ASSESSMENT AND TREATMENT OF COMMON PEDIATRIC SLEEP DISORDERS

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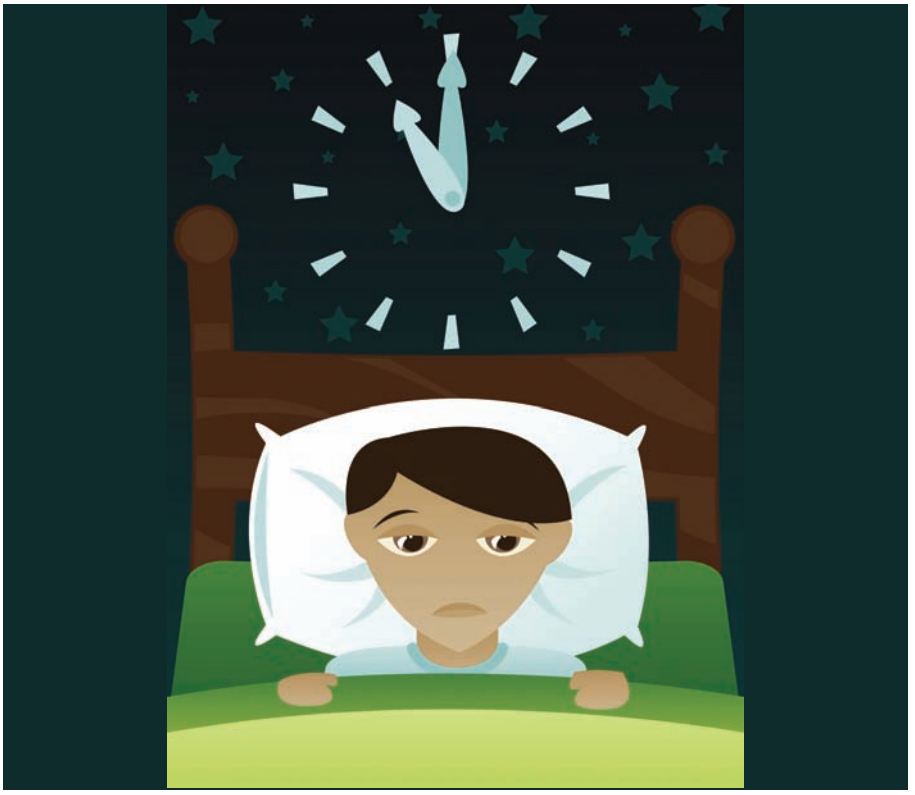
ABSTRACT

Current evidence indicates that chronically disrupted sleep in children and adolescents can lead to problems in cognitive functioning. Behavioral interventions for pediatric sleep problems (e.g., graduated extinction, parent education, positive bedtime routines), especially in young children, have been shown to produce clinically significant improvements. This review describes a few pertinent conditions of sleep disorders in children and adolescents as well as provides clinically useful approaches to sleep complaints and both pharmacologic and nonpharmacological treatments of some common pediatric sleep disorders.

INTRODUCTION

Sleep disorders are common in childhood and adolescence and are associated with neurocognitive and psychosocial impairments as well as an increase in caregiver burden. Sleep problems in infants, children, and adolescents present in a myriad of ways, often leading to significant impairments in multiple aspects of daytime functioning. While bedtime settling difficulties and frequent nighttime awakenings tend to be predominant during infancy and early



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childhood, sleep difficulties due to insufficient sleep hygiene or circadian rhythm disorders tend to be more prominent in adolescence. Onset of specific sleep problems in children and adolescents could further complicate any underlying comorbid medical condition, such as obesity and asthma, and psychological problems, such as depression, anxiety, and substance abuse. Current evidence indicates that chronically disrupted sleep in children and adolescents can lead to problems in cognitive functioning, such as attention, learning, and memory. Behavioral interventions for pediatric sleep problems (e.g., graduated extinction, parent education, positive bedtime routines), especially in young children, have been shown to produce clinically significant improvements. This is of particular importance given the relative lack of data regarding use of pharmacological interventions for sleep difficulties in children. Given the rather significant number of sleep disorders that have been described in the literature, only a few pertinent conditions are discussed in this review. Also, clinically useful approaches to sleep complaints and both pharmacological and nonpharmacological treatments of some common pediatric sleep disorders are reviewed.

GENERAL CONSIDERATIONS IN ASSESSMENT OF CHILDHOOD SLEEP DISORDERS

Obtaining a detailed and accurate history followed by a comprehensive physical exam, including screening for developmental delays and cognitive dysfunction, appears to be a cornerstone for diagnosing pediatric sleep complaints. Routine history taking to assess pediatric sleep complaints needs to be problem-driven and developmentally focused. For example, habitual napping may be developmentally appropriate in toddlers and pre-schoolers, while it is considered pathological during preadolescent years and adolescence. It is equally important to involve family members in the clinical interview to understand the potential etiology of sleep disturbances because children and adolescents often do not recognize nocturnal events that can disturb sleep. For example, patients are usually not aware of snoring and apneic events or abnormal leg movements that occur during sleep. Parental practices and culturally defined family norms also need to be explored prior to providing a diagnosis for a certain sleep complaint in children.[1] For example, the practice of co-sleeping can be culturally acceptable in certain Asian families compared to families from Europe and United States. Assessment of lifestyle factors, such as substance use, television viewing, and cell phone/video game use that leads to delayed bedtimes and insufficient hours of sleep, is important during evaluation of sleep complaints, especially in adolescents. Factors such as increased societal demands, academic pressures, family-related stressors (e.g., parental discord), and onset of puberty heighten the risk of sleep problems in adolescents. Table 1 provides a useful summary to guide clinicians toward a thorough exploration of presenting sleep complaints.

Parents should be encouraged to record children's sleep-wake habits using sleep diaries over a 24-hour period for at least two continuous weeks prior to initial visit. This can be useful to support the reported sleep-related complaints as well as guide routine history taking. Sleep diaries also assist in detecting day-to-day variability in sleep patterns that can often be missed during routine history taking. Graphic diaries appear to be more helpful in understanding sleep-wake cycles in pediatric patients rather than descriptive data.[2] An example of a graphic sleep diary can be found at the sleep education website endorsed by the American Academy of Sleep Medicine (AASM) and is available for free download via internet.[3] A simple acronym like BEARS, which stands for bedtime resistance/sleep onset delay; excessive daytime sleepiness; awakenings at night; regularity, patterns, and duration of sleep; and snoring and other symptoms, can be useful during initial screening of a child's sleep difficulties.[4]

Self-report sleep questionnaires, such as the School Sleep Habits Survey,[5] and Children's Sleep Habits Questionnaire (CSHQ)[6] are useful to screen for more specific sleep disorders in target populations, such as adolescents and school-aged children, respectively. The Sleep Disturbance Scale for Children (SDSC) is a useful 26-item parent questionnaire that was developed for children and adolescents to screen for primary sleep disorders such as obstructive sleep apnea.[7]

Primary sleep disorders, such as obstructive sleep apnea and restless legs syndrome, in children have been shown to be associated with excessive daytime sleepiness, cognitive deficits (e.g., lower intelligence quota [IQ], impaired attentional capacity, and memory) and attention deficit hyperactivity disorder (ADHD).[8–10] Therefore, screening for daytime impairments (e.g., hyperactivity) and school-related impairments (e.g., drop in academic grades) is important in children suspected of having obstructive sleep apnea or restless legs syndrome.

