Sleep Disordered Breathing in Children: A Guide for Clinical Practice

by

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DEDICATION

This thesis is dedicated to those in my life who have sacrificed to make my dreams a reality.
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ABSTRACT

Sleep disordered breathing is described as a spectrum of airway obstruction from upper airway resistance to complete airway occlusion leading to apnea. Research reveals an increasingly large percentage of the pediatric population is affected by various levels of airway obstruction. The effects of airway obstruction are numerous, including effects on the neurobehavioral, cardiovascular, and metabolic systems. Neurobehavioral consequences include alterations in mood, behavior, concentration, and impulsivity. Hypertension, cor pulmonale, ventricular hypertrophy, and pulmonary hypertension have been shown to be a consequence of airway obstruction and hypoxia. Sleep disordered breathing has been shown to be associated with metabolic syndrome, including increased atherogenesis and decreased immunity. Despite the large volume of recent research, provider knowledge and attitudes remain low. The American Academy of Pediatrics and the American Academy of Sleep Medicine both offer guidelines for evaluation and treatment of these children. There are many helpful tools for gathering important information during history and physical assessment to help prioritize patients for polysomnography. Polysomnography remains the gold standard for diagnosing sleep disordered breathing in children and for assessing effectiveness of treatment.
CHAPTER I. INTRODUCTION

Despite great advances over the last twenty years in the field of pediatric sleep medicine, provider knowledge and comfort with diagnosis and treatment of sleep disordered breathing remains low. Sleep disordered breathing (SDB) is described as spectrum of airway obstruction from upper airway resistance to complete occlusion leading to apnea; obstructive sleep apnea (OSA). Gozal describes SDB as a complex interaction of airway tone, central and peripheral drive, and upper airway reflexes along with possible decreased airway volume due to enlarged tonsils and adenoids (Gozal, 2008). Enlarged tonsillar and adenoidal tissues are the main cause of OSA in children between the ages of two and six (Sheldon, Ferber, & Kryger, 2005). Research into the prevalence of these disorders over the last 10 years reveals 3-12% of children are affected by habitual snoring, and between 1-3% have obstructive sleep apnea (American Academy of Pediatrics (AAP), 2002). More recent research into the prevalence of habitual snoring, described as snoring present three or more nights a week, shows as many as 27% percent of children and 5% of infants 2-4 months of age are affected (Gozal, 2008). There is overwhelming evidence in recent literature correlating the sleep disturbances caused by airway obstruction with alterations in mood, behavior, concentration, and impulsivity. Obstructive sleep apnea leads to disturbances in the cardiovascular and endocrine systems, which can affect long term health.

Objectives

The objectives of this paper are to define SDB and present recent research studies correlating SDB and neurobehavioral and cardiovascular disturbances. A clinical problem solving model is used to help healthcare providers spot children most at risk for sleep disordered
breathing and its complications, and to provide a resource guiding diagnostics, referral and follow up. The population addressed is the otherwise healthy child. Children under the age of two and those with more severe co-morbidities are not included. Such children at an increased risk for sleep disordered breathing not covered here are those with severe craniofacial abnormalities (including cleft palate), Down’s syndrome, cerebral palsy and other neuromuscular diseases, sickle cell disease, and children with gastroesophageal reflux.
CHAPTER II. DEFINITION OF PROBLEM

Provider Knowledge

In 2005, Uong and associates developed a questionnaire to establish physician’s attitudes and knowledge regarding OSA in pediatrics. In a pilot study of their questionnaire, they found that knowledge scores were 69.6% (Uong et al, 2005). The biggest gap in knowledge was found to be in regards to the prevalence of OSA, frequency of snoring, and identification of populations most at risk. Less than two-thirds of providers answered these questions correctly. Higher levels of knowledge were related to more recent graduation and those who completed a pediatric residency. Although many rated OSA as clinically important, few rated themselves as confident in managing obstructive sleep apnea. Uong et al found that there was a strong correlation between provider’s confidence in identifying and treating obstructive sleep apnea, with their overall attitudes regarding OSA. Unfortunately, community based physicians, versus academic, had the worst attitudes.

A retrospective study by Richards and Ferdman in 2000 interviewed randomly selected parents of children who had already undergone adenotonsillectomy (AT). All of the parents described their children to have been moderate to severe snoring, and 40% of these parents self referred to otolaryngologist because of concerns with their child’s snoring. Many of these parents stated that the pediatrician was already aware of their concerns. Eighty-two percent had a greater than one year delay from onset of symptoms to surgery, while 51% had greater than two years of delay. Parents had significant enough anxiety regarding their child’s abnormal sleep that they took turns sleeping with the child (76%); while 82% said their family life was greatly disturbed (Richards & Ferdman, 2000). Polysomnography was completed in 34 of the 45 children, and was
found to be abnormal in 32. Parental non compliance was admitted as a cause for delay in five, and 10 had problems with Third party payers. Of the most common reasons for delay or absence of treatment as stated by the pediatricians, recounted by the parents, was that there was not a problem to worry about and/or that it was best to wait until the child was older to intervene (Richards & Ferdman, 2000). Again, lack of knowledge of the provider of the consequences of SDB and the subsequent lack of support to the parents significantly delayed care to these children.

