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DEVELOPMENTAL FEATURES OF SLEEP

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Sleep disorders are common in children and adolescents who present for psychological or psychiatric evaluation. A thorough understanding of sleep and sleep disorders is important for psychiatrists and other mental health professionals, as there is often a relationship among sleep, medical, and psychiatric issues.[103] Not only may sleep disorders be mistaken for psychiatric or psychological disorders, but medical and psychiatric disorders can cause sleep disturbances. The purpose of this article is to provide detailed information about sleep and its evaluation, discuss the most common sleep disorders seen in children and adolescents, and provide an understanding of the relationships among sleep disturbances and medical and psychiatric disorders.

SLEEP PHYSIOLOGY AND DEVELOPMENT

Sleep is a complex process involving multiple physiologic systems. To understand sleep and sleep disorders in children and adolescents, knowledge about sleep stages and development is important. Sleep comprises two distinct states: rapid eye movement (REM) sleep and non-REM sleep. Non-REM sleep is further divided into Stages 1, 2, 3, and 4. Stages 3 and 4 are often referred to as *delta sleep* or *slow-wave sleep*, which constitutes the deepest level of sleep. This deep non-REM sleep occurs in the first 1 to 3 hours after sleep onset, and children have greater amounts of deep slow-wave sleep than adults. Stages 3 and 4 sleep arise during the first year, achieve their highest levels in early

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childhood, decrease by about 40% across adolescent development, and decline more gradually in adulthood. It is difficult to awaken a child from this deep sleep, and once awakened the child is often disoriented and confused. Confused partial arousals, including sleepwalking and sleep terrors, arise from deep Stage 4 non-REM sleep.

Rapid eye movement sleep incorporates aspects of both deep sleep and light sleep. Rapid eye movement sleep is associated with an active suppression of peripheral muscle tone, marked decline in thermoregulatory function, and increased variability in the regulation of blood pressure, heart rate, and respiration. Cortical brain function is extremely active in REM sleep. The majority of dreaming occurs during REM sleep, and when awakened a person is quickly alert. Episodes of REM occur in cycles of 60 to 90 minutes in adults (slightly longer in children), with increasing duration throughout the night. Thus, the longest REM episodes occur in the early morning just prior to awakening, making nightmares most likely to occur in the second half of the sleep period. Another important aspect of sleep that needs to be recognized is that arousals occur throughout the sleep period. These short episodes of wakefulness typically occur five to seven times a night during normal sleep. Children usually return to sleep quickly and have no recall of the awakening.

The regulation of sleep in adults is described as depending on two major biologic processes: (1) a sleep-wake homeostatic process; and (2) the circadian timing system. These factors are likely to play similar roles in children and certainly in adolescents. The homeostatic process—sometimes called *process S*[20]—is modeled as controlling the depth and length of sleep as a function of prior waking. This process often is indexed by the quantity of electroencephalogram (EEG) slow-wave activity (SWA) during sleep. Slow-wave activity and Stages 3 and 4 sleep, which are identified visually based on EEG slow waves, are most prominent early in the sleep phase and are potentiated by prior sleep loss. Electroencephalogram SWA is generated thalamically, and the thalamic gating of sensory activity may account for the high arousal threshold during slow-wave sleep Stages 3 and 4 and the increase in threshold during recovery sleep following sleep loss. Recent evidence from cats has indicated that local increases in adenosine concentration—particularly in the basal forebrain—are correlated with the homeostatic drive for sleep.[123] Other neurotransmitter systems, including histamine, serotonin, glutamate, neuropeptides, and neuroimmunochemical substances, have been shown to modulate non-REM sleep. Little evidence exists for a specific circadian regulation of SWA, although the length and timing of sleep per se are strongly circadian.