Developmental history with focus on sleep and wake patterns as well as potential medical illnesses that affect sleep during infancy and childhood can provide clues to the duration and degree of sleep disturbances in the child. Obtaining a pertinent family history of sleep disorders is equally important given that certain conditions, such as narcolepsy with cataplexy, chronic primary insomnia, restless legs syndrome, obstructive sleep apnea syndrome, and advanced-sleep phase syndrome, have been shown to be influenced by genetic factors.[11]

After organizing the pertinent history obtained from the parent and child regarding the sleep complaints, a physical exam should be

TABLE 1. Evaluation of sleep complaints and pertinent clinical history

SLEEP COMPLAINT	EXPLORING PERTINENT HISTORY
Difficulty falling asleep	Habitual bedtimes (sleep onset/offset on weekdays and weekends/holidays)
	Time taken to sleep onset; "desired" bedtime
	Duration, frequency, and severity of complaints
	Inappropriate nap schedules
	Family history
	Negative associations (fears, worries) with distressing sensorimotor symptoms of restless legs syndrome, nightmares
Difficulty staying asleep (and/or multiple nocturnal awakenings) ± early morning awakenings	Difficulty sleeping through the night (nighttime awakenings, early morning awakenings), activities during the awakenings
	Screen for mood and anxiety symptoms
	Screen for primary sleep disorders (sleep apnea)
	Family history
	Use of alerting substances at bedtime
Excessive daytime sleepiness (EDS)	Total duration of nocturnal sleep
	Quality of morning awakenings
	Difficulty to stay awake in the classroom, while driving, watching TV, eating meals
	Persistent use of stimulants (e.g., nicotine, caffeine) to stay awake
	Exploring other potential symptoms associated with disorders of excessive sleepiness (such as cataplexy, sleep paralysis, sleep attacks, hallucinations)
	Daytime consequences of sleepiness (poor academic performance, learning difficulties, impaired concentration, disruptive behaviors, mood symptoms)
	Family history
	Medication use (long-acting psychotropic medications with "hangover" effects)
	Substance use (alcohol and other illicit drugs, over-the-counter medications)
Poor sleep routine and sleep hygiene due to environment and psychosocial variables	Occupation (odd hours at employment, shift-work schedules)
	Social environment (co-sleeping/sharing bedroom, sleep patterns of parents and other children, pets in bedroom)
	Housing (light, noise, and temperature)
	Activities at bedtime (computer/telephone, homework completion, TV viewing)
	Substance use (alcohol and other illicit drugs, caffeine intake, nicotine use, over-the-counter medications)
	Parental involvement (limit setting, adult supervision)

undertaken. Calculating body mass index (BMI) after obtaining height and weight variables and measuring waist circumference is important since higher BMI and larger waist circumference are independent risk factors in predicting severity of sleep-disordered breathing, especially in older children who are obese.[12] Obtaining blood pressure measurement is equally important. A physical exam can be focused (e.g., examination of upper airway and nasal passages in a healthy, developmentally appropriate child with parental complaints of snoring and excessive daytime sleepiness) or comprehensive (e.g., in children with neuromuscular disorders and chronic illnesses). Physical exam can be aided further by radiological investigations, such as lateral neck x-ray (if adenoidal growth leading to obstructive sleep apnea is suspected) and laboratory investigations, such as serum iron and ferritin levels (if sleep-related limb movements are suspected).

Overnight polysomnography (PSG) has been recommended as a "gold standard" for the diagnosis of sleep-related breathing disorders (SRBD), such as obstructive sleep apnea, in children and adolescents.[13] Polysomnography, however, is not useful for diagnosing behavioral sleep disorders, such as behavioral insomnia, of childhood unless the presence of an underlying primary sleep disorder (e.g., SRBD) is strongly suspected. Diagnostic tests such as multiple sleep latency test (MSLT) can be useful to quantify sleepiness and explore presence of sleep disorders (e.g., narcolepsy) that can predispose children and adolescents to daytime sleepiness.

Teenagers with chronic sleep deprivation appear to be increasingly involved in motor vehicle accidents compared to other age groups making assessment of sleepiness an important public health and safety issue.[14] In this regard, the maintenance of wakefulness test (MWT) may be a useful diagnostic tool to determine if the adolescent's inability to remain awake poses a significant personal and public safety problem.[15] The MWT measures an individual's ability to remain awake in quiet, comfortable, and dark surroundings. Using an instrument called actigraph (that may be worn as a wrist-watch) may help obtain objective sleep-wake measures to guide diagnosis and treatment. A practice parameter update issued by the American Academy of Sleep Medicine (AASM) does note that data obtained from a combination of sleep diaries and actigraphy tend to correlate well, especially in patients with circadian rhythm disorders.[16] The usefulness of actigraphy in behavioral sleep disorders is questionable other than in documenting nocturnal awakenings and delayed/ advanced sleep phase syndrome.

SPECIFIC SLEEP DISORDERS IN CHILDREN AND ADOLESCENTS

SRBD. SRBDs are best understood as occurring across a spectrum that includes habitual snoring at its least severe form and obstructive sleep apnea (OSA) at its most severe form. SRBD also includes upper airway resistance syndrome (UARS) and obstructive hypoventilation syndrome as part of this spectrum. In children and adolescents, concern for symptoms (e.g., snoring) suggestive of underlying SRBD, such as obstructive sleep apnea, needs further exploration into other associated features, including witnessed pauses in breathing, chronic morning headaches, dry mouth/throat, nocturia/nocturnal enuresis, early morning thirst, feelings of grogginess/fatigue upon awakening, history of chronic ear infections, recent weight gain, and compensatory mechanisms, such as hyperextension of neck during sleep and chronic mouth breathing. The association between ADHD and SRBD is well documented in literature through investigations into animal models of SRBD,[17] parental reports,[18,19] objective measures (e.g., polysomnography),[20,21] and neuropsychological assessments.[22] Association of persistent SRBD with learning difficulties, low academic performance, and other behavioral disorders have also been shown in these studies. Treatment outcome studies have shown significant improvement in neurocognitive and behavioral measures of ADHD following the treatment of SRBD,[23,24] providing further evidence into this bidirectional relationship. It has been proposed that prefrontal cortical dysfunction due to chronic SRBD is associated with impaired executive functioning that explains daytime cognitive and behavioral difficulties in children.[25]

Although obesity appears to be one of the leading causes of SRBD in adults, adenotonsillar hypertrophy is the predominant cause of SRBD in typically developing children. Characteristic physical exam finding of tonsillar enlargement is absent at times in children with suspected SRBD, but other characteristic features, such as macroglossia, retrognathia, high-arched palate, and nasal septal deviation, can predispose a child to SRBD. If presence of nasal polyps or posterior nasopharyngeal obstruction is suspected, a consultation with an otolaryngologist for endoscopic evaluation may be appropriate. It is also important to note that children with disorders such as Down's syndrome or Prader-Willi syndrome present with craniofacial abnormalities, including mid-face hypoplasia or micrognathia, that predispose them to SRBD.[26] Other risk factors associated with development of SRBD include obesity (high BMI, large waist circumference), presence of chronic sinus problems, recurrent wheezing, nasal allergies, family history of OSA, and association with African-American race.[27] If a child is suspected of having SRBD after an evaluation, then he or she should be referred for an overnight polysomnogram. A polysomnogram can measure apneas (cessation in airflow in spite of continued respiratory effort) or hypopneas (reduction in width of airflow waveform by 50%, duration greater

than two respiratory cycles and association with hemoglobin desaturation by at least 3% or with an arousal). Utilizing traditional adult criteria, these two measures are then used to determine the apnea-hypopnea index (AHI), which is the total number of apneas and hypopneas per hour of sleep. An AHI between 1 and 5 an hour is generally considered mild OSA, whereas an AHI of five or more an hour is considered to be in the moderate-to-severe range. Adenotonsillectomy (AT) is considered the treatment of choice once moderate-to-severe AHI is documented on initial polysomnography. Symptom alleviation in SRBD after AT has been shown to be as high as 83 percent in a meta-analysis;[28] but persistent symptoms are seen in patients who are obese or have craniofacial abnormalities.[29] A polysomnogram may be repeated in a few months after AT to reassess severity of persistent SRBD.[30] If residual symptoms of sleep apnea appear severe after AT and are associated with significant functional impairments, initiation of nasal continuous positive airway pressure (CPAP) should be considered as an option.[31] Use of leukotriene-receptor antagonists, such as montelukast, and topical intranasal corticosteroids, such as fluticasone spray, appear to hold some promise in treatment of milder forms of SRBD and post-AT residual symptoms and are attributed to reduction in size of adenoids and chronic nasal inflammation.[32–35] Dental appliances and surgical procedures, such as uvulopalatopharneoplasty, are available treatment options in adults with OSA that are rarely utilized in children. In summary, AT combined with weight loss is considered first-line treatment in pediatric SRBD; use of intranasal corticosteroids and leukotriene-receptor antagonists for milder forms of SRBD and nasal CPAP for more severe sleep apnea are other available treatment options. Additionally, screening for presence of SRBD in children with underlying ADHD and learning difficulties should be undertaken.