Delay in treatment

There continues to be significant delays or absence of assessment and treatments in these chronically sleep deprived children, which can result in a child going years without healthy, quality sleep. In 2004, Guilleminault found that chronically elevated airway pressures themselves lead to increased pharyngeal tissue redundancy and soft palate elongation (Guilleminault, Kasey, Khramstosov, Pelayo & Martinez, 2004). What this means for children with already enlarged tonsils and adenoids is that delays in treatment can worsen the obstruction and therefore the short term and long term consequences.

Sleep disordered breathing represents a pediatric public health priority. Many medical professionals have dedicated their research to establishing a link between daytime behaviors and other medical co-morbidities with sleep disordered breathing. Guidelines for identifying, diagnosing, and treating children have been developed by major organizations such as the American Academy of Pediatrics (AAP, 2002). Snoring, and its neurobehavioral consequences, is something parents perceive as ‘normal’ in their children and may not be aware of the negative impact on their child’s life. Providers can
reinforce with parents the importance of sleep for their children’s health and integrate evaluation of sleep disorders into their routine assessments. Treating SDB may significantly improve daytime behavioral and cognitive symptoms which could then improve the quality of life for both child and family (Mitchell, Kelly, Call, & Yao, 2004, Chervin et al, 2006, Goldstein, Fatima, Campbell, & Rosenfield, 2002).
Sleep disordered breathing describes a group of disorders characterized by airway obstruction, whether partial or complete, and can only be formally diagnosed with a polysomnographic sleep study (PSG). The goal of the PSG for sleep disordered breathing is to identify the presence, frequency and severity of airway obstruction along with subsequent interruption in sleep. Polysomnography consists of simultaneous measurement of multiple physiologic parameters related to sleep and wake (Armon, 2009). To assess sleep stages 3 studies are required: electroencephalography (EEG), electroocculography, and surface electromyography (Armon, 2009). The electromyography, depending on placement, can identify either arousals or the presence of parasomnias such as periodic limb movement. A thermistor channel (oral or nasal) is used to evaluate airflow in apneas, but a nasal pressure transducer is needed to identify hypopneas (Armon, 2009). Other parameters that can be monitored during a PSG are electrocardiography (assess hypoxia related arrhythmia), pulse oximetry (assess for oxygen desaturation), thoracic and abdominal respiratory effort, end tidal or transcutaenous carbon dioxide, sound, and/or video recordings (Armon, 2009). Snoring is measured with a microphone attached proximal to the trachea on the neck.

Respiratory pattern scoring is completed using the data retrieved from the PSG, evaluating respiratory events. An apnea is defined as the absence of oronasal airflow for any duration, with persistent respiratory effort (Sheldon, Ferber, & Kryger, 2005). A reduction in airflow, seen on either the thermistor or nasal pressure monitor, of greater than 50% with a desaturation of at least 3% or an accompanied by an arousal defines a hypopnea (Sheldon,
Ferber, & Kryger). The number of apneas plus the number of hypopneas per hour of sleep defines the apnea/hypopnea index (AHI). It is important to note here that although an AHI of greater than one is considered diagnostic for OSA in children, normative data for children has yet to be established and adult norms continued to be used to define respiratory events in children. Much research is underway to better define normative data in children. One such study showed that apnea indices varied across age groups, with the average apnea index in children aged three to five 0.03 and for children aged greater than six the average apnea index was 0.05 (Montgomery-Downs, O’Brien, Gulliver & Gozal, 2006). Another scoring criteria used is the oxygen desaturation index which is defined as the number of total oxygen desaturations of 3% or more divided by the total sleep time (AASM, 2005).

