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Gravens By Design: Optimizing Sleep in the NICU, a Neurodevelopmental Imperative

Daphna Yasova Barbeau, MD, Michael D. Weiss, MD

Throughout history, technology and changing workplace needs have shaped how we sleep as we adjust to shifting schedules. (1) The bustling environment of a Neonatal Intensive Care Unit (NICU) is no exception, and the infants in our care are subjected to our rigorous schedule. The preterm neonate is expected to sleep greater than 90% of the day, and the term infant, over 70% of the day. (2, 3) However, this is not always possible in the NICU. We know that neonatal sleep is regularly disrupted by the chaos within the NICU, such as loud alarms, opening and closing of isolettes, workplace chatter, bright lights, painful procedure, and uncomfortable equipment. In addition, studies show that routine care and noises just outside the isolette cause complete arousal from sleep and, if interrupted in certain sleep phases, lead to physiologic instability like bradycardia, apnea, and desaturations. (4) Recurrent disruptions in sleep lead to a sleep deficit in neonates, just like in older children and adults, and chronic sleep deprivation has been linked to learning problems and the development of cardiovascular morbidity like metabolic syndrome. (5)

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Living in the NICU is disruptive to sleep, and for the very premature high-risk neonates, exposure to the extrauterine environment disrupts the progression of normal sleep development. Studies have shown that normal sleep develops over time in neonatal life, including lengthening of the sleep interval, increased quiet sleep, and, as the postmenstrual age increases, neonates spend less overall time asleep, with increasing quiet sleep, spending less time in the regenerative REM or rapid eye movement sleep. (2, 3) As the neonate ages, we have fewer opportunities to optimize the most important sleep state for learning, even during typical development. Prematurity interrupts this normal development and leads to disordered sleep structure and sleep-breathing disorders into early childhood and adolescence. (6) While many units adhere to a strict "neurobundle" which includes low stimulation for the first 72 hours to 1 week of age, this vigilance to protect sleep and overstimulation seems to wane over time for older neonates when it might be even more critical. As neonates attempt to undergo typical maturation of sleep-wake cycling, our scrupulous adherence to the NICU schedule continues.

Sleep becomes even more important regardless of gestational age and as acuity increases for neonates. Many pathologies in the NICU are associated with disrupted maturation of sleep-wake cycling. (7, 8) It is unclear whether the disease predicts abnormal sleep patterns or vice versa. However, many studies have shown that decreased maturation of sleep-wake cycling is linked to worse neurodevelopmental outcomes; hence, the protection of neonatal sleep is of utmost importance. (9, 10, 11)

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As a result of these findings, minimum guidelines to optimize sleep protection in your unit are proposed. These practices highlight recommendations from the Consensus Committee of the Standards, Competencies, and Best Practices for Infant and Family-Centered Developmental Care in the Intensive Care Unit. (12)

1. **Reduce sleep disrupters:**

   a. *Teach the entire staff about the importance of sleep.* This intervention means recognizing how many people interact daily with an infant's space. A unit-wide curriculum includes everyone, from the environmental services staff to the nursing staff, the administration, and the medical team. Everyone is responsible for safe sleep in the unit. (12)

   b. *Teach families about the importance of sleep.* Encourage sleep protection, educate sleep optimizers, and let baby lead (See below). (12) Including parents in the act of containment brings comfort to neonates and allows parents to interact with their infant regardless of sleep state or clinical illness. They can learn to create the physical boundaries within the bed using equipment and containment holds with their hands, a multimodal experience for infants.

   c. *Monitor the noise level in the neonate's environment.* Infants have awakenings even from brief sound peaks, and prolonged exposure to noise puts infants at risk for hearing deficits. (13, 14) Studies show that the optimal decibel level for units is 45 dB or less. (15)- This is the volume of the humming of a refrigerator, below the 60dB of normal conversation. (16) Many believe that isolettes protect from ambient noise when in reality, the isolette can amplify the sounds in the NICU. (17) It's simple to incorporate the use of decibel meters into daily practice- they are available in application format on phones to combat noise pollution in your unit.

   d. *Decrease bright light.* Studies show that cycled light, as compared to continuous bright light, benefit preterm infants. Cycled light results in a decreased length of stay, a trend towards fewer ventilator days, and a shorter time to full feeds (18). Tools include isolette covers, room/pod dimmers, and timed lighting cycles. (12)

2. **Increase sleep optimizers:**

   a. *Increase Kangaroo Care.* Kangaroo Care accelerates neurobehavioral maturation of sleep. Infants who do Kangaroo Care have more organized sleep states and spend more time in both active and quiet sleep at term corrected age. (19)

   b. *Promote individualized body positioning, swaddling, and containment.* Swaddled infants show a longer sleep duration and self-regulation. (12) Positional aids may assist in this individualized care with a focus on permitting supported movement rather than restriction of movement, promoting midline hand positioning, and allowing older infants to self-soothe with their hands.

   c. *Practice individualized, parent-driven gentle touch.* Studies of gentle human touch found significant increases in the sleep state and decreases in the awake state during and after the interventions. (12)

3. **Let the baby lead:**

   a. *Teach wakefulness cues to parents and staff.* It is possible to identify neonatal sleep states prior to 28 weeks of gestation. (20) Once an infant's care team recognizes their sleep state, they can be encouraged to let babies sleep if not in the transitional or awake state. (12, 20)

   b. *Wake infants gently.* Treat the NICU infant like you would an infant in your own home. Slow, progressive brightening of the lights, greeting the infant with a soft voice when you enter the isolette, and laying hands on them with intention lets them more easily transition into wakefulness.

   c. *Engage infants that are awake.* As infants age, they will be awake more often.

      For some infants, this means they are awake many hours a day, even before they wean from the isolette. Expecting that older infants will sleep all day restricts valuable developmental opportunities. Engagement in developmentally appropriate activities during wakefulness predicts better sleep, and supporting arousal can optimize interactions like feeding. (12)

   d. *Question the "three-hour" rule.* The infant's sleep-wake cycle is approximately 1 hour, so we should protect this cycle when possible. However, not all infants will have a sleep pattern that fits our regimented schedule. We should consider adjusting touch times that are more individualized to each infant.

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Corresponding Author

Daphna Yasova Barbeau, MD
HCA University Hospital
Davie, Florida
USA
Email: daphnayasovabarbeau@icloud.com

Michael D. Weiss, MD
Assistant Professor i
Department of Pediatrics
Division of Neonatology
University of Florida Health Science Center
Gainesville, Florida, USA