Sleep-related movement disorders. Sleep-related movement disorders of childhood encompass sleep myoclonus of infancy, rhythmic movement disorder, periodic limb movement disorder (PLMD), and restless legs syndrome (RLS). Sleep myoclonus of infancy is typically associated with clusters of myoclonic jerks that involve the whole body, trunk, or limbs. They are usually considered to be benign phenomena and gradually disappear after six months of age, necessitating no further treatment.[36]

In rhythmic movement disorder (RMD), a child exhibits repetitive and stereotyped motor behaviors involving large muscle groups and are predominantly sleep related. RMD can also be associated with significant daytime impairments and/or associated with self-inflicted bodily injuries.[37] Diagnosis can be definitively made using video polysomnography,[38] and treatment encompasses ensuring safety of the child during sleep and reassuring parents that RMD should gradually resolve by five years of age. Persistent symptoms beyond five years of age can be seen in children with developmental disorders, but these appear to be a gradual extension of daytime stereotypies that are commonly seen in this subgroup of children.[39] Treatment with benzodiazepines such as clonazepam has been shown to be useful in severe cases of RMD.[40]

Periodic limb movements in sleep (PLMS) are brief jerks (movements) during sleep that can last up to five seconds in duration occurring at 20- to 40-second intervals (periodicity) and occur more commonly in the lower extremities than upper extremities. Patients are usually unaware of these symptoms, but bed partners like siblings and parents are affected by these movements. If sleep disruption due to PLMS is documented on polysomnography and PLMS cannot be explained by any other underlying sleep disorder, then such movements are considered PLMD.[41]

RLS in childhood is diagnosed using adult criteria and is usually supported by other features, such as positive family history, PLMS on polysomnography, improvement with dopamine agents, and presence of iron deficiency. Adult criteria for RLS are as follows: 1) An urge to move the legs, 2) the urge to move begins or worsens when sitting or lying down, 3) the urge to move is partially or totally relieved by movement, and 4) the urge to move is worse in the evening or night than during the day or only occurs in the evening or night. Typically in children less than 12 years of age, diagnosis of RLS needs further support by a child's own age-appropriate descriptors of sensorimotor symptoms, such as "spiders crawling" or "tickles in my legs," along with adult criteria described above.[42] Both sleep-onset and sleep maintenance insomnia can be a common occurrence in children with underlying RLS. This is thought to be due to concept of "negative associations" where children associate sleep with distressing sensations in their limbs thereby perpetuating fear and anxiety surrounding bedtime. It may, therefore, be useful to screen children for sensorimotor symptoms suggestive of RLS who present with insomnia. Behavioral treatment options for RLS and associated sleep disturbances in children and adolescents include enforcing strict routines for bedtime and wake-up time, reducing environmental stimulation prior to/at bedtime (e.g., limiting TV and video games), and encouraging daily physical exercise. It is helpful to ascertain the child's current serum iron status through measurement of serum ferritin levels as symptoms of RLS and PLMS have been shown to be associated with low serum ferritin levels (<50ng/dL).[43]

Dopamine pathways have been implicated as the common pathophysiological link in comorbid RLS and ADHD. Low serum iron stores can affect levels of dopamine since iron is the cofactor for tyrosine hydroxylase, a rate-limiting enzyme, during production of dopamine. Iron supplementation has been shown to be effective in reducing symptoms of

RLS[44] and PLMD, as well as daytime symptoms consistent with ADHD.[45] Iron therapy is usually initiated at doses of 1 to 2mg/kg (elemental iron) with a target to achieve ferritin levels more than 50ng/dL, and concomitant vitamin C supplementation can help in better iron absorption.

Clinicians should thoroughly assess for symptoms of ADHD in patients with RLS and vice versa. Dopaminergic agonists, such as pramipexole and ropinirole, are approved by the United States Food and Drug Administration (FDA) for treatment of RLS in adults, but are not approved for use in children.

Other pharmacological agents (clonidine, gabapentin, clonazepam, benzodiazepine) have been shown to be effective in treatment of adult RLS symptoms,[46–48] but controlled trials in children are largely lacking. These medications may be useful to treat severe RLS associated with sleep disruption and daytime impairments in older children and adolescents.

Dopaminergics, such as pramipexole and ropinirole, have been shown to be useful in adults, and some limited data support their use in pediatric RLS (particularly comorbid ADHD).[49,50] The sedating effects of these medications can be a potential advantage in children with RLS and sleep-onset/ maintenance difficulties, but daytime grogginess and hyperactivity can be problematic (especially in children with underlying ADHD) and should be monitored.

Bupropion has been shown to be effective in reducing symptoms of PLMS in adults with comorbid depression, and is potentially useful in children and adolescents.[51] Use of antidepressants, such as serotonin reuptake inhibitors, has been shown to exacerbate symptoms of RLS as well as increase periodic limb movements in sleep.[52] However, one review concludes that the data to support antidepressant use as a potential etiological factor for RLS is "limited."[53] Nevertheless, antidepressants should be used with caution in children with RLS and PLMS, and other potential therapeutic agents described above should be explored in comorbid mental disorders and sleep-related movement disorders.

In summary, if clinical suspicion for RLS/PLMS exists through subjective data and objective findings (polysomnogram) during an evaluation of a child, behavioral interventions should be initiated along with evaluation of iron status followed by iron supplementation, if needed.

Childhood insomnia. Insomnia in children is defined as repeated difficulty with sleep initiation, duration, consolidation, or quality that occurs despite age-appropriate time and opportunity for sleep, which results in daytime functional impairment for the child and/or family. Behavioral insomnia of childhood (BIC) most often presents as bedtime refusal or resistance, delayed sleep onset, and/or prolonged night-time waking that requires parental intervention.[54] BIC is classified into three categories: sleep-onset association type, limit-setting type, and combined type. In the sleep-onset association type, children have difficulty initiating sleep independently and associate falling asleep with certain circumstances, such as place (couch or parent's bed), a person's presence (parent), or an activity (feeding from a bottle, being rocked, watching television). Thus, these circumstances are required for the child to re-initiate sleep in the middle of the night. In limit-setting type, the child delays bedtime with multiple requests or refusal, while the parent has difficulty setting limits, allowing bedtime to delay. If a child requires certain circumstances to initiate sleep and there are difficulties with parental limit-setting, the diagnosis is combined type.

Etiology of pediatric insomnia is almost always multifactorial, and this understanding helps guide the clinician toward a thorough assessment and formulating a treatment plan. Assessment should include screening for presence of concurrent medical, psychiatric, and developmental disorders; associated functional impairments at school and home; and any associated burden on caregivers. It is also vital to screen for presence of OSA or RLS, as these may be possible etiologies behind a presenting symptom such as insomnia.