The timing of REM sleep is more clearly regulated by circadian timing mechanisms, although homeostatic regulation is also clear in that REM sleep suppression leads to REM sleep rebound. The peak propensity for REM sleep coincides with the trough of the circadian temperature rhythm.[37, 165] Rapid eye movement sleep is also cyclic over a shorter (ultradian) time frame, alternating with non-REM sleep across the night. This non-REM–REM cycle arises from a well-described reciprocity of neuronal discharge in the brain stem. Rapid eye movement sleep may be characterized as a pontine process, and it has been suggested that "the pons is both necessary for generating and sufficient to generate the principal phenomena of REM sleep."[146] Rapid eye movement arises in two pontine nuclei, the lateral dorsal tegmental (LDT) pontine nuclei and the pedunculopontine tegmental (PPT) nuclei. The LDT-PPT neurons are cholinergic and are the REM-On units; that is, their firing occurs prior to and throughout REM sleep, recruiting other pontine regions to complete the REM "process,"

motor suppression, bursts of rapid eye movements, cortical activation, and so forth.

The ultradian non-REM–REM cycle arises from the reciprocity of the LDT-PPT REM-On neurons with the REM-Off neurons located in the serotonergic raphe nuclei and the noradrenergic nucleus locus coeruleus. Activity of the serotonergic and noradrenergic neurons is associated with the termination of a REM sleep episode. The reciprocal relationship of these neuronal populations in broad terms involves inhibition by serotonergic and noradrenergic cell groups of the LDT-PPT region and excitation of the raphe and nucleus locus coeruleus by the cholinergic REM-On LDT-PPT. These neurophysiological and neurochemical interactions account for the well-known pharmacologic actions on REM sleep, such as REM suppression by many antidepressants and REM potentiation by cholinergic agonists (e.g., REM induction by arecholine or physostigmine).

Figure 1 illustrates the non-REM and REM sleep patterns in the transition

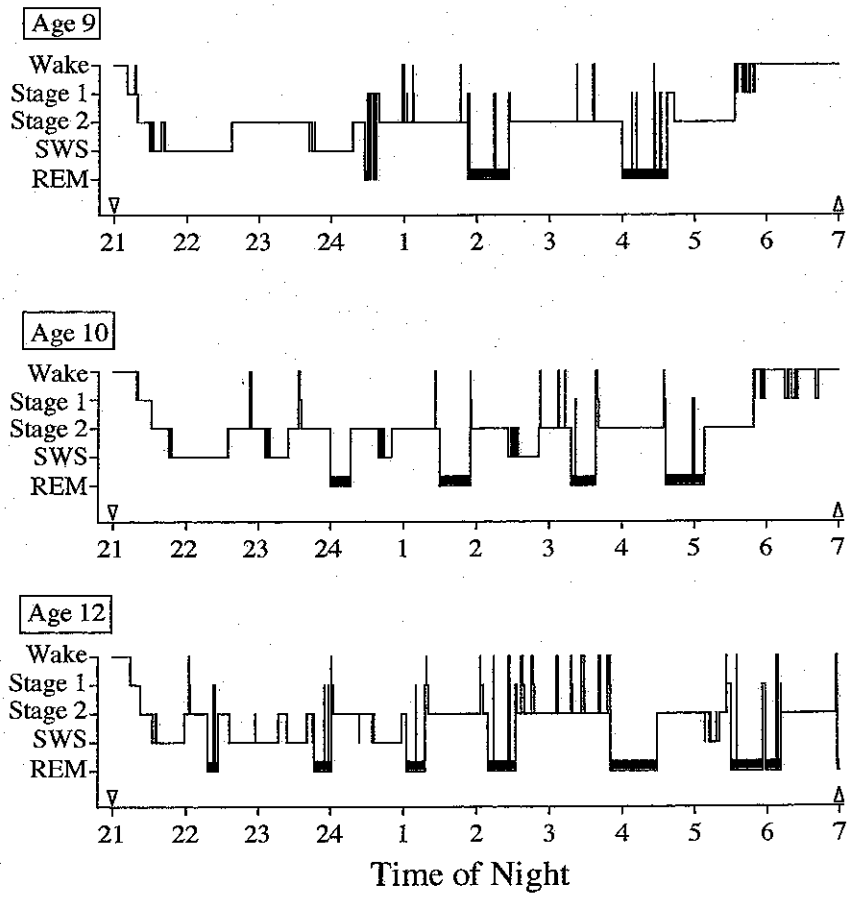

Figure 1. Non-REM and REM sleep patterns in the transition from late childhood to early adolescence. ∇ = lights out. △ = lights on.

