Balancing Safe Sleep and Developmental Care

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Ruth B. Seabrook, MD
Disclosures

- Ruth B. Seabrook
  - Nothing to Disclose

- Jenn Gonya
Objectives

- Understand the most recent AAP recommendations for safe sleep practices in infants
- Review the importance of developmental care in supporting healthy growth and development of preterm infants
- Explore the balance between implementation of safe sleep guidelines and use of developmental care
- Discuss strategies for implementation of safe sleep guidelines in the NICU
Why Worry About Sleep Protection?

Dr. Jenn Gonya, PhD
Why worry about sleep protection?

• Brain Development

• Systems Development

• Dyadic Development

• Cognitive Development
Brain Development

Systems Development

Model of the Synactive Organization of Behavioral Development

The Principle of Synaction

Development proceeds through the continuous balancing of approach and avoidance, continuous intraorganism subsystem interaction and differentiation and organism-environment interaction to realize a hierarchical species unique developmental agenda.

Dyadic Development

Bronfenbrenner’s Ecological Theory

- Chronosystem
- Macrosystem
- Exosystem
- Mesosystem

Microsystem

- Family
- School
- Peers
- Religious Affiliation
- Workplace, and Neighborhood
- Government System, Religious System
- Overarching beliefs and values

Dimension of Time

You

Nationwide Children’s
When your child needs a hospital, everything matters.”
Dyadic Development

The Child

Cultural Context

Social and Economic Context

Immediate Environment
Dyadic Development
Cognitive Development

- Extremely preterm infants exhibit significant delays in communicative, cognitive, and motor function at 2.5 years when compared to term babies. (Manson and Stjernqvist. *Acta Paediatrica*. 2014)

- Premature infants (almost 1/3) with CLD, Severe IVH, PVL, and/or low SES are at higher risk for failing school readiness assessments. (Patrianakos-Hoobler et al. *Pediatrics*. 2009)
Kangaroo Care and Sleep

Discriminant analysis showed that preterm infants who participated in kangaroo care had brain maturation closer to full term infants who had not been exposed to kangaroo care.

Preterm infants who participated in kangaroo care had fewer REMs, more quiet sleep, increased respiratory regularity, and longer sleep cycles.
Benefits of Developmental Positioning
Prone Positioning Improves Oxygen saturation levels

Oxygen saturation levels, individual data are shown. □, Prone posture; ▪ supine posture.
Comparison of Oxygen Saturation, FRC, and Respiratory Mechanics in the Prone and Supine Postures

<table>
<thead>
<tr>
<th></th>
<th>Prone</th>
<th>Supine</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen saturation (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen-dependent</td>
<td>96 (94–97)</td>
<td>95 (94–95)</td>
<td>.015</td>
</tr>
<tr>
<td>Nonoxygen-dependent</td>
<td>96 (94–98)</td>
<td>95 (95–98)</td>
<td>.25</td>
</tr>
<tr>
<td>FRC (mL/kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen-dependent</td>
<td>25 (14–36)</td>
<td>23 (13–32)</td>
<td>.019</td>
</tr>
<tr>
<td>Nonoxygen-dependent</td>
<td>27 (19–39)</td>
<td>26 (17.7–35)</td>
<td>.06</td>
</tr>
<tr>
<td>Crs (mL/cm H₂O/kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen-dependent</td>
<td>0.8 (0.2–1.6)</td>
<td>0.6 (0.4–1.4)</td>
<td>.43</td>
</tr>
<tr>
<td>Nonoxygen-dependent</td>
<td>1.1 (0.7–1.4)</td>
<td>1.0 (0.4–1.5)</td>
<td>.37</td>
</tr>
<tr>
<td>Rrs (cm H₂O/L/sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen-dependent</td>
<td>132 (98–195)</td>
<td>131.3 (87–195)</td>
<td>.62</td>
</tr>
<tr>
<td>Nonoxygen-dependent</td>
<td>119 (67–207)</td>
<td>120 (89–166)</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Consequences of Inadequate Musculoskeletal Support