**Obstructive sleep apnea**

The American Academy of Sleep Medicine does not require an arousal from sleep to be demonstrated to diagnose obstructive sleep apnea in children. Children have been shown to have higher arousal from sleep thresholds (Busby, Mercier, & Pivik, 1994). The AASM diagnostic criteria for OSA require the presence of any one of many combinations of data found in evaluation of the child. The criteria used includes the presence of caregiver reports of daytime and nighttime behaviors, one respiratory event an hour (apnea or hypopnea of at least two respiratory cycles in duration), arousals from sleep with increased respiratory effort, arterial oxygen desaturation in association with apneic episodes, markedly negative esophageal pressure swings, snoring, and paradoxical ribcage motion (AASM, 2005).
Upper airway resistance syndrome

Obstructive sleep apnea is characterized by either partial or complete obstruction which can lead to any one or a combination of the following: hypoxia, hypercapnia, increased intrathoracic pressures, and arousal from sleep (Sheldon, Ferber & Kryger, 2005). The difference between primary or habitual snoring and upper airway resistance syndrome (UARS) is that the partial upper airway obstruction found in snoring, or occasionally without, is accompanied by increased respiratory effort and is terminated by an arousal from sleep (Sheldon, Ferber & Kryger, 2005). Upper airway resistance syndrome is by definition not related to gas exchange abnormalities because the partial obstruction combined with the arousal from sleep prevents significant hypoxemia and/or hypercarbia.

Primary snoring

Although previously thought to be a benign process, snoring has been linked to significant cognitive and behavioral dysfunction. The most frequently assessed symptom of sleep disordered breathing is snoring, although snoring may not always be present in the disorder (AAP, 2002). Primary snoring is nightly or frequent snoring not associated with apnea, hypoventilation, or sleep fragmentation (Sheldon, Ferber & Kryger, 2005). Habitual snoring is that which is present three or more nights a week (Sheldon, Ferber & Kryger, 2005).
CHAPTER IV. CONSEQUENCES OF SLEEP DISORDERED BREATHING

Adults with OSA experience consequences to their mood, behavior, ability to concentrate, and immunity (Schroder & O’Hara, 2005, Mills & Dimsdale, 2003). Studies in adults with OSA show significant deterioration of dexterity, disorientation, morning confusion, personality changes, outbursts, aggression, irritability, depression and anxiety all thought to be related to sleep fragmentation (Durmer & Dinges, 2005). Cognitive dysfunction, such as alterations in attention, concentration, complex problem solving, and short term recall, is thought to be directly related to hypoxemia (Findley et al., 1986).

Children with obstructive sleep apnea may experience similar symptoms as adults in terms of consequences of OSA, but children are less well studied. It can be inferred that owing to children’s rapid development, the long term consequences of SDB in children may be even more deleterious. Studies that are published have reported the negative effects of obstructive sleep apnea on children’s cognition and behavior, cardiac and endocrine system functions.

Neurobehavioral Effects

In 1892, Osler described children who had “loud and snorting respirations” and “prolonged pauses” were “stupid looking” and answered questions slowly (Gozal, 2008). Over a century later, the neurobehavioral consequences of SDB began to be studied extensively. In a groundbreaking study, Gozal (1998) reported that treatment for OSA in children who were performing at the bottom quartile of their first grade class resulted in an entire letter grade improvement of performance the following year. Children who were not treated for their sleep apnea in the same study did not improve at all scholastically (Gozal, 1998).
The Tucson Children’s Assessment of Sleep Apnea (TuCASA) is the first of its kind in-home polysomnographic epidemiological study of pediatric sleep and was designed to “investigate the prevalence and correlates of objectively measured sleep disordered breathing” (Goodwin et al., 2003). These researchers found that of 1,219 children between the ages of 6-12 years, children with learning problems were 2.4 times more likely to snore and 2.5 times more likely to have excessive daytime sleepiness. Of the children with excessive daytime sleepiness, they were 3.2 times more likely to snore and 5.7 times more likely to have had a parent witness an apneic event (Goodwin et al, 2003).

A history of snoring has been shown to be linked to a four to five fold increase for newly developed hyperactivity, with a fourfold increase in overall SDB scores (Chervin & Ruzicka, 2005). Gozal found that 30% of children who were rated as having frequent loud snoring or diagnosed OSA, had significant hyperactivity and inattentitiveness (2008). Of the children in this study who had attention deficit/hyperactive disorder (ADHD) meeting the Diagnostic and Statistic Manual of Mental Disorders IV (DSM IV) (American Psychiatric Association (APA), 2000) criteria, only 20% had objective sleep disturbances and were not more likely to have true OSA (Gozal, 2008).

Correlations between SDB and reported inattentive and hyperactive behaviors in children with OSA are often not significant enough to meet DSM IV (APA, 2000) criteria, but enough to affect quality of life of both parents and children including school performance. In one study of five to seven year olds with parentally reported attention deficit/hyperactive disorder symptoms, mildly hyperactive children were more likely to have sleep disordered breathing than controls, but the same links were not found in more severely hyperactive children (O’Brien et al, 2003).
Results of one study of 229 children aged 2-13 showed treatment with adenotonsillectomy decreased symptoms in 5-25% of children with SDB, and over one-half of children no longer qualified for the diagnosis of Attention Deficit Hyperactivity Disorder (Chervin & Ruzicka, 2005).

