Sleep Related Breathing Disorders

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Introduction

The assessment and management of Sleep Related Breathing Disorders (SRBD) are important clinical and research priorities in individuals with Neural Tube Defects (NTD), specifically in those with Myelomeningocele (MMC).[1]

SRBD is common in the general pediatric population with a prevalence of up to 5% in children and 11% in adolescents.[2-3] In the general adult population, the prevalence of Obstructive Sleep Apneas (OSA) defined by ≥5 apnea and hypopnea events per hour of sleep associated with excessive sleepiness is approximately 3-7% in men and 2-5% in women.[4] Untreated and unrecognized SRDB are associated with significant neurocognitive, psychological, metabolic, immunologic, cardiovascular consequences and even death. Chronic SRBD have been identified as the cause of death in 12.8-16.3% of patients with MMC independent of adjustments for sensory level, motor level and birth head circumference.[5-7] Sudden unexplained death during sleep is also described, especially between birth and 19 months of age.[8]

The types of SRBD described in patients with NTDs include central apnea, periodic breathing, obstructive apnea, and central hypoventilation.[4,11,13,25-28] Central apnea refers to pauses in respiratory effort; periodic breathing refers to series of at least 3 central apneas separated by breaths of no more than 20 seconds; obstructive apneas and hypopneas refer to partial or complete airway obstruction, and central hypoventilation refers to persistent low tidal-volume breathing or bradypnea causing hypercarbia and hypoxemia (central hypoventilation syndrome/ventilatory dysfunction). Patients with MMC also have absent arousal responses to hypoxia and hypercapnia and absent ventilatory responses to hypoxia and hypercapnia.[6,13-15,27-28] Unfortunately, symptoms alone do not predict treatment outcome.[16]

The prevalence of SRBD in MMC has been reported between 62-81%; the prevalence of moderate to severe OSA in this population has been reported to be as high as 20-31%.[2,13,17] Obstructive events are more likely to occur during rapid eye movement (REM) sleep state. Efforts to quantify the incidence of central apneas are based on small series and case reports and likely represent under recognition / reporting. In children with MMC, risk factors for SRBD include higher spinal cord lesions, brain stem dysfunction resulting from decreased cervicomedullary subarachnoid space, very abnormal Chiari malformations, pulmonary function abnormalities (obstructive lung disease and restrictive lung disease), and disorders of upper airway maintenance.[7,13-14] Obesity is an independent risk factor for SRBD in all children with an estimated prevalence of 13-78%.[3] The combination of higher obesity rates in individuals with MMC and an abnormal brainstem respiratory brainstem control center secondary to their Chiari malformation place this population at increased risk for SRBD.

The clinical course of infants and children with MMC and central respiratory control abnormalities is variable. In infants up to a year, the most common presentations include stridor, apnea, and feeding difficulties. These symptoms may not be present perinatally but can present before 3 months of age.[4,18] When present in young infants, neurological deterioration may progress rapidly and can result in cardiorespiratory arrest and death.[18,30] In infancy, central apneas, periodic breathing, hypoventilation, breath holding spells, and cyanosis have been described even after relief of upper airways obstruction with decompression, shunt revision,

and/or tracheostomy tube placement.[9-11] In older children, the most frequently reported symptoms include apnea, blue spells, shortness of breath, snoring, choking, and irritability.[17] Excessive daytime sleepiness is less common in children than in adults.[30] Symptoms of SRBD in adults include snoring, witnessed cessation of breathing, gasping or choking at night, excessive daytime sleepiness, impaired cognition, and mood changes.[1,19] Because adults with NTD are a recognized high-risk population for SRBD, the recent US Preventive Services Task Force (USPSTF) recommendations to not routinely screen for SRBD in adults within the general population do not apply.[19]

Little is known about the effect of neurosurgical intervention (hydrocephalus intervention, cervical decompression) on sleep hygiene/SRBD in individuals with NTD. Although cervical decompression of symptomatic Chiari malformation may be effective, this treatment does not always resolve the apneic symptoms in infants.[4] Persistent central apneas, periodic breathing, hypoventilation, breath holding spells, and cyanosis have also been described after relief of upper airway obstruction with decompression, shunt revision, and tracheostomy tube placement.[9-11]