It is also important to determine whether the difficulties with sleep onset and/or maintenance are due to inappropriate/inconsistent sleep schedules or napping schedules. For example, parents may have expectations of napping that may be outside of a child's developmental need or implement inconsistent or inappropriate naps (e.g., naps closer to bedtime), which lead to difficulty regulating the child's sleep-wake schedule. Eliminating the nap at an inappropriate age can also result in an increase in the child's behavioral difficulties at bedtime rather than helping with earlier sleep onset and/or sleep maintenance. The same issues relate to teenagers. Variable sleep schedules, later bedtimes, and early school start times are strongly associated with inappropriate napping in adolescents.[55] Adolescents who regularly take long naps will likely take longer to fall asleep at bedtime, further disrupting the sleep-wake cycle.

Behavioral interventions should be the mainstay of treatment of pediatric insomnia and should be offered as initial treatment (or in conjunction with medications) to parents and children. Behavioral interventions aim to help children initiate and maintain sleep independently, resulting in increased total sleep time and improved sleep quality. A recent review published by the American Academy of Sleep Medicine found that behavioral interventions produce both reliable and lasting improvements in bedtime problems and night wakings in infants and young children.[56] Sleep problems in children younger than age 5 improved in 94 percent of the 54 studies reviewed, and over 80 percent of children benefited from treatment with most improvements continuing for 3 to 6 months.

Extinction and parent education/prevention received strongest support after empirical review. Gradual extinction, bedtime fading, positive routines, and scheduled awakenings were also strongly supported as treatments for young children. It is important to note that the key component for success is parental consistency when implementing the specific techniques, particularly during the presence of an extinction burst once unmodified or gradual extinction is implemented. Some interventions may need to be tailored for the parent and child when taking into account issues such as siblings, room-sharing, parental stress, and parental skills in limit setting.

For older children and adolescents, behavioral strategies that aim to reduce arousal at bedtime are often recommended. First, sleep hygiene education is particularly important. In addition, progressive muscle relaxation, stimulus control, and cognitive behavioral therapy techniques, such as thought stopping, increasing positive thinking, and journaling "worries" at bedtime, are often recommended. A few behavioral interventions are outlined in Table 2.

Sleep difficulties that underlie pediatric psychiatric disorders have been well documented in the literature. Although an exhaustive overview of such associations is beyond the scope of this paper, some practical information is provided here that may aid clinicians.

Possible association of hypoarousal and ADHD has been proposed based on the clinical findings, thereby raising the question of whether the hyperactivity is an adaptive behavior against the underlying daytime sleepiness (due to hypoarousal).[57] Conversely, hyperarousal (possibly involving serotonin and norepinephrine neurotransmitters) surrounding bedtime has also been implicated in delayed sleep onset and reduced sleep duration in subjects with ADHD. Additionally, sensory integration deficits, circadian-mediated phase delay, rebound effects of stimulants, and comorbid anxiety disorders contribute to insomnia in children with ADHD. Medications, such as alpha agonists (e.g., clonidine, guanfacine) and melatonin, appear to be particularly useful in treating insomnia in children with ADHD; whereas, antihistamines, sedating antidepressants (e.g.,trazodone), benzodiazepines, and benzodiazepine receptor agonists tend to worsen daytime hyperactivity due to hangover effects and should be used with caution in these children.

Subjective sleep complaints are common in children with major depressive disorder as well as anxiety disorders. Objective sleep data appear to correlate more robustly for anxiety disorders and adolescent depression than in childhood depressive disorder.[58] It has also been hypothesized that a bidirectional relationship exists between sleep difficulties and affective states. In other words, unstable emotional states can lead to persistent sleep problems and chronic sleep deprivation can result in disrupted behaviors and mood.[59] For example, one study that sought to explore directional association between insomnia, depression, and anxiety in a community sample of adolescents concluded that prior history of depression did not predict later onset of insomnia, although a history of insomnia did predict occurrence of depression in later life. Also, a prior history of anxiety disorder was associated with increased risk of insomnia.[60] Treatment of depression and comorbid insomnia in these patients requires a two-pronged approach that includes cognitive-behavioral strategies in conjunction with an antidepressant (preferably a sedating antidepressant or addition of a low-dose sedative-hypnotic like trazodone or melatonin to a nonsedating antidepressant) to enable remission of symptoms. In pediatric bipolar disorder, sleep-related symptoms that tend to predominate include reduced need for sleep along with other manic symptoms, such as elation, grandiosity, and increased energy. Typically, after establishing the diagnosis, stabilization of underlying manic symptoms with appropriate treatment is associated with improved sleep-wake patterns. In children with anxiety disorders, hypervigilant states that promote increased awareness to potential external environmental threats are thought to promote sleep-onset and maintenance difficulties.[61] This would particularly be relevant in the case of childhood posttraumatic stress disorder (PTSD).

Sleep disturbances in children with PTSD can encompass various parasomnias, including night terrors, nightmares, sleep enuresis, and severe insomnia.[62] In one of the earliest reviews on childhood PTSD, Terr[63] describes two types of PTSD with distinct sleep disturbance: Type I trauma where children experience a specific acute traumatic event resulting in hyperarousal and associated insomnia, and type II trauma where children experience more intense and chronic traumatic stressors resulting in increased sleep. Nightmares, as a specific sleep disturbance, are uniquely frequent in children and adolescents suffering from traumatic events, such as sexual assault/ abuse,[64] and are usually treatment resistant.[65] Thematic content of nightmares in PTSD occurs along lines of previously experienced trauma and also tends to occur in increasing frequency. Available psychopharmacological treatments (e.g., prazosin, a selective alpha-2 antagonist)[66] of nightmares and other sleep disturbances in pediatric PTSD are very limited when compared to adults, and behavioral treatments, such as imagery rehearsal (rehearsal of less fearful explanations and images of nightmares during the day resulting in positive dream imagery during the night), can be useful in adolescents and children without developmental disorders. Children with other underlying anxiety disorders (e.g., generalized anxiety disorder, phobias, panic disorder) can present with excessive fears around bedtime and have

TABLE 2. Behavioral treatments for insomnia of childhood

TREATMENT METHOD	MOST RELEVANT POPULATION	DESCRIPTION
Age appropriate and consistent bedtime and sleep schedule	All children	Child is put to bed at developmentally appropriate bedtime consistently 7 days a week with minimal variation
Bedtime routine	All children	A series of subsequent steps taken in the half hour prior to bedtime. Steps are completed in same manner each night to "cue" that initiation of sleep time is approaching. Should be no longer than 30 minutes with 2–3 relaxing activities (bath, story) and end in the bedroom. For younger children or developmentally delayed children, incorporate picture charts. Can also check off boxes and earn stickers for completion of each step of the routine or completion of the entire routine.
Extinction	Young children	"Cry it out" method. Child is placed in bed or crib while still awake, then parents are instructed not to respond to cries or protests. Must warn parents of extinction burst, as protests will first increase prior to decreasing.
Graduated extinction	Young children	Child is placed in bed or crib while still awake, then parents leave the room and wait increasing numbers of minutes before re-entering the room for a brief, neutral interaction with the child. After each re-entry, the number of minutes before the next entry is gradually increased after each trial and over the course of several days.
		Also used to fade parental presence to teach child to fall asleep independently. Rather than leave the room, the parent moves further away from the child every few nights. In both cases, warn parents of extinction burst that may occur within first few nights.
Positive routines	Young children	Implement bedtime routine that is positive and enjoyable parent-child interaction with one or two of child's preferred activities. Parent provides consistent praise, but if child refuses a step or tantrums, the routine is ended, child is put to bed, and interaction ceases.
Faded bedtime	Young children, young children with late bedtime	Child is put to bed close to time he or she is most likely to fall asleep. Once falling asleep within 15–20 minutes, bedtime is moved 15 minutes earlier every 2–3 nights until desired bedtime is reached.
Faded bedtime with response cost	Young children, children with developmental delays	Child is put to bed close to time he or she is most likely to fall asleep. Once falling asleep within 15–20 minutes, bedtime is moved 15 minutes earlier every 2–3 nights until desired bedtime is reached. Once in bed, if child does not fall asleep quickly within a set period of time, child is removed from the bed for a specific period of time.
Scheduled awakenings	Young children	Establish baseline pattern of awakenings using sleep diary. Within 15–30 minutes prior to the typical night waking determined from sleep diary, parent preemptively awakens the child by shaking them lightly and asking them to awaken. Once the child responds by opening eyes slightly or mumbling, the parent allows the child to fall back asleep or provides a "typical" response to soothe the child back to sleep (i.e., rocking, feeding, patting). Procedure is implemented on a nightly basis for 2–4 weeks.
Parent education	All children	Education regarding sleep hygiene measures, good sleep promoting habits, reduced caffeine, consistent and developmentally appropriate sleep-wake times.
Cognitive behavioral therapy	Children approximately age 8 or above	Methods include progressive muscle relaxation, deep-breathing exercises, imagery, cognitive techniques to decrease negative thoughts at bedtime, or keeping a worry journal, all of which can be used independently or as a package together to reduce level of arousal and anxiety at bedtime, increasing likelihood of ability to initiate sleep.