A similar effect has been seen in adolescents. One study of adolescents between the ages of thirteen and fourteen showed that loud snoring was found in 12.9% of low school performers compared to 5.1% of high performers (Gozal & Pope, 2001). Snoring and learning problems together correlated 98.9% in SDB (Budhiraja & Quan, 2009). This study found that learning problems was both a specific and sensitive indicator of children who have SDB (95.9% and 11.3% respectively) (Budhiraja & Quan, 2009).

Cardiovascular effects

Several cardiac consequences of SDB have been well established in children: hypertension, ventricular hypertrophy, cor pulmonale and pulmonary hypertension. The hypoxia and negative intrathoracic pressures associated with OSA have been related to cor pulmonale, pulmonary hypertension, and pulmonary edema (Sofer et al., 1988). A relationship between SDB and elevations in blood pressure has also been identified in children (Amin et al., 2008, Bixler et al., 2008, Enright et al., 2003). Amin and associates identified a relationship between SDB and increased morning blood pressure surges, blood pressure load, and mean nocturnal and diurnal blood pressures (Amin et al., 2008). In children with OSA, AHI less than five was associated with morning blood pressure surges where AHI greater than five was related to elevations in nocturnal and diurnal blood pressures (Amin et al., 2008). Bixler et al found that there were significant elevations in systolic blood pressure in children as young as five when the
AHI was greater than five (2008). Taken together, this evidence suggests that the longer a child goes with untreated OSA, the more negative the effects may be on the autonomic nervous system and cardiovascular health.

In another TUCASA study, Enright and associates found that SDB was associated with daytime hypertension in a large community based population (Enright et al., 2003). These researchers found the relationship to be linked only to those children who had events where they de-saturated 3% or more from baseline. In those found to have an AHI greater than one, heart rate was significantly elevated both during periods of wakefulness and sleep. In children with severe OSA, defined by these authors as an AHI greater than five, there was a significant increase in relative heart muscle thickness in the presence of hypertension (Amin et al., 2008).

Studies have shown that an improvement or resolution of ventricular dysfunction can occur after AT (Ugur et al., 2008, Tal, Leiberman, Margulis, & Sofer, 2004, Gorur et al., 2001).

Metabolic effects

There have been reports of children with OSA who have developed metabolic syndrome with an AHI greater than five, where a 6.49 increase in odds of developing the syndrome was found even when other factors were eliminated (Redline et al, 2007). As part of the metabolic syndrome, Redline and colleagues found strong evidence relating sleep disordered breathing to elevated blood pressures, fasting low density lipoprotein and insulin levels. Studies have also shown a link between the development of atherosclerosis and those children with moderate to severe sleep disordered breathing. Pro inflammatory markers known to be related to atherogenesis such as elevated C-reactive protein, elevated Interleukin 6 (IL-6) and decreased Interleukin 10 (IL-10) have been found in children with OSA (Tauman, O’Brien, & Gozal, 2007,

In a study of metabolic alterations in obese and non obese children before and after AT, although there was significant improvements of AHI and sleep fragmentation in the non obese patients there was no changes in fasting glucose or insulin levels while there were significant improvements in high density lipoprotein, low density lipoprotein, and C-reactive protein with a mild increase in body mass index (Gozal et al, 2008a). In the same study, the obese children had no changes in body mass index or glucose but an improvement in insulin levels and all other factors was found. The authors concluded that OSA has a significant impact on other components of metabolic syndrome except for insulin resistance. Insulin resistance is directly related to body mass index which could explain why without a reduction in BMI the insulin resistance persisted in this study (Steinberger & Daniels, 2003).

Difficulty in research

One of the main problems for researchers seeking to prove a correlation between SDB and the above effects is that clear diagnostic criteria specific for sleep apnea in children has yet to be formalized. In the recent past adult sleep apnea criteria have been used to interpret sleep apnea severity in children and this may have led to Type I statistical errors, or inappropriate rejection of the hypothesis, where behavioral and cognitive effects were measured. For instance, one study found SDB not to be directly related to hyperactivity except where the child was found to have periodic leg movements greater than five and hour and that the severity of sleep disruption seemed more significant than hypoxemia or the number of respiratory events (Chervin & Archbold, 2001). This research shows that adult guidelines for measuring the AHI may not be
useful because it is not the only predictor of adverse outcomes. Given current pediatric diagnostic criteria, a review of this evidence may reveal a different conclusion.

Until true population norms are established for pediatric patients, results may create controversy over using American Sleep Disorders Association’s criteria for respiratory events during sleep. Many researchers contend that the lack of consistent correlation between sleep disordered breathing and neurobehavioral disturbances is due to inadequate standardized measures of scoring and the inability as of yet to pinpoint what specific criteria causes the disturbances. Similarly, it could be the lack of standardized diagnostic criteria that is contributing to the lack of available evidence. This is where providers are required to piece together the often subtle presentation of SDB and use their clinical judgment as to who needs treatment and who does not – a question that remains unanswered to this day.