<table>
<thead>
<tr>
<th>Malalignment</th>
<th>Musculoskeletal consequence</th>
<th>Functional limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperextended neck and retracted shoulders</td>
<td>• Shortened neck extensor muscles and excessive cervical lordosis</td>
<td>• Interferes with development of head centering and midline in supine</td>
</tr>
<tr>
<td></td>
<td>• Shortened scapular adductor muscles</td>
<td>• Interferes with development of graded head control in prone and sitting</td>
</tr>
<tr>
<td>“Frog” legs</td>
<td>• Shortened hip abductor muscles</td>
<td>• Difficulty organizing posture in supine</td>
</tr>
<tr>
<td></td>
<td>• Shortened iliotibial band</td>
<td>• Difficulty bringing hands to midline</td>
</tr>
<tr>
<td></td>
<td>• Increased external tibial torsion</td>
<td></td>
</tr>
<tr>
<td>Everted feet</td>
<td>• Muscles turning the foot inward are overstretched</td>
<td>• Interferes with movement transitions out of prone and sitting positions</td>
</tr>
<tr>
<td></td>
<td>• Foot alignment is changed due to muscle imbalance</td>
<td>• Interferes with crawling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Prolonged wide-based gait with out-toeing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Musculoskeletal Implications of Preterm Infant Positioning in the NICU. Sweeney, Jane; PT, PhD; Gutierrez, Teresa; PT, MS; Journal of Perinatal & Neonatal Nursing. 16(1):58-70, June 2002.
Safe Sleep Recommendations in the NICU
Definitions

SIDS: Sudden infant death Syndrome

- Death that cannot be explained after a thorough case investigation in infant <1 year

SUID: Sudden explained infant death

- Includes both SIDS and other attributable causes of death, including:
  - sleep related deaths: asphyxiation, suffocation, entrapment
  - Other causes: infections, ingestions, metabolic disease, cardiac channelopathies

Moon et al. 2011, e1341-e1367
SIDS and Sleep related deaths remain major problems

- Despite initial improvements, both SIDS and prone sleeping rates have plateaued
- SIDS and sleep-related deaths remain
  - #3 cause of infant mortality
  - #2 cause of infant mortality in Ohio
  - #1 cause of post-neonatal mortality

Kattwinkel et al. 2005, 1245-1255; Carrier 2009, 163-168; 2013 Ohio Child Fatality Review
Safe Sleep and Prematurity

- Infants born prematurely have an increased risk of SIDS
  - ~10% of infants are born preterm (Beck et al. 2010, 31-3)
  - 20+% of SIDS cases were born preterm (Blair et al. 2006, 101-106; Øyen et al. 1997, 613-621)

Thompson and Mitchell 2006, 107-111
Sleep Position and Risk of SIDS in Preterm Infants

- The association between prone sleep position and SIDS is perhaps STRONGER in infants born preterm compared to infants born at term (Øyen et al. 1997, 613-621)
- Preterm infants are more likely to be placed prone for sleep following hospital discharge (Vernacchio et al. 2003, 633-640)
Why are preterm infants more vulnerable to Sleep-Related Deaths?

- A variety of respiratory and airway protective reflexes mature along a continuum that extends beyond term CGA
  - Impaired reflexive responses to hypoxia and hypercapnea (Darnall, Ariagno, and Kinney 2006, 883-914)
  - Laryngeal reflexes, breathe/suck/swallow, regulation of UA motor tone (Darnall, Ariagno, and Kinney 2006, 883-914)
  - Altered/delayed maturation of baroreceptor sensitivity may predispose to fulminant hypotension (Witcombe et al. 2012, e89-e96)
- Higher arousal thresholds in prone positioning, particularly during highest risk period for SIDS (Horne et al. 2002, 746-750)
Key Points: Safe Sleep Environment