from late childhood to early adolescence. The normal transition of waking to non-REM sleep and then to REM sleep is clearly evident in all three graphs, as is the declining interval from sleep initiation to REM sleep across this age span. The developmental progression of REM sleep from birth to early childhood is even more striking. Full-term newborn humans sleep approximately two thirds of the time, equally divided between active and quiet sleep, which are the immature precursors of REM and non-REM sleep. The newborn enters sleep through active sleep, a transitional process that gradually changes over the first year. Latency from sleep onset to REM sleep in the older child is quite long—on the order of 3 hours. In early adolescence, this delay to the first REM sleep episode is reduced to about 90 to 110 minutes, with a more gradual decline accompanying adulthood. The circadian pattern of REM sleep propensity manifests as longer REM episodes late in the night near the time of the body temperature minimum.

If the latency to REM sleep depends on the pressure for SWA, then developmental trends in REM sleep latency relate to the maturation of non-REM sleep and SWA. As the newborn brain matures, sleep spindles (12 to 14 cycles per second non-REM sleep EEG activity) and SWA begin to appear from 3 to 6 months of age. The emergence of these thalamically generated cortical EEG signs likely depends on an adequate cortical "superstructure," indexed by some as cortical synaptic density.[47] Slow-wave activity during sleep peaks in early childhood, and Stages 3 and 4 decline markedly (approximately 40%) across the second decade.[27] This developmental trend is evident in Figure 1. Sleep-wake activity continues to diminish gradually across the lifespan, and stage 4 sleep may be very minimal in the elderly, particularly men. The homeostatically regulated increase in SWA, however, is maintained, even in the aged.[21, 28] With chronic sleep restriction—as in the insufficient sleep pattern common among adolescents—SWA may be quite pronounced.

Age-related (developmental) processes also affect sleep regulation. These developmental factors affect both sleep physiology and sleep consolidation and duration. The primary physiologic change is in the proportion of REM versus non-REM sleep. During the newborn period, REM sleep (referred to as active sleep during this age) accounts for approximately 50% of sleep and gradually reduces over time to adult levels of 25% to 30%. This decrease in REM sleep is also accompanied by a dramatic decrease in delta sleep, especially following puberty, which is the reason most children grow out of sleepwalking and sleep terrors.

Sleep requirements also change across age. Newborns sleep approximately 16 hours a day in 1- to 4-hour episodes. Sleep consolidation occurs quickly, with most sleep occurring during the night by 6 months of age. At 1 year of age, children sleep on average 11 hours at night and take two naps totaling 2.5 hours. By 3 years of age, the average child gets 10.5 hours of sleep at night plus one 1.5-hour nap. And, by 4 or 5 years of age, most children have given up daytime naps, with all sleep occurring at night. By 18 years of age, sleep accounts for approximately 8 hours a day. It is important to note that these sleep requirements are generalizations and significant individual differences exist.

CLASSIFICATION OF SLEEP DISORDERS

Before discussing specific sleep disorders, it is important to outline the classification system. Sleep disorders are classified into two major categories, the dyssomnias and the parasomnias, as delineated by the International Classifica-

tion of Sleep Disorders (ICSD).[43] The dyssomnias include those disorders that result in difficulty either initiating or maintaining sleep, or involve excessive daytime sleepiness. The parasomnias, on the other hand, are disorders that disrupt sleep after it has been initiated and are disorders of arousal, partial arousal, or sleep-stage transitions. They are disorders that intrude into the sleep process, but usually do not result in complaints of insomnia or excessive sleepiness. Note that these terms, as they are defined by the ICSD, differ slightly from their use in the fourth edition of the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV).[6] The DSM-IV defines dyssomnias as those sleep disorders in which the predominant disturbance is in the amount, quality, or timing of sleep. The parasomnias are described as sleep disorders that involve abnormal behavioral or physiologic events occurring in association with sleep, specific sleep stages, or sleep-wake transitions. Both methods of defining these terms, however, result in the same classification of specific disorders.

