a greater impact on policymakers than identifying and addressing psychosocial risk factors?
- How can we best disseminate our science to policymakers and to the public to maximize our influence and compel others to enact meaningful change?

Health care systems in Europe, Australia, New Zealand, and Canada have all adopted the recommendations provided in this paper and have significantly improved infant outcomes, as well as reduced hospital costs (Broom, Parsons, Carlisle, Kecskes, & Thibeau, 2017; O'Brien et al., 2015). In the United States, however, individual and institutional-based interventions alone are unlikely to help a significant number of families who experience socioeconomic barriers to visitation and do not have the resources to be present in the NICU. Rather, public policies addressing the social determinants of health will have a greater impact on the health outcomes of infants and their families than individual and institutional-based strategies. Research focused on identifying best strategies for successful adoption and implementation of social and policy initiatives is critically important. Recommendations for future research will help to fill clear gaps in nursing knowledge. However, the new knowledge derived from these questions will unlikely lead to meaningful reductions in toxic stress across US NICUs unless that knowledge is paired with innovations in action.

Implications for Public Policy

According to the AAP report, the nation's health would be significantly bolstered if investments were devoted to primary prevention and promotion of prenatal and early childhood health (Shonkoff et al., 2012). Federal approaches to public policies with demonstrable health benefits will be the most efficient and effective way to provide equitable access to socioeconomic resources that have an enormous impact on population health. Yet the United States remains significantly behind other developed countries in providing policies and programs that strengthen caregiver and community capacities to promote the foundations of pediatric health (i.e., stable and responsive relationships, safe and supportive environments, and optimal nutrition). Broader public policies that address poverty, access to high-quality health care, and availability of resources have not been adopted due to the political climate in the United States. In the 7 years since the AAP report was published, little progress has

been made in the policy arena that will address toxic stress in our children. Although the Patient Protection and Affordable Care Act of 2010 was effective in increasing access to health insurance among the poor through expansion of Medicaid, the Supreme Court ruling in 2012 made Medicaid expansion voluntary by state, resulting in access being dependent on geographic location (Courtemanche, Marton, Ukert, Yelowitz, & Zapata, 2017; Daw & Sommers, 2018; Kominski, Nonzee, & Sorensen, 2017). In the following paragraphs, we discuss public policies we believe will efficiently and effectively minimize toxic stress in America's children. Crucial socioeconomic resources that can be provided through federal public policies include (1) paid family leave, (2) universal health care, (3) increased welfare programs, and (4) affordable childcare.

Paid Family Leave

Paid family leave is significantly associated with reduced rates of congenital anomalies, low birthweights, prematurity, and overall mortality (Burtle & Bezruchka, 2016; Rowe-Finkbeiner, Martin, Abrams, Zuccaro, & Dardari, 2016; Ruhm, 2011). The United States is the only developed nation that does not have a mandate for paid family leave during critical illness or the birth of a child (Shepherd-Banigan & Bell, 2014). Most employer-based paid leave policies will not cover the entire period of a NICU hospitalization (which is often months for the sickest infants). Many working families, especially families with lower incomes, cannot afford to take unpaid leave because they cannot pay for basic necessities without work income or partial wage supplements. In 2011, the US Department of Labor estimated that only 11% of families had access to paid family leave benefits (Gault, Hartmann, Hegewisch, Milli, & Reichlin, 2014; US Department of Labor Bureau of Labor Statistics, 2012). Because families who are most likely to depend on paid leave for financial survival are the least likely to receive leave benefits, NICU parents often have no choice but to return to work (Shepherd-Banigan & Bell, 2014). Implementing a federal paid family leave law would provide families with a necessary financial resource to take time off to care for their critically ill infants and help buffer potentially toxic stress responses in the NICU.

Universal Health Care

The United States is also the only developed nation that does not have universal access to affordable health care insurance (Fisher, 2012). Only three fourths of adults in the United States are continuously insured, while over a third of adults in poverty report having an unmet health care need due to cost (Okoro et al., 2017). Although health insurance coverage for children has improved since the implementation of the Affordable Care Act in 2014, almost 4 million children remain uninsured, 22% of whom are less than 3 years old (Edelman Wright, 2017). Lack of insurance or interruptions in insurance coverage have been repeatedly linked to reduced access to health care, unmet health care needs, and poor health outcomes in children (Abdullah et al., 2010; DeVoe, Tillotson, & Wallace, 2009; Devoe, Tillotson, Wallace, Lesko, & Angier, 2012; Federico, Steiner, Beaty, Crane, & Kempe, 2007; Flores et al., 2016, 2017; Fry-Johnson, Daniels, Levine, & Rust, 2005; Szilagyi, Schuster, & Cheng, 2009).

