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Promoting and Protecting Infant Sleep

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Sleep is essential to brain development and maturation in infants.¹ Infants require extensive sleep for further development of the neurosensory systems; structural development of the hippocampus, pons, brainstem, and midbrain;² and optimizing physical growth.³ Protecting infant sleep is a critical component of providing developmentally appropriate care for premature and full-term infants in the neonatal intensive care unit (NICU) because many of these infants are hospitalized during one of the most critical periods of brain development.⁴ To best provide developmentally appropriate care, identification of sleep-wake states is necessary.

Sleep-wake states can be distinguished both through EEG and biobehavioral techniques. Electroencephalography (EEG) can be useful in the detection of sleep-wake states and cycles in infant, but most nurses are not trained to interpret EEGs. Generally, nurses utilize observation of biobehavioral responses to determine changes in sleep-wake states. Sleep-wake states are observable behaviors regulated by neuronal-controlled physiologic mechanisms recurring longitudinally in infants.⁵ Sleeping and waking evolve into distinct states as the brain continues to develop the neural structures and connections necessary for cyclical synchronization with other physiologic mechanisms (e.g., heart rate variability, thermoregulation).⁵ If the infant's brain has not reached the necessary stage of development to perform certain behaviors, the infant is unable to display the overt behaviors associated with various sleep-wake states. Thus, as premature infants develop so do their behaviors displayed through the range of sleep-wake states in their behavioral repertoire.⁶

Scales to describe sleep-wake states have been used for decades to better understand how the infant interacts with his environment.⁷ The underlying objective of the scales is to identify infant behaviors and their relationship to phases of development that are portrayed through their individual responses to their environment.⁸ The Brazelton Neonatal Behavioral Assessment Scale (BNBAS)⁹ was an early scale that was developed for term infants and measured four dimensions: interactive capacities, motor capacities, response to increased stimulation, and physiological response to stress. The BNBAS was later adapted for use in the premature infants and is known as the Assessment of Preterm Infants' Behavior (APIB).⁸ Other researchers describe sleep-wake behaviors based on eye movement, respiratory pattern, gross motor movement, and muscle tone.^{7, 10} See Table 1 for categorization of sleep-wake states and the behaviors associated with each state defined

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through eye movement, respiration pattern, motor movement, muscle tone, and vocalizations.¹⁰ Identification of the behaviors associated with specific sleep-wake states is important because endogenous stimulation occurs during the active sleep state and endogenous stimulation aids in the development of the neurosensory systems (touch, vestibular, auditory, and visual).¹¹ Animal models suggest that deprivation of sleep, both active and quiet sleep, can result in impaired development and loss of brain plasticity.²

Initially, preterm and term-infants appear to have an ultradian rhythm (< 24-hour cycle) regulating sleep-wake cycles.¹² The thought is that the ultradian rhythm may be driven by infant care schedules.¹² In older, healthy infants (> 4 weeks of age¹³), the timing of the sleep-wake cycle is associated with their internally driven circadian rhythm.⁵ The circadian rhythm is synchronized to the light-dark cycle promoting wakeful activities and restful activities depending on the timing of the cycle.⁵ The average time a healthy full-term infant spends sleeping during the 1st week of life is 16 hours, which decreases to 15 hours by the 16th week of life.¹ The average duration of the sleep cycle is 47 minutes for healthy term infants and 50 minutes for 12-week and 24-week-old term infants.¹⁴ When REM and NREM were compared in full-term, preterm, and small for gestational age (SGA) infants at 40 weeks gestation, full-term infants spent the most time in REM sleep, followed by preterm infants, and the SGA infants had the shortest cycle. But for NREM sleep, SGA infants spent the most time in the state followed by preterm and full-term infants.¹⁵ The development and length of sleep-wake cycles are also influenced by gender,¹⁶ neurological injuries,^{17, 18} epilepsy,¹⁹ and prematurity.^{16, 20} Given the complexities of sleep-wake state development and the importance of sleep in relationship to long-term outcomes, neonatal nurses need to promote and protect sleep, as much as possible, in vulnerable hospitalized infants.