In much of the existing research, small sample sizes may lead to data which is skewed towards labeling results as insignificant. Also, parents who enroll their children into research studies, or who present to specialty clinics for treatment, often have children with more severe outward signs of behavioral problems, severe snoring, and apnea resulting in a self-selection bias when attempting to interpret study results. Existing research often uses validated parent rated questionnaires to gather data about a child’s sleep disturbances. Parents can be biased about the subject due to their exposure to the subject, or lack thereof, and their perceptions of the importance of sleep in general and of symptoms such as snoring, hyperactivity, and inattentiveness.
CHAPTER V. EVALUATION OF THE PATIENT

Assessment of snoring

The symptoms of sleep disordered breathing can be easily assessed at each well-child visit. At this time it is not possible to diagnose a child from a clinic assessment, it does facilitate the detection of symptoms which suggest the need for further objective evaluation with PSG. The initial question of ‘does your child snore’ is the first step in this assessment strategy. Although OSA can be present without a history of snoring, it is very rare. Loud snoring was found to be both specific (89.5%) and sensitive (29.5%) in diagnosing SDB (Budhiraja & Quan, 2009). The same study found that the presence of snoring and excessive daytime sleepiness was correlated 97% of the time with SDB; whereas the presence of snoring in males was 95.1%. While the AAP encourages healthcare providers to assess children for snoring at each routine physical examination (2002), research shows that providers are not doing this (Archbold, Pituch, Panahi & Chervin, 2002). It is important to note that the subjective description of snoring does not provide the practitioner with enough information. A full PSG is required to adequately diagnose OSA versus primary snoring. As discussed above, more severe OSA is linked to cardiovascular complications and may be a modifiable risk factor for long term cardiac morbidity and mortality. Research showing that treatment of SDB can improve outcomes is motivation enough to encourage change of practice in assessment for providers.

Assessment tools

While the PSG continues to be the gold standard for diagnosis of OSA in children, practitioners can use validated symptom identification questionnaires such as the Childhood Sleep Habits Questionnaire (Owens, Spirito, McGuinn, & Nobile, 2000) or the Pediatric Sleep
Questionnaire (Chervin, 2000) to screen children for PSG testing. With the questionnaires, the provider can more comprehensively evaluate the child’s sleep habits, sleep behaviors, and daytime behaviors. The Childhood Sleep Habits questionnaire is for ages 4-12 years old and is a parental report of a typical week. Reliability and validity was verified by a sample of children with confirmed sleep disordered breathing and a sample of elementary school children (Owens et al, 2000). The Pediatric Sleep questionnaire is more sleep disordered breathing specific, used for ages 2-18 years. Polysomnography was used to verify its internal consistency for identifying sleepiness, behavior; snoring and sleep disordered breathing (0.66, 0.84, 0.86, and 0.89 respectively), making it a good symptom identification tool when PSG is not immediately feasible (Chervin, 2000). This screening creates an opportunity for the provider not only to evaluate for SDB, but to identify teaching opportunities regarding better sleep hygiene. Although other questionnaires exist evaluating specifically sleep habits, or sleepiness; the two mentioned above have been validated with PSG data in children to provide more comprehensive information on sleep habits, daytime sleepiness, sleep behaviors, dyssomnias, parasomnias, SDB, and behavior. For parents who may not have been aware of their children’s sleep behaviors, the parent can be sent home with the questionnaire and document the child’s behaviors. It is important to note that these are tools meant only to help identify those who may require further evaluation, and cannot be used for diagnostic purposes.

The Conners’ Parent Rating Scale is a screening tool used to evaluate problem behaviors in children and adolescents (Conners et al, 1998). The Conners’ Parent Rating Scale has been repeatedly shown to be valid and reliability in identifying children most affected by these behaviors (Conners et al, 1998). This questionnaire includes subscales and indices which
measure attention deficit/hyperactive disorder index and/or DSM IV checklists, which are formatted differently for parental, teacher, or self reporting of behaviors. In the context of sleep disordered breathing, evaluating levels of problematic behaviors can help to identify those children already having daytime complications related to their SDB and also provide a tool for follow up after treatment of SDB to monitor how behaviors are resolved, improved, or warrant further treatment. Problematic behaviors that occur during sleep are prevalent in pediatric OSA and are known as parasomnias. The parasomnias include sleep walking, night terrors, and other behaviors.

Evaluation for parasomnias

Parasomnias are defined by Sheldon, Ferber, & Kryger as “dysfunctions associated with sleep, sleep stages, or partial arousals from sleep” (2005, p. 282). Parasomnias such as sleep walking, sleep talking and night terrors were found to have a strong correlation to SDB. Sleep walking was found to be present in 7% of children with SDB versus 2.5% of controls, sleep terrors were found to be strongly related in those whose respiratory disturbance index was greater than two, and found a strong correlation between sleep talking and enuresis (Goodwin, 2004).

