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Psycho-cognitive behavioral problems in sleep disordered children[☆]

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Abstract

Sleep disturbances are common in childhood and adolescence. Sleep problems in early infants tend to be persistent and prominent in preschool and school-aged children. Chronic sleep disorders, especially in young children may lead to neurobehavioral problems and psycho-cognitive impairment. Sleep difficulties may be the result of underlying medical conditions, (breathing disorders) or psychological problems. Research studies have shown the association between sleep disorders and day time cognitive impairment, behavioral problems, poor school performance and inattention in children. Appropriate diagnosis and early management of sleep disorders in children lead to improvement of neurocognitive function and behavioral problems in these children.

Key Words: sleep disorder; behavioral problems; cognitive impairment; association; children

Abbreviations: OSAS, obstructive sleep apnea syndrome; ADHD, attention deficit hyperactivity disorder; S-SDB, suspected-sleep disordered breathing; ESS, Epworth sleepiness scale.

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INTRODUCTION

Sleep disorders are common in childhood; bedtime tribulations and frequent night waking in children have been reported widely. Sleep disorders have deleterious psychological effects; researchers have reported a significant association between these all too common problems and cognitive impairment. In addition, problematic behavior including moodiness, irritability in children has often been attributed to insufficient sleep, adversely affecting parental and family functioning^[1-3]. Sleep difficulties in early infants due to insufficient sleep hygiene tend to be chronic and become more prominent in preschool and school-aged children. Early behavioral and pharmacological interventions for sleep problems not only result in better sleep but also in improved daytime cognitive functioning such as attention, learning and memory in children. Both pharmacological and non-pharmacological treatments of pediatric sleep disorder promote better sleep thus improving daytime functioning for the parents and the entire family. Sleep problems in children may be the result of underlying medical conditions such as obesity, adenoid hypertrophy and psychological conditions such as depression and anxiety.

The objective of this paper is to discuss the

various etiologies of childhood sleep disorders, to define the relationship between sleep disturbances and neurobehavioral psychocognitive impairment, and also to review the strategies used to manage different types of sleep problems in children.

SLEEP-DISORDERED BREATHING IN CHILDREN

Sleep apnea is the most common reason for referral to sleep laboratory centers. The prevalence of sleep breathing disorders in a pediatric population has been reported to range from 0.7% to 10.3%.

The definition of apnea in pediatric cases is an absence of airflow at the nose and mouth for more than two breaths (respiratory cycle). Hypopnea is defined as reduction of at least 50% in the oronasal flow signal amplitude for more than two breaths (respiratory cycle). Others use 10 seconds, 15 seconds or more for definition of the duration in pediatric sleep apnea^[4-6].

Breathing is better during wakefulness compared to sleep, because sleep is associated with increased upper respiratory airway resistance and decreased respiratory response to hypoxia and hypercapnia. The term sleep-disordered breathing includes both respiratory disorders specific to sleep and the medical conditions that are exacerbated by sleep such as nocturnal hypoxemia in chronic lung disease. Sleep

apnea in children is classified into obstructive sleep apnea, central sleep apnea and mixed type sleep apnea.

OBSTRUCTIVE SLEEP APNEA

Obstructive sleep apnea is defined as the absence of airflow in the presence of continued respiratory effort. It is a disorder of breathing during sleep, and is presented by partial or complete upper airway obstruction. Normal ventilation and the normal sleep pattern is disrupted by this obstructive apnea during sleep; subsequently leading to syndrome-obstructive sleep apnea syndrome (OSAS) in children and adults. OSAS is more common during childhood than adults. Studies suggest a prevalence of 1–3 % in children. OSAS in children occurs equally among male and female, in contrast to adults in whom OSAS is more common in male.

ETIOLOGY OF OBSTRUCTIVE SLEEP APNEA

Most children with OSAS have adenotonsillar hypertrophy and unlike adults are not obese. On the other hand, in young children failure to thrive is more common, but in adolescents obesity is common. Other etiological factors for OSAS include micrognathia, macroglossia and retrognathia. Some genetic syndromes such as Pier Robin syndrome, Down syndrome, hypothyroidism, Arnold Chiari malformation, myotonic dystrophy and other neuromuscular disorders may be associated with OSAS.

Studies revealed that structural factors play an important role in childhood OSAS. Endoscopic evaluation in children demonstrated a narrower upper airway in OSAS than control subjects. Besides, this narrow upper airway is more collapsible in OSAS^[7-8].

