Transition to a Safe Home Sleep Environment for the NICU Patient

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Of the nearly 3.8 million infants born in the United States in 2018, 8.3% had low birth weight (<2500 g [5.5 lb]) and 10% were born preterm (gestational age of <37 completed weeks). Many of these infants and others with congenital anomalies, perinatally acquired infections, and other disease require admission to a NICU. In the past decade, admission rates to NICUs have been increasing; it is estimated that between 10% and 15% of infants will spend time in a NICU, representing approximately 500 000 neonates annually. Approximately 3600 infants die annually in the United States from sleep-related deaths, including sudden infant death syndrome International Classification of Diseases, 10th Revision (R95), ill-defined deaths (R99), and accidental suffocation and strangulation in bed (W75). Preterm and low birth weight infants are particularly vulnerable, with an incidence of death 2 to 3 times greater than healthy term infants. Thus, it is important for health care professionals to prepare families to maintain their infant in a safe sleep environment, as per the recommendations of the American Academy of Pediatrics. However, infants in the NICU setting commonly require care that is inconsistent with infant sleep safety recommendations. The conflicting needs of the NICU infant with the necessity to provide a safe sleep environment before hospital discharge can create confusion for providers and distress for families. This technical report is intended to assist in the establishment of appropriate NICU protocols to achieve a consistent approach to transitioning NICU infants to a safe sleep environment as soon as medically possible, well before hospital discharge.

INTRODUCTION

According to the 2016 policy statement from the American Academy of Pediatrics (AAP) Task Force on Sudden Infant Death Syndrome, all infants, including preterm and low birth weight infants, in the NICU should be placed in the supine position for sleep as soon as they are

abstract

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medically stable and significantly before their anticipated discharge from the hospital. In particular, very preterm infants should be kept predominantly in the supine position by 32 weeks’ postmenstrual age (PMA) so that they become acclimated to supine sleeping before discharge from the hospital.1–3 There are many other factors that define a safe sleep environment to minimize the risk of sudden infant death syndrome (SIDS), accidental suffocation and strangulation, and undetermined sleep deaths (collectively known as sudden unexpected infant death [SUID]), as outlined in the same 2016 policy statement.

During NICU hospitalization, infants are routinely kept in an environment that is not consistent with these recommendations for numerous reasons, on the basis of both treatment of underlying pathophysiology as well as the normal physiology of the preterm infant. Pathologic conditions resulting in short-term respiratory distress (respiratory distress syndrome and transient tachypnea of the newborn) or long-term respiratory compromise (bronchopulmonary dysplasia and pulmonary hypoplasia) result in use of positioning inconsistent with safe sleep messaging. Other conditions that may be pathologic, such as gastroesophageal reflux (GER), lead to the use of therapeutic interventions such as side-lying position and elevation of the head of the bed, maneuvers the literature suggests may be of questionable value.4 To reduce the need for narcotic and anxiolytic medications, which have been reported to have adverse effects on neurodevelopment,5–7 infants with neonatal opioid withdrawal syndrome (NOWS) may be positioned prone or swaddled firmly. Developmental care for the optimal growth and maturation of the preterm infant can include the use of nonsupine positioning, soft mattresses, and positioners. Although developmental care has been shown to be beneficial to the long-term neurodevelopmental outcomes of preterm infants, many of the tools involved in the constantly monitored NICU environment are contraindicated after hospital discharge. Transition to a safe sleep environment as soon as medically possible, well before discharge from the hospital, is extremely important because in preterm infants the adjusted odds ratio (aOR) for SIDS is 1.85 to 2.72 and for suffocation is 1.86 to 2.59 compared with term infants, and the sleep environment greatly affects the risk of these sleep-related deaths.1,8

Although the AAP through its Committee on Fetus and Newborn recommended the transition to the use of the supine position by 32 weeks’ PMA3 in 2008, and this recommendation was supported by the AAP Task Force on Sudden Infant Death Syndrome in 2011,1,2 there is long-term and ongoing nonadherence to this recommendation from NICU providers.3,9,10 Research on resistance to this recommendation has thus far been focused on only NICU nurses. In a 2006 survey of 252 NICU nurses, 65% identified prone positioning as the best general sleep position for preterm infants, followed by 12% who believed either prone or side-lying position was the best sleep position.9 In addition, the nurses surveyed were inconsistent regarding how they determined when a preterm infant is ready to sleep supine. Answers included close to discharge (13%), when maintaining their body temperature in an open crib (25%), PMA of 34 to 36 weeks (15%), PMA ≥37 weeks (13%), and when the infant’s respiratory status was stable (6%). Nursing beliefs and knowledge continue to be a barrier to a culture of consistent safe sleep messaging. A 2016 survey of 96 NICU nurses found that 53% strongly agreed that recommendations make a difference in preventing SIDS, and only 20% strongly agreed that parents would model nurses’ behaviors at home.10

Various reasons are given to explain why nonsupine positioning and other common practices contrary to a safe sleep environment persist even when infants are approaching discharge from the NICU. However, studies find that when expectant or new parents receive education on infant sleep safety on a consistent basis, their knowledge increases and their safe sleep behaviors improve, regardless of the setting (eg, well-infant nursery, NICU, Special Supplemental Nutrition Program for Women, Infants, and Children office, community health center).11–14 The purpose of this report is to address the many issues that result in conflict with safe sleep guidelines, looking at the validity of practices based on review of the evidence regarding pathophysiology and normal physiology of the vulnerable infant. The goal of this technical report is not to provide an all-encompassing review of the literature for each issue but rather a summary of data for each issue and provide suggestions to resolve conflicting practices. By creating a consistent approach to transitioning the infant in the NICU to a safe sleep environment as soon as medically possible, well before hospital discharge, families can be exposed to modeling of safe sleep behaviors that could decrease the risk of SUID in this vulnerable population. Areas of concern include developmental care and/or neurodevelopmental issues, positional plagiocephaly and/or torticollis, orthopedic issues

13

13

2
(developmental hip dysplasia), respiratory distress, GER and/or aspiration, thermoregulation, jaundice, and neonatal drug withdrawal. Some of this content and the advice provided may also be applicable to infants in the well newborn and pediatric inpatient units.

**DEVELOPMENTALLY SENSITIVE CARE**

Infants born preterm have increased risks of poor neurodevelopmental outcomes, with risks increasing as the gestational age decreases.\(^{15,16}\) Developmentally sensitive care is a broad term given to a number of interventions aimed at modifying the imperfect extraterine environment to optimize physical and neurodevelopmental outcomes for preterm and ill neonates.\(^{17}\) This is achieved through a patient-centered approach that protects sleep, manages pain and stress, supports essential activities of daily living (ie, positioning, feeding, and skin care), integrates family and/or caregivers into the plans of care, and modifies the physical environment.\(^{17}\) Conflicting information exists about the effectiveness of formalized and programmatic approaches to developmentally sensitive care.\(^{18,19}\) However, there is evidence that components of these approaches, particularly skin-to-skin care (SSC)\(^{20–22}\) and breastfeeding,\(^{23}\) promote improved short-term outcomes in response to the suboptimal environment of the NICU. Despite the disagreements in the literature about the effects of programs or packages of developmental care, integration of developmentally sensitive care in the NICU has been endorsed by professional organizations,\(^{24,25}\) and formal programs, recommendations, guidelines, and quality metrics exist.\(^{26–28}\) Commonly used techniques of developmental care that may affect the appropriate transition to safe sleep include positioning, use of positioning aids, swaddling, and SSC.

