

Editorial

The role of families in providing neuroprotection for infants in the NICU



Although technology has allowed us to successfully resuscitate increasingly immature infants, their survival comes with a variety of costs. The majority of challenges that premature infants face is because their development occurs outside the protective environment of the womb. This puts them at high risk for motor, cognitive and behavioral challenges. Within the relatively short history of neonatology, a great deal of effort has been spent on research and technology to improve care of premature lungs and hearts, and guts, but until recently, relatively little attention has been given to improving care of premature brains.

We have known for a long time that brain development involves genetics as well as hormonal influences and other endogenous factors, but what we have learned in the last few decades is that brain development is absolutely dependent on experiences - experiences that can have either positive or negative influences on brain development. Much animal research has demonstrated that early stressful environmental influences on the brain during sensitive developmental periods contribute to adverse outcomes. This research is supported by newer evidence from studies of human neurobiology.

A critically sensitive period for brain development occurs in the 3rd trimester – the very time that prematurely born infants end up in our NICUs. During this critical period, all the brain cells are present but not yet organized. During this period, much change is going on in the brains of premature infants. Under our caregiving hands and watchful eyes, their brains, shielded only by a thin layer of soft skull, are growing and organizing at lightning speed. Neurons are forming at a rate of 250,000 per minute. That is 15 million new neurons every hour or 360 million new neurons every day and over a billion new neurons every 3 days, and we get to have an impact on how these billions and trillions of neurons are connected, because the connections between the neurons depends largely upon experiences. How the neurons connect will prepare them for the world they are born into. If a baby is born into a harsh world, that baby will need different neuronal connections than if the baby is born into a safe and secure world. The brain of even a full term baby is still very immature and waiting to be shaped into the type of brain that will best serve the needs of that baby as he/she grows up.

The term “Neuroprotection” refers to interventions used to support the developing brain. It can also refer to strategies to 1) support the brain after neuronal injury, 2) decrease neuronal cell death 3) allow healing and 4) support development of new synaptic connections. What we have learned is that the most optimal support for the developing brain of premature infants in the NICU is provided within the philosophy of neuroprotective, family-centered, developmental care.

The Neonatal Integrative Developmental Care Model describes 7 Neuroprotective Core Measures for Family-Centered Developmental Care. Each core measure uses neuroprotective interventions as strategies to 1) promote optimal synaptic neuro-connections, 2) promote

normal development, and 3) and hopefully prevent disabilities. The Neonatal Integrative Developmental Care (IDC) model identifies seven distinct core measures that provide clinical guidance for NICU staff in delivering neuroprotective family-centered developmental care to pre-term infants and their families in the NICU (Altimier and Philips, 2013, 2016). Each core measure has:

1. A Standard or standards(s) with a policy, protocol, or guideline that guides care of the infant/family as it relates to that specific core measure,
2. Corresponding infant characteristics, which are measurable reflections of the desired core measure outcomes, are identified, and specific goals target the improvements/outcomes desired, and
3. Clinical applications which include neuroprotective interventions that define and specify the actions required to meet the goal(s). These must be evidence-based, reliably applied and scientifically valid (Altimier and Philips, 2016).

The seven neuroprotective core measures are depicted in the Neonatal Integrative Developmental Care Model (see Fig. 1) as core measures:

- # 1 The Healing Environment,
- # 2 Partnering with Families,
- # 3 Positioning & Handling,
- # 4 Safeguarding Sleep
- # 5 Minimizing Stress & Pain
- # 6 Protecting Skin, and
- # 7 Optimizing Nutrition.

Within this model, the Healing Environment is depicted as central with the mother as the ideal environment for the baby – emphasizing the critical importance of skin-to-skin contact (SSC) and zero separation. All the other core measures overlap around it to illustrate their inter-connectedness, and integrative nature. A healing environment involves the *physical environment*, including things like space, privacy safety, and people (staff and family members) within the environment, as well as the *sensory environment*, including things that impact babies’ developing sensory systems, and *chemical elements*, including nutritional exposures and toxic exposures. To promote optimal neuroprotection, the healing environment must have enough space to provide privacy for family, staff and infant(s) and must promote safety for family, staff and infant(s).