CLINICAL MANIFESTATION OF OBSTRUCTIVE SLEEP APNEA

The most common presenting sign in children with OSAS is a history of snoring and difficulty in breathing during sleep. Snoring is usually continuous in children. Some studies reported an increased incidence of persistent wheezing and sinusitis in children with OSAS^[9].

Parents report snoring, retractions, paradoxical breathing and episodes of increased respiratory efforts with pauses in snoring. These symptoms are followed by gasping and sleep movements. Bruxism is seen in one third of children. In adults with OSAS, apnea during sleep is usually terminated by arousal from sleep which is a protective mechanism. Although these frequent arousals from sleep are protective mechanisms for obstructive sleep apnea in adults, it results in disabling daytime sleepiness. Unlike sleep apnea in adults, excessive daytime sleepiness is uncommon in children, and hyperactivity, growth failure, enuresis, headache especially in the morning; neural behavioral disorder and restless leg syndrome are more common symptoms in children^[10].

COMPLICATIONS OF OSAS

Prolonged OSAS results in serious complications, namely, failure to thrive, corpulmonale, hypertension and mental retardation. Serious complications are less common because of early detection and early intervention^[7]. Children with OSAS have neurocognitive deficits, poor attention and poor learning. Screening studies on the first grade students showed high proportion of sleep-disordered behavior in the lowest grade school performance children. Poor learning and neurocognitive deficit may be caused by hypoxia and hypoxemia or sleep fragmentation in these children. One study reported auditory brain stem response in children with OSAS showing a prolonged transmission time between waves III and V compared to controls. This auditory brain stem response abnormality may be caused as a consequence of the chronic hypoxic and hypercapnic status occurring in the brain stem and cochlea^[11].

MANAGEMENT OF OSAS

The primary treatment for childhood obstructive sleep apnea with adenotonsillar hypertrophy is adenotonsillectomy. Children without an underlying disease and other obstructive causes improve postoperatively^[12-13]. Children with other underlying diseases and young children with severe OSAS have an increased risk for postoperative respiratory compromise. Different studies about the outcome of adenotonsillectomy for obstructive sleep apnea in children revealed improvement in polysomnography neurobehavior and quality of life in these children. Most of the children tend to improve one year after surgery^[14-17]. These studies report improvement in school performance, attention, behavior and cognitive function tests in children, but obese children have more persistent OSAS and poor quality of life scores after adenotonsillectomy. Postoperatively, the children will show similar behavioral improvement regardless of obesity^[18]. Another treatment approach is to remove or correct other causes of obstruction, orthodontic treatment for retrognathia and surgical management for jaw, oral cavity and pharynx malformation.

POLYSOMNOGRAPHY IN CHILDREN

Pediatric polysomnography needs pediatric criteria for interpretation. Pediatric polysomnograms show validity, reliability and clinical utility. The gold criteria for diagnosis of sleep-related breathing disorders in children are not polysomnography alone, and interpretation of both polysomnography findings and clinical evaluation are necessary. It has been proposed that children suspected of sleep-related breathing disorders, with neurological, neurodevelopmental disorders, genetic syndromes, obesity, inborn error of metabolism and craniofacial

syndrome could strongly benefit from the procedure. Preoperative and postoperative polysomnography are helpful in predicting improvement or persistence of obstructive sleep apnea syndrome after surgery^[19-21]. Comprehensive polysomnography includes monitoring of neurophysiologic measures such as electroencephalography, chin and anterior tibialis electromyography and electroolfactography as well as cardiorespiratory variables, such as chest wall motion, abdominal motion, nasal pressure, oronasal pCO₂ level and oxygen saturation (sPO₂) (by ear oximeter) and electrocardiography. Diagnostic findings are based on the arousal index (normal < 5 per hour); non rapid eye movement and rapid eye movement sleep stages (normally, rapid eye movement occupies 25% of total sleep); precutaneous evaluation of arterial sPO₂; CO₂ level and leg movement per hour (normal < 5 per hour)^[22].