**Positioning and Use of Positioning Aids**

As the fetus rapidly grows in size during the third trimester of pregnancy, the intrauterine environment becomes more restrictive, and the fetus moves into a midline position of flexion.\(^{29}\) This position of the head, shoulder, hip, and knee flexion; scapular protraction; and posterior pelvic tilt help the fetus develop appropriate skeletal shapes, flexor muscle tone, stretch reflexes, and self-regulating behaviors.\(^{29}\) With preterm birth comes, among other things, loss of the physiologic flexion positioning of the intrauterine environment.\(^{29}\) If not supported, the preterm infant lies flat and asymmetric, with hip and joints abducted with abnormal rotation, unable to bring himself or herself to a flexed and midline position for comfort and self-regulation. Over time, this may lead to musculoskeletal and neurodevelopmental abnormalities, such as upper extremity hyperabduction and flexion and generalized muscular rigidity. To help prevent these morbidities and provide comfort and decrease measures of stress, neonatal nurses, families, and other caregivers therapeutically position the preterm infant in a flexed, midline, and contained position, with the head and neck in a neutral posture, shoulders rounded with hands brought to the midline, trunk in “C” curve, pelvis in posterior tilt, hips and legs in symmetrical and neutral flexion and rotation, and feet supported.\(^{29–31}\) Therapeutic positioning is achieved through the use of various positioning devices and supports, such as diapers or blanket rolls as well as commercially available products.\(^{30–33}\) Currently, there is no standardized protocol or device to direct and provide therapeutic positioning, leaving the choice in many cases to the individual nurse or caregiver.\(^{34}\) The Infant Positioning Assessment Tool was developed to help provide caregiver education, standardization, and evaluation of therapeutic positioning.\(^{35,36}\) The Infant Positioning Assessment Tool has demonstrated initial validity and reliability but has not been widely implemented.\(^{35,37,38}\) As the infant matures and approaches readiness for discharge from the hospital, an interdisciplinary, collaborative, and thoughtful approach is required to determine how and when the use of positioning devices is discontinued and removed from the infant’s bedding to achieve a safe sleep environment. Additionally, communication and education of the infant’s caregivers and family are crucial elements to avoid confusion, conflicting information, and inappropriate use of the devices after discharge from the hospital.\(^{39}\)

Many developmental care guidelines include the AAP Safe Sleep recommendations and encourage the transition into a safe sleep environment for medically stable infants after the age of 32 weeks’ gestation and before discharge from hospital to home.\(^{10,40–42}\) Some centers have developed quality and process improvement programs to establish more concrete timing and increased compliance with the Safe Sleep recommendations.\(^{43,44}\)

**Impact of Light and Noise Reduction on the Safe Sleep Environment**

NICUs and special care nurseries can be overstimulating to preterm and sick newborn infants. Lighting, noise, and temperature can be sources of noxious stimuli.\(^{45–47}\) In an effort to
modify the external environment to decrease stressful stimulation, many nurses and caregivers will place a blanket or other covering over the infant’s head of the bed. If not well secured, these coverings could become loose and cover the infant, increasing the risks of smothering. The removal of loose blankets in the crib is an important strategy toward implementing a safe sleep environment.1,2

Swaddling
The practice of swaddling infants has been described in many cultures throughout history.49 Infant swaddling, in which a cloth or device is wrapped around the infant to contain the infant’s body and extremities, has been shown to promote sleep49; improve self-regulation, particularly in preterm infants50; and decrease crying time.50 Swaddling also has been shown to promote supine sleep position.51 However, inappropriate use of and/or tight swaddling can increase the risks of developmental hip dysplasia, cause overheating, and restrict breathing. It has been associated with vitamin D deficiency, acute respiratory tract infections, and delayed regain of birth weight and may interfere with early establishment of breastfeeding.49,52,53 There is a much greater risk of SUID when a swaddled infant is placed in or rolls to the prone position.54–56 When swaddled, preterm infants should be placed in the supine position, have their hands brought to midline under the chin, and hips and knees should be in the flexed position and able to move freely.50 Term infants, especially those with NOWS, may benefit from swaddling with arms tucked in the swaddle to reduce startle response and prevent the hazard of loose blankets in escaping from the swaddle. Because of the risk of SUID when swaddled infants are in the side or prone position, swaddling should be discontinued when the infant begins to attempt to roll over.50,55,56 For a more extensive discussion about the potential risks and benefits of swaddling, refer to the technical report, “SIDS and Other Sleep-Related Infant Deaths: Evidence Base for 2016 Updated Recommendations for a Safe Infant Sleeping Environment” (currently undergoing revision).1

Skin-to-Skin Care
SSC, or kangaroo mother care, is the practice of placing the infant’s unclothed chest against the mother’s unclothed chest for immediate, continuous, and sustained contact and exclusive breastfeeding.57 SSC was initially adopted as an alternative to incubators in countries with limited resources in the late 1970s and subsequently demonstrated improved survival for preterm and low birth weight infants.58 Now widely adopted in countries with both limited and abundant resources, the practice of SSC has been shown to promote temperature and blood sugar stability, lower respiratory rate, increase oxygen saturation, decrease symptoms associated with mild to moderate pain, and promote maternal bonding and attachment and breastfeeding. These advantages may all contribute to overall physiologic and neurobehavioral development.22,59–61 However, safety concerns have arisen with the increased practice of SSC. Dislodgement of life support equipment and dropping small and immature infants, falling out of bed, and airway obstruction have all been reported. When occurring in healthy term or late preterm infants, these events are referred to as sudden unexpected postnatal collapse, which frequently results in death or severe neurologic impairment.62 These unfortunate but real events remind caregivers and parents to be mindful and vigilant of the position of the infant’s airway and the safety of caregiver holding to prevent falls when providing SSC.22,62 If this is undertaken in the NICU, the infant should be monitored and secured, preferably with a conforming wrap carrier. The parent should be positioned in a recliner or approved kangaroo care chair or hospital bed and the kangaroo care provider should be educated by staff about how this situation differs from the home environment. Because of the concerns noted above and the known dangers of sharing sleep surfaces, such as bed-sharing in the home environment, adults should be thoroughly educated about the dangers of sleeping during SSC.

Conclusions Regarding Developmentally Sensitive Care

1. Developmentally sensitive care is an important component to the health and well-being of the preterm infant.
2. Many of the tools and therapies used to promote developmentally sensitive care are not consistent with a home safe sleep environment.
3. It is important to transition infants to a home safe sleep environment well before discharge from the NICU.
4. Good communication with the use of a multidisciplinary team is key for consistent transitioning of NICU patients to a home safe sleep environment (see A Rational Approach to Transition of the NICU Patient to a Home Sleep Environment for details).

DEFORMATIONAL PLAIOCEPHALY AND TORTICOLLIS

Variations in head shape are often observed in term and preterm infants in the NICU. These head shape abnormalities can be secondary to nursing care practices, limitations on positioning, muscle
Preterm infants are more susceptible to developing plagiocephaly because of decreased mineralization of the skull bones. In addition, they are more likely to have been positioned prone, which may be indicated when the infant is medically unstable to decrease stress, promote sleep, improve feeding tolerance, and enhance oxygenation and ventilation. Although therapeutic positioning to promote medical stability takes precedence during the acute phase of illness, whenever possible, nurses should make efforts to choose positions that promote symmetrical cranial shape.\textsuperscript{65–67}

Since the early 1990s, DP has been increasing in prevalence and is being more frequently diagnosed. Most parents and health care professionals attribute this increase to the supine sleep position recommended for infant safety,\textsuperscript{68} although this has been challenged in recent studies.\textsuperscript{69–72} It was estimated that 46.6\% of 7- to 12-week-old infants had nonsynostotic plagiocephaly (NSP) in a Canadian cohort study,\textsuperscript{72} and in a Swedish study in 2009, 42\% of 2-month-old infants had some degree of NSP.\textsuperscript{73} In a prospective New Zealand study, there were significant multivariate risk factors for NSP at 6 weeks, including newborn passive head rotation (aOR: 9.51; 95\% confidence interval [CI]: 2.59–34.94), 6-week sleep position (aOR: 5.27; 95\% CI: 1.81–15.39), and upright time (aOR: 3.99; 95\% CI: 1.42–11.23). At 4 months, risk factors were limited passive head rotation at birth (aOR: 6.51; 95\% CI: 1.85–22.98), limited active head rotation at 4 months (aOR: 3.11; 95\% CI: 1.21–8.05), tried but unable to vary head position at 6 weeks (aOR: 4.28; 95\% CI: 1.58–11.59), low activity level at 4 months (aOR: 3.28; 95\% CI: 1.16–9.29), and average to difficult rating on the Pictorial Assessment of Temperament test (aOR: 3.30; 95\% CI: 1.17–9.29).\textsuperscript{70}

Whether congenital muscular torticollis is the main predisposing factor for DP remains controversial. Although one study found asymmetries of the head and neck to be common in normal newborn infants, and 16 (16\%) of 102 were found to have torticollis at birth,\textsuperscript{74} other recent studies suggest that cranial shape is more often determined by postnatal factors than prenatal and perinatal factors and that most concomitant cervical imbalance (positional torticollis) develops postnatally along with DP.\textsuperscript{75}

DP results from unevenly distributed external pressure, resulting in abnormal head shapes. Most cases involve unilateral occipital flattening, ipsilateral frontal bossing, and anterior shifting of the ipsilateral ear and cheek.\textsuperscript{76} A rapidly growing head is malleable and most susceptible to deformation between 2 and 4 months and declines thereafter.\textsuperscript{70,72,77} Placing the infant repeatedly on the same side according to infant preferences, as well as slower motor development, are risk factors for the development of DP. In the NICU, occupational and physical therapists often make use of various positioning devices and supports, such as blanket rolls and commercially available products, to prevent progression and to correct DP and torticollis.\textsuperscript{70–77} However, these therapies are contraindicated when the infant is getting closer to discharge from the hospital, as they are generally not consistent with home infant sleep safety recommendations.