PREVALENCE OF SLEEP DISORDERS

Surveys have found that approximately 20% to 25% of children experience some type of sleep disturbance.[18, 74, 90, 128, 129] For example, Salzarulo and Chevalier[143] interviewed the families of 218 children 2 to 15 years of age who were referred for pediatric or child psychiatric consultation, and found that sleep talking was quite common (32%), followed by nightmares (31%), waking at night (28%), trouble falling asleep (23%), enuresis (17%), bruxism (10%), sleep rocking (7%), and night terrors (7%). In Dollinger's 1982 survey of mothers referring their children to a university clinic,[46] the most common sleep problems (among 3- to 15-year-old children) were sleep talking (53%), restless sleep and bedtime refusal (both 42%), and refusing to go to sleep without a nightlight (40%). Other sleep problems included bad dreams (35%), difficulty in going to sleep (26%), crying out in sleep (16%), and nightmares (11%). Another study of healthy preadolescents, 8 to 10 years of age, found that 43% of the children were experiencing a sleep problem that had lasted more than 6 months.[76] Looking at specific sleep disorders, parasomnias were present in 29% of the children, with enuresis (2%), sleep walking (5%), and night fears (15%) reported.

HOW TO EVALUATE PEDIATRIC SLEEP COMPLAINTS

A thorough evaluation of pediatric sleep complaints is essential. The first step in evaluating a child or adolescent for a sleep disorder is the completion of a thorough sleep history. All aspects of the sleep-wake cycle need to be reviewed. A review of *sleep habits* needs to be conducted, including co-sleeping, sleep schedules (both weekday and weekend), and intake of caffeinated beverages. Information should be collected about *bedtime routines*, including evening activities, bedtime stalling or refusal behaviors, and the latency to sleep onset. Details about *nocturnal behaviors* and other abnormal events during sleep should be detailed, such as night terrors, confusional arousals, seizures, and enuresis. The number and duration of nighttime awakenings need to be evaluated. Information about common symptoms related to sleep-disordered breathing should be assessed, including snoring, breathing pauses, restless sleep, sleeping in abnormal positions, sweating, mouth breathing, and early morning headaches.

Furthermore, information about *diurnal behaviors*, such as difficulty to

awaken, daytime sleepiness, fatigue, naps, meals, caffeine intake, medications, and feelings of anxiety and depression should be reviewed. Additional information about daytime functioning and significant life events should be collected. Daytime functioning needs to incorporate all aspects, including school performance, social relationships, and family functioning. Problems in any of these areas can be indicative of sleep problems and can also contribute to sleep difficulties, given that adjustment sleep problems are common following such events as a death of a family member, a change in school, or a recent move. More subtle issues can also lead to sleep problems. For example, family financial problems can result in sleep disturbances in children, even if the parents do not believe that the child is aware of such problems. Often children, and especially adolescents, are much more aware of family tensions than parents know.

The second step in the evaluation of sleep problems is the collection of sleep diaries. A typical sleep diary includes information on the time to bed, latency to sleep onset, number and duration of nighttime awakenings, time of waking, total sleep time, and duration and time of naps. Two weeks of baseline sleep diaries are usually adequate to delineate sleep patterns.

The third step is to determine whether an overnight sleep study is needed. In cases concerning a specific underlying physiologic problem, nocturnal polysomnography (PSG) is an essential component of assessment. A PSG is warranted principally to diagnose sleep-disordered breathing, especially obstructive sleep apnea; to investigate sleep-related causes of excessive daytime sleepiness, such as narcolepsy or sleep fragmentation due to frequent nocturnal arousals (such as periodic limb movement disorder); and occasionally to delineate the cause of episodic nocturnal phenomena (for example, parasomnias vs. nocturnal seizures).

