



# womb world

## Pre-Term Newborn Monograph





## Introduction

**Womb to World** is a model of signal-based, family-centered care for infants and toddlers that includes five pillars: **signals, sensory support, positioning, sleep & calm states and skin care.** This monograph will focus on the adaptation of this model for preterm infants (those born prior to 37 weeks' gestation<sup>1</sup>) as well as the important role families play in support of the long-term health and development of their preterm infants.





# PILLAR ONE: SIGNALS

Regardless of their gestational age at birth, infants have an innate ability to communicate; however, the signals preterm infants use for communication can be more difficult to interpret. With family-centered care, healthcare professionals assist parents in learning how to read and respond to their infant’s unique signals. Autonomic signals, such as color changes or fluctuations in vital signs, and motor signals, such as changes in muscle tone or flailing of the limbs, indicate the preterm infant is experiencing stress. Responding quickly to stress signals and supporting the preterm infant with calming strategies, including nonnutritive sucking and grasping, will help mitigate stress in the moment and assist with the development of self-regulatory behaviors in the future.<sup>2</sup>



**Arm & Leg Extension:**

Arms and/or legs are held in position of extension.



**Gaze Aversion:**

Moves eyes away from caregiver/situation.



**Furrowed Brow:**

Concerned or worried look creating lines/wrinkles on forehead.



**Stop Sign:**

Fingers are extended or splayed, often with arm extended.

# PILLAR TWO: SENSORY SUPPORT

The seven senses (touch, body awareness, movement, smell, taste, hearing and vision) are used for learning, exploring and interacting with the world. For preterm infants, the early exit from the womb into the NICU can mean senses are stimulated earlier or more intensely than desired, which can have an impact throughout a preterm infant’s life. From birth until a preterm infant reaches two years old, approximately 1.8 million synapses are formed in the brain every second.<sup>3</sup> Considering this rapid brain growth, the need to protect and promote the developing sensory systems is essential. With proper guidance, parents can become the best advocates for their new infants.

**Touch:**

The tactile system is the first of the sensory systems to develop, and input can be detected by the infant prior to 25 weeks’ gestation.<sup>4</sup> While in utero, touch is muted and overwhelmingly positive; however, in the NICU, touch often includes negative experiences such as needle pokes, suctioning and having tape applied to the oral area. To minimize the effects of negative touch, healthcare professionals should encourage parents to provide positive touch in age-appropriate ways, including hand hugs, skin-to-skin holding and infant massage. Infant massage stimulates the receptors of the parasympathetic nervous system, increases weight gain, promotes parent-infant bonding and has been linked to a shorter length of stay in the NICU.<sup>5</sup>



**Body Awareness & Movement:**

Proprioception, or awareness of body position, and kinesthesia, or movement awareness, are the next two sensory systems to develop in the womb and are known together as the movement senses. Input to these senses begins during the first trimester of pregnancy via movement of the mother and of the fetus within the mother.<sup>6</sup> They are largely dependent on the vestibular system in the inner ear, as well as receptors in joints throughout the body that continue to develop into the second trimester.<sup>3</sup> Special considerations must be made by caregivers in the NICU since infant movement is not coordinated alongside other sensory input as it is within the womb. This can cause preterm infants to attempt to stabilize their bodies against superimposed movement by stiffening their extensor muscles, and these patterns of stabilization can result in difficulties with motor skills, which may persist throughout childhood.<sup>7</sup>

**Taste & Smell:**

The olfactory and gustatory senses combine in utero as the chemosensory system.<sup>8</sup> Between 26 and 28 weeks’ gestation, smell and taste begin to develop, and at the end of the 28th week, extremely preterm infants can begin to recognize familiar scents.<sup>9,10</sup> Prior to term age, smell becomes linked with the parts of the brain that tie to emotion and memory.<sup>9,10</sup> Immediately following birth, the sense of smell supports breastfeeding, and providing preterm infants with exposure to their mother’s scent via a scent cloth or skin-to-skin holding can facilitate feeding behavior and promote physiologic stability.<sup>8,11-14</sup> Early exposure to breastmilk via oral immune therapy and therapeutic tasting has been shown to decrease the risk of bacterial infections such as NEC and late-onset sepsis and has also been linked to decreased length of NICU stay.<sup>12,13</sup>