Many infants with DP undergo additional treatment at home. Such treatments, including physical therapy, need to be in line with safe sleep recommendations. Devices that promote a nonsupine sleep position or have the potential to compromise the airway are not appropriate. The “Congress of Neurological Surgeons Systematic Review and Evidence-Based Guideline on the Management of Patients With Positional Plagiocephaly: The Role of Repositioning” stated that it cannot at this time endorse any sleep positioning device because it would be contrary to the repeated recommendations set forth by the AAP Task Force on Sudden Infant Death Syndrome to avoid placing any soft surface bedding in the infant’s crib.\textsuperscript{78} Although orthotic helmet therapy can be difficult for the parents and can cause side effects, including sweating, irritation, and pain for the infant, they can provide significant and faster improvement of cranial asymmetry in infants with positional plagiocephaly compared with conservative therapy. The Congress of Neurologists recommends a helmet for infants with persistent moderate to severe plagiocephaly after a course of conservative treatment or if the infant presents at an advanced age.\textsuperscript{79}

A recent randomized controlled trial in Finland evaluated the causal relationship between DP and cervical imbalance (positional torticollis). The intervention group was given instructions to create a nonrestrictive environment that promotes spontaneous physical movement and symmetrical motor development.\textsuperscript{77} The instructions focused on 3 areas: alternating head position laterally (left and right) during feeding and sleep, avoiding excessive awake time in supine position (including prolonged placement in car seats and other devices) in addition to using tummy time daily, and preventing...
restriction of movement. Infant neck stretching exercises were performed by the parents if an infant showed signs of muscular imbalance of the neck.\textsuperscript{77} Infants in the intervention group were less likely to have DP at follow-up, and if present, the asymmetry was milder. In addition, infants who had DP were more likely to have torticollis. This study concluded that early intervention reduces the prevalence and severity of DP at 3 months.\textsuperscript{77}

The Finnish randomized controlled trial was similar to a prevention project among Swedish child health nurses that incorporated a short cranial asymmetry prevention program.\textsuperscript{80} In this study, researchers concluded that education of child health nurses, who in turn educate parents about NSP prevention, is successful in increasing parents’ awareness of safe interventions to prevent acquired cranial asymmetry.\textsuperscript{80}

These studies provide an evidence-based approach that the parents can use to maintain the supine position for infant safety while decreasing the risk of NSP and/or DP and cervical imbalance (positional torticollis). For more information on congenital muscular torticollis, see the 2019 AAP State of the Art report: Congenital Muscular Torticollis: Bridging the Gap Between Research and Clinical Practice.\textsuperscript{81} For more information on DP, see the Congress of Neurologic Surgeons Systematic Review and Evidence-Based Guidelines for the Patients With Positional Plagiocephaly.\textsuperscript{78,79,82–84}

**Conclusions Regarding DP and Torticollis**

1. DP and torticollis occur commonly in the NICU environment.
2. The preterm infant is especially at risk for DP because of decreased mineralization of the skull bones, as well as more prone and side positioning.
3. Positioning devices recommended by qualified personnel, such as but not limited to occupational and physical therapists, can be used to prevent, control, and correct DP and torticollis while infants are under continuous monitoring in the NICU.
4. Parents need to be educated regarding the use of sleep positioning devices: that their use is limited to the inpatient setting under strict monitoring and that they are not part of a safe sleep environment.
5. Orthotic helmets may be appropriate for infants with persistent moderate to severe plagiocephaly after a course of conservative treatment or if the infant presents at an advanced age.\textsuperscript{79}
6. Parents should be educated to avoid excessive use of car seats and infant positioning devices that can promote DP.
7. Education regarding tummy time should emphasize that it be performed during awake, supervised periods only and never when the infant is asleep, even with close supervision.
8. It is important to transition infants to a safe sleep environment well before discharge from the NICU.

**DEVELOPMENTAL DYSPLASIA OF THE HIPS**

Clinical hip instability occurs in 1% to 2% of term infants, yet up to 15% of term infants have hip instability or immaturity detectable by imaging studies.\textsuperscript{85} Developmental dysplasia of the hip (DDH), which was previously called congenital hip dislocation, is the most common neonatal hip disorder and is no longer considered congenital but developmental in origin. The incidence of DDH is approximately 1 to 2/1000 live births, but this estimate does not encompass the entire spectrum. At birth, an involved hip is rarely dislocated but is dislocatable. The clinical significance depends on whether the hip stabilizes, subluxates, or dislocates and is dependent on many factors, including breech position, female sex, incorrect lower extremity swaddling, and positive family history. Breech presentation may be the single most important risk factor; DDH is reported to occur in 2% to 27% of boys and girls presenting in breech position.\textsuperscript{86–88} Other nonsyndromic findings associated with DDH include being the first born, presence of torticollis, foot abnormalities, and oligohydramnios.\textsuperscript{89,90}

Many mild forms of DDH resolve without treatment. The clinical hip examination plus or minus abnormalities on ultrasonography will determine the need for an abduction brace (frequently referred to as a Pavlik harness). Potential risks associated with the use of the Pavlik harness include aseptic necrosis of the femoral head, temporary femoral nerve palsy, and obturator (inferior) hip dislocation.\textsuperscript{88,91,92} Stopping treatment after 3 weeks if the hip does not reduce and proper strap placement with weekly monitoring are important to minimize the risks associated with brace treatment.\textsuperscript{93,94} Some clinicians use double or even triple diapering to manage DDH; although innocuous, it is probably ineffective.\textsuperscript{95}

Transitioning the NICU patient to a safe home sleep environment often involves swaddling, which reduces crying and facilitates better sleep. In utero, the infants’ legs are in the fetal position with the knees bent up and across each other. Sudden straightening can loosen the joints and damage the soft cartilage of the socket. Improper swaddling may lead to hip dysplasia and should be avoided in infants with this diagnosis. Infants should never be placed in prone or side positions while swaddled. Proper hip swaddling techniques can be found...
for more information, refer to 4. Parents should be well-educated
PEDIATRICS Volume 148, number 1, July 2021 7
systemic problems affecting from airway compromise or other infants will have respiratory distress bronchopulmonary dysplasia. Some respiratory conditions, such as transient tachypnea of the newborn, with rapid resolution, such as will have acute respiratory distress in the prone position, because it has been shown to increase the risk of rebreathing exhaled gases, which can result in hypoxia or hypercarbia. The prone position decreases the rate of heat loss and increases body temperature, putting the infant at risk for overheating. Prone positioning has been shown to alter autonomic regulation of the cardiovascular system, especially in preterm infants, potentially decreasing cerebral oxygenation. Prone positioning also encourages longer and deeper sleep periods with fewer awakenings and behaviors associated with stress. The SIDS triple risk hypothesis suggests that some infants who die because of SIDS had an intrinsic abnormality in the brainstem that prevented appropriate arousal to an environmental threat. All of these elements (rebreathing, overheating, and impaired sleep arousal) have been implicated in increased SIDS risk. However, there is some evidence of potential respiratory benefit with prone positioning.

**Acute Respiratory Distress**

Once umbilical catheters are removed, one of the commonly used interventions to decrease respiratory symptoms in the newborn infant is prone positioning. Numerous studies have been performed to understand what components of ventilation and oxygenation are affected by prone positioning, as well as the effects of PMA and degree of illness (acute versus chronic lung disease). Wagaman et al found that prone positioning of preterm infants with acute respiratory disease resulted in significantly improved arterial oxygen tension, dynamic lung compliance, and tidal volume. Improved diaphragmatic excursion may contribute to increased tidal volume seen with prone positioning. In the supine position, the abdominal contents can oppose excursion of the diaphragm, limiting ventilation. Improvement in oxygenation may be related to improved ventilation-perfusion matching. In the supine position, some lung tissue is dependent to the heart and mediastinal structures, increasing the risk of atelectasis in the unstable newborn lung. In addition to improved lung volume, there is evidence of less intrapulmonary shunting and improved thoracoabdominal synchrony in the prone position.