Polysomnography typically involves recordings of EEG, electrooculogram (EOG), electromyogram (EMG), oxygen saturation, nasal and oral airflow, thoracic and abdominal respiratory movements, and limb muscle activity. Most overnight studies are done in the sleep laboratory, although home studies may be requested. Laboratory studies have the benefit of increased validity and inclusion of behavioral observation. In addition, home and nap studies have a high false-negative rate for sleep-disordered breathing. As an adjunct to a nocturnal PSG, a multiple sleep latency test (MSLT) is often conducted to objectively evaluate an individual's level of daytime sleepiness and sleep onset structure, although no widely accepted norms for children currently exist. The MSLT consists of four 20-minute nap opportunities given at 2-hour intervals. The test is evaluated for speed of falling asleep and latency to REM sleep.

Sleep can also be assessed through estimation from activity data. Long-term ambulatory monitoring with a wrist-worn (or in patients less than 3 years of age, ankle-worn) actigraph can provide excellent information across nights or even weeks. Actigraphy differs from actimetry in that the former collects activity counts on a minute-to-minute basis around the clock, whereas the latter collects total activity counts for longer spans of time, for example, an entire day. With actigraphy, valid and reliable estimates of the times of sleep onset and sleep offset, as well as total amount of sleep and sleep interruptions, are possible. Computer algorithms validated versus PSG show that actigraphy—particularly in combination with a behavioral report such as sleep diary or parental report—provides a very useful estimate of sleep.[141] A minimum of five nights of actigraphy provides reliable estimates for many sleep variables.[1] The measures obtained from actigraphy do not include assessment of non-REM and REM sleep, however. On the other hand, reliable, objective estimates of the length

and timing of sleep over the course of the school week can be very useful for clinical assessment.

DIFFERENTIAL DIAGNOSIS

Differential diagnosis is important because many sleep disorders present with similar symptomatology, such as difficulty sleeping or excessive daytime sleepiness. Differentiation between a sleep disorder and other medical or psychological problems is also important. For example, a child with apparent night terrors may actually have a seizure disorder. In other cases, difficulties at bedtime may be symptomatic of a more general problem with noncompliance. Nighttime fears may be just one of many extensive fears in an extremely anxious child.

Furthermore, it is important to keep in mind that some children may have more than one sleep disorder, especially the frequent coexistence of medical and behavioral sleep disorders.[116] For example, a child may have both obstructive sleep apnea and behavioral issues with bedtime refusal. Once a sleep disorder is identified, a thorough evaluation for all other sleep disorders should still be conducted. If not, sleep problems may continue, even with successful treatment. Last, because sleep disorders can be associated with physical illness or another psychological disorder, an evaluation of other factors may be essential.

IMPACT OF SLEEP DISTURBANCES

A number of studies, largely in adults, have documented the pervasive impact of sleep disturbances in a variety of domains. These studies have consistently found negative mood changes and significant decrements in cognitive functioning and performance decrements related to excessive daytime sleepiness.[120] Several mechanisms likely account for these negative effects of sleep disturbances. The first possible cause is the actual sleep deprivation, that is, shortened sleep or lack of sleep, which may occur with sleep disorders resulting in sleep onset delay, such as delayed sleep phase syndrome. In general, even partial sleep deprivation has been shown to result in diminished performance, especially if it occurs on a recurring basis. Dahl[39] proposes that the sleep loss incurred from inadequate or disturbed sleep in children influences prefrontal cortex functioning, resulting in decrements in executive functioning involved in the control of attention and emotions. Sleep fragmentation, or sleep interruption, is a second mechanism. Sleep fragmentation occurs with such sleep disorders as obstructive sleep apnea and periodic limb movements in sleep, when sleep is periodically interrupted throughout the night. Finally, a third general mechanism has been proposed related to the CNS effects of hypoxemia, and possibly hypercarbia, in sleep-disordered breathing.