Another component of the history which is an important sign in the symptomology is the presence of enuresis. In responses to a questionnaire of 17, 646 parents of children reported 11.2% habitual snoring, with 26.9% of those having enuresis (11.6% of non-snorers reported enuresis) (Capdevila, Crabtree, Kheirandish-Gozal, & Gozal, 2008). Of the habitual snorers, 378 were randomly selected for PSG, and 149 were confirmed as having OSA. The percentage of children with enuresis in the habitual snoring versus OSA group was not significantly different.
Therefore, when enuresis is present, the practitioner should continue further investigation into the presence of SDB with the use of PSG. Other physical symptoms associated with OSA in children are more easily recognized with objective or physical assessment.

**History of upper airway infections**

Recurrent otitis media is known to be perpetuated by enlarged tonsils and adenoids. Enlarged tonsillar and adenoidal tissues are the main cause of OSA in children between the ages of two and six (Sheldon, Ferber & Kryger, 2005). Therefore, AT is the first line of treatment for OSA in this age group. One study found that in 16,231 children of who 11.3% were found to have habitual snoring, 34.4% had tympanostomy tubes where non snorers had tubes 13.6% of the time (Gozal et al., 2008b). Recurrent otitis media was found in 44.8% of habitual snorers where it was seen in 29.3% of non snorers. Richards and Ferdman found that 84% of children with SDB were chronic mouth breathers, 64% had frequent otitis media; 56% had a history of sinusitis, and 51% complaints of frequent sore throat (2000).

Chronic mouth breathing is often related to rhinitis and upper airway allergies. Upper airway allergies were reported in 20.3% of mouth breathers in one study (Urschitz et al, 2004). They also found a strong correlation between SDB and more than 7 upper airway infections a year. A study on the relationship between atopy and SDB found an increased prevalence of atopy in habitual snoring (21.5% versus 13%) (Kalra, 2006). They also found that in children who habitually snored, their parents had a history of atopy 15% of the time. Mouth breathing and/or snoring may also cause sore throats, which is another finding strongly correlated with SDB in the Urschitz et al study, especially in girls. Size and shape of the oropharynx may also be a key physical assessment finding on exam. Guilleminault found the presence of upper airway allergies
in 26.5% of children referred for SDB (2004). Of 400 children in that study, 18 had deviated septums, 96 had indications of rhinitis, and 162 had tonsillar hypertrophy rated at 4+, 139 rated 3+, and 99 rated 2+. All of the children referred had narrow oropharynx on assessment. Both the presence of atopy and the shape of the oropharynx are genetically inheritable and risks for either may be found on assessment of the child’s family history.

Family history

In assessing the history of children with OSA, one study found almost 50% of children had first degree relatives with obstructive sleep apnea, 55% had siblings with OSA, and 50% had at least one relative with OSA (Ovechinsky et al, 2002). Guilleminault found that where there is a strong familial link to OSA, there is often times inherited craniofacial abnormalities (1995). Another study found a threefold increase in habitual snoring when there was parental history of habitual snoring (Kalra, 2006). The relationship between genetics and prevalence of obstructive sleep apnea is currently not known, but research is underway to determine how and if these relationships do exist.

Physical Assessment

Along with identifying children who have day or nighttime behaviors indicative of sleep disordered breathing there are history and physical components which are helpful in identifying at risk children and prioritize children for PSG who might benefit from intervention. As tonsillar hypertrophy is strongly correlated to the presence of airway obstruction, tonsils should be evaluated for hypertrophy. Adenoidal hypertrophy is diagnosed by a lateral neck radiograph. Assessment of tonsillar and adenoidal hypertrophy is subjective; therefore description of the severity of hypertrophy does not dictate further evaluation or treatment options but does indicate
a need for PSG when correlated with the remainder of the history and physical examinations (Sheldon, Ferber & Kryger, 2005). Measurements of neck circumference and body mass indices are used to identify obesity as a risk factor for obstructive sleep apnea (Hatipoglu, Maxicioglu, Kurtoglu, & Kendirci, 2009). Due to the compliancy of children’s rib cages, pectus excavatum may be present (AASM, 2005).

Failure to thrive has been reported in children with OSA but is rare in the United States perhaps due to earlier diagnoses and treatment of children with more severe forms of obstructive sleep apnea; in particular those children with co-morbid genetic or craniofacial abnormalities (AASM, 2005). The pathophysiology of failure to thrive is thought to be related to increased work of breathing during more severe obstructive sleep apnea.