In a Cochrane review from 2012, researchers evaluated positioning for acute respiratory distress in hospitalized infants and children using data from 24 studies with a total of 581 participants. Although the data combined studies of infants and children, 60% were preterm infants. Seventy percent of the study participants were evaluated while on mechanical ventilation. Results were limited because of lack of data for many parameters, small participant numbers, and short study times. There was a small but statistically significant improvement in oxygenation (2% higher oxygen saturations) when positioned prone. Prone positioning also provided a small improvement in tachypnea, with a decrease of 4 breaths per minute.

Although these results are statistically significant, they may be of marginal clinical relevance. However, because the extremely preterm infant will have a prolonged hospital course in the NICU, the benefit of prone positioning during the acute phase of respiratory illness may outweigh the importance of modeling safe sleep positioning at that time. Nonsupine positioning can still be viewed as a teachable
moment between clinician and family. Early safe sleep education can be incorporated into explanations as to why the infant is positioned nonsupine during acute respiratory distress.

### Chronic Respiratory Distress

Fewer data are available for determining any benefits of prone positioning in the convalescent preterm infant with resolving pulmonary disease. A small study of 20 preterm infants (median gestational age of 30 weeks; range, 27–32 weeks) recovering from respiratory distress syndrome evaluated pulmonary mechanics at a median postconceptional age of 35 weeks. In oxygen-dependent infants, oxygen saturations and functional residual capacity were higher in the prone position, but there were no differences in compliance or resistance of the respiratory system. In addition, there were no differences in any of the measurements for non–oxygen-dependent infants.

In another study of healthy preterm infants approaching discharge with no history of respiratory distress, there was no effect of prone versus supine positioning regarding respiratory rate; tidal volume; minute ventilation; lung compliance; pleural pressure; or inspiratory, elastic, and resistive work of breathing. Other studies have shown conflicting results; Hutchinson et al found increased tidal and minute volumes but also increased work of breathing in late preterm infants in the prone position. Elder et al found no impact of position on oxygen saturations in preterm infants approaching hospital discharge. Leipala et al found an increase in tidal volume but lower respiratory muscle strength in the prone compared with the supine position in preterm infants studied immediately before discharge from the hospital.

The contradiction of improved respiratory function for some preterm infants with the decreased risk of SIDS or sleep-related deaths must be resolved or, as Poets and von Bodman noted, we are left with a "cognitive dissonance otherwise resulting from parents seeing their infant being nursed in the prone position for several weeks while being told that they must place their infant supine once at home." At some point, the diminishing benefits of prone positioning are outweighed by the risk of SUID, a leading cause of postneonatal mortality. Clearly, this needs to be addressed well before discharge from the NICU.

### Upper Airway Obstruction

Numerous congenital abnormalities of the airway can result in respiratory compromise. Pierre Robin sequence can be particularly challenging in regard to infant sleep safety because of the gravity-dependent tongue-based obstruction. For infants on the mildest end of the spectrum who do not experience significant airway obstruction while in the supine position and have normal arterial saturations and adequate gas exchange, there is no need to deviate from standard safe sleep recommendations. In the 40% of cases that are severe, infants will require an inpatient surgical intervention, such as mandibular distraction osteogenesis, tongue-lip adhesion, or tracheostomy, resulting in a stable airway in supine position at discharge. However, the intermediate cases are more problematic because they are not severe enough for early surgical intervention but require the side or prone position for a stable airway. In these cases, it may be appropriate for an infant to sleep on the side or in prone position with consideration of using a home monitor with or without pulse oximetry. Although home monitoring does not prevent or reduce the risk of SUID and is not recommended for that purpose, in this situation monitoring including consideration of pulse oximetry is appropriate for limiting airway obstruction, which could lead to hypoxic injury or death. Regardless, these infants should be managed by a specialized team proficient in the care of such disorders.

### Conclusions Regarding Respiratory Distress

1. For the infant with acute respiratory distress, regardless of gestational age, nonsupine positioning may be used as clinically indicated to stabilize and/or improve respiratory function.
2. If nonsupine positioning is used, especially as the infant matures, parents should be educated about infant sleep safety and the reasons for deviating from home safe sleep recommendations.
3. Once the acute respiratory distress is resolving, the infant should be placed supine for modeling home safe sleep, and the parents should receive additional education before hospital discharge.
4. For infants who have developed chronic lung disease, periodic assessments can be performed to monitor the infant’s progress. Once the infant has weaned to a standardized minimal supplemental respiratory support (determined by the individual institution), then supine positioning can be maintained, and parents should receive additional education before hospital discharge.
5. Management of the infant with upper airway obstruction needs to be individualized on the basis of the severity of the obstruction. Nonsupine positioning may be necessary to prevent excessive hypercarbia or hypoxemia.
Consideration should be given to home monitoring of the marginal airway.

APNEA OF PREMATURITY

Infant apnea is defined by the AAP as "an unexplained episode of cessation of breathing for 20 seconds or longer, or a shorter respiratory pause associated with bradycardia, cyanosis, pallor, and/or marked hypotonia." Apnea can be classified as central, obstructive, or mixed, on the basis of airflow and respiratory effort. The incidence of apnea is inversely proportional to gestational age. Although all infants born at less than 28 weeks' gestation will have recurrent apnea, the incidence decreases to 20% by 34 weeks' gestation, and these events resolve in 98% of infants by 40 weeks' PMA. It is unclear as to what degree of apnea is considered acceptable, and there is concern about the long-term neurodevelopmental effects of recurrent apnea and periodic breathing on the preterm infant. Measurements of cerebral oxygenation using near-infrared spectrophotometry have demonstrated decreases in tissue oxygenation during apneic events in preterm infants both late in hospitalization and up to 6 months' postterm corrected age. It has been suggested that intermittent hypoxia resulting from continuing apnea and periodic breathing can cause hypoxic cerebral injury and worsening of neurodevelopmental outcomes.

Some research has suggested that use of the prone position may reduce apnea frequency and/or severity. In a small study of 35 preterm infants that used a crossover design placing each infant supine and prone, there were significantly more central and mixed apneas in the supine position. In addition, during mixed apneas, there were greater decreases in heart rate (P = .02), longer duration of bradycardia (P = .0003), and longer accompanying desaturations (P = .03) when infants were in the supine position. In another small crossover design study of 14 stable preterm infants, there was no positional difference in the incidence of bradycardia, but there was an increase in apnea density, defined as the number of episodes lasting >6 seconds during quiet sleep (4.5 vs 2.5; P = .01), and periodic breathing (percentage of quiet sleep, 13.6% vs 7.7%; P = .015) when infants were in the supine position.

In more recent studies, researchers have found either no positional differences in the incidence of apnea or bradycardia or a reduction in alarms with supine positioning. Bhat et al found preterm infants in prone position to have more central apneas (median: 5.6 vs 2.2; P = .04) but fewer obstructive apneas (0.5 vs 0.9; P = .007). While supine, the infants had more awakenings (9.7 vs 3.5; P = .003) and arousals per hour (13.6 vs 9.0; P = .001). These studies were also limited by small sample size. A 2017 Cochrane review identified 5 eligible trials totaling 114 infants in which no statistical differences were identified between supine and prone positioning with regard to the frequency of apnea, bradycardia, or oxygen desaturations. The overall quality of evidence was low, and the reviewers concluded that they “cannot recommend use of one body position over another for spontaneously breathing preterm infants with apnea.” For additional information on apnea of prematurity, refer to the AAP clinical report: Apnea of Prematurity.

Home Monitors

Home monitors are frequently used in the NICU setting to allow for earlier discharge of infants with mild, persistent apnea of prematurity. However, they have not been found to be protective against SUID and are not recommended for this purpose. In addition, the use of non-medical-grade monitors has increased in popularity. As per task force recommendations, parents should be educated that no monitor takes the place of following the safe sleep recommendations.

Conclusions Regarding Apnea and Prone Positioning

1. There is inadequate evidence to justify the use of prone positioning for the treatment of apnea of prematurity.
2. For more information on apnea of prematurity, refer to the AAP clinical report on apnea of prematurity.