We know the optimal environment for fetal development is inside mother’s womb. The intra-uterine environment provides positive sensory input which is crucial for normal brain development. It provides a variety of normal stimuli in an integrated and multimodal fashion;

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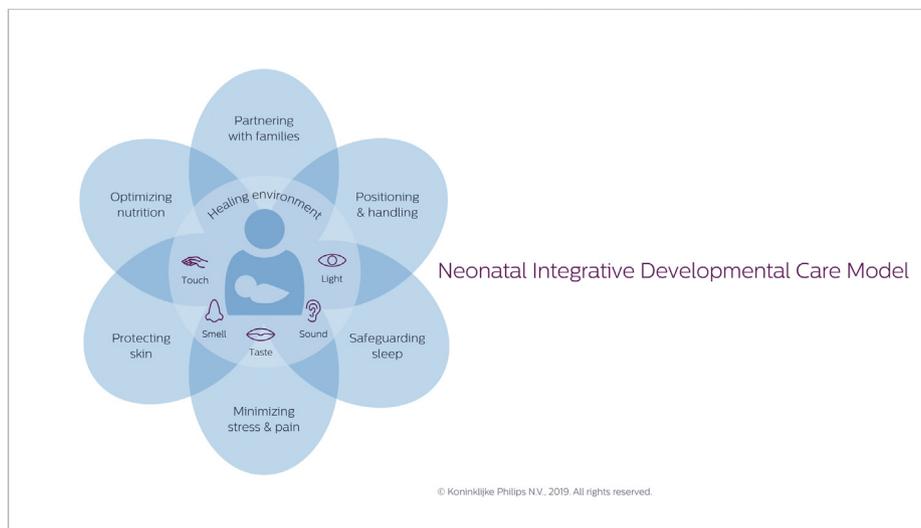


Fig. 1. Neonatal integrative developmental care model.

while at the same time, protecting the fetus from harsh outside stimulation by limiting light and noise exposure. It also supports normal sleep development through cycling of mother's hormones, temperature, and activity levels. The fetus has unrestricted access to mother, secure boundaries of the uterine wall and abundant vestibular and tactile stimuli. In addition, the fetus is provided with rhythmic and cyclical stimulation, from mother's rhythms, all nutritional needs are met via the placenta, and all auditory input is transmitted through liquid and solid media.

In contrast to the developmentally “expected” environment of the womb, the extra-uterine environment of the NICU provides negative sensory input to the rapidly forming brain with many developmentally “unexpected” sensory stimuli happening out of the normal developmental sequence and with many unexpected fluctuations in sensory input.

The full term infant is prepared for a variety of sensory experiences, but even the full term infant has an immature self-regulatory system and needs a consistent, nurturing caregiver to modulate the sensory input and help develop the synaptic connections for what will eventually become the infant's own self-regulation. We know that normal patterns of self-regulation along with motor control, learning and adapting are formed when appropriate sensory information is experienced by the infant in developmentally expected ways and modulated by a consistent, nurturing caregiver.

The preterm infant is NOT prepared for exposure to high levels of inappropriate sensory input with numerous caregivers, both of which are inherent in most current NICUs. These changes alter normal brain development, neuronal organization, and adaptation periods. It is essential that we examine the environment in which preterm infants spend a critical period of their development and make modifications when necessary to ensure we provide an optimal healing environment.

The August 2019 Issue of The Journal of Neonatal Nursing (JNN) will focus on the neuroprotective family-centered developmental care of infants and families in the NICU. More specifically, the Healing environment of Skin-to-Skin contact (or kangaroo care) and Partnering with Families will be the primary focus and will end with overall practice and research recommendations for quality developmental care in the NICU.

Andréane Lavallée and her team from Montréal start this issue as they share part 2 of a two-part manuscript which highlights practice and research recommendations for quality developmental care in the NICU. This article follows their recently published article in the Journal of Neonatal Nursing (JNN; 2018 DOI: [10.1016/j.jnn.2018.08.008](https://doi.org/10.1016/j.jnn.2018.08.008)), entitled PART I: Narrative Overview of Developmental care

interventions for the preterm newborn. Developmental care interventions, which may promote preterm infant's neurodevelopment during the hospitalization in the Neonatal Intensive Care Unit, should be implemented and integrated to care delivered by nurses, other healthcare professionals, and parents. These interventions may have an impact on the preterm infants' developing brain and optimize their short and long-term health outcomes. Based on their previous narrative overview, more high-quality research is still needed in this field. Nevertheless, best practices of developmental care can still be recommended to improve today's neonatal clinical practice. The aim of this article is to provide both practice and research recommendations according to the seven categories of developmental care interventions in the neonatal intensive care unit: family-centered care, sleep protection, assessment and management of pain, infant positioning, optimized infant-driven feeding, administration of human milk, and control of the environmental light and noise.