From the findings with adults, it can be extrapolated that similar effects are expected in children and adolescents, although there is a paucity of research on the impact of sleep disturbances on children's functioning. The most empiric support, and the most consistent findings, are based on clinical observation and parental report, which indicate that sleep problems in children result in changes in mood and behavior.[3, 67, 69, 88] These changes often are paradoxic in nature, with younger children presenting as irritable and overactive, with a short attention span. These symptoms can be similar to those seen with attention-deficit hyperactive disorder (ADHD).

The second area of impact concerns neuropsychological functioning. The few studies conducted, similar to those found with adults, have found that children experiencing sleep disturbances have difficulties with focused attention, vigilance, reaction time, executive functioning, and, to a certain extent, memory.[29, 42, 69, 88, 116] Finally, it is expected that sleep problems affect overall functioning in the child's naturalistic setting, both in regard to the short-term and long-term effects of sleep disturbance. Initial studies have found that sleep problems can be related to academic functioning.[59] It is likely that sleep problems also affect social functioning, as supported by mostly anecdotal evidence.

Additional support for the previous conclusions has been found in studies looking at the impact of treatment of inadequate or disturbed sleep. For example, significant improvements in cognitive performance and behavior have been reported following the treatment of obstructive sleep apnea[4, 67] and young children's sleep disturbances.[99]

Furthermore, it is worth mentioning that sleep disturbances can also have a significant impact on the family. A number of studies have documented negative effects on parental sleep and subsequent impairment of daytime functioning related to sleepiness in families with children who have clinically significant sleep disturbance.[115] Additionally, another study found improvements in parents' mood, marital satisfaction, and total sleep time following treatment of their young child's sleep disturbances.[101]

PEDIATRIC SLEEP DISORDERS

Excessive Daytime Sleepiness and Hypersomnolence

Complaints of excessive sleepiness during the day or a greater sleep requirement than expected at a given age are common. These two symptoms may indicate of a wide range of sleep problems. Five of the most common sleep disturbances are reviewed subsequently.

Inadequate Amounts of Sleep

A frequently overlooked cause of excessive daytime sleepiness in children and adolescents is lack of sufficient sleep. Late evening activities, early morning school start times, and erratic sleep schedules can all contribute to inadequate sleep time. Answers to general questions about "usual" sleep schedules during a sleep history can be misleading. Reports often overestimate the amount of sleep the child or adolescent is achieving. By asking more directly about time in bed on specific nights, shorter sleep times are often described. Furthermore, parental reports about time to bed, especially with adolescents, are often inaccurate and can overestimate total sleep times. Information about weekdays versus weekends can also be helpful. Late sleep onsets and long hours in bed on weekends are often indications of erratic schedules and inadequate sleep on weekdays. Sleep diaries and actigraphy are also helpful in elucidating actual sleep patterns.

The issue of insufficient sleep has been examined most carefully in adolescents, in whom surveys, field studies, and laboratory assessments converge to indicate that many obtain inadequate sleep, and a minority are markedly impaired by excessive sleepiness. Much less is known in younger children, although it is important to address the issue in any child presenting with excessive sleepiness. Sleep need varies across individuals and appears to be more com-

monly underestimated than overestimated. Thus, parents may assume that 8, 9, or 10 hours of sleep are sufficient for a preadolescent and not realize that a chronic sleep deficit may accumulate over time if sleep need is not met. Older adolescents likely do not need less sleep than preadolescents. In one longitudinal study of 10- to 16-year-old children, the average sleep length at every age (given an identical 10-hour sleep opportunity over the course of three nights) showed no significant change with age. The mean was about 9.25 hours.[27] At the same time, these boys and girls were more likely to waken spontaneously at younger (prepubertal) ages than when older. Furthermore, at mid- to late puberty, adolescents began to manifest a midday augmentation of sleepiness despite similar levels of nocturnal sleep.[30] These findings indicate that sleep need does not decline with age across this span.

