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Best Evidence and Recommendations

Alternative Safe Sleep Positioning in the NICU

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PICO(T): In infants in the neonatal intensive care unit (NICU) who are not medically appropriate for flat, supine positioning, what are best practice recommendations for an alternate safe sleep position at time of discharge?

P (Population/problem): NICU infants who are not medically appropriate for flat, supine positioning
I (Intervention/issue): best practice recommendations for an alternate safe sleep position
C (Comparison): current safe sleep recommendations
O (Outcome): safe sleep
T (Timeframe): at time of discharge

Background:
According to the Centers for Disease Control and Prevention (CDC) 2020 there are 3,500 sudden unexpected infant deaths, including Sudden Infant Death Syndrome (SIDS) a year in the United States. In the 1990s, the American Academy of Pediatrics (AAP) introduced recommendations to place infants non-prone while sleeping. Implementation of these recommendations led to a decrease in sleep related deaths in children. However, there was a rise in suffocation and strangulation deaths through the early 2000s. In 2011 and again in 2016, the AAP expanded their guidelines to include recommendation to modify an infant's sleep environment and thereby further reduce the risk of all types of sleep related deaths (Task Force on Sudden Infant Death Syndrome, 2011 and 2016). The 2016 recommendations emphasize the supine sleep position on a flat and firm surface, avoidance of soft bedding and additional items in the crib, encouraging room sharing without bed sharing, pacifier use, and avoiding overheating.

The recommendation for supine sleep position stems from epidemiologic associations to SIDS, however, the underlying pathophysiologic cause of SIDS is not fully understood, thus it is not well documented why supine sleep positioning has a protective effect (Bergman, 2015). One hypothesis put forth by Filiano and Kinney is the "triple risk" model. This model theorizes that SIDS deaths only occurs when there is an overlap of three risks: a) a vulnerable infant; b) a critical developmental period in homeostatic control; and c) exogenous stressors or environmental factors such as prone positioning (Filiano & Kinney, 1994). Factors contributing

to the vulnerability of the infant may also be intrinsic such as gender, prematurity, genetic polymorphisms, and prenatal exposure to drugs and/or alcohol.

An updated working "triple risk" model postulates that SIDS results from the convergence of multiple factors primarily (but not exclusively) involving 5-HT-mediated mechanisms in the medulla (Task Force on SIDS, 2016). To decrease the incidence of sleep deaths, it is therefore important to understand the modifications that caregivers can make to the sleep environment to alleviate external stressors.

Premature and medically fragile infants often require care which looks very different from the safe sleep environment recommended by the AAP during their hospitalization in the neonatal intensive care unit (NICU). For example, therapeutic positioning is one of the earliest interventions for preterm infants in a NICU. Positioning aids are often used to support optimal growth and development. For example, the practice of maintaining an infant's head in midline position for the first 72 hours of life has been adopted as best practice by NICUs to prevent intraventricular hemorrhage. NICUs also use positioning aids to support and protect the joints of an infant too small to resist gravity. Alternating the sleep position between side lying, prone, and supine prevents pressure injuries and positional deformities in infants who cannot change their own position. Depending on their condition and acuity, a hospitalized infant might require therapeutic aids to modulate body temperature, elevation of the head of bed to improve circulation, or specific positioning to accommodate medical equipment or procedures.

One additional use of positioning occurs in efforts to improve tolerance of gastric feeds without emesis, cardiorespiratory events, signs of aspiration, or symptoms of gastroesophageal reflux (GER). Premature and medically fragile infants have an increased incidence of these symptoms secondary to factors such as decreased tone of the lower esophageal sphincter, increased intrabdominal pressure, increased respiratory rate, immature esophageal motility, presence of nasogastric tubes, and use of caffeine (Kultursay, 2012). Providing full nutritional needs via oral or gastric feedings is a top goal of NICU care, and typically involves incremental increases in the volume and total calories provided over the course of a few days or weeks. Often infants have an increase in symptoms as their feedings are progressed. NICU caregivers will employ positioning strategies during or after feedings including elevating the head of the bed, placing the infant sidelying on the right or left side, or placing the infant in a swing or infant chair in an elevated sitting position as a strategy to reduce the symptoms. The infant then often falls asleep in these positions.