The second review is by Harriet Hunt and her team from Exeter England who present a systematic review of quantitative and qualitative evidence for parent-to-parent support for parents of babies in neonatal care. This systematic review explores the effects and experiences of parent-to-parent support (P2P) in neonatal intensive care from the perspectives of those giving, receiving, or implementing support and identify four major themes.

As preterm infants are at risk of speech, language and communication difficulties, providing parents with information about language development and strategies to promote communication are essential to integrate into neonatal care. A third systematic review highlighted in this issue of JNN is presented by Harding, Levin, Crossley, Murphy, and van den Engel-Hoek. The authors investigate parent – infant language and communication interaction and the specific attributes associated with providing a good communication environment with premature infants on the neonatal intensive care unit.

A parent's ability to actively participate in their child's care in the Neonatal Intensive Care Unit (NICU) is dependent on the healthcare professional's ability to communicate with and support them in caring activities. When newborn children of immigrant parents require care in a neonatal unit, parents frequently encounter not only a new language, but are also exposed to a new healthcare organization and frequently, an entirely new culture. An original article by Patriksson, Nilsson, and Wigert, examine parents' experiences of communication with healthcare professionals in a neonatal unit when language barriers are present.

Dabas, Joshi, Agarwal, Yadav, & Kachhawa, present a randomized controlled study to assess the effect of audio-assisted relaxation

technique on postpartum mothers of hospitalized 26–33 weeks gestation neonates in terms of reduction in maternal stress, anxiety, and improvement in milk output.

Another study by Utami and Huang will explore health care providers' perception, knowledge, barriers and practices of kangaroo care for premature infants in perinatology wards in Indonesia.

Nuraini, Pratomo, Hadi, Noviati, & Sianipar, all from Indonesia, share their qualitative research that includes in-depth interviews, group discussions, and observations of neonatal nurses' skills in Kangaroo Mother Care (KMC). This study aimed at assessing the skills of neonatal nurses one year after KMC training was implemented in a District General Hospital located in Indonesia.

At a point where palliative care and hospice becomes imminent is when partnering with families and communication skills become essential. Frequently, NICU nurses are reluctant to hand over medical and nursing care of a neonate, especially a chronic neonate, to pediatricians and pediatric nurses. Strong relationships form between families and NICU staff which results in care becoming very "personalized." The same holds true for palliative care and hospice. Hospice staff juggle many complex issues when caring for infants at the end-of-life. Such issues center around the referral process from hospital services borne from an apparent reluctance of hospital staff to let go, through involving hospice. Education, partnership working, planning for all possible outcomes seems crucial in further developing quality palliative care for infants and their families. Hospice has been pivotal to children's palliative care provision in the United Kingdom (UK) for more than 3 decades. Some hospices have recently expanded to include care of infants transferred from neonatal units as well as antenatal referrals. Despite developments, evidence suggests hospice care is often not offered to parents in neonatal units (NNU). Professors Jayne Price and Rosa Maria Mendizabal-Espinosa examine hospice professionals' perspectives of 17 staff from 3 children's hospices regarding the provision of neonatal palliative care including the challenges and opportunities experienced in caring for infants in hospice.

Along with Lavallée et al.'s specific recommendations outlined in the first article of this issue, Altimier & Phillips complete this issue by further detailing specific neuroprotective interventions related to all seven core measures of neuroprotective family-centered developmental care through the Neonatal Integrative Developmental Care Model.

The Neonatal Integrative Developmental Care Model, (Philip's HealthTech, Cambridge, MA) which outlines seven core measures for neuroprotective family-centered developmental care of premature infants, is a framework that guides clinical practice in many neonatal intensive care units (NICUs) around the globe (Fig. 1). The seven neuroprotective core measures are depicted as overlapping petals of a lotus as the: 1) healing environment, 2) partnering with families, 3) positioning & handling, 4) safeguarding sleep, 5) minimizing stress and pain, 6) protecting skin, and 7) optimizing nutrition. Skin to Skin Contact (SSC) is considered the foundation for care of infants in the NICU and its importance as the "normal environment" and the ideal place of care is described.