Income plays a major role in insurance access and affordability. Low-income families are more likely to lack health insurance coverage (Devoe et al., 2007; Kreider et al., 2016; Larson & Halfon, 2010), have higher out of pocket costs (Devoe et al., 2007; Galbraith, Wong, Kim, & Newacheck, 2005; Gwet & Machlin, 2018), and experience unmet health care needs due to cost (Fry-Johnson et al., 2005; Kreider et al., 2016; Wherry, Kenney, & Sommers, 2016). Americans spend roughly 13% of their income on out-of-pocket health care expenses, which presents a huge financial liability for low-income families (Gwet & Machlin, 2018). Even low-income families with private insurance experience significant unmet health care needs due to unaffordable premiums, high deductibles, and co-payments (Devoe et al., 2007). Compared to families with public health care insurance, families with private insurance report greater financial burden, decreased access to affordable health care services, and missed care as a result of inability to pay (Kreider et al., 2016). Full-year public coverage provides significantly greater protection from financial burden than full-year private coverage (Galbraith et al., 2005), as Medicaid significantly decreases the poverty rate (Wherry et al., 2016).

The insurance status of the parent has been repeatedly shown to impact their children's access to insurance and access to care (DeVoe et al., 2015). Thus, expanding public insurance access for adults and children improves pediatric health care access and health outcomes (Feinberg, Swartz, Zaslavsky, Gardner, & Walker, 2002; Flores et al., 2017; Sommers, Blendon, Orav, & Epstein, 2016; Sommers, Gunja, Finegold, & Musco, 2015; Vistnes, Lipton, & Miller, 2016). Affordable access to comprehensive health care insurance has also been repeatedly shown to predict receipt of high-quality pediatric health care (DeVoe, Ray, Krois, & Carlson, 2010; DeVoe et al., 2009; Devoe et al., 2012) and improvement in child health outcomes (Abdullah et al., 2010; Flores et al., 2016, 2017; Fry-Johnson et al., 2005). Universal, affordable access to health care, regardless of employment status or ability to pay insurers, would ensure that all children and their families can obtain critical preventive care for promoting health, regardless of income (Gorin, 1997; Lewis, 2004; Montagu & Goodman, 2016; Morgan, Ensor, & Waters, 2016; Potera, 2017; Rahman et al., 2017; Rashford, 2007).

Therefore, the United States needs to ensure that every American is insured and able to access and afford evidence-based health care services that prevent chronic disease and promote health. This includes significantly expanding and funding Medicaid, Children's Health Insurance Program, a universal public health care plan, and a variety of evidence-based programs that decrease costs by leveraging preventative health

services. For example, home visiting programs are well-studied, evidence-based interventions that significantly improve childhood outcomes while reducing health care costs (Avellar & Supplee, 2013; Duffee et al., 2017; Olds et al., 2014). Expanding the Maternal, Infant, and Early Childhood Home Visiting Program, mandating it as a reimbursable service, and fully and continuously funding it through Medicaid, the federal government, and private insurance companies (Herzfeldt-Kamprath, Calsyn, & Huelskoetter, 2017) would greatly improve health outcomes for our nation's children and families. The United States should include same-rate reimbursement for telemedicine in a comprehensive universal health care bill, so that parents who have transportation difficulties can receive high-quality care for their NICU infant after discharge. Moreover, using telemedicine when parents cannot be present in the NICU can provide a unique opportunity for parents to receive education about the skills needed to safely care for their baby after discharge. In this way, parents can focus on applying what they have learned while they are physically present in the NICU.

Poverty and Welfare Programs

Poverty is one of the most significant contributors to poor physical and mental health in childhood and beyond (Beardslee, Gladstone, & O'Connor, 2012; Berkman & Sivaramakrishnan, 2008; Gladstone & Beardslee, 2009; Kim & Saada, 2013; Kramer, Seguin, Lydon, & Goulet, 2000; Moore et al., 2017). Poverty has also been repeatedly associated with preterm birth, low birthweights, and congenital anomalies, the most common reasons for admission to the NICU (Bassil et al., 2013; Institute of Medicine (US) Committee on Understanding Premature Birth and Assuring Healthy Outcomes, 2007; Olson, Diekema, Elliott, & Renier, 2010). In the United States, about one in four infants and toddlers live in poverty (Coball & Jiang, 2018). The United States is the wealthiest country in the world, but is consistently among the top five nations with the highest inequality in wealth (Brandmeir, Grimm, Heise, & Holzhausen, 2015; Organisation for Economic Co-operation and Development, 2017). The wealthiest 1% of US families control nearly 40% of our nation's wealth, and the wealthiest 10% of families control nearly 80% of our wealth (Board of Governors of the Federal Reserve System, 2017; Egan, 2017; Ingraham, 2017). According to the World Economic Forum, the United States ranks 23/30 developed countries in wealth inequality by the Inclusive Development Index, a comprehensive measure of inequality that includes income, health, poverty, and sustainability (Samans, Blanke, Drzeniek Hanouz, & Corrigan, 2017; White, 2017).