associated bedtime refusal as well as increased frequency of nightmares.[67] Children can then attempt to delay routine bedtimes and inappropriately demand excessive reassurance or to cosleep with parents. Parents should be strongly discouraged from engaging in such practices as they tend to strengthen the child's underlying fears and create a more vicious cycle of heightened anxiety and disrupted sleep. Instead, parent education emphasizing effective limit-setting, strict bedtime routines, positive reinforcement using rewards, and practice of relaxation strategies (e.g., deep-breathing exercises) should be promoted. In our clinical experience, in more severe cases, low-dose benzodiazepine (e.g., clonazepam) for a brief duration when coupled with behavioral strategies mentioned above tend to reduce bedtime anxiety and promote sleep consolidation.

Although only few consensus statements have been published to guide treatment approaches in pediatric insomnia,[68,69] they have been largely helpful to ascertain rational pharmacotherapy principles. For example, a drug with a short therapeutic half-life (1–2 hours) is most useful in treating problems with sleep onset; whereas, a longer-acting medication may be needed for sleep maintenance. A longer-acting medication, however, is more likely to result in daytime effects, such as sleepiness and hyperactive behaviors. Similarly, dosing and timing of administration of the medication is an equally important consideration as both these factors can interfere with a child's underlying sleep circadian rhythm and potentially prolong the time to sleep-onset or cause sleep-maintenance difficulties.[70]

Screening for concurrent use of nonprescription sleep aids, herbal supplements, alcohol, illicit substances, and recreational drugs is very important given the additive effects on sleep and daytime side effects when a new prescription sedative is initiated. It is also important to screen for history of impulsive and nonaccidental overdoses prior to prescribing sedative-hypnotics, as some have the high potential for toxicity in overdose (e.g., benzodiazepines).

After understanding parental expectations regarding the presenting sleep problem, practical treatment goals should be clearly defined before clinicians can consider medications that target specific sleep problems. It is imperative that medication use be short term and be used in conjunction with behavioral interventions. Although discussion of every pharmacological agent used in treatment of pediatric insomnia in detail is beyond the scope of this article, some pertinent agents are discussed in Table 3.

Parents and children with underlying psychiatric disorders, such as ADHD, anxiety disorders, and mood disorders, often report significant sleep-related problems (e.g., bedtime resistance, sleep terrors, nightmares, restless sleep, nocturnal wakings, and daytime sleepiness).[71] The treatment approach to insomnia in these patients should include a careful consideration of whether pharmacological treatment of insomnia could potentially exacerbate underlying comorbid illness or whether it will improve the overall quality of life. For example, in children with anxiety and mood disorders, treatment of underlying anxiety and/or mood symptoms with antidepressants can often be helpful in alleviating sleep difficulties. Addition of a medication with sedating properties can be helpful in treating persistent insomnia in these children for whom underlying psychiatric symptoms appear to be in adequate control.

Parasomnias. Parasomnias are defined as undesirable physical events or experiences that occur during entry into sleep, within sleep, or during arousals from sleep within the *International Classification of Sleep Disorders, Second Edition* (ICSD-2). Broadly, they are classified as either rapid eye-movement (REM) parasomnias or non-REM parasomnias depending on their association with either of the two sleep stages. Non-REM parasomnias (also termed *arousal disorders*) involve simple or complex behaviors as a consequence of arousal from slow-wave sleep, usually in the first half of the night. They are associated with mental confusion and amnesia to the event, and a positive family history can often be elicited. Confusional arousals, night-terrors, and sleep walking (somnambulism) are considered to be part of non-REM parasomnias.

Confusional arousals tend to occur immediately after sleep-onset or early mornings and are associated with a transient confusion in thought process after awakening. There appears to be an increased prevalence in early childhood that usually resolves by age 5. Simple reassurance to parents should suffice; complex behaviors may need behavioral intervention, such as maintaining sleep diaries and initiating scheduled awakenings, if these arousals can be "anticipated."

Night terrors are associated with inconsolable crying (consoling usually delays recovery from the event) and heightened autonomic system activity. Night terrors appear to have a benign course during childhood; however, more severe forms of the illness may require behavioral interventions, such as scheduled awakenings and treatment with benzodiazepines (e.g., clonazepam).

Sleep walking involves complex behaviors, such as ambulation during continued sleep. Chronic sleep deprivation has been shown to increase frequency and intensity of sleep-walking episodes; therefore, the importance of maintaining adequate sleep hygiene to prevent such episodes cannot be overstated. It is also important to note that certain conditions (e.g., Tourette's syndrome and migraines) appear to be associated with increased prevalence of sleep walking and are speculated to be due to abnormal serotonin systems in the brain.[72]

Parasomnias have been shown to be precipitated by undiagnosed SRBD, such as OSA, due to the

TABLE 3. Pharmacological agents in childhood insomnia

MEDICATION	DOSING	SAFETY CONCERNS	PEARLS
Alpha-agonists (clonidine, guanfacine)	• Oral clonidine 0.05mg at bedtime (titrated by 0.05mg every 5 days) • Oral guanfacine 0.5mg at bedtime (gradual titration by 0.5mg every 5 days)	Cardiovascular risk at higher doses and overdose	• Guanfacine is less sedating and has less anticholinergic and cardiovascular side effects compared to clonidine. • Guanfacine is helpful in comorbid seizure disorders due to anticonvulsant effects; newer longer-acting formulation can be useful in treatment of attention deficit hyperactivity disorder (ADHD) and help with sleep maintenance. • Rapid eye movement (REM) suppression may occur, resulting in REM rebound upon discontinuation • Often prescribed to target sleep onset delay in children with ADHD
Melatonin and its receptor agonists (e.g., Ramelteon)	• Clear dosing guidelines for melatonin unavailable in children • 0.5–3mg/day (administered 2–3 hours prior to sleep onset)	Possible suppression of the hypothalamic-gonadal axis (caution in children with delayed puberty)	• Often prescribed to target sleep onset delay in children with ADHD and developmental disorders • More useful for chronobiotic rather than hypnotic properties (thus, useful in circadian rhythm sleep disorders) • Effective doses may be higher in children with developmental disorders (up to 10mg/day). • Ramelteon (melatonin-receptor agonist) has limited data for use in children • Newer agents (Agomelatine) can have potential uses in treating comorbid anxiety and insomnia (due to melatonin agonist and serotonin antagonist properties)
Antihistamines	• Diphenhydramine (0.5mg/kg, with maximum dose of 25mg/day) • Hydroxyzine (0.5mg/Lb)	Daytime drowsiness, dry mouth, urinary retention, paradoxical hyperactivity, cardiac toxicity in overdose	• Sedative effects through H_1 receptor blocking properties • Development of tolerance requiring escalating doses • Anxiolytic and anticholinergic properties of antihistamines can potentiate substance abuse in adolescents.
Benzodiazepines (e.g., clonazepam, lorazepam) and benzodiazepine-receptor agonists [BZRAs] (zaleplon, zolpidem, eszopiclone)	Ultra-short half-life (zaleplon, 1–2 hours), short half-life (zolpidem, 2–3 hours), intermediate to long half-life (eszopiclone, 6 hours)	Behavioral disinhibition and agitation with aggression and impulsivity, paradoxical hyperactivity	• Clonazepam useful in treatment for periodic limb movement disorder and in treatment of arousal parasomnias • Limited use in children due to potential for abuse; none are approved for use in children by FDA. • BZRAs have been shown to induce complex sleep-related behaviors (e.g., sleep eating and sleep walking); longer-acting medications (e.g., eszopiclone) are used mostly in adults due to lack of development of tolerance.
Antidepressants	• Trazodone at lower doses (12.5–50mg/day) • Tricyclics (amitriptyline, nortriptyline)	Priapism with trazodone; treatment-emergent anxiety and agitation; exacerbation of symptoms of restless legs syndrome with tricyclics; significant cardiotoxicity in overdose	• Most tricyclics are potent REM sleep suppressants and suppress slow wave sleep • Should be used at the lowest possible doses to avoid cardiac side effects • Sedating antidepressants (e.g., mirtazapine) have limited data in children; rapid eye movement suppression by mirtazapine appears to be minimal.
Herbal supplements	Chamomile, lavender, tryptophan, kava kava	necrotizing hepatitis (kava kava); eosinophilia myalgia syndrome (tryptophan)	Use of herbal supplements have limited-to-no evidence of efficacy.