CENTRAL SLEEP APNEA

Central hypoventilation syndrome is caused by an increase in arterial carbon dioxide tension. It is derived as a decrease in central nervous system ventilation. Patients with central hypoventilation syndrome cannot breathe normally despite a normal upper lower respiratory tract. Causes of central hypoventilation syndrome include idiopathic congenital central hypoventilation syndrome (Ondine's curse syndrome), Arnold-chiari malformation, obesity hypoventilation syndrome, structural central nervous system abnormality, increased intra cranial pressure, mitochondrial disorder and other inborn errors of metabolism and drug intoxication. It may be idiopathic or may occur with inflammatory or other disorders of the brain stem^[23]. Some underlying diseases cause mixed central hypoventilation syndrome (central sleep apnea) and obstructive sleep apnea. These medical conditions include Arnold chiari malformation, achondroplastic dwarfism, muscular dystrophies and Pick Wichian syndrome^[24]. Central hypoventilation syndrome in children may be understood as a failure to switch to mature respiratory central pattern at birth. Neurotrophic factors; namely, "brain derived neurotrophic factors" regulate the maturation and differentiation of respiratory neurons. The reduced expression of brain-derived neurotrophic factors in the cerebrospinal fluid of infants with Ondine's curse syndrome is suggestive of dysregulation in the breathing and respiratory system^[25]. In order to rule out underlying diseases, an MRI study of the head and upper cervical cord is needed. An auditory brain stem response is also useful in assessing the function of the brain stem.

MANAGEMENT OF CONGENITAL HYPOVENTILATION SYNDROME

In children and early infants with congenital

hyperventilation system, respiratory stimulants are usually not effective. These children usually require tracheostomy and assisted ventilation. It seems that bi level positive airway pressure with decreased cardiorespiratory monitoring is indicated. In early infants, the risk of sudden infant death is twice, but most infants respond to tactile stimulation. In early infants, especially in premature newborns, 7% of apnea spells require cardiopulmonary resuscitation. Parents need education and instruction for safe stimulation of the infants and cardiopulmonary resuscitation. Children with idiopathic (congenital) central hypoventilation syndrome have a defect in the center of respiration during non-rapid eye movement sleep. In these children, control of respiration during the waking state and in rapid eye movement sleep is normal. These children breathe normally while awake but are apneic during non-rapid eye movement sleep. Response of the respiratory drive to carbon dioxide in children with congenital central hypoventilation syndrome is blunted. Pressure during the expiratory phase may avoid the need for tracheostomy. Another therapeutic option is diaphragmatic pacing (phrenic nerve). Finally, in these children during all sleep periods cardiopulmonary monitoring is imperative^[25].

ASSOCIATION BETWEEN ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD) AND SLEEP DISTURBANCES

As the previous section discussed, children with sleep disordered breathing have oppositional behavior, cognitive problems, inattention and hyperactivity. Some of these children fulfilled the ADHD index. On the other hand, children diagnosed with ADHD according to the fourth edition of Diagnostic and Statistical Manual of Mental Disorders criteria and the statistical manual of mental disorders may have slept disordered breathing. Some studies on children referred for and diagnosed with ADHD revealed the high presence of obstructive sleep apnea in these children. In these studies, surgery (adenotonsillectomy) was compared to methylphenidate for treatment of hyperactivity and attention deficit. The total ADHD score improved more in the surgical group than the methylphenidate group. After surgery, the inattention and hyperactivity subscale were significantly lower than the methylphenidate group and close to those obtained in normal controls. Therefore, the researchers concluded that surgical treatment of the underlying sleep disordered breathing in children with ADHD may prevent unnecessary long term methylphenidate usage and the potential side effects of these drugs^[26]. Previous research studies reported severe sleep disorders in children with attention deficit hyperactivity disorder. Sleep data in children with ADHD describe the relationship between sleep disorder and ADHD and provide the effects of stimulants on sleep^[27].

Parents of children with ADHD report sleep disturbances in children with ADHD (medicated and unmedicated), but some of these findings have not been confirmed by objective sleep data. These data suggest increased night time activity and somnolence in unmedicated children in comparison with medicated children. Data also show increased periodic limb movements in sleep in children with ADHD^[28]. Some studies conclude that children with ADHD are in fact sleepy day time children which may explain the beneficial effects of stimulant medication. Objective sleep measurements often show longer sleep in these children and this finding may explain this theory more precisely, suggesting that daytime somnolence is the primary cause of the hyperactivity and inattention disorder in these children.

Some studies reported that experimental sleep restriction which leads to day time somnolence has been associated with attention deficit hyperactivity like behavior. They also showed poor cognitive achievements. This finding may describe the effects of stimulant medication on the improvement of symptoms in these children. In adults, sleep disordered breathing causes excessive daytime sleepiness, but in children hyperactivity is often described. Researchers hypothesized that children with suspected sleep disordered breathing are both more hyperactive and sleeper than controls.