- Place back to sleep for every sleep
  - Do not place infants on their side
- For Preterm infants:
  - When medically stable
  - By 32 weeks
- Place infant alone, in a crib
  - No bedsharing
- Use a firm sleep surface
- Do not have soft objects (pillows, toys, blankets) in the bed or under the sleeping infant
- Avoid tobacco smoke exposure
- Avoid overheating
- Breastfeed
- Promote Pacifier use

Moon et al. 2011, e1341-e1367
Follow the ABCs of Safe Sleep


Every Baby. Every Sleep.

www.SafeSleep.Ohio.gov

Babies are safest alone, on their backs, in an empty crib.

Developmental positioning in the NICU

http://www.cuh.org.uk/rosie/services/neonatal/nicu/developmental_care/support_comforting_baby.html

http://www3.imperial.ac.uk/cpd/courses/subject/medical/developmentcare/presenters

Importance of Modeling

- Parental practices are highly influenced by their observation of how their infant is cared for in the hospital (Aris et al. 2006, 281-294; Blair et al. 2006, 101-106; Vernacchio et al. 2003, 633-640)

- Multiple studies have shown that NICU nurses recommend exclusive supine sleep position at discharge only ~50% of the time (Aris et al. 2006, 281-294; Grazel, Phalen, and Polomano 2010, 332-342)
## Importance of Modeling

### TABLE 2. Primary Influence on Infant Sleep Position 1 Month After Hospital Discharge Stratified by Sleep Position and Birth Weight Category

<table>
<thead>
<tr>
<th></th>
<th>No. (%)</th>
<th></th>
<th>No. (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRONE</strong></td>
<td></td>
<td><strong>&lt;1500g</strong></td>
<td></td>
<td><strong>Supine</strong></td>
</tr>
<tr>
<td>Infant’s preference</td>
<td>9 (32.1)</td>
<td>Physician or other medical professional</td>
<td>39 (50.0)</td>
<td></td>
</tr>
<tr>
<td>Physician or other medical professional</td>
<td>8 (28.6)</td>
<td>Followed nursery practice</td>
<td>12 (14.5)</td>
<td></td>
</tr>
<tr>
<td>Previous children</td>
<td>4 (14.3)</td>
<td>Family</td>
<td>7 (8.4)</td>
<td></td>
</tr>
<tr>
<td>Followed nursery practice</td>
<td>3 (10.7)</td>
<td>Infant’s preference</td>
<td>7 (8.4)</td>
<td></td>
</tr>
<tr>
<td>Family/friends</td>
<td>1 (3.6)</td>
<td>Previous children</td>
<td>6 (7.2)</td>
<td></td>
</tr>
<tr>
<td>Educational materials</td>
<td>0 (0.0)</td>
<td>Infant’s preference</td>
<td>5 (6.0)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3 (10.7)</td>
<td>Educational materials</td>
<td>5 (6.0)</td>
<td></td>
</tr>
<tr>
<td><strong>&lt;1500g</strong> &amp; <strong>Supine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prone sleepers N = 84</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infant’s preference</td>
<td>18 (21.4)</td>
<td>Physician or other medical professional</td>
<td>247 (47.0)</td>
<td></td>
</tr>
<tr>
<td>Previous children</td>
<td>18 (21.4)</td>
<td>Educational materials</td>
<td>108 (20.5)</td>
<td></td>
</tr>
<tr>
<td>Family/friends</td>
<td>16 (19.0)</td>
<td>Followed nursery practice</td>
<td>50 (9.5)</td>
<td></td>
</tr>
<tr>
<td>Physician or other medical professional</td>
<td>10 (11.9)</td>
<td>Previous children</td>
<td>43 (8.2)</td>
<td></td>
</tr>
<tr>
<td>Followed nursery practice</td>
<td>6 (7.1)</td>
<td>Family/friends</td>
<td>37 (7.0)</td>
<td></td>
</tr>
<tr>
<td>Educational materials</td>
<td>6 (7.1)</td>
<td>Infant’s preference</td>
<td>14 (2.7)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>11 (16.7)</td>
<td>Other</td>
<td>27 (5.1)</td>
<td></td>
</tr>
</tbody>
</table>