GASTROESOPHAGEAL REFLUX DISEASE

GER is a normal developmental process that involves the involuntary passage of gastric contents into the esophagus. GER episodes are usually brief, with little or no symptoms. Many healthy, term infants have 30 or more episodes per day of GER and are known as “happy spitters.” Generally, these episodes dissipate over the first year of life as the smooth muscle of the lower end of the esophagus increases in tone with maturation. These episodes of GER are classified as transient lower esophageal sphincter relaxations, whereas pathologic GER, or gastroesophageal reflux disease (GERD), involves signs and symptoms of esophagitis with reflux into the esophagus, oral cavity, and/or airways. Putative morbidities of GERD in preterm infants include frequent vomiting, aspiration pneumonia, irritability, failure to thrive, and exacerbations of respiratory symptoms. GER and GERD probably represent 2 ends of a spectrum of the same
condition, varying with the severity of the gastric reflux.\textsuperscript{134,135}

As feeding volume increases and/or abdominal straining occurs, the likelihood of acid reflux episodes increases.\textsuperscript{132} The presence of a nasogastric or orogastric tube may also contribute to GER because its presence impairs the ability of the lower esophageal sphincter to completely close, especially in the first postprandial hour.\textsuperscript{136,137} Esophageal motility, transit time, and gastric emptying are known to be slower in the preterm infant. Full maturation of the intestinal motor function does not occur for several months. Contractions of the gastrointestinal tract with feedings are neurally regulated but modulated by gastrointestinal tract hormones.\textsuperscript{138}

Small enteral feedings (20–24 mL/kg per feeding) produce a more mature motor pattern validated by improved feeding tolerance and faster gastric emptying and intestinal transit time.\textsuperscript{139} Approximately 80% of infants with uncomplicated GER will improve with conservative measures alone, including small frequent feeds and holding the infant upright for 20 to 30 minutes after feeding. If present, removal of a nasogastric or orogastric tube may also improve symptoms of GER.\textsuperscript{137,140}

In term infants, GER symptoms can be abated by avoidance of overfeeding and exposure to tobacco smoke, change of formula, and the use of thickened feeds.\textsuperscript{141} Thickening of human milk with starch is problematic because the viscosity decreases over time because of amylase in the milk, which degrades the starch in the thickener.\textsuperscript{142} Care should be taken with thickening feeds for preterm infants because a xanthan gum product has been linked to late-onset necrotizing enterocolitis.\textsuperscript{143} In addition, commercially available formulas that thicken on acidification in the stomach are not nutritionally optimal for the preterm infant. Although there is no reason to suspect that thickening of feeds would work differently in preterm as compared with term infants, there are few data showing the efficacy of thickened feeds in this population.\textsuperscript{4}

According to Salvatore and Vandenplas in 2002, as many as 15% to 40% of infants with GER or GERD have a cow milk protein intolerance or dietary protein–induced gastroenteropathy. After the neonatal period, a trial of an elemental formula may be indicated in infants younger than 1 year if a cow milk protein intolerance is suspected.\textsuperscript{144} For infants receiving human milk, similar improvement can be obtained by restricting all dairy, including casein and whey, in the mother’s diet.\textsuperscript{141} Cow milk protein intolerance is most often diagnosed in infants on the basis of their symptoms and how they respond to dietary changes. There is evidence to support a trial of an extensively hydrolyzed protein formula for 2 to 4 weeks in term infants, but if no improvement occurs with this dietary change, the infant’s normal diet can be resumed.

In the preterm infant, the persistence of symptoms, despite holding the infant upright for 20 to 30 minutes, small frequent feeds, and removal of the nasogastric or orogastric tube if feasible, often leads to the use of therapeutic interventions, such as side-lying and elevation of the head of the bed. There is no benefit to elevating the head of the bed, and it should be avoided, especially after discharge, because it may actually increase the risks of SUID.\textsuperscript{145} Often, a combination of pH and electrical impedance monitoring is used to evaluate the effect of body positioning on GER and GERD.\textsuperscript{145–148} Placing the preterm infant in the left lateral position after feeding versus right lateral position and placing the infant prone versus supine may decrease GER episodes.\textsuperscript{147,149,150} Although placement of the infant in the right lateral position may increase GER episodes, it may promote gastric emptying.\textsuperscript{150} Prone and lateral positioning of infants from birth to 12 months is associated with an increased risk of SUID and should be avoided. The risks associated with prone and/or lateral positioning outweigh any benefit gained. Multiple studies in different countries have not shown an increase in the incidence of aspiration since the change to supine sleeping.\textsuperscript{151–153}

Despite the evidence against aspiration in the supine position, many parents and caregivers remain unconvinced.\textsuperscript{154–162} Coughing or gagging is misconstrued as aspiration, although it represents the normal protective gag reflex. The AAP concurs with the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition that the risk of SUID outweighs the benefit of prone or lateral sleep position on GER. Therefore, most infants from birth to 12 months of age should be positioned supine during sleep. Elevating the head of the infant’s crib while the infant is supine is not effective in reducing GER.\textsuperscript{163,164} If the head of the bed is elevated, the infant may slide into positions that may compromise the airway and result in the death of the infant.

In the 1980s, the US Food and Drug Administration had approved several devices to reduce GER or positional plagiocephaly. However, after reports to the Consumer Product Safety Commission (CPSC) of a number of deaths, the Food and
Drug Administration required manufacturers to demonstrate that the product benefit outweighed the risk of suffocation. Many manufacturers dropped their claims of medical benefit, but devices continued to be sold by retailers directly to the public as non–medical-grade devices.

In 2019, inclined sleepers (which are frequently advertised as being beneficial for infants with GER) came under additional scrutiny after a series of deaths were reported to the CPSC and additional deaths were uncovered in a *Consumer Reports* article. Major manufacturers voluntarily recalled their products. The CPSC issued a statement for a supplemental proposed rule (Supplemental NPR), proposing to adopt the current ASTM International standard for inclined sleep products, with modifications that would make the mandatory standard more stringent than the voluntary standard. The proposed changes include limiting the seat back angle for sleep to 10 degrees or less.

Often, health care providers are pressured to elevate the head of the bed and/or provide pharmacologic interventions despite the lack of evidence supporting these practices. A recent study demonstrated that infants could more easily roll from supine to prone in an inclined sleeper, and once in the prone position, they would fatigue faster than they would on a stable, flat surface because of the high musculoskeletal demands necessary to maintain safe posture to prevent suffocation. The study also found that prone positioning on an inclined sleep surface places the infant at higher risk of airway obstruction or suffocation, as evidenced by oxygen saturation results. These results may provide a mechanism to some of the suffocation deaths related to car seats and other sitting and carrying devices.

Safe sleep is paramount during maturation of the lower esophageal sphincter, which will abate the symptoms of GER with time. Therefore, supine positioning is the preferred safe sleep position for infants with GER or GERD. For a more extensive discussion of GER and GERD in the preterm and young infant, see the AAP clinical report “Diagnosis and Management of Gastroesophageal Reflux in Preterm Infants” or the “Pediatric Gastroesophageal Reflux Clinical Practice Guidelines: Joint Recommendations of the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition and the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition.”

**CONCLUSIONS REGARDING GER AND GERD**

1. GER is extremely common in infants in the NICU.
2. Because of the increased risk of SUID, infants should not have the head of the bed elevated, nor should they be laid down on their side or prone.
3. Term infants can be treated with small, frequent feeds; holding the infant upright after feeding; thickened feeds; elemental formula; and removal of the nasogastric or orogastric tube, when appropriate. If the mother is providing human milk, elimination of all cow milk protein from her diet may be beneficial.
4. Preterm infants can be treated as above, but care should be taken to avoid commercial thickeners because of the association with necrotizing enterocolitis.
5. For more information, refer to the AAP clinical report on GER in the preterm infant (“Diagnosis and Management of Gastroesophageal Reflux in Pre-term Infants”).

**THERMOREGULATION**

Temperature regulation in the newborn infant is frequently referred to as being immature at birth secondary to the lack of completely developed thermoregulatory mechanisms, including large surface area-to-volume ratios and the relatively small insulating body shell. As a result of this immaturity, neonates do show greater fluctuations of body temperature and difficulty in achieving acceptable thermoregulation.