propensity of apneic events to produce sleep fragmentation, arousals, and chronic sleep deprivation;[73] therefore, presence of SRBD should be screened for in children who present with recurrent parasomnias. Treatment usually encompasses behavioral management (e.g., sleep hygiene, avoiding sleep deprivation, and scheduled awakenings), ensuring safety of the child, and use of benzodiazepines in severe forms.

Arousal disorders, at times, are mistakenly grouped under the common entity *nightmares*. It is important to note this distinction because nightmares are considered to be REM sleep-related parasomnia and can involve a different management strategy altogether. Nightmares are arousals from "dream" sleep (REM stage), and there is no associated confusion or amnesia to the event. Nightmares usually resolve by age 6, and persistent symptoms beyond this age may require further evaluation to rule out underlying anxiety disorders, affective distress, or trauma exposure (and probable PTSD). In some cases, fear of nightmares may cause some children to be afraid to initiate sleep at the beginning of the night (negative associations), leading to either delayed sleep onset or sleep maintenance insomnia. A neurocognitive model implicating disturbance in affect-mediating network (affective network dysfunction or AND) and its neurophysiological counterpart, termed *AMPHAC* (amygdala, medial prefrontal cortex, hippocampus, anterior cingulate) has recently been proposed to explain nightmares.[74] Parental reassurance regarding the benign nature of nightmares can be helpful. Cognitive behavioral strategies, such as progressive muscle relaxation and imagery rehearsal (described above in insomnia section), can be useful in some cases.

Other REM parasomnias, such as REM behavior disorder (mostly seen in parkinsonism) and recurrent intermittent sleep paralysis (RISP), are relatively rare in childhood. Sleep enuresis belongs to a miscellaneous group of parasomnias (e.g. sleep-related bruxism, sleep-related groaning, sleep talking or somniloquy) that are not related to any specific stage of sleep.

Sleep enuresis is defined as recurrent involuntary voiding during sleep at least twice per week in children at least 5 years of age, and is usually classified as either primary or secondary. Associated family history and distinct male predominance in prevalence is usually present. In primary nocturnal enuresis, the child has never been consistently dry at night. If the child has experienced at least six months of dryness at night and then begins bedwetting, the condition is referred to as secondary nocturnal enuresis. Secondary enuresis can occur due to recent psychological stressors (e.g., trauma, death in family) or undiagnosed medical illnesses, such as diabetes, epilepsy, urinary tract infections, hyperthyroidism, and OSA. Restricting evening intake of fluids, limiting caffeine intake, establishing a bedtime toileting schedule, and positive reinforcements with rewards can be beneficial. Behavioral treatments, such as using dry-bed technique (i.e., strict schedule of waking the child at predetermined times of night to get the child to use the bathroom) and the urine alarm/bell pad that is activated with urination during sleep, in conjunction with medications (e.g., desmopressin and oxybutinin) have been shown to be helpful.

Diagnostic evaluation using an overnight polysomnogram is rarely needed to diagnose parasomnias unless initial clinical evaluation is equivocal for "type" of parasomnia and if the child is engaging in dangerous nocturnal behaviors. An interesting caveat to remember when a child presents with suspected parasomnia is that clinicians should have high suspicion for underlying seizure disorder, as certain forms of epilepsy, such as benign focal epilepsies and frontal lobe complex partial seizures, can occur during sleep.[75,76] Seizure events, compared to parasomnia, appear to have their onset at any age, are associated with frequent night-time attacks with no clear patterns, are brief in duration, and appear to be fairly stereotyped in motor movements.[77] Video electroencephalogram (VEEG) evaluation or home video recordings of the event can be helpful in distinguishing epileptiform phenomena from parasomnias.

Circadian rhythm sleep disorders. Delayed sleep phase syndrome (DSPS) is the most common sleep disturbance seen in adolescents and is characterized by a physiological shift in sleep onset to later times of the night. Adolescents with DSPS have difficulty falling asleep at their desired bedtime and an inability to wake spontaneously at the desired time in the morning. This results in delayed bedtime, delayed sleep-onset, earlier sleep offset during school days, reduced sleep duration, chronic sleep deprivation, and excessive daytime sleepiness. Remarkably, most adolescents with DSPS can sleep into late mornings or early afternoon if provided with an opportunity to sleep in an uninterrupted fashion, such as during holidays or weekends.

Chronic sleep deprivation due to circadian rhythm disorders and sleep restriction has been shown to affect certain measures of neurobehavioral functioning.[78] Screening for illicit substance use or use of caffeine and nicotine can be helpful to ascertain etiology behind delayed bed times in teenagers. Undiagnosed symptoms of depression or anxiety can precipitate delayed sleep-onset and/or early morning awakenings, and merits further evaluation. Some teenagers can voluntarily delay their bedtime as a means to avoid school (intentional sleep-phase delay), and should be screened for underlying reasons that prompt such behaviors (e.g., exposure to school-related bullying, academic pressures, undiagnosed learning disabilities, worsening ADHD). Again, behavioral interventions, such as maintaining a consistent sleep-wake schedule seven days a week, are the mainstay

of treatment. This is often achieved by using behavioral contracts to engage teens to participate in sleep-promoting behaviors. Melatonin, via its chronobiotic and hypnotic potential, at doses of 0.5 to 3mg 2 to 3 hours prior to bedtime, along with exposure to bright light in the mornings 15 to 20 minutes after awakening, can be helpful to treat sleep-onset difficulties and "reset" the disrupted circadian rhythm.[79, 80] Techniques such as chronotherapy involve "guiding" the sleep phase to a desired bedtime. If sleep-phase delay is less than 2 to 3 hours, bedtimes are gradually brought forward in 15-minute increments every three days; whereas, particularly severe forms of DSPS may require drastic sleep delays in two-hour increments for a few days to achieve desired bedtime.

CONCLUSION

Pediatric sleep problems are a common occurrence and are associated with significant daytime impairments. Pediatric sleep problems can present as the primary sleep disorder or as a secondary consequence of an underlying medical or psychiatric disorder, and they can compromise social, academic, and neurobehavioral functioning. Over the past decade, there has been a growing body of literature with regard to effective diagnostic methods for identifying pediatric sleep disorders and utilization of evidence-based behavioral approaches coupled with rational pharmacotherapy, when needed. However, there appears to be a rather slow development in awareness regarding childhood sleep difficulties among the general public and healthcare professionals. This review provides brief yet useful information that can be helpful for professionals involved in pediatric healthcare, which hopefully will increase awareness regarding developmentally appropriate diagnostic and treatment approaches available for common pediatric sleep problems.

