

COMMENTARY

Viral bronchiolitis and the detrimental effects of sleep

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Abstract

Infants recovering from bronchiolitis and no longer requiring supplemental oxygen will have brief episodes of oxygen desaturation during sleep when monitored with pulse oximetry. These episodes can be explained by the inhibition of the tonic activity of the inspiratory muscles during rapid eye movement sleep. Pulse oximetry monitoring should be discontinued, and these infants considered for discharge.

Although there can be no doubt that sleep is beneficial for adults and children, sleep for some individuals may be detrimental or even fatal, such as falling asleep while driving. The ill effects of sleep may also be apparent in those with sleep disordered breathing, such as obstructive sleep apnea. Many physicians may not be aware of the negative influence of sleep on infants recovering from acute viral bronchiolitis. This is best illustrated by a brief case history.

Baby Jane, a previously healthy six month old infant, had the misfortune to contract a respiratory syncytial virus (RSV) infection and was admitted to hospital. In addition to her respiratory distress and poor feeding, it was her need for supplemental oxygen by nasal prongs that triggered her admission. Her oxygen saturation by pulse oximetry (SpO₂) was 85% in room air, below the cut-off of 90% used by the emergency department as one of the criteria for admission. In spite of her cough, tachypnea, subcostal retractions, mild wheeze, and inspiratory crepitations, her course in hospital was uneventful. Supportive care and oxygen were provided, and she was fed orally. On Day 3 of admission, she had minimal respiratory distress and was feeding well. Because she was receiving supplemental oxygen, she remained on continuous SpO₂ monitoring. Anticipating discharge, she had her SpO₂ measured while breathing room air, awake, and in her mother's arms. SpO₂ was 93% and oxygen supplementation ceased. She remained connected to the pulse oximeter and the staff noted her SpO₂'s remained 92-93% awake but fell to 88-89% when asleep. She was restarted on supplemental oxygen when sleeping but taken off nasal prongs when awake. Baby Jane remained in hospital two more days until it was determined that her SpO₂ would not fall below 90% during sleep in room air.

This scenario is repeated frequently during the annual bronchiolitis season and leads some physicians to believe that monitoring by pulse oximetry has led to an increase in length of stay (LOS) for infants with bronchiolitis^{1,2,3}.

Pulse oximetry is a simple non-invasive monitoring device, used initially in acute care settings – emergency departments, intensive care units, and operating rooms since the early 1980's. Known as the "fifth vital sign" pulse oximetry is now widely used on pediatric wards

in patients at risk for hypoxemia⁴.

Acute viral bronchiolitis is the leading cause of hospital admission in infants less than 12 months of age. Most admitted patients are hypoxemic and monitored with pulse oximetry. Admission rates for bronchiolitis have increased in recent years and some physicians believe this is associated with the overdiagnosis of borderline hypoxemia by pulse oximetry^{5,6}.

Guidelines for pulse oximetry, spot checks versus continuous monitoring, and acceptable SpO₂ levels have varied. SpO₂ minimums have fallen from 94%⁷ to the generally accepted levels of 90%. The American Academy of Pediatrics (AAP)⁸, Royal Children's Hospital (Melbourne)⁹, and Canadian Pediatric Society (CPS)¹⁰ recommend 90% while the UK National Institute for Health and Care Excellence (NICE) recommends 92%^{11,12}.

Focusing on the circumstances around the time of discharge and considering that as many as 25% of infants with bronchiolitis will have an increased LOS as a result of a perceived need for oxygen², what do the guidelines recommend? The AAP does not specify discharge criteria, simply stating, "clinicians may choose not to administer supplemental oxygen if the oxyhemoglobin saturation exceeds 90% . . ." ⁸. The guideline does recognize that transient desaturation is a normal phenomenon in healthy infants where as many as 60% will exhibit a transient oxygen desaturation below 90% to values as low as 83%¹³. The Royal Children's Hospital guideline recommends discontinuing oxygen when SpO₂ is persistently \geq 90% but also state stopping SpO₂ monitoring if not requiring oxygen for 2 hours⁹. They note that "infants with bronchiolitis will have brief episodes of mild/moderate desaturations to levels less than 90%. These brief desaturations are not a reason to commence oxygen therapy." The CPS, while not specifically focusing on discharge, does recognize that transient oxygen desaturations can occur and that continuous monitoring may lead staff to react to normal transient dips in SpO₂ and restart oxygen therapy¹⁰.

The only guideline to mention sleep is NICE¹¹. For discharge, NICE recommends that infants ". . . have maintained oxygen saturation over 92% in air for four hours, including a period of sleep." This recommendation, unfortunately, will lead to

the re-institution of oxygen therapy when brief desaturations less than 92% occur. In August 2019 NICE proposed that they needed to update their guideline stating that “the update will focus on safe and effective levels of oxygen saturation when discharging patients”¹¹.

Recognizing that healthy infants and infants with bronchiolitis can have brief oxygen desaturations, how might this be related to sleep?

Tonic activity of the intercostal muscles and diaphragm are important for the maintenance of functional residual capacity (FRC) in infants. During rapid eye movement (REM) sleep, the tonic activity of inspiratory muscles is inhibited and in healthy newborns the thoracic gas volume is reduced 31%¹⁴. The lack of tone in the intercostal muscles may cause the chest distortion to be readily apparent in the infant with a compliant chest wall. The fall in FRC leads to a subsequent drop in SpO₂ detected by the pulse oximeter.

Seeking to determine whether episodes of desaturation prior to discharge in patients with bronchiolitis were associated with sleep, Kaditis et al performed continuous SpO₂ measurements from 10 pm to 8 am¹⁵. They compared patients recovering from bronchiolitis with patients without lung disease and those with chronic partial upper airway obstruction without lung disease. Prior to discharge, infants with bronchiolitis exhibited low basal SpO₂'s and multiple abrupt SpO₂ drops during the night. The authors speculated that the low SpO₂'s reflected the sleep associated reduction in FRC and deterioration in ventilation-perfusion (V/Q) mismatch. They also commented on the frequent clinical scenario of re-instituting oxygen administration during sleep in infants with bronchiolitis who have been weaned off oxygen while awake, the point of this article. We have physiological evidence for drops in SpO₂'s during sleep in infants with bronchiolitis, a phenomenon that also occurs in adolescents with asthma^{16,17}.

What might be possible solutions to address this issue? The Choosing Wisely campaign recommends avoiding continuous pulse oximetry in children admitted for respiratory illnesses who are not using supplemental oxygen¹⁸. The AAP clinical practice guideline on bronchiolitis suggests similar advice⁸. The message is that continuous pulse oximetry is more likely to detect transient oxygen desaturations of uncertain significance. The CPS guidelines also recommend

intermittent monitoring except for high risk patients¹⁰.

This author suggests one step further. When an otherwise healthy infant is recovering from bronchiolitis and (1) has minimal respiratory symptoms, (2) is feeding satisfactorily (75% of normal intake), (3) is maintaining SpO₂'s \geq 90% when awake in room air for more than 2 hours and not requiring supplemental oxygen, and (4) there are no social/family issues to prevent discharge, discontinue pulse oximetry monitoring and send the patient home.

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