

R E M REM: A PUBLICATION FOR RESIDENTS AND FELLOWS

PERSPECTIVE: The Long-Term Effects of Light Exposure on Establishment of Newborn Circadian Rhythm

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Development of newborns continues postnatally. Evidence has accumulated on the early life programming effects of light exposure on the maturing visual axis and the developing circadian rhythm. Consideration of the effects of light at night and insufficient light during the day should occur when giving anticipatory guidance in the care of newborn infants. Long-term health consequences of light imprinting may occur with inappropriate light-dark environments during the newborn period.

Keywords: circadian rhythm, light exposure, newborn

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When will my baby sleep through the night? Parental concern about a newborn's sleeping patterns is a frequent issue in the first 3 to 4 months of an infant's life. During the initial newborn examination and subsequent well infant examinations, a pediatric provider should evaluate for a normal examination, appropriate growth and development, and give anticipatory guidance that supports safety and continued infant development. Infant's sleep matures after birth. A newborn spends 70%, or 16 to 17 hours, of a 24-hour period sleeping.¹ At 16 weeks, the time an infant spends sleeping decreases to 14 to 15 hours in a 24-hour period. Newborns typically do not sleep more than 4 hours at a time, and their sleep is scattered throughout the 24-hour period. A diurnal pattern with greater sleep at night is not established until 12 to 16 weeks.¹ It is important to give guidance that supports appropriate sleep-wake development in the newborn.

Knowledge regarding the establishment of infant circadian rhythms in the first 3 to 4 months of life is not well recognized by pediatric health care providers.² However, given that light through the eye is a well-recognized component in establishing the circadian rhythm, it is helpful to the pediatrician to consider the establishment of vision as an adjacent pathway. One of the most important parts of a newborn examination is obtaining a bilateral red reflex, which is reflected from an intact, unobstructed retina.³ It is known that if an infant has a congenital cataract, retinoblastoma or developing hemangioma that would block the line of vision to the retina, for the development of vision to occur the newborn must be medically treated immediately. If the obstruction in the line of vision is not removed in a newborn, vision will not develop.⁴ How then should the importance of the eye and the opsin light detecting components in the retina be considered in regard to the entrainment of circadian rhythm?⁵ What are the long-term effects of light at night or lack of bright light during the day on establishing newborn circadian rhythm in the first 3 to 4 months of life? Is there an imprinting effect of light exposure in the newborn?⁶ Just as

vision will not develop if obstructed in a newborn, the establishment of circadian rhythm will likewise be impeded if the newborn does not receive appropriate day/night light exposure.

Circadian rhythm is the approximately 24-hour cycle of change in the physiology of life.² The sleep-wake cycle is part of the circadian rhythm. The infant is born with a weak sleep-wake rhythm connected to the mother.⁷ Circadian rhythm has to develop in the newborn. Light enters the eye, light is detected at the retina, and information is then relayed through the retino-hypothalamic tract to the suprachiasmatic nucleus. The suprachiasmatic nucleus is the central clock in the brain that sends output to the other parts of the brain and body that triggers the circadian rhythm.⁷ Melatonin, cortisol, body temperature, movement, blood pressure, digestion, and consolidated sleep are all part of the circadian rhythm. The newborn infant develops the components of circadian rhythm postnatally.⁷ A rhythm of cortisol develops at 8 weeks of age, melatonin and sleep efficiency develop at approximately 9 weeks, and body temperature rhythm and that of circadian genes develop at 11 weeks.⁸

Growing concern has occurred in regard to the adverse health impacts of light at night in adults.⁹ Light impact on the newborn should also be of concern. One of the most significant effects of light in the newborn is circadian entrainment. Newborn primates are entrained by low intensity lighting.² Actigraphy has shown an association between light and peak activity patterns in human infants indicating the importance of light in infant circadian rhythms.^{10,11} Light exposure in newborns does not change the eye or retina, but it changes the pathways involving the suprachiasmatic nucleus in the brain.⁷ Additionally, aberrant light exposure in mice postnatally had long lasting effects into adulthood on the genes in peripheral circadian clocks in the heart, lungs, and spleen.¹² A change in the peripheral circadian genes has been linked to changes in blood pressure, airway inflammation, and immune response.¹² The imprinting effects on the circadian rhythm of the newborn persist into adulthood.

It is known that light is significant for circadian entrainment, but what does abnormal light exposure in a newborn do later in life? In mice, exposure to dim light at night in infancy showed long lasting effects on the development of anxiety-like behaviors.¹³ A large multicenter study suggested that low levels of light exposure in newborns may influence the onset of bipolar disorder.¹⁴ Additional hypotheses on the perinatal photoperiod effect on metabolic disorder and cancer are being considered.⁶ In a completely different direction, others have considered that SIDS is a disorder of circadian entrainment.¹⁵ As the circadian rhythm matures postnatally, sleep is consolidated at night. The highest incidence of SIDS occurs from 2 to 4 months of age, which is when sleep efficiency should have developed. A study by Cornwell and Feigenbaum demonstrated that infants at low risk of SIDS had more time awake during the day and more time asleep at night relative to infants at high risk of SIDS.¹⁶ Genetic studies have also indicated that clock genes¹⁷ and genes important in the circadian entrainment pathway¹⁸ are found in individuals with autism, schizophrenia, and other psychiatric disorders, suggesting the possibility that abnormal light may cause or contribute to the etiology of many diseases. Abnormal light during the newborn period causes many long-term health problems.

Since the development of the light bulb 130 years ago, people's natural exposure to light has changed.⁹ Satellites are even detecting yearly increases in artificial light at night from space.¹⁹ Long-term health consequences are related to the infant's appropriate establishment of circadian rhythm. Light is the major entrainer of circadian rhythm postnatally.⁷ Pediatricians should consider the importance of infant exposure to light, and parental education on light should be part of the well infant examination. Anticipatory guidance should be given during the well infant examination that promotes the normal establishment of circadian rhythm to prevent long term health consequences. The infant should be exposed to light during the day and essentially no light exposure at night. Light exposure during the day and avoidance of light exposure during the night will promote normal circadian rhythm development in babies.

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The author has seen and approved the manuscript. The author reports no conflicts of interest.