Vernacchio et al. 2003; 633-640
Barriers: Fear of Reflux

- No increased incidence of aspiration since change to supine positioning

- NASPGN: recommends supine positioning unless risk of death of reflux outweighs risk of death from SIDS
  (Vandenplas et al. 2009, 498-547)
  - Impaired airway protective reflexes
  - Severe anatomic abnormalities - type 3-4
  - laryngeal clefts
Barriers: Perception of Infant Comfort

- Arousal from sleep is an important protective response during sleep to prevent SIDS
## Perceived Barriers: Parents

### Table 3. Barriers to Adopting Supine Sleep Recommendations After Discharge

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Health care professionals—variable, inconsistent information, trust issues</td>
</tr>
<tr>
<td>2.</td>
<td>Female friends/family—often relied upon but may give outdated information</td>
</tr>
<tr>
<td>3.</td>
<td>Infant comfort/preference</td>
</tr>
<tr>
<td>4.</td>
<td>Fear of choking/aspiration</td>
</tr>
<tr>
<td>5.</td>
<td>Believe bed sharing with parent protective against SIDS</td>
</tr>
<tr>
<td>6.</td>
<td>Do not believe positioning related to SIDS</td>
</tr>
<tr>
<td>7.</td>
<td>Observation of NICU or newborn nursery staff placing infants prone</td>
</tr>
<tr>
<td>8.</td>
<td>Limited knowledge or misinformation</td>
</tr>
<tr>
<td>9.</td>
<td>Previous children slept prone</td>
</tr>
<tr>
<td>10.</td>
<td>Fears related to head shape</td>
</tr>
</tbody>
</table>

Adopted from: Carrier 2009, 163-168
Perceived Conflicts

- Physiologic benefits of non-supine positioning during ACUTE phases of illness
  - Improved oxygenation, decreased WOB
- Developmental support: promoting flexed, midline positioning
- Positional Plagiocephaly
  - Particularly in absence of supervised Tummy Time
Reconciling Differences

- Benefits of prone/supported positioning are well-documented in infants <32wk (McMullen 2013, 8-12)
- Benefits of supine-only positioning are well documented in infants after discharge to home (Moon et al. 2011, e1341-e1367)
- There is a lack of evidence on when or how to transition preterm infants to the supine position
Current AAP Recommendations

- Preterm infants should be placed supine for sleep
  - As soon as “medically stable”
  - Well in advance of anticipated discharge
  - By 32 week CGA

- Health care professionals in NICUs should endorse and model SIDS risk-reduction recommendations from birth
  - Staff in NICUs/nurseries should model SIDS risk reduction strategies
Current Experiences
Gelfer et al.

- QI project to improve proportion of infants in the NICU compliant with safe sleep practices prior to discharge
- Multidisciplinary team helped develop working definition of medically stable

NICU Therapeutic Positioning

Examples of when NICU Therapeutic Positioning is appropriate:
- Respiratory symptoms such as tachypnea, retractions, grunting and oxygen dependency
- Nasal CPAP
- Nasal Cannula requirements other than home oxygen requirements
- Phototherapy
- Scalp IV or central lines
- Neonatal Abstinence Syndrome
- Lack of handling due to social reasons (please address with primary team)
- Any medical condition that requires prone or side lying positioning
- If tummy time cannot be implemented due to inability to be positioned prone (such as ostomy/surgical site)