REFERENCES

1. Owens JA. Introduction: Culture and sleep in children. *Pediatrics.* 2005;115(1 Suppl):201–203.
2. Sheldon SH. Diagnostic methods in pediatric sleep medicine. *Sleep Med Clin.* 2007;2(3):343–351.
3. American Academy of Sleep Medicine (AASM). Evaluate your sleep: sleep diary. http://www.sleepeducation.com/pdf/sleepdiary.pdf. Accessed December 22, 2009.
4. Owens JA, Dalzell V. Use of the "BEARS" sleep screening tool in a pediatric residents' continuity clinic: a pilot study. *Sleep Med.* 2005;6(1):63–9
5. Carskadon MA. School sleep habits survey. http://www.sleepforscience.org/contentmgr/showdetails.php/id/93. Accessed December 16, 2009.
6. Owens JA, Spirito A, McGuinn M. The Children's Sleep Habits Questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. *Sleep.* 2000;23(8):1043–1051.
7. Bruni O, Ottaviano S, Guidetti V, et al. The Sleep Disturbance Scale for Children (SDSC). Construction and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *J Sleep Res.* 1996;5(4):251–261.
8. Rhodes SK, Shimoda KC, Waid LR, et al. Neurocognitive deficits in morbidly obese children with obstructive sleep apnea. *J Pediatr.* 1995;127:741–744.
9. Cortese S, Lecendreux M, Mouren MC, et al. ADHD and insomnia. *J Am Acad Child Adolesc Psychiatry.* 2006;45(4):384–385.
10. Cortese S, Konofal E, Lecendreux M, et al. Restless legs syndrome and attention-deficit/hyperactivity disorder: a review of the literature. *Sleep.* 2005;28(8):1007–1013.
11. Kimura M, Winkelmann J. Genetics of sleep and sleep disorders. *Cell Mol Life Sci.* 2007;64(10):1216–1226.
12. Bixler EO, Vgontzas AN, Lin HM, et al. Sleep disordered breathing in children in a general population sample: prevalence and risk factors. *Sleep.* 2009;32(6):731–736.
13. Section on pediatric pulmonology, subcommittee on obstructive sleep apnea syndrome. Clinical practice guideline: diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics.* 2002;109:704–712.
14. Hutchens L, Senserrick TM, Jamieson PE, et al. Teen driver crash risk and associations with smoking and drowsy driving. *Accid Anal Prev.* 2008;40(3):869–8676. Epub 2007 Oct 26.
15. Littner MR, Kushida C, Wise M, et al. Practice parameters for clinical use of the multiple sleep latency tests and the maintenance of wakefulness test. *Sleep.* 2005;28(1):113–121.
16. Morgenthaler T, Alessi C, Friedman L, et al. Practice parameters for the use of actigraphy in the assessment of sleep and sleep disorders: an update for 2007. *Sleep.* 2007;30(4):519–529.
17. Row BW, Liu R, Xu W, et al. Intermittent hypoxia is associated with oxidative stress and spatial learning deficits in the rat. *Am J Respir Crit Care Med.* 2003;167:1548–1553.
18. Gottlieb DJ, Vezina RM, Chase C, et al. Symptoms of sleep-disordered breathing in 5-year-old children are associated with sleepiness and problem behaviors. *Pediatrics.* 2003;112:870–877.
19. Melendres MC, Lutz JM, Rubin ED, et al. Daytime sleepiness and hyperactivity in children qith suspected sleep-disordered breathing. *Pediatrics.* 2004;114:768–775.
20. O'Brien LM, Holbrook CR, Mervis CB, et al. Sleep and neurobehavioral characteristics of 5- to 7-year-old children with parentally reported symptoms of attention-deficit/hyperactivity disorder. *Pediatrics.* 2003;111:554–563
21. O'Brien LM, Mervis CB, Holbrook CR, et al. Neurobehavioral implications of habitual snoring in children. *Pediatrics.* 2004;114:44–49.

22. Blunden S, Lushington K, Kennedy D, et al. Behavior and neurocognitive performance in children aged 5–10 years who snore compared to controls. *J Clin Exp Neuropsychol.* 2000;22(5):554–568.
23. Chervin RD, Ruzicka DL, Giordani BJ, et al. Sleep-disordered breathing, behavior, and cognition in children before and after adenotonsillectomy. *Pediatrics.* 2006;117:e769–e778.
24. Avior G, Fishman G, Leor A, et al. The effect of tonsillectomy and adenoidectomy on inattention and impulsivity as measured by the Test of Variables of Attention (TOVA) in children with obstructive sleep apnea syndrome. *Otolaryngol Head Neck Surg.* 2004;131:367–371.
25. Beebe DW, Gozal D. Obstructive sleep apnea and the prefrontal cortex: towards a comprehensive model linking nocturnal upper airway obstruction to daytime cognitive and behavioral deficits. *J Sleep Res.* 2002;11:1–16.
26. Muzumdar H, Arens R. Diagnostic issues in pediatric obstructive sleep apnea. *Proc Am Thorac Soc.* 2008;5(2):263–273.
27. Redline S, Tishler PV, Schluchter M, et al. Risk factors for sleep-disordered breathing in children. Associations with obesity, race, and respiratory problems. *Am J Respir Crit Care Med.* 1999;159(5 Pt 1):1527–1532.
28. Brietzke SE, Gallagher D. The effectiveness of tonsillectomy and adenoidectomy in the treatment of pediatric obstructive sleep apnea/hypopnea syndrome: a meta-analysis. *Otolaryngol Head Neck Surg.* 2006;134(6):979–984.
29. Contencin P, Guilleminault C, Manach Y. Long-term follow-up and mechanisms of obstructive sleep apnea (OSA) and related syndromes through infancy and childhood. *Int J Pediatr Otorhinolaryngol.* 2003;67:S119–S123.
30. Tauman R, Gulliver TE, Krishna J, et al. Persistence of obstructive sleep apnea syndrome in children after adenotonsillectomy. *J Pediatr.* 2006;149:803–808.
31. Palombini L, Pelayo R, Guilleminault C. Efficacy of automated continuous positive airway pressure in children with sleep-related breathing disorders in an attended setting. *Pediatrics.* 2004;113;e412–e417.
32. Goldbart AD, Goldman JL, Veling MC, et al. Leukotriene modifier therapy for mild sleep-disordered breathing in children. *Am J Respir Crit Care Med.* 2005;172:364–370.
33. Berlucchi M, Salsi D, Valetti L, et al. The role of mometasone furoate aqueous nasal spray in the treatment of adenoidal hypertrophy in the pediatric age group: preliminary results of a prospective, randomized study. *Pediatrics.* 2007;119:e1392–e1397.
34. Alexopoulos EI, Kaditis AG, Kalampouka E, et al. Nasal corticosteroids for children with snoring. *Pediatr Pulmonol.* 2004;38:161–167.
35. Kheirandish L, Goldbart AD, Gozal D. Intranasal steroids and oral leukotriene modifier therapy in residual sleep-disordered breathing after tonsillectomy and adenoidectomy in children. *Pediatrics.* 2006;117:e61–e66.
36. Benign sleep myoclonus of infancy. In: *The International Classification of Sleep Disorders: Diagnostic and Coding Manual, Second Edition.* Westchester, IL: American Academy of Sleep Medicine; 2005:211–212.
37. Sleep related rhythmic movement disorder. In: *The International Classification of Sleep Disorders: Diagnostic and Coding Manual, Second Edition.* Westchester, IL: American Academy of Sleep Medicine; 2005:193–195.
38. Dyken M, Lin-Dyken D, Yamada T. Diagnosing rhythmic movement disorder with videopolysomnography. *Pediatr Neurol.* 1997;16:37–41.
39. Hoban TF. Rhythmic movement disorder in children. *CNS Spectr.* 2003;8:135–138.
40. Jankoviç SM, Sokiç DV, Vojvodiç NM, et al. Multiple rhythmic movement disorders in a teenage boy with excellent response to clonazepam. *Mov Disord.* 200823(5):767–768.
41. Restless legs syndrome and periodic limb movement disorder. In: *The International Classification of Sleep Disorders: Diagnostic and Coding Manual, Second Edition.* Westchester, IL: American Academy of Sleep Medicine; 2005:178–186.
42. Allen RP, Picchietti D, Hening WA, et al. Restless legs syndrome: diagnostic criteria, special considerations, and epidemiology: a report from the restless legs syndrome diagnosis and epidemiology workshop at the National Institutes of Health. *Sleep Med.* 2003;4:101–119.
43. Kotagal S, Silber MH. Childhood-onset restless legs syndrome. *Ann Neurol.* 2004;56:803–807.
44. Kryger MH, Otake K, Foerster J. Low body stores of iron and restless legs syndrome: a correctable cause of insomnia in adolescents and teenagers. *Sleep Med.* 2002;3(2):127–132.
45. Simakajornboon N, Gozal D, Vlasic V, et al. Periodic limb movements in sleep and iron status in children. *Sleep.* 2003;26(6):735–738.
46. Wagner ML, Walters AS, Coleman RG, et al. A randomized double-blind placebo controlled study of clonidine in restless legs syndrome. *Sleep.* 1996;19:52–58
47. Garcia-Borreguero D, Larrosa O, de la Llave Y, et al. Treatment of restless legs syndrome with gabapentin: a double-blind, cross-over study. *Neurology.* 2002;59:1573–1579.
48. Silber MH, Ehrenberg BL, Allen RP, et al. An algorithm for the management of restless legs syndrome. *Mayo Clin Proc.* 2004;79:916–922.
49. Konofal E, Arnulf I, Lecendreux M, et al. Ropinirole in a child with attention-deficit hyperactivity disorder and restless legs syndrome. *Pediatr Neurol.* 2005;32:350–351.
50. Walters AS, Mandelbaum DE, Lewin DS, et al. Dopaminergic