PubMed and Cumulative Index of Nursing and Allied Health Literature (CINAHL) were searched to obtain English language publications from 1996 to May 2011 for evidence supporting current recommendations to protect and promote sleep in neonatal intensive care units (NICU). The inclusion criteria of studies were clinical studies examining interventions or care practices that impaired or enhanced sleep patterns, infants were being cared for in the NICU and included human infants (< 1 year of age). Studies were excluded if participants were > 1 year of age at the start of the study, did not include humans, focused on parent outcomes, or primarily focused on sudden infant death syndrome (SIDS). The findings were organized by the evidence to support interventions implemented to influence sleep behaviors of infants in the NICU.

Nursing care and interventions had both positive and negative effects on infant sleep-wake states. After premature infants received necessary nursing care, they exhibited more quiet sleep than before the care was delivered.^{21, 22} Premature infants had increased amounts of active awaking when procedural nursing care (vital signs or other procedures) was provided compared to routine care (feeding, diaper changing, bathing) or contact care (touching, holding, carrying).²³ During procedural care, active waking was greater than in contact care or routine care. As premature infants developed, they continued to maintain active sleep during contact care; whereas, when premature infants were exposed to routine care a more rapid decline was noted in active sleep as they matured.²³ Additional factors identified as increasing quiet sleep were no caregiving, social interactions, infant in lateral position, and use of non-nutritive sucking. Active sleep was increased by no caregiving and decreased by the use of non-nutritive sucking.²⁴ Thus multiple aspects of current nursing care, social interactions, and infant position can impact the sleep-wake states in premature infants. See Table 2 for interventions that may promote sleep.

Skin-to-skin contact (Kangaroo Care)^{25, 26} is also thought to be beneficial to premature sleep cycles and brain development. Skin-to-skin contact interventions are generally

implemented for premature infants at 32 weeks and continue until the infant is discharged home. Research suggests skin-to-skin contact improves sleep-wake cycling, which may indicate accelerated brain maturation, in both preterm and term infants.^{25, 26} The benefits of skin-to-skin contact may also be associated with improved arousal modulation, emotional regulation, and toy manipulation at 3 and 6 months of age for premature infants.²⁶

Touch,²⁷ massage,²⁸ and music are emerging as possible interventions to improve sleep states with subsequent positive impact on early brain development.^{27, 28} Further research about the effect of touch and/or massage on premature infants, which should elucidate the impact of touch and massage on premature infant brain development.^{4, 29} When considering these interventions, it is important to recognize that current recommendations from the American Academy of Pediatrics (AAP)³⁰ are to limit sound to less than 45 decibels and that music within appropriate sound levels may be beneficial to premature infant development. Arnon et al.³¹ conducted a within-subjects, counterbalancing, repeated measures study to determine if delivery of music (live, recorded, or none) impacted the sleep-wake states of the infants. Live music was found to significantly induce active sleep 30 minutes after the intervention compared to the other intervention groups. However, other researchers³² were unable to detect differences between sleep-wake cycles and length of quiet sleep in term and near-term infants exposed to music. Further research is needed to determine the type and quality of music that is best for the developing brain.

In an attempt to adjust nursing care to be more developmentally driven, the Newborn Individualized Developmental Care and Assessment Program (NIDCAP) has been recommended as a potentially useful way for nurses to provide care.³³ The program advocates for decreased light through covering the incubator, decreased noise, use of supportive bedding, and promotion of state transition to sleep by hand swaddling, non-nutritive sucking, or grasping.³⁴ Premature infants who received the developmental care versus the standard care had increased sleep times in total sleep time, active sleep, and quiet sleep.³⁴ However, Westrup et al.³⁵ failed to find any differences in quiet sleep of very low birth weight infants between developmental care (NIDCAP) versus standard care. The differences could be related to the study designs employed by each researcher and the differences between the sample characteristics. Additional research is necessary to understand the implications of an individualized, developmental care program on sleep-wake states.

Conclusions

Sleep is critical to brain maturation in infants. Deprivation of sleep (2-4 hours) in healthy infants has been found to lead to short-term alterations in cardiac function during the next sleep cycle³⁶ and increased respiratory events (e.g., apnea).³⁷ The importance of observing sleep-wake states in premature and critically ill term infants is to ensure that nursing care focuses on prevention of stress in the infant, which may lead to loss of caloric intake and physiologic alterations.³⁸ Many interventions exist that have the potential to improve sleep in premature and critically ill infants and ongoing research continues to provide additional information about how to best deliver the interventions. Providing nursing care that protects sleep in the NICU is critical to ensuring vulnerable infants receive the best care possible.

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