The AAP guidelines state "staff in the NICU should model and implement all SIDS risk-reduction recommendations as soon as the infant is medically stable and well before hospital discharge" (Task Force on SIDS, 2016 p.2022). The transition to a sleep environment that meets AAP recommendations can be difficult for both infants and families in the NICU. Nonetheless, hospitals are increasingly encouraged and striving to model an appropriate environment for infant sleep for several reasons. First, hospitals working toward a National Safe Sleep Hospital Certification through Kids for Cribs are required to have a hospital policy that incorporates the AAP guidelines, train staff, and educate parents. Second, modeling a safe sleep environment in

the hospital is one of the most effective ways to influence parents' implementation of safe sleep practices at home.

There are some infants who continue to struggle with sleeping in a flat, supine position even as they are nearing readiness for hospital discharge in other aspects of their medical care. Typically, these infants have underlying diagnoses resulting in complications that will persist past NICU discharge. Examples include hypoxic ischemic encephalopathy (HIE), a brain injury that, when severe, can impair an infant's swallowing reflex and airway protection mechanisms resulting in poor ability to swallow their own saliva despite having appropriate respiratory effort. Another example is esophageal atresia (EA), a structural anomaly of the esophagus that even after surgical repair typically results in poor peristalsis of the esophagus with pooling of saliva in the pharynx or upper esophagus. In both HIE and EA, the infants' airways can become compromised by their inability to clear secretions. The infants who have difficulty tolerating feedings without GER symptoms or cardiorespiratory events may also continue to struggle with flat, supine positioning if their symptoms are severe and persistent. NICU practitioners are committed to promoting the AAP recommendations for a safe sleep environment however, for medically complex infants, sleeping flat and supine may actually be detrimental to their health and safety.

The purpose of this evidence-based practice project is to present literature review findings and determine the best practice for NICU infants who are not medically appropriate for flat, supine sleep at the time of discharge from the hospital.

Search Strategies and Databases Reviewed:

- Databases searched for this review included Google Scholar, CINAHL, Medline in EBSCO and Pub Med.
- Key search words: alternative safe sleep, sleep, side lying sleep, prone sleep, sleep positioners, sleep wedges, infant sleep position, reflux, craniofacial syndrome, cleft palate, downs syndrome, TEF/EA, prematurity, sleep maturity, aerodigestive, neonatal monitoring, airway structure, barriers to safe sleep, back to sleep, readiness for safe sleep, NICU positioning, autonomic sleep development. This search yielded 68 articles.
- Websites reviewed included FDA.gov and CPSC.gov
- Queries were posted to social media professional groups including Certified Neonatal Therapists Facebook group, Neonatal ICU Nurses Rock! Facebook group, myNANN (National Association of Neonatal Nurses), and National Association of Neonatal Therapists Member Community. These queries yielded 4 responses.
- Professional Correspondence with article authors from Royal Manchester Children's Hospital, University of Wisconsin School of Medicine and Public Health, Children's Hospital of Philadelphia, and Children's Hospital of Colorado.

Synthesis of Evidence:

A multifaceted literature review was undertaken to examine aspects that were suspected to contribute to the body of knowledge on this topic, guided by the symptoms that infants display

when they do not tolerate flat, supine sleep position. Relevant information is summarized below by topic.

Relationship between Gastroesophageal Reflux (GER) and Sleep:

As measured in infants by polysomnography and esophageal multichannel intraluminal impedance-pH (MII-pH) monitoring, GER events occur less frequently during sleep states, but the GER events are characterized by distinct chemical characteristics with longer duration of esophagus-acid contact (Ammari et al, 2011; Djeddi et al, 2013; Quereshi et al, 2015)

GER Impact on the Cardiorespiratory System:

- There is a correlation between cardiorespiratory events (CRE) and GER episodes in some patients. Nobile et al found a temporal association of CRE and GER episodes in 12% of patients, with predisposing factors for symptom correlation of lower milk intake, high work of breathing, and lower birth weight (Nobile et al, 2019). Djeddi et al (2013) found that GER events were preceded by a decrease in parasympathetic nervous system tone, suggesting that a change in autonomic nervous system activity is a factor contributing to the mechanism of reflux in infants.