As with many other health behaviors, achieving changes in sleep habits can be difficult and requires diligence by clinicians, parents, and the child or adolescent. Children and adolescents may resist change because they perceive their social, work, and school schedules as inflexible. Behavioral contracts can be successful if clear consequences for both success and failure are outlined. This approach is essential when daytime sleepiness affects school performance or social functioning.

Obstructive Sleep Apnea

Obstructive sleep apnea syndrome (OSAS) is part of the spectrum of sleep-disordered breathing that also includes primary snoring (snoring without respiratory compromise) and upper airway resistance syndrome (usually in children due to adenotonsillar hypertrophy).[43, 66] During sleep, increased upper airway resistance and the inability to maintain airway patency leads to a pattern of repeated partial (hypopnea) or complete (apnea) cessation of airflow. These obstructive events result in two major consequences: repeated episodes of hypoxia and hypercapnia; and frequent arousals from sleep, leading to sleep fragmentation and subsequent behavioral and neurocognitive evidence of sleep disruption. Common symptomatology in children includes loud, disruptive, chronic snoring, breathing pauses, snorting or gasping respirations, mouth breathing, restless sleep, sleeping in unusual positions, and excessive sweating during sleep. There may be a history of chronic problems with tonsils and adenoids, or ear infections. Impact on daytime functioning may present as excessive sleepiness or excessive activity.

The prevalence of OSAS is estimated at 1% to 3%, and the peak age for development of symptoms is 2 to 6 years. There also appears to be an increased risk of OSAS in early to midadolescence that more closely resembles adult OSAS in clinical presentation and in its frequent association with obesity. Many children with OSAS have a positive family history of sleep-disordered breathing. Children at particularly high risk for sleep apnea include those with maxillofacial abnormalities, micrognathia, a history of cleft palate, neuromuscular disease or hypotonia, and Down syndrome. Children who are morbidly obese (greater than 150% ideal body weight), including those with Prader-Willi syndrome, are also at increased risk for OSAS.[95]

Sleep apnea in children can be difficult to diagnose based on clinical history. The degree of adenotonsillar hypertrophy does not necessarily correlate with clinical symptomatology or severity of apnea as defined by polysomnographic variables, including the apnea-hypopnea index (number of breath stoppages or partial obstructions per hour of sleep), and symptomatology also may not be predictive of OSAS. Numerous studies have attempted to develop predictive

models of OSAS in children based on symptomatology, but all have had little success.[26, 110, 134, 158] Therefore, overnight polysomnography is considered to be the "gold standard" in the diagnosis of OSAS in children and adolescents.

Severe OSAS can result in pulmonary hypertension, right heart failure, and cor pulmonale, as well as growth failure and systemic hypertension. Milder OSAS may simply result in frequent brief arousals from sleep, which enable the airway to open and breathing to resume. These frequent arousals, of which both parents and children may be unaware, can lead to significant daytime sleepiness and consequently a host of internalizing and externalizing behavior problems and academic difficulties, including irritability, aggressiveness, distractibility, inattention, and hyperactivity.

The most common treatment of pediatric OSAS is tonsillectomy or adenoidectomy, which relieves symptoms in about 70% of all pediatric cases.[135, 152, 164] Weight loss, if appropriate, should be strongly recommended. Furthermore, nasal continuous positive airway pressure (CPAP) is successful in the treatment of obstructive sleep apnea in adults, and is being used more frequently as a treatment for some children with sleep apnea, especially those in whom a surgical intervention is inappropriate or only partially successful. The utility of other treatment modalities used for OSAS in adults, such as dental devices and uvulopalatopharyngoplasty (UPPP), has not been well studied in children.