Diagnostics

Even with the lack of formally accepted pediatric diagnostic scoring criteria, PSG remains the gold standard for producing the most comprehensive, objective assessment of SDB in children. Without PSG, the otherwise healthy child with OSA may be missed as questionnaires, history and physical exams alone cannot identify the severity of SDB. Providers must be aware of PSG resources within their communities. If an in-lab PSG is not available, research has shown unattended home PSG can provide quality data (Goodwin et al, 2001). Home night pulse oximetry is helpful in diagnosing hypoxia, but if it is negative further diagnostics are indicated because hypoxia alone does not diagnose sleep disordered breathing. It is important as a provider to educate the parents on the importance of testing, because the cost and the inconvenience of testing are outweighed by the benefit of treating the child. Providers, and
parents, need to trust in the evidence that the disease is greatly impacting their child, the
caregivers, and the entire family.

Experts in the field such as Cao and Guilleminault warn that where less expensive testing
may indicate a need for OSA treatment if positive, parents need to be aware of the potential need
for further PSG testing (2008). The American Thoracic Society recommends PSG for all
patients; especially those being referred for possible AT because those with more severe
obstructive sleep apnea have increased post operative risks following surgery. These risks
include the transient worsening of obstruction due to postoperative edema, increased respiratory
secretions, respiratory depression related to narcotics and anesthesia (1999). Patients at higher
risk for complications require overnight monitoring and higher intensity of post-operative care to
monitor recovery from surgery, where most ATs are currently done on an outpatient basis.
CHAPTER VI. FOLLOW UP

Follow up after treatment with AT is at present one of the biggest missing links in the post-operative care of children with SDB. It was previously thought that AT was highly curative, but recent research shows that the persistence of obstruction remains in as many as 12-36% of children (Mitchell, 2007). One study showed only 25% had complete normalization with AT, defined by the authors as an AHI less than one (Tauman et al., 2006). Persistence correlated well in several studies with obesity and/or high preoperative AHI (Mitchell, 2007, Costa et al., 2009, Tauman et al., 2006). Mitchell found a reduction in mean preoperative AHI from 27.5 to 3.5, 12% with persistent moderate OSA (AHI between 10 and 19) and 36% with persistent severe OSA (AHI greater than or equal to 20 (2007). It remains to be shown what level of AHI, if any, is most indicative of negative cognitive, behavioral and other physiological effects; therefore, whether a reduction to an AHI of 3.5 in the above study cannot be shown to be a ‘cure’.

Remaining hypoxemia, mean de-saturations of 88%, raised a concern for continued cardiovascular effects after treatment (Costa et al., 2009). This research shows that obstruction can be multilevel, enlarged tonsils and adenoids representing only one level especially in children with obesity.

Treatment of residual obstruction

Children with residual obstructive sleep apnea may be candidates for continuous positive airway pressure (CPAP) treatment and/or adjunctive treatment such as elimination of triggers of upper airway inflammation, reduction in body mass index, and sleep hygiene education. Not only is it important to follow up on the level of improvement of sleep disordered breathing, but
confirmation of the resolution of neurobehavioral, cardiovascular, and metabolic disturbances is crucial.

**Positive airway pressure treatment**

Continuous positive airway pressure treatment utilizes a blower attached to a mask to deliver either continuous positive pressure, or can be delivered with bi-level pressures varying inspiratory and expiratory pressures independently. Although adherence is an issue with CPAP in all age groups, it has been shown to be effective in reducing the AHI. One study found the AHI reduction to be from approximately 27 to three and significant improvement in hypoxemia (Marcus et al., 2006). Compliance with positive pressure treatment is a challenge for children, families and providers. If the provider is not comfortable initiating therapy with positive pressure, referral to a pediatric sleep center is warranted.

**Reduction in atopy**

Kheirandish, Goldbart and Gozal recently showed a significant improvement in AHI after a combination of intranasal steroids and a leukotriene modifier was administered to persistent OSA post-AT (2006). Again, in children AHI has not been shown to be a good indicator of the level of neurobehavioral consequences, therefore more research is needed to show if either of the above therapies are ‘curative’.

**Lifestyle modifications**

As obesity is one of the top causes of sleep disordered breathing in all age groups, reduction of body mass index is indicated to reduce obstruction and improve outcomes. Although there is no research showing reduction in BMI as improving AHI in children, it has shown improvement in adults (Tuomilehto et al., 2009). Weight reduction in children is often
challenging, as the family will need to be supportive of the lifestyle changes and most likely are responsible for the presence of poor lifestyle choices to begin with. A review of the current research showed that changes can be modest varying on the intensity of the program (Agency for Healthcare Research and Quality, 2008).