Impact of Positioning on GER:

- In infants with positive GER symptom association, the most effective intervention for reducing GER episodes was left lateral positioning plus proton pump inhibitor. It was noted that left lateral positioning was more effective than head of bed elevation, regardless of acid-suppressive therapy (Loots, 2014).

Relationship between Respiratory Events and Esophageal Motility:

- Infants presenting with apparent life-threatening events (ALTE), or brief resolved unexplained events (BRUE) were evaluated with respiratory plethysmography and esophageal manometry. The prolonged respiratory events were linked with dysfunctional proximal aerodigestive protective mechanisms that suggest abnormal swallowing-respiratory junction interactions identified as esophageal dysmotility and/or mechanical airway abnormalities (Hasenstab & Jadcherla, 2014).
- The working group for pediatric GER clinical practice guidelines recommends not to use positional therapy to treat symptoms of GERD in sleeping infants (Rosen et al, 2018)

Autonomic System Functioning: Further literature review of autonomic system function and sleep architecture was undertaken to increase understanding of the rationale for supine positioning during sleep.

- In healthy term infants, Wong et al. (2019) found cardiorespiratory differences between prone and supine position during sleep; polysomnography data showed faster heart rate, lower oxygen saturation, longer duration of oxygen saturation below 90% in prone sleep. However, this study did not account for sleep state.
- Elder et al. (2011) found sleep state (active sleep vs quiet sleep), not sleep position, to be the predominate influence on respiratory variability in healthy term and convalescent preterm infants.

- Verbeek et al. (2008) further found that hypoxic ventilatory response was not affected by sleep state, but that infants in active sleep always aroused in response to induced hypoxia and had shorter arousal latency than in quiet sleep.
- Sleep position has been shown to have an effect on arousability with prone sleepers having fewer cortical arousals during active (REM) sleep (Kato et al, 2006). Understanding the potential effects of sleep position on cardiorespiratory function and arousability is critical as a failure of protective mechanisms to adequately activate is a suspected component of SIDS. The studies reviewed did attempt to study both term and preterm infants but did not include infants with any other medical diagnoses.

Findings Specific to Special Populations Or Diagnoses

Pierre Robin Sequence (PRS):

- PRS is a structural airway defect, defined by micrognathia, glossoptosis, and resultant airway obstruction, and cleft palate can also be present (Evans et al., 2011). Initial management for safe airway maintenance of these infants is prone positioning, which allows the mandible and tongue to fall forward, decreasing airway obstruction. Monitoring must be ongoing because obstructive sleep apnea has still been noted.

- Surgical treatment may be indicated when prone positioning is not effective. Mandibular distraction osteogenesis (MDO) slowly advances the mandible forward relieving the obstruction. Surgical intervention does not always mean correction of obstructive airway. Hammoudeh et al. (2012) had a series of 22 infants with Pierre Robin that received a MDO, after polysomnography 10 showed improvements from severe obstructive sleep apnea, 12 remained having moderate to severe obstruction.

- Children's Hospital of Los Angeles completed a study that examined changes from prone vs non prone using polysomnography. Infants in the study were inpatient, some outpatient, receiving nonsurgical therapies and others received surgical intervention. In the 11 infants, 82% had a decrease in obstructive apnea-hypopnea indexes (OAHIs), meaning prone positioning partially relieved the upper airway obstruction. Important to note, this study recognized there was "variation in the extent of improvement experienced by each infant and there was no resolution of OSA (obstructive sleep apnea) in any of the participants in the prone position. Six of seven participants with OSA still had residual severe OSA demonstrating that prone positioning is not a curative therapy." The authors propose that prone should be a prescribed therapy and may not be beneficial for all infants (Hong et al., 2020).

Cleft Palate:

- Sleep positioning in lateral or prone is recognized as a therapeutic intervention to address Sleep Disordered Breathing (SDB) in infants with cleft palates, however, there has not been sufficient research to demonstrate if there are advantages or risks to certain sleep positions using a polysomnography.