**Hearing:**

The structure of the ear begins to form at approximately 20 weeks, and by 25 weeks, the preterm infant has functional hearing.<sup>15</sup> Between 28 and 33 weeks, auditory processing develops as the brain stem connects to the primary auditory cortex, and between 31 and 33 weeks, the preterm infant is able to recognize their mother’s voice.<sup>16</sup> Between 34 and 36 weeks’ gestation, preterm infants are able to distinguish mood in language.<sup>16</sup> For the preterm infant, noises louder than 45dB can cause adverse changes to infant vital signs including heart rate, respiratory rate, oxygen saturation, blood pressure and intracranial pressure.<sup>17</sup> However, appropriate auditory input, most notably quiet parent voices, can increase oxygen saturation, weight gain and nonnutritive sucking, improve pain control and support long-term language development.<sup>16</sup> Studies have also shown that when parents are unable to be present in the NICU, exposing the preterm infant to low-frequency recordings of their mother’s voice supports their physiologic stability.<sup>18</sup>

**Vision:**

Unlike hearing, which needs external stimuli to properly form, a preterm infant’s visual system does not require external input. In the womb, only very diffuse light can be detected.<sup>19</sup> Early exposure to too much light can negatively impact vision and visual processing throughout the preterm infant’s life, even if the visual structures appear unchanged.<sup>19</sup> Therefore, NICU caregivers and parents should ensure that isolette covers or eye protection are used with preterm infants until 32 weeks of age in order to minimize early exposure to light whenever possible.<sup>19</sup> Caregivers can begin to introduce cycled lighting at 32 weeks, and by 36 weeks, preterm infants will be able to limit light exposure to their own eyes.<sup>19</sup>



# PILLAR THREE: DEVELOPMENTALLY-SUPPORTIVE POSITIONING

Therapeutic positioning in the NICU can help improve lung mechanics, decrease reflux symptoms and support neuromotor development.<sup>20-22</sup> Furthermore, there are numerous potential health problems associated with a lack of supportive positioning, especially with early preterm infants. For example, poor hip positioning and ill-fitting diapers can have long-term effects on development and lower extremity alignment.<sup>23</sup> Other potential risks of poor positioning in the NICU can include delayed motor skills, plagiocephaly and feeding-related obstacles.<sup>23</sup> It is essential for healthcare professionals to balance the positioning and developmental needs of the preterm infant with their medical concerns. It is also necessary for caregivers to be mindful of when and how an infant is moved, as changing a preterm infant's position too rapidly can cause physiological disruptions to respiratory rates, oxygen saturation and blood pressure.<sup>20,21</sup>

Positioning the preterm infant with limbs toward the midline of the body in flexion mimics the womb and is supportive of long-term development.<sup>24</sup> Attention to head positioning throughout the NICU stay reduces the risk of head shape deformities including plagiocephaly and dolichocephaly. Commercial positioning aids and/or swaddling have been shown to improve motor behavior, alignment and movement across the midline and to decrease abrupt movement by supporting the preterm infant in a flexed, contained position.<sup>25,26</sup> Since early reflex development and movement correlate with head positioning, studies suggest midline positioning may support improved physical orientation and development.<sup>24</sup> Midline head positioning is recommended for extremely preterm infants for their first 72 hours of life, as it helps to prevent increased intracranial pressure, improves oxygenation and empowers cerebral venous drainage.<sup>27,28</sup>

### Skin-to-Skin Holding:

Skin-to-skin holding, or kangaroo care, has numerous developmental and sensory benefits for all infants and should be initiated as soon as medically possible. Ventral-to-ventral positioning is recommended to allow the infant's and mother's chemoreceptors to be in contact for maximal benefit to both participants.<sup>29,30</sup> Supported diagonal flexion holding is another type of skin-to-skin holding that promotes eye contact and encourages communication between infant and parent for moderate to late preterm infants.<sup>31</sup> Care should be taken with all skin-to-skin holding to position the infant in a way that supports flexor muscles in order to support alignment and motor development.<sup>32</sup>

Skin-to-skin holding has numerous benefits for the preterm infant, including deep sleep, which supports brain development<sup>31</sup>, improved weight gain and decreasing the effect of painful procedures such as heel lancing.<sup>33</sup> Skin-to-skin holding also allows parents to share beneficial bacterial flora, which decreases the incidence of sepsis, pneumonia and necrotizing enterocolitis (NEC).<sup>33</sup>

NICU caregivers should encourage parents to participate in skin-to-skin holding with their preterm infants early, often and for extended periods of time, as medically appropriate. If parents are tired or starting to fall asleep while doing skin-to-skin, the baby needs to be moved to a safe sleep environment.