It is well-established that prevention of hypothermia and achieving normothermia in newborn infants decreases mortality and optimizes outcomes. Achieving a neutral thermal environment is the goal for every patient in the NICU. Achieving a neutral thermal environment requires that thermoregulatory control be a balance between heat production and heat loss. Measures to achieve this goal include drying the infant at birth; providing warmth and insulated surfaces, as needed; providing radiant heat; and avoiding cool air currents. In addition, humidity is routinely used in incubators in the NICU. Certain clinical scenarios require chemical mattresses and polyethylene wraps or bags to prevent heat loss.

Hats are also routinely used in the delivery room to reduce heat loss. Estimates of heat loss from the head and face of the newborn infant vary but have been reported at up to 85%. Some estimates, based on study of clothed adults, may be significantly inflated. An infant simulation study using a heated mannequin model found wearing a hat decreased the local heat loss by an average of 18.9% in all clothed and thermal conditions. The type of hat used to reduce heat loss is
important. A simple stocking net hat has been shown to provide minimal improvement in temperature.\textsuperscript{175} Although data are inconsistent, a polyethylene hat has been shown to be more effective in preventing heat loss in the delivery room for preterm infants.\textsuperscript{176} In a small study, researchers found a cotton-wool (Gamgee) material reduced heat loss in term infants.\textsuperscript{177}

Although preterm infants cannot regulate their body temperature as well as term infants, their thermoregulatory ability improves with maturation.\textsuperscript{178} Weight-based criteria for weaning out of the incubator to a cot or bassinet varies from center to center.\textsuperscript{179–181} A Cochrane review in 2011 concluded that transfer to a cot when the infant attained a weight of 1600 g did not have adverse effects on temperature stability or weight gain, and earlier weaning from the incubator did not necessarily lead to earlier discharge.\textsuperscript{182}

Discharge readiness is usually determined by demonstration of functional maturation, including the physiologic competencies of thermoregulation.\textsuperscript{179} Often, the ability to increase metabolism and generate heat reaches that of the term infant before 40 weeks’ PMA, which is reassuring at the time of discharge planning from the NICU. Prone sleeping infants have a reduced ability to lose heat, which can lead to overheating.\textsuperscript{180} Evidence points toward probable differences in autonomic control of metabolism and cardiorespiratory function in the prone versus supine position.\textsuperscript{170}

Nonetheless, overheating, as well as prone positioning, is an independent risk factor for SUID and must be avoided.\textsuperscript{1} Although studies have shown an increased risk of SUID with overheating, the definition of overheating has varied, making it difficult to recommend a specific room temperature guideline to avoid overheating.\textsuperscript{183,184}

Infants should be dressed appropriately for the environment.\textsuperscript{175–177} In term infants, this is usually 1 layer more than an adult. However, there is significant variation in how preterm infants are transitioned from the incubator to the open crib, including weight criteria, PMA, number of layers of clothing provided, and use of wearable blankets and hats.\textsuperscript{179,180} In one study, infants were placed in the bassinet with 2 layers of blankets or a sleep sack and a hat.\textsuperscript{180} Although the focus during transition to the open bassinet is on prevention of hypothermia, once the infant demonstrates temperature stability, providers should turn their attention to modeling safe sleep and the dangers of overheating and overbundling. Infants are safest when they do not sleep with blankets.\textsuperscript{173,185} If there is concern that the infant will become cold, an infant sleeping bag, sleeping sack, or wearable blanket is recommended as an alternative to blankets. When using a sleeping bag, special care should be taken with the preterm infant to ensure they cannot slip inside and that the head cannot become covered.\textsuperscript{186} Some wearable blankets come with a swaddle feature. There is no evidence to recommend swaddling (wrapping the infant in a light blanket or wearable blanket with a wrap) as a strategy to reduce the risk of SUID.\textsuperscript{1} Refer to the section on developmentally sensitive care for a discussion of the risks and benefits of swaddling.

Parents and/or caregivers should be educated on evaluating the infant for signs of overheating, including sweating or the chest feeling hot to the touch.\textsuperscript{1} Overbundling and covering of the face and head should be avoided.\textsuperscript{173} Head covering is associated with an increased risk of SUID. This increased risk with head coverings generally refers to covering with bedding or bed clothes. Only one study refers specifically to hats, finding that although the majority did not wear hats, there were significantly more hat-wearing infants among the SIDS infants compared with the control infants.\textsuperscript{187} A systematic review of 10 population-based, age-matched controlled studies found the pooled prevalence of head covering in SIDS victims was 24.6% compared with 3.2% of controls. The causal mechanism of this increased risk remains unclear, but hypoxia, rebreathing, and thermal stress have been hypothesized as mechanisms.\textsuperscript{173} Although it may be unlikely that dislodgement of a hat could lead to obstruction of an infant’s airway, there may be legitimate concern regarding their contribution to overheating and/or thermal stress. A recent article questioned the necessity of hats for preterm infants after initial stabilization.\textsuperscript{188} A chart review of 729 infants transitioned out of supplemental heat without the use of hats found a failure rate attributable to hypothermia of 2.7%. Given the questionable benefit of hat use and the potential for harm, clinicians should weigh the risk/benefit ratio in regard to discharging an infant from the NICU with a hat. If the infant is discharged wearing a hat, the clinician should provide instruction for families to discontinue use once the infant demonstrates stable temperatures in the home environment. This should include education about how to determine that the infant’s temperature is stable.

**Conclusions Regarding Thermoregulation**

1. Preterm and low birth weight infants are prone to temperature instability and may require
Additional bundling to avoid hypothermia.

2. Excessive bundling should be avoided because overheating and head covering have been associated with an increased risk of SUID.

3. If an infant is discharged wearing a hat, families should be counseled to discontinue its use once the infant demonstrates temperature stability in the home environment.

4. If swaddling is performed, it is important that it is done properly, the infant is always placed supine, and it is discontinued when the infant begins to attempt to roll.

**Hyperbilirubinemia and Phototherapy**

Hyperbilirubinemia is an extremely common problem in both the term and preterm infant. During the first week of life, up to 60% of term newborn infants and 80% of preterm infants will develop jaundice because of the immaturity of the liver, leading to elevated concentrations of circulating unconjugated bilirubin. Beyond the common physiologic jaundice of the newborn infant, there are many hemolytic conditions and other abnormalities that can lead to excessive jaundice. Nomograms are available to help the clinician detect which term and late preterm infants are at higher risk of going on to develop excessive jaundice that untreated could lead to kernicterus and permanent bilirubin encephalopathy.

The mainstay of therapy for neonatal unconjugated hyperbilirubinemia is phototherapy. The factors that affect the dose of phototherapy are the irradiance of the light used, the distance from the light source, and the amount of skin exposed. The infant should be naked except for diaper and eye protection. The phototherapy dose increases as the distance from the light to the infant decreases. Spectral power increases as the amount of skin exposed to phototherapy increases and can be maximized by using a phototherapy blanket under the infant while using phototherapy lamps over the infant.

When using standard phototherapy units, many providers choose to rotate the infant between supine and prone positioning. Several small studies have been undertaken to evaluate the utility of changing the position of the neonate during phototherapy, and no benefit in relation to decrease in bilirubin concentrations was found. All recent studies have been evaluated in a systematic review that also concluded that supine positioning is as effective as turning infants periodically. Two more recent and larger trials provide additional evidence suggesting that positional change is unnecessary for successful use of phototherapy. Donneborg included infants as young as 33 weeks’ gestation and used higher light irradiance compared with older studies. The study demonstrated identical rates of decrease in total serum bilirubin at 12 and 24 hours after initiation of phototherapy, regardless of supine or alternating positioning. Most recently, Bhethanabhotla et al studied 100 infants of greater than 34 weeks gestational age and found no difference with or without positioning in the duration of phototherapy or the rate of decrease in total serum bilirubin concentration.

Although the AAP guideline “Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation” did not comment on positioning of the infant during phototherapy, there is an analysis and statement from the United Kingdom’s National Institute for Health and Clinical Excellence (NICE) on this issue. The NICE Guideline Development Group accepted that, in term infants, the position of the infant during phototherapy has no significant influence on duration of phototherapy or mean change in serum bilirubin concentration. It concluded that to ensure consistent advice regarding the risk of SIDS, infants should be placed in a supine position.