- Davies et al., (2017) conducted a qualitative survey of 12 UK clinical nurse specialists (CNS) of recommended home sleeping position for newborns. Seven of the centers practiced lateral position because they assumed the infants would experience SDB. Five centers practiced supine positioning in order to adhere to the national guidance, however lateral positioning was advised if respiratory distress/airway obstruction was witnessed by parents. All CNSs reported concern about lack of clinical evidence and recognized a need for further research.
- In infants with cleft palate undergoing polysomnography for obstructive sleep apnea evaluation, there were not significant changes in the polysomnographic parameters between supine and non-supine positioning during sleep. Polysomnographic testing should be considered to confirm improvements prior to advising against AAP (Greenlee et al., 2019).

Lack of Direct Evidence for an Alternative Sleeping Position

- There is no clear evidence for a specific sleep position that has been studied and shown benefits for medically complex infants. In fact, many of the studies reviewed exclude infants with diagnoses that dominate our population such as bronchopulmonary dysplasia (BPD) , necrotizing enterocolitis (NEC) , anatomic or chromosomal anomalies, hypoxic ischemic encephalopathy (HIE), etc. making it difficult to find evidence that applies to a level IV NICU population directly.
- There is no positioning device available for parental consumer use, nor any FDA approved medical device, that is approved for use during sleep. Devices available are only approved for use while an infant is awake and being monitored by an adult (FDA.gov and CPSC.gov).
- Four facilities were contacted, none of which had a formal policy or standardized safe sleep program for medically complex infants. Professionals from these facilities acknowledged this as a gap in current practice.

Assessment of Readiness for Supine Sleeping and Individualized Care Planning

- At this point in time, there is no scientific method to determine an infant's medical and developmental readiness to transition to a flat, supine sleeping position. Evaluation of three published algorithms meant to guide decision making for transition to flat, supine sleep revealed that none of these algorithms provided guidance or solutions for infants who never meet the criteria of readiness provided by the algorithm. The algorithm continues to indicate to continue with therapeutic positioning. These algorithms have not been tested for validity nor reliability (Gelfer et al., 2013; Hofherr, 2018; Hwang et al., 2015).
- The NANN Guideline for Newborn Safe Sleep 2020 highlights two critical practice recommendations: 1) There may be a need for an alternate plan made by the medical team for infants who do not remain stable in the supine position, with risks and benefits being discussed with parents; and 2) that parents will model their caregiving after what they see their nurses do in the hospital. Therefore, modeling consistent and repeated implementation of a specific plan is important for these high-risk infants (Bassler et al., 2020).

- The document published by the AAP in 2016 with updated recommendations lays out numerous recommendations for a safe sleep environment based on literature review and expert opinion. This document also encourages the medical team to make an individualized plan for a patient when it states "The guidance in this statement does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate" (Task Force on SIDS, 2016 p.2016).

Practice Recommendations:

There is not one clear sleep position that has proven to be beneficial or safe for all patients. Until there is additional evidence to support positions for specific clinical problems (e.g. poor secretion management) or medical diagnoses (e.g. esophageal atresia), the evidence available suggests that the best practice is the use of an individualized safe sleep plan tailored to each patient's specific needs. Every baby deserves to have a safe sleep plan that the multidisciplinary team can confidently provide, and the family can replicate at home. In order to systematically derive a specific plan and safely implement it, the following practice improvement steps are recommended:

- Evaluate organizational safe sleep policy and consider expansion to include pathways to assess whether a patient can safely progress to a supine position, or whether the patient would need an individualized safe sleep positioning plan.
- Develop criteria for a safe sleep challenge for patients requiring an individualized safe sleep plan (similar to the concept of a car seat challenge as described in Davis, 2015).
- Create electronic medical record forms for multidisciplinary teams to document and communicate the individualized safe sleep plan including specific position, devices, and education provided for parents.
- Ensure communication of individualized safe sleep plan to primary care and specialty physicians for post-discharge follow up with family on implementation at home, as well as ongoing assessment for readiness to transition to flat, supine sleep.
- Develop discharge education materials including visual and written aids. In addition, develop a discharge checklist for NICU staff to ensure all critical elements have been demonstrated by the family.
- Review terminology and visuals on all safe sleep materials to ensure language is family centered and maintains a positive perception of their infant's state and capabilities.

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