Identification/Tools:
To screen for OSA, the American Academy of Pediatrics recommends that each child be questioned regarding snoring and other signs and symptoms of OSA.[3] Several questionnaires are available to screen for sleep disorders such as the Children's Sleep Habits Questionnaire and the Pediatric Sleep Questionnaire (PSQ). These instruments are not specific to NTDs. The PSQ is a valid and reliable instrument that can be used to identify SRBD or associated symptom-constructs (habitual snoring, insomnia, excessive daytime sleepiness, inattentive/hyperactivity, sleep terrors, sleepwalking, nocturnal bruxism).[6] In adults, validated questionnaires to predict the presence of sleep apnea include the STOP-BANG (Snoring, Tiredness, Observed apnea, High blood Pressure-Body Mass Index (BMI), Age, Neck Circumference, Gender), Berlin, Epworth Sleepiness Scale (ESS), and OSA 50 (Obesity-Snoring-Apnea-Age>50).[8,20]

In children, clinical evaluation alone (history, physical exam, audio or visual recordings, standardized questionnaires) does not have sufficient sensitivity or specificity to establish a diagnosis of SRBD.[11,16,20] Specifically, Waters et al. report 83% accuracy and 65% sensitivity in predicting the presence of moderate/severely abnormal SRBD in patients with MMC based on a history of stridor and dysphagia in infancy, a history of apnea or cyanosis, or a high level of spinal lesion. Overnight observed polysomnography (PSG) that includes the measurement of respiratory variables (carbon-dioxide levels, oxygen saturation, sleep state and electromyogram recordings) remains the "gold standard" to identify SRBD but is not readily available in all settings.[3] Nocturnal pulse oximetry has been used as an abbreviated testing method to detect moderate to severe SRBD with positive predictive value of 44% and a negative predictive value of 100%.[13]

Because of the low sensitivity of clinical evaluation alone, the high morbidity associated with untreated OSA, and the high incidence of sleep apnea in patients experiencing sudden death, it is recommended that all patients with NTD, whether they are symptomatic or asymptomatic, undergo polysomnography that evaluates for central apneas, hypoventilation, as well as obstructive sleep apneas.

Outcomes

Primary

1. Improve recognition of signs and symptoms of sleep related breathing disorders (SRBD) across the lifespan, recognizing that symptoms important for its recognition in infants will be different than in adults.

Secondary

1. Implement a strategy to identify SRBD in the clinical setting through reliable screening methods that improve timely referral for additional appropriate assessment (polysomnography).

Tertiary

1. Minimize the adverse impact of unrecognized SRBD on physical well-being (including sudden, unexplained death) and neurocognitive function.

0-11 months

Clinical Questions

1. Is there any predictable sequence to cranial nerve dysfunction (is eating affected before facial weakness and/or respiratory regulation) or is each child different?
2. Is there any anatomic (imaging) or physiologic marker that identifies children at greatest risk for SRBD?
3. Do any observed signs/symptoms predict a greater need for a specific intervention (ventricular shunting, foramen decompressions, oxygen supplementation)?

Guidelines

1. Screen for SRBD signs and symptoms in all infants with NTD at each health care maintenance visit using available standardized questionnaires.[3,12,16,24]
2. Encourage that all symptomatic infants or those with additional risk factor for OSA (high spinal lesion, small cervicomedullary arachnoid space, or severe Chiari malformation) undergo a formal evaluation for SRBD with overnight polysomnography or be referred to a specialist with expertise in sleep-related breathing disorders.[3,13,16,20,29]
3. Refer all infants with documented SRBD referred to appropriate specialists with expertise in SRBD (pediatric pulmonologist or sleep specialist), neurosurgeon, and/or otolaryngologist) for ongoing management.[14,17-18]
4. Conduct periodic cardiac evaluations on infants with documented SRBD and hypoxemia to assess for pulmonary hypertension and cor pulmonale.[3]