In a cross-sectional study on 108 patients with suspected sleep-disordered breathing (S-SDB), a modified Epworth sleepiness scale (ESS) and the Conners abbreviated symptom questionnaire were administered.

Polysomnography was used in children with S-SDB. The results showed patients with S-SDB had a higher ESS and higher Conners score than controls.

No significant difference was noted in the ESS and Conners scores of children with snoring and obstructive sleep apnea. This study explained these children were more hyperactive and sleeper than the controls.

SLEEP MYOCLONUS

Sleep myoclonus is typically presented with myoclonic jerks of the upper and lower limbs or the whole body. These jerks are seen during sleep and disappear with wakefulness. They have a benign condition and gradually disappear after six months of age. Treatment with antiepileptic drugs is not necessary and may exaggerate the myoclonus jerks in these infants.

PERIODIC LIMB MOVEMENT

They are brief movements (jerks) during sleep that can last 5 to 10 seconds with 20 to 40 second intervals. Periodic limb movement occurs more commonly in the lower extremities. Only some fine movement in the fingers of the upper extremities, of which parents are unaware, may be observed. Parents usually report periodic limb movement and a positive family history of periodic limb movement in the parents, siblings and other

members of the family.

RESTLESS LEG SYNDROME

Restless leg syndrome is defined as a sudden need to move the lower extremities because of a disagreeable sensation at sleep onset. Restless leg syndrome in children is associated with sleep disorder and ADHD. Different studies report that restless leg syndrome affects 2–5% of the population. In approximately one-third of the children with restless leg syndrome there is a positive family history. The diagnosis of restless leg syndrome in children is based on the adult criteria and is usually supported by other features such as behavioral disorder, attention deficit and positive family history. The diagnosis is best made by polysomnography or videotaping, which disclose the periodic limb movement during sleep^[28]. There is correlation between low serum ferritin levels (< 50 ng/DI) and low serum iron levels and restless leg syndrome^[29-30].

MANAGEMENT OF RESTLESS LEG SYNDROME IN CHILDREN

Behavioral treatment and associated sleep disorders in children with restless leg syndrome is beneficial. Reducing environmental stimulation especially before bed time and inducing strict rules for bedtime and waking. Daily physical examination may cause improvement in sleep initiation. Iron supplementation in individuals with low serum ferritin levels is helpful^[31]. Finally, treatment with clonazepam, clonidine, gabapentine and dopaminergic agents such as levodopa have been quite effective.

Dopamine pathways have been implicated as the common pathophysiological comorbid in restless leg syndrome and ADHD.

Iron is the cofactor for tyrosine hydroxylase, therefore during the production of dopamine low serum iron stores may affect the level of dopamine^[32].

Iron supplementation is effective not only in reducing symptoms of restless leg syndrome, but also for behavioral disorders consistent with ADHD.

Dopaminergic agonists such as pramipexole and ropinirole are approved by the United States Food and Drug Administration for the treatment of restless leg syndrome in adults, but these drugs are not approved in child patients.

ASSESSMENT OF SLEEP DISORDERS IN CHILDREN

Assessment of sleep disorders in children needs a complete history and physical examination. History taking needs special focus on the developmental profile. Children should be assessed for cognitive function and developmental delay. Developmental history with focus on sleep is the important part of history taking which may be obtained from the parents and children. Regarding physical examination, body weight, height and head

circumference are important factors. Obtaining blood pressure is equally important. The upper airway tract should be examined. History of snoring during sleep may be supported by radiological investigation such as lateral neck x-ray for adenoid hypertrophy. In the restless leg syndrome, laboratory investigations such as serum iron and serum ferritin levels are helpful. Polysomnography is diagnostic for sleep breathing disorders. Diagnostic overnight poly somnography is really needed for insomnia and parasomnias in children. Video electroencephalography distinguishes epileptic disorders from parasomnias. Sleep deprivation has been shown to affect neurobehavioral function.

CONCLUSION

Sleep problems in the pediatric population are common disorders. Pediatric sleep disorders can cause neurobehavioral problems, neurocognitive deficit, psychiatric disorders, poor school performance and failure in growth. Recent studies have confirmed the association between sleep disorders and neurobehavioral problems and psychocognitive impairment. An appropriate diagnostic and management approach for improvement of sleep disorders in children may prevent daytime neurobehavioral problems and neurocognitive impairment.

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