Sleep hygiene is another lifestyle modification which can improve SDB. One researcher found that poor sleep hygiene may actually have even more of a negative influence on snoring children’s daytime behaviors (AASM, 2007). All children, especially those who may have residual daytime behaviors and/or obstructive sleep apnea, benefit from good sleep hygiene. Such principles of sleep hygiene are listed in Table 1.
CHAPTER VII. MODEL FOR ASSESSING, DIAGNOsing AND TREATING SLEEP DISORDERED BREATHING IN CHILDREN

In Table 2, a model is presented to help guide assessment, selection of diagnostics and referrals, and treatment of sleep disordered breathing in children. The first step is to assess for the presence of frequent and/or loud snoring at each routine well child examination, and whenever suspicion arises that the child maybe suffering from disruptions in sleep and further evaluation must be made. If the child does not present to the clinic with snoring, it is important to continue assessment methods for the presence of SDB especially for a child who presents with behavioral, weight, and/or endocrine complaints.

The next step is a thorough history of the child and the child’s family, including a more detailed sleep history (see model for more specific details to assess). At this point, a tool (such as those described in Chapter VII.) can be utilized to assist gathering the history. Again, even with the most detailed history, children with SDB can be missed. A polysomnography is warranted in all children who snore more than three nights a week (Chervin & Archbold, 2001).

Children can then be referred to an Otolaryngologist if indicated for tonsillar and/or adenoidal hypertrophy. If surgery is indicated, the child will then need to undergo a repeat PSG to assure there is resolution of OSA. If there is no resolution of OSA after AT, or AT was not initially indicated, referral to a Pediatric Sleep Specialist or a provider certified in initiating positive pressure therapy will be needed. Children’s sleep should continue to be assessed on a yearly basis at minimum in all children. Even those who have had an AT may present with snoring at a future time.
CHAPTER VIII. SUMMARY

Sleep disordered breathing has numerous negative effects on the quality of life in children. Consequences of SDB include cognitive, neurobehavioral, cardiovascular and metabolic. Unfortunately, children are not routinely assessed effectively for the presence of SDB, therefore a majority goes undiagnosed and untreated. There are several guidelines and tools available to assist the provider in obtaining a history and physical to identify at-risk children. Following a guideline or model can help providers through the assessment, diagnosis, treatment, and follow up of the pediatric patient with sleep disordered breathing.

Much of the effects of SDB can be prevented by providers keeping the assessment of snoring part of their routine assessments and taking the time to communicate the importance of sleep for children’s development to parents. Due to the large amount of evidence correlating SDB and its complications, there is an increased clinical and academic interest. It is important to continue to seek out opportunities to increase knowledge of SDB and stay up to date on the current guidelines. As a nurse practitioner it is important as always to establish good communication with patients and families. Evaluating a child for SDB can be quite like putting the pieces of a puzzle together and takes time and dedication to improving both parent’s and children’s quality of life. Parents must be encouraged to recognize the importance of their child’s sleeping patterns and the healthy quality of sleep their child deserves to have. Providers must advocate for healthy childhood sleep and educate families on the best ways to achieve this important goal.

The AASM lists many unresolved issues and ideas for further direction from the course of the disease, to uncertainties in diagnosis and treatment. “The natural course of the disease, the
best techniques for monitoring patients during polysomnography, the effects of mild OSA, and the threshold necessitating treatment require further study” (AASM, 2005). The research in the field of sleep medicine is multiplying exponentially, empowering providers to make a significant impact in the health and well being of these patients and families. Providers can look forward to being able to provide more comprehensive care and to have a better understanding of the pathophysiology; causes and effects through current research.
<table>
<thead>
<tr>
<th>Table 1. Good sleep hygiene guidelines</th>
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<tr>
<td>1. Consistent bedtime and morning awakenings</td>
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<td>2. Consistent bedtime rituals</td>
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<td>3. Cool, dark, and quiet bedroom</td>
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<td>4. Avoid excessive fluid intake before bedtime</td>
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<td>5. Avoid stimulation before bedtime including caffeine, stimulating medications and vigorous activity</td>
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<td>6. Children should not go to bed hungry, and may have a snack before bedtime</td>
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<tr>
<td>7. Developmentally appropriate naps.</td>
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<tr>
<td>8. Get a full night’s sleep based on general age guidelines (preschool 11-13 hours, school aged 10-11 hours)</td>
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<tr>
<td>(AASM, 2007; Sheldon, Ferber &amp; Kryger, 2005)</td>
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</table>
Table 2. Model for assessing, diagnosing and treating sleep disordered breathing

Yes

Is snoring present?

Polysonography

Obstructive sleep apnea without indications for AT

Or

Obstructive sleep apnea persisting after AT

Normal

Continue routine assessment of snoring and assure resolution of complications

Positive airway pressure

Refer to Otolaryngologist if indicated for AT

Repeat polysomnography

Complete resolution of SDB?

References