The United States is particularly deficient in providing social protection for our most vulnerable families, including providing public goods, services, employment, and compensation that serve as social safety nets for our poorest and sickest patients (Samans et al., 2017; White, 2017). In 2016, approximately 12% of all US households and 30% of single-mother households experienced food insecurity (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2017). A survey of nearly 100,000 Americans found that over 60% of households were worried about having enough income to pay their rent or mortgage (Njai, Siegel, Yin, & Liao, 2017). Food and housing insecurity are chronic, toxic stressors with documented effects of poor health outcomes in children and their families (Cutts et al., 2011; Schure, Katon, Wong, & Liu, 2016; Winden, Chen, & Melton, 2017).

We must address the social determinants of health if we want to actually improve health outcomes. For example, it is difficult to treat maternal depression if a NICU mother cannot afford to pay for food, housing, health care, or heat. Broader public policies that address poverty, income inequality, and food/housing insecurity must become a priority. These policies include raising the minimum wage and indexing it with inflation, expanding the earned income tax, increasing access to quality, low-cost financial services and home ownership, revising the tax code to ensure capital gains tax rates are proportionate to income tax rates, incentivizing family savings through refundable tax credits, and increasing benefits from the Supplemental Nutrition Assistance Program, Supplemental Nutrition Program for Women, Infants, and Children, and Temporary Assistance for Needy Families.

Affordable Childcare and Early Childhood Education

One of the most commonly cited barriers to family presence and participation in the NICU is lack of affordable childcare for siblings of critically ill infants (Blomqvist et al., 2013; Greene et al., 2015; HeineMann et al., 2013). Due to the critically ill status of many infants in the NICU, younger siblings and community members are often restricted from visiting due to safety and infection control reasons (e.g., flu season). In the United States, the costs of early childcare rival that of college tuition, and make up nearly 30% of a family's income (Childcare Aware of America, 2017). The United States has one of the highest costs of childcare in the world, ranking 5th among developed countries (Childcare Aware of America, 2017; Organisation for Economic Co-operation and Development, 2016). Policies that would help low-income families include significant expansion of Child Care and Development Block Grants, Early Head Start, Head Start, universal preschool for all 3- and 4-year-olds, and childcare subsidies that ensure no more than 10% of a family's income is spent on childcare.

American Public Policy

Passing federal legislation to address the social determinants of health will not be easy. However, it is not acceptable to conclude that nurses and nursing organizations should prioritize individual and institutional interventions because the societal ones are difficult. As a profession, nursing is governed by a Code of Ethics that encompass a commitment to promote the public good (Fowler, 2017). Advocacy is an essential component of practice (Fowler, 2017), as nurses are

accountable to the patients we care for and to society. Furthermore, nurses are in a strategic position to advocate for socioeconomic resources that empower vulnerable families to expertly care for their infants.

One of the primary purposes of the American Academy of Nursing is to serve both the public and the nursing profession by advancing public policy to transform America's healthcare system. In 2018, Tilden and colleagues highlighted the critical need for the Academy to form strategic partnerships that address the social determinants of health (Tilden et al., 2018). Tilden and colleagues also asserted that "significant efforts to improve health require societal actions that include upstream investments" (Tilden et al., 2018). We agree and believe that the combined power of health care organizations like the AAN, AAP, Pediatric Policy Council, American Nurses Association (ANA), and the American Medical Association (AMA) would be enormous in garnering support for legislation that greatly increases our society's investments in the upstream, social determinants of health. As an organization comprised of nursing's most accomplished leaders, we urge the Academy and other professional organizations and their members to mobilize, form strategic partnerships with allied health care organizations, and lead political efforts to enact sweeping change in providing equitable and affordable access to resources such as paid family leave, health care, childcare, and welfare programs.

Conclusion

Over the last several decades, neonatal professionals in the United States have made multiple changes to reduce toxic stress exposure in the NICU. However, difficult changes remain unaddressed, and harmful toxic stress exposure continues, largely due to systemic financial and political constraints. The AAP technical report rightly stated "the causal sequences of risk that contribute to demographic differences in educational achievement and physical well-being threaten our country's democratic ideals by undermining the national credo of equal opportunity" (pp 233, Shonkoff, 2012). A top priority for pediatrics must be the adoption and integration of evidence-based practices, interventions, and policies into health care and society at large. Implementation science must be the fuel for evidence-based pediatric practice that reduces toxic stress.

None of the research and practice changes we have outlined in this paper will matter if our families cannot afford to be with their infant in the NICU. To thoroughly address toxic stress in the NICU, professional nursing organizations, including the American Academy of Nursing whose primary role is to advocate for policies that improve health, must gather their considerable resources to advocate for and support legislation that will provide universal access to paid family leave, high-quality and affordable health care, childcare, and a socioeconomic safety net to overcome poverty. Only when families have the resources they need to be successful in helping their children grow and develop will we see the true transformative change so desperately needed in pediatric health care. Moving pediatric health care forward depends on our ability to convince our leaders that caring for our infants, children, and families is a critical and necessary upstream investment that will improve health, educational achievement, and opportunity for all of our citizens. We urge the Academy, its members, and the entire nursing profession to use their voice and their vote to step-up and speak for our children and our future.

Supplementary material

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.outlook.2018.11.002.

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