1-2 years 11 months

Clinical Questions

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Guidelines

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malformation) undergo a formal evaluation for SRBD with overnight polysomnography or be referred to a specialist with expertise in sleep-related breathing disorders.[3,11,13,16,20,22]
3. Refer all children with documented SRBD to appropriate specialists with expertise in SRBD (pediatric pulmonologist or sleep specialist), neurosurgeon, and/or otolaryngologist for ongoing management.[14,17-18]
4. Conduct periodic, comprehensive cardiac evaluations on children with documented SRBD and hypoxemia to assess for pulmonary hypertension and cor pulmonale.[3]
5. Discuss sleep hygiene (expectations, normal variations, and interventions) with parents and caregivers to promote healthy sleep. (clinical consensus)

3-5 years 11 months

Clinical Questions

1. Is there a sufficiently sensitive and specific method (questionnaire, screening test) prior to polysomnography that would support routine screening of children with NTD for SRDB? Is there a clinical profile (signs, symptoms, other risk factors like obesity, hypertension) that would warrant a higher priority referral?
2. Are asymptomatic individuals with NTD really asymptomatic or are they only unrecognized?

Guidelines

1. Recognize that the symptoms of SRBD in children (mouth breathing, a history of delayed growth, features of inattention and hyperactivity) are different compared to adults (snoring and excessive daytime sleepiness are less frequent).[2,7,9-11,13,16,22]
2. Ask questions related to sleep quality, quantity and other possible symptoms at every visit (at least annually). Standardized screening questionnaires for SRBD in children are useful in clinical settings.[3,12,24]
3. Further evaluate changes in respiratory status/function.[3,14,17]
4. Discuss sleep disordered breathing with parents and care providers so they can better observe for early symptoms or changes.[8]

6-12 years 11 months

Clinical Questions

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4. Discuss sleep disordered breathing with parents and care providers so they can better observe for early symptoms or changes.[8]

13-17 years 11 months

Clinical Questions

1. Are asymptomatic individuals with NTDs really asymptomatic or are they only unrecognized?
2. What is the effect of SRBD on morbidity and mortality?

Guidelines

1. Use a standardized sleep questionnaire to query patients at each visit (at least annually) because patients are unlikely to discuss sleep-related symptoms spontaneously with a primary care or specialty provider.[3,15-16,24,26]
2. Recognize clinical findings that may either contribute to or be the result of sleep disordered breathing: hypertension, obesity, and scoliosis.[1,3,23]
3. Improve patients' awareness of SRBD, its presentation and its adverse impact on quality of life.[1,6,8,23]

18+ years

Clinical Questions

1. Are asymptomatic individuals with NTD really asymptomatic or are they only unrecognized?
2. Does SRBD increase or evolve with adulthood?
3. What is the effect of SRBD on morbidity and mortality?

Guidelines

1. Use a standardized sleep questionnaire to query patients at each visit (at least annually) because patients are unlikely to discuss sleep-related symptoms spontaneously with a primary care provider.[3,19-20,24,26]
2. Recognize clinical findings that may either contribute to or be the result of sleep disordered breathing: hypertension, obesity, and scoliosis.[1,3,23]
3. Improve patients' awareness of SRBD, its presentation and its adverse impact on quality of life.[1,6,8,23]

Research Gaps

1. Is the frequency of or reasons for sleep disorders in the NTD population truly greater/ different than the general population or is this the result of referral/assessment bias?
2. Are these frequency differences related to the presence or degree of Chiari malformation and/or brainstem dysfunction?
3. How do unrecognized sleep disordered breathing disorders contribute to the neurocognitive profile/decline in individuals with a NTD?
4. Is there any anatomic (imaging) or physiologic marker that identifies children at greatest risk for SRBD?
5. Do any observed signs/symptoms predict a greater need for a specific intervention (ventricular shunting, foramen decompressions, oxygen supplementation)?
6. Is there a sufficiently sensitive and specific method (questionnaire, screening test) prior to polysomnography that would support routine screening of children with NTD for SRDB? Is there a clinical profile (signs, symptoms, other risk factors like obesity, hypertension) that would warrant a higher priority referral?
7. Are asymptomatic individuals with NTD really asymptomatic or are they only unrecognized?
8. Does SRBD increase or evolve with adulthood?

9. What is the effect of SRBD on morbidity and mortality?

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