# PILLAR FOUR: SLEEP & CALM STATE

While the NICU is necessary for supporting preterm infants through their first weeks or months of life, it is often not a conducive environment for uninterrupted sleep due to necessary medical procedures and the activity in the hospital environment.<sup>34</sup> For all infants, sleep is essential for supporting brain development, temperature regulation and energy efficiency.<sup>35</sup> For preterm infants, sleep is further associated with improved weight gain and immune function, stabilization of heart rate and the formation of a daily melatonin cycle.<sup>36,37</sup>

High levels of light and sound in the NICU can interrupt the preterm infant's rest, leading to reduced oxygen saturation levels and changes in motor activity.<sup>38</sup> NICU caregivers should provide opportunities for the infant to rest quietly in order to decrease stress and support growth and development.<sup>38</sup> When not being held skin-to-skin or receiving medical care, extremely preterm infants should be allowed to sleep in the isolette as much as possible in order to support development and minimize sensory stimulation while promoting uninterrupted sleep.<sup>39</sup> Between 28 and 30 weeks, organized sleep states begin to emerge, and ocular dominance, which allows for vision, begins to form.<sup>19</sup> During this time, sleep disruption due to factors like deep sedation, intense noise, bright lights or unusual movement can have long-term disruptive effects on the visual system.<sup>7,40</sup>

### Clustered Care in the NICU:

One of the best ways to minimize stress for preterm infants is to cluster care in the NICU in order to minimize sleep disruptions.<sup>41</sup> Caregivers may find that some infants have optimal times for care when the infant is more likely to wake naturally, and aligning their care schedule based on these signals or cues is recommended.<sup>39</sup> Performing procedures or even touching a preterm infant can disrupt their rest. Arousals or awakenings happen in 57% of contacts with a sleeping infant,<sup>42</sup> indicating that to promote healthy sleep, procedures should be prioritized during the infant's waking hours.<sup>41</sup>

### Promoting Calm State:

Caregivers should remain mindful of a preterm infant's stress levels at all times in order to promote a calm state, even during tasks like diaper changes. Diaper changes, and other seemingly simple tasks, have been shown to increase infants' heart rates and decrease oxygen saturation.<sup>43</sup> Simply slowing the pace of daily tasks such as feeding, bathing and diapering also supports the infant in the development of self-regulation and further promotes calm state.<sup>39</sup>

### Safe Sleep in the NICU:

Preterm infants, once >32 weeks of age and medically stable, should be placed in the supine position for every sleep so they may acclimate to sleeping in this position prior to NICU discharge.<sup>44,45</sup> Infants born between 24-32 weeks are three times more likely to have a sleep-related death, and infants born between 33-36 weeks are twice as likely to have a sleep-related death as compared to full-term infants.<sup>46</sup> Studies show that parents mimic the care they see nurses provide for their newborns,<sup>46</sup> so it is imperative that healthcare professionals utilize safe sleep positioning in the NICU to help prevent SIDS or SUID (sudden unexplained infant death).<sup>44</sup> NICU caregivers should also ensure parents are knowledgeable about all of the AAP recommendations regarding safe sleep, including placing infants supine on a firm mattress in an otherwise empty crib and co-rooming but never co-sleeping.<sup>47,48</sup>