The mother/child dyad is the center of the lotus surrounded closely by symbols representing various aspects of the healing environment, highlighting the physical, extra-uterine environment in which the infant now lives, the significance of the developing infant's sensory system, and the influence of people (patient, family, and staff) who help to create a healing environment for hospitalized infants and their families. The Neonatal Integrative Developmental Care Model utilizes neuroprotective interventions as strategies to support optimal synaptic neural connections, promote normal neurological, physical, and emotional development and prevent disabilities.

1. Guiding principles

- a. All infants are in a critical period of brain growth and organization
 - Everything that happens in the NICU impacts brain development

- Providing excellent, evidence-based care is always our goal
 - The way we provide our care, influences developmental outcomes
- b. Neuroprotective developmental care is relational
 - Treat every baby as a little human being who has their own unique identity
 - Do exams and procedures "with" the baby, not "to" the baby
 - Notice individual differences and preferences in each baby
 - c. Emotional connection with parents/families is essential for optimal outcomes
 - Parents are the most important caregivers for their baby in the long run
 - Support parent-infant attachment in every possible way in the NICU
 - Provide psychosocial support for NICU parents as needed
 - Skin-to-skin contact is the most fundamental form of neuroprotective care
 - Skin-to-skin contact with mother is the "natural habitat" for all newborns outside the womb
 - Skin-to-skin contact supports all 7 of the Neuroprotective Core Measures
 - Encourage and facilitate skin-to-skin contact whenever possible, and for as long as possible

The Neonatal Integrative Developmental Care Model: Seven Core Measures for Neuroprotective Family-Centered Developmental Care

Leslie Altimier, RN, DNP & Raylene Phillips, MD

1.1. Core measure 1: healing environment

A healing environment protects the developing sensory system of preterm infants.

- a. Protect the Tactile System with gentle touch
 - Provide gentle yet firm tactile support
 - Facilitate early, frequent, and prolonged skin-to-skin contact
 - Promote infant massage when appropriate
- b. Protect Vestibular system with slow movements
 - Use slow gentle movements during handling
 - Contain infant in all care (positioning, bathing, weighing, holding, etc.)
- c. Protect Olfactory system by minimizing odors
 - Let hand sanitizers dry before putting hands inside incubator
 - Maintain a fragrance-free and scent-free NICU
- d. Protect Gustatory system by providing positive taste opportunities
 - Provide breastmilk mouth care
 - Promote nuzzling/suckling when skin-to-skin
- e. Protect auditory system by minimizing noise
 - Talk in a "library voice" when near bedsides
 - Keep pagers and phones on vibrate
 - Noise meters/Red/Yellow/Green Traffic lights should be set ≤ 55 dB
- f. Protect visual system by minimizing direct light
 - Cover baby's eyes during exams and procedures
 - Be sure incubator covers and blankets protect from direct light
 - Diurnal Lighting for infants > 31 weeks CGA

1.2. Core measure 2: partnering with families

Parents are the most important caregivers in a baby's life.

- a. Go out of your way to make parents feel welcome in the NICU
 - Always greet parents and introducing yourself with name and role
 - Having a baby in the NICU is usually an unexpected crisis for families
 - Expect the need to repeat conversations/explanations more than once

- Use lay language free from acronyms when talking with parents
- b. Involve parents as active members of the caregiving team
 - Educate, coach and mentor parents in caring for their baby in the NICU
 - Include parents in medical rounds and nursing shift change discussions
 - Ask parents how they think their baby is doing – then listen
- c. Skin-to-skin contact helps heal wounds of interrupted bonding/attachment
 - Recognize importance of parent-infant attachment on brain development
 - Facilitate early, frequent, and prolonged skin-to-skin contact

1.3. Core measure 3: positioning and handling

Positioning should mimic the fetal position in the womb.

- a. Maintain head in a midline position
 - Be extra vigilant with ventilated ELBW infants
 - Ask RT to help reposition ETT and/or reposition infant if needed
- b. Maintain limbs and trunk in flexed, tucked position
 - Gently reposition infant after extending limbs during exams/procedures
 - Reposition infant in positioning aid after exams/procedures
- c. Handle preterm and sick infants with slow, gentle movements
 - Ask for help with procedures or complicated handling
 - Ask staff or parent to provide 4-handed support if needed
 - Monitor the neonate closely during interventions for behavioral cues that indicate stress
- d. Skin-to-skin contact is the “natural habitat” for all newborns
 - Skin-to-skin contact is the closest to being back inside the womb
 - Facilitate early, frequent, and prolonged skin-to-skin contact

1.4. Core measure 4: safeguarding sleep

Sleep is essential for healing, growth, and optimal brain development.