therapy in children with restless legs/periodic limb movements in sleep and ADHD. Dopaminergic Therapy Study Group. *Pediatr Neurol.* 2000;22:182–186.
51. Nofzinger EA, Fasiczka A, Berman S, et al. Bupropion SR reduces periodic limb movements associated with arousals from sleep in depressed patients with periodic limb movement disorder. *J Clin Psychiatry.* 2000;61:858–862.
52. Yang C, White DP, Winkelman JW. Antidepressants and periodic leg movements of sleep. *Biol Psychiatry.* 2005;58:510–514.
53. Picchietti D, Winkelman JW. Restless legs syndrome, periodic limb movements in sleep, and depression. *Sleep.* 2005;1;28(7):891–898.
54. American Academy of Sleep Medicine. *The International Classification of Sleep Disorders: Diagnostic and Coding Manual, Second Edition.* Westchester, IL: American Academy of Sleep Medicine; 2005.
55. Wolfson AR, Carskadon MA. Sleep schedules and daytime functioning in adolescents. *Child Dev.* 1998;69:875–887.
56. Mindell JA, Kuhn B, Lewin DS, et al. Behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep.* 2006;29(10):1263–1276.
57. Lecendreux M, Konofal E, Bouvard M, et al. Sleep and alertness in children with ADHD. *J Child Psychol Psychiatry.* 2000;41:803–812.
58. Dahl RE, Harvey AG. Sleep in children and adolescents with behavioral and emotional disorders. *Sleep Med Clin.* 2007;2(3):501–511.
59. Dahl RE. The development and disorders of sleep. *Adv Pediatr.* 1998;45:73–90.
60. Johnson EO, Roth T, Breslau N. The association of insomnia with anxiety disorder and depression: exploration of the direction of risk. *J Psychiatr Res.* 2006;40(8):700–708.
61. Dahl RE. The regulation of sleep and arousal: development and psychopathology. *Dev Psychopathol.* 1996;8:3–27.
62. Anders TF, Eiben LA. Pediatric sleep disorders: a review of the past 10 years. *J Am Acad Child Adolesc Psychiatry.* 1997; 36(1):9–20.
63. Terr LC. Childhood traumas: an outline and overview. *Am J Psychiatry.* 1991;148:10–19.
64. Krakow B, Sandoval D, Schrader R, et al. Treatment of chronic nightmares in adjudicated adolescent girls in a residential facility. *J Adolesc Health.* 2001;29(2):94–100.
65. Spoormaker VI, Montgomery P. Disturbed sleep in post-traumatic stress disorder: secondary symptom or core feature? *Sleep Med Rev.* 2008;12(3):169–184.
66. Raskind MA, Peskind ER, Hoff DJ, et al. A parallel group placebo controlled study of prazosin for trauma nightmares and sleep disturbance in combat veterans with post-traumatic stress disorder. *Biol Psychiatry.* 2007;61(8):928–934.
67. Mindell JA, Barrett KM. Nightmares and anxiety in elementary-aged children: is there a relationship. *Child Care Health Dev.* 2002;28:317–322.
68. Mindell JA, Emslie G, Blumer J, et al. Pharmacologic management of insomnia in children and adolescents: consensus statement. *Pediatrics.* 2006;117(6):e1223–1232.
69. Owens JA, Babcock D, Blumer J, et al. The use of pharmacotherapy in the treatment of pediatric insomnia in primary care: rational approaches. a consensus meeting summary. *J Clin Sleep Med.* 2005;1(1):49–59.
70. Owens JA, Moturi S. Pharmacologic treatment of pediatric insomnia. *Child Adolesc Psychiatr Clin N Am.* 2009;18(4):1001–1016.
71. Ivanenko A, Crabtree VM, Obrien LM, et al. Sleep complaints and psychiatric symptoms in children evaluated at a pediatric mental health clinic. *J Clin Sleep Med.* 2006;2(1):42–48.
72. Hughes JR. A review of sleepwalking (somnambulism): the enigma of neurophysiology and polysomnography with differential diagnosis of complex partial seizures. *Epilepsy Behav.* 2007;11(4):483–491.
73. Schenck CH, Mahowald MW. Parasomnias associated with sleep-disordered breathing and its therapy, including sexsomnia as a recently recognized parasomnia. *Somnologie.* 2008;12(1):38–49.
74. Nielsen T, Levin R. Nightmares: a new neurocognitive model. *Sleep Med Rev.* 2007;11(4):295–310.
75. Panayiotopoulos CP, Michael M, Sanders S, et al. Benign childhood focal epilepsies: assessment of established and newly recognized syndromes. *Brain.* 2008;131:2264–2286.
76. Stores G, Zaiwalla Z, Bergel N. Frontal lobe complex partial seizures in children: a form of epilepsy at particular risk of misdiagnosis. *Dev Med child Neurol.* 1991;3:998–1009.
77. Tinuper P, Provini F, Bisulli F, et al. Movement disorders in sleep: guidelines for differentiating epileptic from non-epileptic motor phenomena arising from sleep. *Sleep Med Rev.* 2007;11:255–267.
78. Sadeh A, Gruber R, Raviv A. The effects of sleep restriction and extension on school-age children: what a difference an hour makes. *Child Dev.* 2003;74(2):444–455.
79. Lockley SW. Timed melatonin treatment for delayed sleep phase syndrome: the importance of knowing circadian phase. *Sleep.* 2005;28:1214–1216.
80. Revell VL. Advancing human circadian rhythms with afternoon melatonin and morning intermittent bright light. *J Clin Endocrinol Metab.* 2006;91(1):54–59.