Continue to evaluate infant for readiness to start Back to Sleep positioning

Gelfer et al. 2013, e1264-e1270
Initiating SSP Algorithm

- **Is the infant ≥1500 grams?**
  - Yes
    - Does the infant have any medical conditions precluding him/her from starting SSP? (Photoraphy, scalp IV/central lines Neonatal Abstinence Syndrome, etc…)
    - Yes: Continue with NICU Therapeutic Positioning, re-evaluate periodically.
    - No: Does the infant have respiratory symptoms: tachypnea, retractions, grunting, and oxygen dependency?
      - Yes: Continue with NICU Therapeutic Positioning, re-evaluate periodically.
      - No: Is the infant in an open crib?
        - Yes: Introduce SSP: modify positions and blankets to maintain temperature and comfort while transitioning infant.
        - No: Remove Z-Flo, toys, and unnecessary objects from islette. Blanket rolls can be used as positioners if swaddling is not adequate.
  - No: NICU Therapeutic Positioning, re-evaluate at 1500 grams.

**FIGURE 1**
Algorithm to determine when an infant is ready to begin SSPs. BPD, bronchopulmonary dysplasia.

Gelfer et al. 2013, e1264-e1270
Current Experiences
Gelfer et al.

- Results:
  - Improved compliance with supine positioning, use of firm sleep surface, and removal of soft objects from bed
  - Improvement with parental compliance with safe sleep practices (23% vs 82%)

“A simple operational definition of ‘physiologically stable’ is needed for implementation of SSPs in the NICU”

Gelfer et al. 2013, e1264-e1270
Ongoing Work at Nationwide Children’s Hospital
## Assessment of Safe Sleep Readiness

<table>
<thead>
<tr>
<th>State: Stability of level of consciousness when expected to be arousing</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping/drowsy throughout</td>
<td>Quiet fuss/weak cry/Irritable/hyperalert - any diffuse or disorganized arousal</td>
<td>Drowsy but has intermittent alertness</td>
<td>Waking/calmly alert with care/cry is consoled easily</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Motor: Posture/tone stability | Low tone/limp at any time | Extends limbs, frantic and/or tense | Holds tucked posture briefly on own or with light containment/needs some support due to cong. anomaly | Keeps/returns to tucked posture on own |

| Autonomic: Hi/low HR/RR/Sats during care, visceral and color responses | Significant color Δ, twitches, emesis and/or vitals Δ +/- >30 beats from baseline, servo temp control | Moderate color Δ, visceral upset and/or vitals Δ +/- 20-30 beats from baseline, incubator | Mild to mod color Δ, visceral upset, &/or vitals Δ +/- 10-20 beats from baseline, open crib | Stable color/no visceral upset and/or vitals Δ +/- <10 beats from baseline, open crib |

| Regulation: Response to support | Self-regulatory strategies may be absent, difficult to co-regulate | With caregiver support, shows some regulatory strategies (suck, grasp, tuck) | Has brief success on own using self-regulatory strategies or sustains with light/intermittent support | Uses own self-regulatory strategies successfully, minimum to no support necessary |

| Respiratory support | Oscillator | Vent | CPAP/HFNC | NC/room air |

### Scoring Guide:
- 90 - 100: Full SSP in place
- 80 - 90: Supine only and positioning aids PRN
- 65 - 75: Supine and sidelying with positioning aids PRN
- 25 - 60: Developmental positioning required

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Courtesy of: Jennifer Hofherr, MS, OTR/L, C/NDT & Roberta Thomas, MPT
Summary

- Developmentally appropriate care is important for promoting protected sleep and healthy long-term neurodevelopment in premature infants
- SIDS and sleep-related deaths remain one of the top causes of infant mortality
  - Premature infants are at increased risk for SIDS and sleep-related death
- Parents are strongly influenced by how they see their infant cared for in the NICU
  - We have an obligation to model safe sleep practices in the NICU
- A clearer definition of “medically stable” is needed to facilitate transition to safe sleep practices
References

References (2)


References (3)