- a. Never waken a sleeping baby unless necessary
 - Support long periods of restful, uninterrupted sleep whenever possible
 - Time routine cares/exams to coincide with baby's sleep/wake cycles
 - Wake the neonate slowly, gently, with a soft voice associated with touch
- b. Protect sleep states by minimizing noise and light
 - Talk in a “library voice” when near bedsides
 - Be sure direct light is not shining on sleeping babies
- c. Group interventions (assessments, labs, vital signs, etc.) to provide long periods of undisturbed rest
 - Continuous evaluation during these groupings is essential to ensure the neonate is tolerating the procedures and is not overly stressed.
 - Monitor the infant's ability to self-calm
- d. Skin-to-skin contact promotes the most optimal sleep cycles
 - Remember - newborns sleep best when in skin-to-skin contact
 - Facilitate early, frequent, and prolonged skin-to-skin contact

1.5. Core measure 5: minimizing stress and pain

Stress and pain are part of NICU life – but both can be minimized.

- a. Supporting a healing environment helps to minimize stress
 - Protect babies from excess noise and light
 - Talk in a “library voice” and cover baby's eyes during exams
 - Watch for signs of stress during exams and pause when possible

- Extended digits and limbs indicates stress
- Excessive tone or absence of tone indicates stress
- b. Use positioning and boundaries to provide containment
 - Be sure baby is well-contained during exams and procedures
 - Be sure baby is repositioned properly after exams and procedures
- c. Use extra supports during painful procedures
 - Ask staff or parent to provide 4-handed support when needed
 - Many parents are willing and eager to help support their baby
 - Give them a chance to participate if they are available and willing
- d. Be sure Sweet-Ease is given 2 minutes prior to painful procedures
 - Understand mechanism of action (activation of endogenous opioid receptors.
 - Understand absorption (via buccal mucosa - not via digestion).
- e. Be sure adequate analgesics are given for painful procedures if needed
 - Be proactive with post-op pain management
- f. Skin-to-skin reduces stress and pain - Mother's presence is analgesic
 - Facilitate early, frequent, and prolonged skin-to-skin contact

1.6. Core measure 6: protecting skin

Skin is a conduit for nerve cells to send sensory messages to the brain.

- a. Monitor humidity level inside incubator during first week for ELBW infants
 - Be sure humidity is provided until skin is keratinized - about 5–10 days
 - Being skin to skin on mother's chest provides about 50% humidity
- b. Monitor nasal septum for skin breakdown if nasal prongs are used
 - Check prongs frequently – there should be no pressure on septum
 - Check septum each shift for erythema or breakdown
- c. Monitor other susceptible skin areas
 - Check mouth for oral thrush and diaper area for rash
 - Check trunk/limbs for pressure ulcers and IV sites for erythema/infiltrates
- d. Provide education to families on how to do swaddled bathing
- e. Provide a quiet, dim, draft-free environment
- f. Provide a radiant warm heat source to promote a neutral-thermal environment.

1.7. Core measure 7: optimizing nutrition

Human milk is the optimal diet for most human infants.

- a. Discuss the medical need for breastmilk with parents whenever the opportunity arises
 - Explain how breastmilk is a medicine, especially for preterm infants
 - Explain need for early/frequent pumping if baby is unable to breastfeed
- b. Support mother's early and continued milk supply
 - Provide enthusiastic support for any breastmilk mother provides
 - Explain the importance of ongoing pumping to maintain milk supply
- c. Provide ongoing breastfeeding education and support
 - Explain how important breastmilk is for healing and nutrition
 - Explain how important breastmilk is for brain development and vision
 - Explain how important breastmilk is to decrease risk of NEC and sepsis
- d. Skin-to-skin contact increases breastfeeding initiation and duration
 - SSC increases prolactin and oxytocin – both needed for lactation
 - Facilitate early, frequent, and prolonged skin-to-skin contact
- e. Cue-based, infant-driven feeding prevents later oral aversions

- Oral feedings should be safe, developmentally appropriate and nurturing
 - Provide cue-based rather than volume feedings
 - Monitor feeding readiness and signs of stress during feeds
- f. Support breastfeeding well before discharge
- Babies can practice suckling when skin to skin whenever interested
 - The first oral feeding should be at the breast if mother has been pumping
 - If term baby has excessive difficulty latching, get lactation support
 - Check mouth for anomalies, e.g. cleft (cleft palate or tongue-tie)
 - If present, alert physician to get appropriate treatment

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