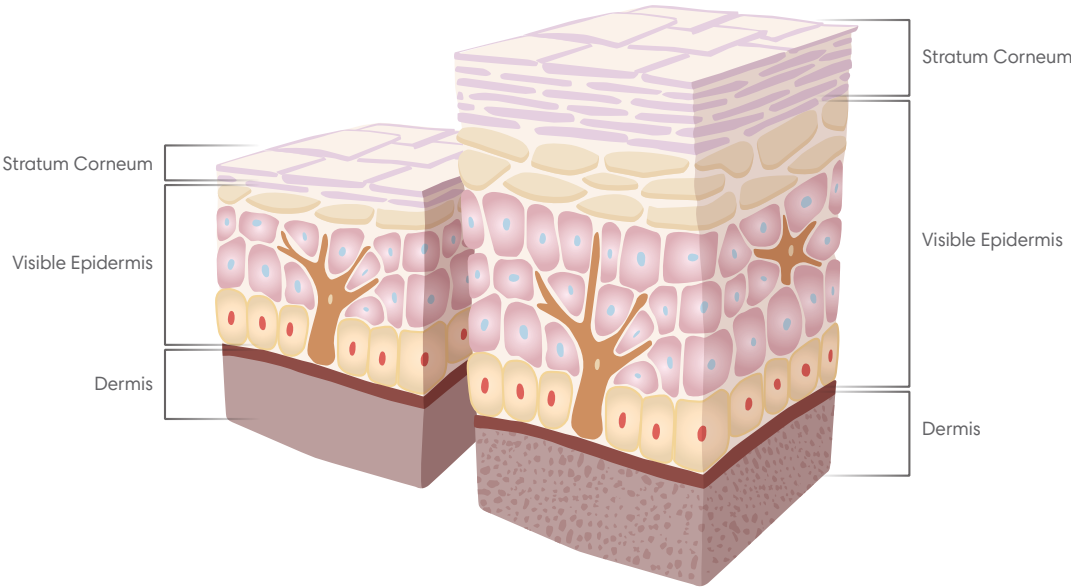
PILLAR FIVE: SKIN CARE

The skin is made up of three major layers: the stratum corneum, the epidermis and the dermis. The outermost layer, the stratum corneum, is derived from the epidermis and plays a key role in protecting the infant from water loss and irritant exposure.<sup>49,50</sup> The epidermis consists of several layers of keratinocytes and specialized cells, such as Langerhans cells and melanocytes, and is important in the development of the acid mantle, protection from irritants, immunosurveillance and tactile discrimination. The innermost layer, the dermis, gives the skin resiliency, flexibility and strength.

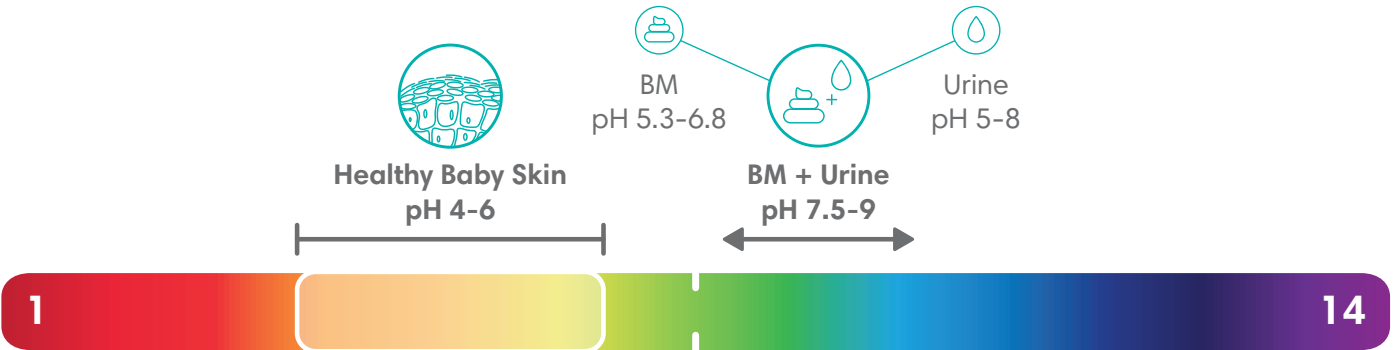
Most of the skin’s development occurs in the last trimester of pregnancy; therefore, preterm infant skin is thinner and less cohesive, which increases their susceptibility to skin damage and allows access of bacteria, viruses and allergens. Skin barrier integrity can be assessed by measuring trans-epidermal water loss (TEWL), or the rate of water loss from the skin. Higher TEWL values are indicative of a poor skin barrier, and extremely premature infants exhibit the highest TEWL values compared to full-term infants.<sup>51</sup> Poor skin barrier is a major concern for preterm infants as it can lead to poor thermal regulation, electrolyte imbalance and water loss. It is directly influenced by gestational age, temperature (both body and environmental) and the infant’s weight.

Preterm infant skin also has an underdeveloped dermis layer with reduced amounts of key proteins like collagen and elastin, which are important in maintaining the skin’s structure. With these limitations, repetitive motions, like rubbing; or the removal of adhesives can easily harm preterm skin as it lacks resiliency to mechanical trauma and tears more easily.<sup>52</sup> Overall, preterm infants are at risk for many skin problems, which have short- and long-term impacts, including delayed barrier maturation, high water loss, increased permeability, skin compromise, infection and thermal instability.<sup>53,54</sup>

Skin Development of Premature vs. Full-Term Babies



**Skin Care Tips & Guidelines for Healthcare Professionals**  
AWHONN/NANN recommend assessing neonatal skin integrity from head to toe at least one time per day, including checking under all medical devices, using warm sterile water when bathing areas with skin breakdown, using petrolatum-based ointments or products containing zinc oxide at every diaper change for preterm infants at risk of diaper dermatitis and using superabsorbent disposable diapers with frequent changes while maintaining developmentally supportive care practices to best support the skin of preterm infants.<sup>68</sup>