The NICE recommendation did not include preterm infants, because it was released before the most recent studies that included infants as early as 33 weeks’ gestation. However, the consistency of the results in both term and middle-to-late preterm infants should provide clinicians with confidence in maintaining these infants in a strictly supine position if there is no other contraindicating medical condition. Modeling the supine position is a powerful tool in the education of families regarding infant sleep safety and SUID risk reduction. These more mature preterm and term infants are likely to have short stays in the NICU, so early modeling of safe sleep is more pressing, and the use of phototherapy should not interfere with supine sleep positioning.

**Conclusions Regarding Phototherapy**

1. Hyperbilirubinemia and the use of phototherapy is common in term and preterm infants in the NICU.

2. There is no benefit to changing an infant’s position while under phototherapy. However, the provider may choose to place the infant on a bilirubin blanket, in addition to an overhead phototherapy unit, if the absolute total serum bilirubin concentration is increasing rapidly, in effect,
performing double-sided phototherapy.
3. Unless there are other competing medical issues, infants should be kept supine while receiving phototherapy to model and promote infant sleep safety.

**NEONATAL OPIOID WITHDRAWAL SYNDROME**

NOWS is a clinical condition observed in neonates experiencing withdrawal from in utero opiate exposure.\(^{197}\) Symptoms caused by central nervous system irritability, autonomic nervous system dysfunction, and gastrointestinal and respiratory tract distress typically appear 2 to 3 days after birth and can last for weeks or months.\(^{197}\) Although opiate replacement therapy may be indicated on the basis of the severity of clinical presentation, the foundation of treatment and support of the infant with NOWS is directed at supportive, nonpharmacologic care aimed at minimizing the stimulation that is being experienced and/or supporting the infant to self-regulate.\(^{198,199}\) These measures include promoting SSC,\(^{200}\) rooming-in and breastfeeding,\(^{201-203}\) decreasing light and noise,\(^{200}\) swaddling and positioning,\(^{200}\) use of pacifiers and/or rockers,\(^{200}\) and massage.\(^{200}\) Many of these interventions, commonly associated with developmentally sensitive care, previously described in this report, have variably been shown to help support preterm infants’ neuroregulation, decrease length of medical treatment, and decrease hospital length of stay.\(^{198,200,203}\)

Despite a paucity of evidence, these interventions are being used to help support infants struggling with NOWS.\(^{198,200,203}\)

SSC has been recommended as a strategy to help support infants with NOWS for many of the same reasons as previously mentioned in this article, such as improved neurologic regulation, establishment of breastfeeding, and maternal bonding.\(^{200}\) One of the benefits of SSC is to enhance breastfeeding.\(^{204}\) which in turn has been shown to decrease the severity of NOWS symptoms, days of pharmacologic treatment, and hospital stay.\(^{198,205}\) Current recommendations support breastfeeding when the mother is compliant with maintenance therapy.\(^{197}\)

The importance of not falling asleep with the infant during SSC, especially after hospital discharge, should be stressed with opioid-dependent parents. The opioid-dependent parent falling asleep with the infant would be analogous to bed-sharing with someone who is impaired in his or her alertness or ability to arouse because of sedating medications, which greatly increases the risk of SIDS.\(^{1}\) Falling asleep with the infant during SSC is of particular concern for the mother of an infant with NOWS, because during pregnancy, women often require increases in methadone dosing because of factors such as increased intravascular volume and increased tissue reservoir and hepatic metabolism of the drug.\(^{206}\) The optimal approach to methadone dose management in the postpartum period, however, is not well defined, and there is the theoretical concern that methadone concentrations may increase as plasma volume and hepatic clearance return to the prepregnant state. Yet in a study of 101 methadone-maintained pregnant women, researchers found no significant increase in oversedation events: after adjusting for benzodiazepine prescriptions, the incident relative rate of an event among postpartum women compared with pregnant women was 1.74 (95% CI: 0.56–5.30).\(^{206}\)

Nevertheless, opioid exposure is still of concern because a retrospective study has implicated opiates in sudden infant death, with maternal methadone use identified in 31% of 32 neonatal deaths evaluated by autopsy.\(^{207}\) It is unclear whether the deaths were directly related to the methadone or other environmental factors. In addition, the frequent occurrence of polysubstance use (eg, tobacco and alcohol) among those who use opioids further increases the risk of sudden infant death, particularly associated with bed-sharing.\(^{208-210}\) Thus, presence of maternal substance use disorder warrants extensive safe sleep education before discharge from the hospital.

Swaddling is frequently used in the care of infants with NOWS and seems to be an effective therapeutic intervention for this population. Although no studies specifically address swaddling and infants with NOWS, it is believed the intervention may be useful to decrease excessive crying and promote sleep.\(^{198,199,211}\) Refer to the section on developmentally sensitive care for additional information on benefits and risks of swaddling.

Swings and motion devices are commonly used in NICUs, well newborn units, and pediatric inpatient units to calm fussy infants, particularly those suffering from NOWS. Rocking devices have been used through the ages for their calming effect on crying infants. Although not extensively studied, there are reports demonstrating the consoling effect of rocking.\(^{212,213}\) The data are inconsistent regarding direction of the movement, and one study showed more benefit by rocking at 60 cycles per minute versus 45 cycles per minute.\(^{213}\) A recent study showed benefit of rocking by either a parent or mechanical device, although rocking by the parent appeared to be more effective.\(^{214}\) It is important that staff use motion devices appropriately,
while infants are awake and properly monitored. In addition, infants should be moved to a safe sleep environment if they fall asleep in a swing or motion device, because these are not considered safe sleep surfaces. Although infants are under constant monitoring in the NICU environment, leaving a sleeping infant in a swing or motion device is poor modeling for families and undermines safe sleep messaging.

There is some evidence that placing infants who are experiencing narcotic withdrawal in the prone position decreases the severity of NOWS scores as well as caloric intake. As described previously in this article, prone positioning may increase the risks of musculoskeletal abnormalities as well as SUID, is not consistent with AAP safe sleep recommendations, and is not recommended as a strategy to console infants with NOWS outside of a monitored unit. Prone positioning may be useful for monitored inpatients during the acute withdrawal phase of NOWS but should be discontinued, and the patient should be placed in supine position as soon as possible and before discharge from the hospital.

The time that the infant may need these interventions focused on neurodevelopmentally sensitive care will depend on the length and severity of NOWS symptoms. Particularly in infants whose NOWS symptoms seem to worsen without these interventions, transition to safe sleep practices before discharge from the hospital often presents challenges to NICU clinicians and families. Each center caring for infants with NOWS should develop and implement a standardized process to identify when the infant has reached medical stability and transition to safe sleep recommendations before discharge from the hospital.

**CONCLUSIONS REGARDING NOWS**

1. There are some commonly used interventions in the treatment of NOWS (ie, prone positioning) that are not consistent with home infant sleep safety.

2. Early and frequent education is critical to prevent families from thinking that therapeutic interventions in the hospital that are not consistent with home infant safe sleep guidelines can be replicated in the home environment.

3. The use of therapeutic interventions that are not consistent with home infant sleep safety should be minimized. When they are necessary, it is important to review their use and transition to a safe sleep environment as early as possible.

4. Clear, consistent, safe sleep messaging should be emphasized with families of infants with NOWS well in advance of discharge from the hospital.

**HUMAN MILK AND BREASTFEEDING**

Although not directly related to the transition to safe sleep, a discussion about infant sleep safety is not complete without mentioning breastfeeding and human milk feeding. The benefits of breastfeeding are numerous, including decreased risk of infection; decreased risk of allergies, asthma, and eczema; decreased risk of obesity, inflammatory bowel disease, high cholesterol, and type 1 diabetes mellitus; and possibly decreased risk of some childhood cancers. In addition, in preterm infants, human milk has been shown to improve feeding tolerance and reduce the risk of necrotizing enterocolitis. Multiple studies have shown that breastfeeding is associated with a decreased risk of SUID. A recent meta-analysis found that providing term infants with any human milk for at least the first 2 months of life decreased the risk of SUID by 40% (relative risk 0.60 [0.44–0.82]).

The reduction in risk of SUID from human milk may be multifactorial. Human milk has biologically active components that are immunoprotective through their antimicrobial and immunomodulatory activity. Among the many components are white blood cells, stem cells, immunoglobulins (especially secretory immunoglobulin A), lactoferrin, lysozyme, and human milk oligosaccharides. The decrease in viral infections (which have been associated with an increased risk of SUID) may partially explain this protective effect of human milk. In addition, polyunsaturated fatty acids in human milk, in particular docosahexaenoic acid, are important in the overall maturation of the central nervous system, especially the cardiorespiratory center, and myelination of the brain. In one study, infants who died of SIDS had delayed myelination of the brain compared with control infants.