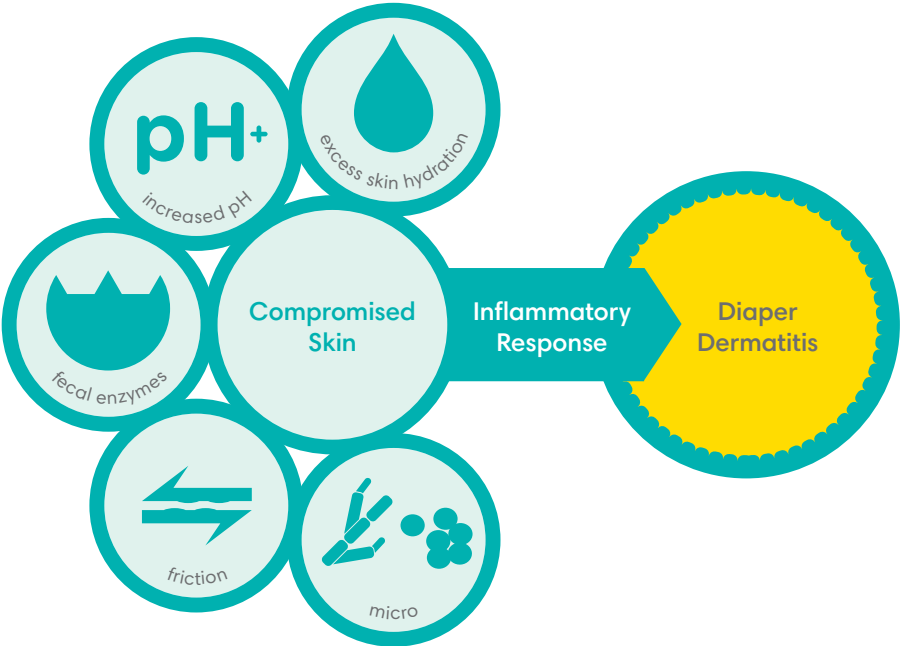


Understanding Preterm Infant Skin pH

All infants, both preterm and full term, are born with a skin pH >6.0. In the days and weeks following birth, the skin pH decreases, with the rate of acidification being slower in extremely preterm infants.<sup>55,56</sup> This is because the vernix caseosa, which does not begin to form until 26 weeks, has been shown to encourage skin acidification. Therefore, the skin of extremely preterm infants can take as long as four weeks to reach the desired slightly acidic pH, compared to full-term infants who reach it in as little as three days.<sup>55</sup> This decrease in skin pH marks the establishment of the acid mantle and maturation of the stratum corneum.<sup>55</sup> Healthy skin pH is variable based on body location and ranges from 4-7, with average pH values reported between 4.5-6.0.<sup>57,58</sup> Reaching a healthy, acidic skin pH is essential for skin development in terms of integrity, functionality and dampening of inflammation.<sup>50,59-62</sup> It also helps the skin achieve bacterial homeostasis, which allows for healthy bacteria while protecting against pathogens and other irritants.<sup>63-65</sup> Between 32 and 37 weeks’ gestation, the epidermis matures significantly, allowing preterm infants to tolerate immersion baths. Swaddle immersion baths, where the naked infant is swaddled in a simple blanket and placed in a prepared immersion bath at 100°F, should be used for preterm infants older than 32 weeks whenever possible in the NICU.<sup>66</sup>

Diaper Care

Both preterm and full-term infants are at risk of skin compromise, but preterm infants are particularly sensitive due to their immature skin. The causes of diaper dermatitis, which are multifactorial and exceed 25% in the NICU,<sup>67</sup> include overhydration of the skin, generalized body edema and skin irritation from mechanical friction. Frequent or loose stools and prolonged exposure to urine, stool and/or bile salts can increase skin pH, which makes the skin more prone to breakdown. Exposure to infectious agents, which is heightened with elevated skin pH, and medications such as antibiotics, which may negatively impact the typical microflora of the skin, leave the skin more vulnerable to breakdown.





## Conclusion

The mother's womb is an amazing home, where time spent fosters the invaluable processes of neurological and physical development. When infants are prematurely exposed to the comparatively harsh extrauterine environment, the billions of synapses forming in their brains become interrupted. And while there's no substitute for the warmth and protection of the womb, the methods described in this model can help ease that journey from womb to world for the preterm infant.

The Womb to World concept of family-centered and signal-based care for preterm infants is a step forward in the modernization of NICU care. **Healthcare professionals have an important role in guiding care to focus on signals, sensory support, positioning, sleep & calm state and skin care for each of the preterm infants in their care, and to educate parents to be active participants in their child's care.** With supportive caregiving, each infant can have a smoother journey from womb to world.



## Notes

## Notes



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