Given the increased risk of SUID in the preterm infant, breastfeeding and the use of human milk after discharge may be even more important in this population. However, successful maternal milk production is dependent on early initiation, and in the case of the preterm or term infant with respiratory distress, it requires the mother to provide expressed milk through pumping or hand expression. As a result, clinicians need to provide education regarding the benefits of breastfeeding on admission to the NICU, or earlier if possible, and work in multidisciplinary teams to enhance support for breastfeeding, milk expression, and provision of mother’s milk throughout the NICU stay. Furthermore, preterm infants and their mothers require...
significant support when they are discharged from the hospital and transition to direct breastfeeding in the home setting.\textsuperscript{234}

Finally, as noted in the previous discussion on SSC, it is critical that parents be aware of the dangers of falling asleep with their infant. This is especially important when mothers are rooming-in with their infant and not under constant observation by NICU staff. Although it is often stated that breastfeeding naturally results in maternal drowsiness from the release of prolactin and oxytocin, there are few data to support this concept.\textsuperscript{235,236} Breastfeeding mothers are often exhausted in the early days and weeks from sleep deprivation and disruptions in their normal circadian rhythms. In a 2019 study, researchers found that after delivery, new mothers averaged 3.7 hours of sleep, and the longest interval of sleep observed was between 2 and 3 hours throughout the postpartum hospital course.\textsuperscript{237} Of the 101 participants, 50 required at least 1 intervention or corrective action to address unsafe sleep.\textsuperscript{237}

Mothers may also be emotionally or physically exhausted from the stress and other demands of a NICU hospitalization.\textsuperscript{230} The risks for infant falls or smothering are analogous to those seen with rooming-in on the well newborn unit with healthy mother-infant dyads. Studies have observed associations between postpartum sleepiness and fatigue and decline in cognitive neurobehavioral functioning.\textsuperscript{239,240} Education of staff and families is crucial, and staff should also take care to evaluate the mother’s level of sleepiness.\textsuperscript{238,241} The risk of falls and sudden unexpected postnatal collapse should be minimized by conducting frequent assessments and monitoring of the mother-infant dyad and evaluating the level of maternal fatigue. If the mother or caregiver is tired or sleepy while holding the infant, the infant should be moved to a separate sleep surface.\textsuperscript{62}

This can be an opportunity for open, nonjudgmental discussion regarding the family’s infant sleep safety plan for home. The AAP 2016 policy statement on SIDS recommends room-sharing with the infant on a separate sleep surface.\textsuperscript{2} The policy also states numerous conditions under which bed-sharing is particularly dangerous. And even in situations in which there are no other risk factors, there is some evidence of increased risk with bed-sharing, especially in the youngest age groups and among those who were born preterm or with low birth weight. Sample size limitations prevent a determination of how large that risk is, but clearly the data do not support a definitive conclusion that bed-sharing in the youngest group is safe, even under less hazardous circumstances. For additional information, refer to both the AAP clinical report “Safe Sleep and Skin-to-Skin Care in the Neonatal Period for Healthy Term Newborns”\textsuperscript{62} and AAP technical report “SIDS and Other Sleep-Related Infant Deaths: Evidence Base for 2016 Updated Recommendations for a Safe Infant Sleeping Environment.”\textsuperscript{1}

CONCLUSIONS REGARDING HUMAN MILK AND BREASTFEEDING

1. The use of human milk is recommended for its numerous health benefits, including reducing the risk of SUID.
2. Special care should be taken when mothers are rooming-in and breastfeeding to minimize the risk of falling asleep with the infant in the adult bed.
3. Provide mothers with appropriate outpatient support to optimize breastfeeding success after discharge from the hospital.

A RATIONAL APPROACH TO TRANSITION OF THE NICU PATIENT TO A HOME SLEEP ENVIRONMENT

Consistent messaging and modeling in the newborn nursery have been shown to improve parental intent to keep infants supine and not share sleep surfaces.\textsuperscript{11,242–244} In the NICU environment, McMullin et al found that a bundled intervention for nursing can lead to consistent modeling of safe sleep before hospital discharge. The intervention included nursing education, crib cards, written instructions reviewed with parents, and sleep sacks for modeling to parents. Audits 6 months after the intervention found 98% of infants supine in open cribs, 93% of infants in sleep sacks, and 88% of bassinets with safe sleep crib cards visible.\textsuperscript{245}

Standardized programs have also demonstrated higher rates of supine sleep and other safe sleep behaviors in the home.\textsuperscript{246,247} Given that 20% of SUID cases involve preterm infants and preterm infants are at a twofold to threefold increased risk of SUID,\textsuperscript{248–250} it is critical that families of infants in the NICU be exposed to safe sleep environmental modeling and education for a successful transition to a safe sleep environment in the home. The AAP through its Committee on Fetus and Newborn recommends that “preterm infants should be placed supine for sleeping, just as term infants should, and the parents of preterm infants should be counseled about the importance of supine sleeping in preventing SUID. Hospitalized preterm infants should be kept predominantly in the supine position, at least from the postmenstrual age of 32 weeks onward, so that they become acclimated to supine sleeping before discharge.”\textsuperscript{2}
Many states have been focusing efforts on hospital-based interventions to promote safe sleep behaviors, anticipating that the downstream effect will be a decrease in SUID and infant sleep-related deaths. Some studies and epidemiological data support this tactic. In Tennessee, Heitmann et al analyzed a Department of Health program to implement a safe sleep policy at all 71 birthing hospitals in the state. Audits revealed a 45.6% decrease in infants found with any risk factors for unsafe sleep. There were significant decreases in infants found asleep nonsupine, with a toy or object in the crib, and not sleeping in a crib.

Creating a culture of infant sleep safety in the NICU setting can be challenging. At the institutional level, diffusion of innovation theory can help guide culture change. Successful quality improvement efforts require a team of key players, including (1) opinion leaders, the respected leaders who have influence over others; (2) change agents, the key people who support change, stabilize adoption, and solve problems; and (3) change aides, trustworthy people on the front lines who help maintain change.

In addition, people respond differently to change, so it is important to seek out the innovators or risk takers who like new things and the early adopters who accept change readily. It is equally important that change agents and aides work closely with the late majority or skeptics and the traditionalists who prefer the status quo. Resistance to change is common, so consensus building is essential to success. Ideally, the components of change should be developed by a multidisciplinary team to reflect input from physicians, nursing, lactation consultants, respiratory therapists, and development therapists (physical therapists, occupational therapists, and speech therapists). Having access to local, state, and national statistics regarding SUID can facilitate breakdown of barriers to promoting consistent safe sleep education and modeling. Statistics can be obtained through multiple sources, including state departments of health; the Centers for Disease Control and Prevention, through CDC Wonder linked birth and infant death records (https://wonder.cdc.gov/lbd.html); and yearly state child death review reports. In addition, hospitals can work together with local coroners, medical examiners, and child death review teams to provide feedback on the effectiveness of safety efforts. One study demonstrated the efficacy of a sustained quality improvement effort that linked outcome data from local child fatality review teams. The average death rate decreased from 1.08 infants per 1000 births preintervention to 0.48 infants per 1000 births after complete intervention with feedback from child fatality review teams and performance improvement methodology.

CONCLUSIONS
As clinicians, we must find equipoise between the acute physiologic needs of the infant and the inevitable necessity to provide a home safe sleep environment before discharge from the hospital. There are many
competing and conflicting needs for the NICU patient and family. Preterm infants are at increased risk of SUID, so as providers, we should focus on sharing regular, repetitive, and consistent education with families throughout the hospitalization. Through our messaging with not only our words but also our modeling behaviors, we will enable NICU families to be properly prepared for the transition home to a safe sleep environment.

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ABBREVIATIONS
AAP: American Academy of Pediatrics
aOR: adjusted odds ratio
CI: confidence interval
CPSC: Consumer Product Safety Commission
DDH: developmental dysplasia of the hip
DP: deformational plagiocephaly
GER: gastroesophageal reflux
GERD: gastroesophageal reflux disease
NICE: National Institute for Health and Clinical Excellence
NOWS: neonatal opioid withdrawal syndrome
NSP: nonsynostotic plagiocephaly
PMA: postmenstrual age
SIDS: sudden infant death syndrome
SSC: skin-to-skin care
SUID: sudden unexpected infant death

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