Narcolepsy

Narcolepsy is a chronic disorder characterized by excessive sleepiness, often presenting as repeated episodes of naps or lapses into sleep of short duration throughout the day.[43, 64, 65, 106] The classic symptoms of narcolepsy include excessive daytime sleepiness, cataplexy (the sudden loss of muscle tone following a strong emotion), sleep paralysis, and hypnogogic hallucinations. All individuals with narcolepsy experience excessive daytime sleepiness, with some or all of the other symptoms. Cataplexy, a pathognomonic symptom of narcolepsy, is triggered by a strong emotion, such as laughter, anger, or fear, and results in loss of bilateral muscle tone. It can be as mild as a feeling of weakness in the knees or as dramatic as falling to the floor and being unable to move. Episodes of cataplexy last from a few seconds to a few minutes, with complete recovery. Obtaining a history of cataplexy and other symptoms consistent with narcolepsy can be difficult, especially in children and adolescents.

Narcolepsy is not rare, with an incidence of approximately 1 in 10,000. The typical age of onset is late adolescence or early adulthood, although documented cases have been found in prepubertal children.[41, 84] The emergence of symptoms of narcolepsy in children and adolescents can occur in any combination, with some experiencing such symptoms as hypnogogic hallucinations prior to the onset of daytime sleepiness. Diagnosis of narcolepsy requires overnight PSG, which usually includes a MSLT. Early-onset REM periods at bedtime and during naps, fragmented nighttime sleep, and objective documentation of excessive daytime sleepiness are all characteristics of narcolepsy. Repeat studies in younger individuals are often required.

Narcolepsy is a neurologic disorder with a strong genetic predisposition. Most identified cases of narcolepsy have HLA-DR2 antigen. It is important to note, however, that the prevalence of narcolepsy is much less than the prevalence of this HLA marker (0.05% compared with 35%). A family history of narcolepsy and excessive sleepiness can be helpful in confirming a diagnosis, although it is not found in many cases.

Treatment of narcolepsy includes education about the disorder for the child

or adolescent and the family, adherence to a regular schedule that allows the child to obtain optimal sleep with good sleep habits (often including scheduled naps), use of short-acting stimulant medication for treatment of daytime sleepiness, and use of REM-suppressant medications (such as protriptyline) for symptoms of cataplexy. Unfortunately, no controlled treatment trials have focused on children or adolescents with narcolepsy, thus more research is needed.

Idiopathic Hypersomnolence

A small percentage of children and adolescents have significantly increased sleep needs without evidence of the REM sleep abnormalities seen in narcolepsy, a condition called hypersomnolence. Most individuals with idiopathic hypersomnolence nap daily for 1 to 2 hours, but in contrast to narcoleptics do not find short naps refreshing. Idiopathic hypersomnolence often occurs with a family history of excessive sleep needs. Adolescents with an idiopathic hypersomnolence may sleep 12 hours each night and still show clear objective sleepiness in MSLT studies. Polysomnography and MSLT studies are necessary to differentiate idiopathic hypersomnolence from narcolepsy. Furthermore, a psychiatric evaluation should be conducted, as depression can be a cause. These disorders also are treated frequently with planned naps and stimulant medication. Family education is important because idiopathic hypersomnolence can have significant effects on daytime functioning. Teacher education is also essential, as hypersomnolent adolescents are often considered a problem in school, with many labeled as "lazy" or "belligerent." Academic performance and social functioning can be greatly affected by idiopathic hypersomnolence.

Kleine-Levin Syndrome

Kleine[83] and Levin[87] first described symptoms of hypersomnolence, hypersexuality, and compulsive overeating in a group of adolescent boys. In addition, mental disturbances, including irritability, confusion, and occasional auditory or visual hallucinations, have been reported. This syndrome (with more than 100 published cases) occurs three times more frequently in boys than in girls.[16] Symptoms typically begin during adolescence, either gradually or abruptly. In about half the cases the onset follows a flu-like illness or injury with loss of consciousness. Frequently, there is an episodic nature to the symptoms, with symptoms lasting 12 hours to 3 weeks and recurring at intervals of weeks to months. The syndrome usually resolves spontaneously during late adolescence or early adulthood.

Laboratory tests, imaging studies, EEGs, and endocrine measures do not appear to be helpful in making the specific diagnosis of Kleine-Levin syndrome. Differential diagnosis in these cases includes organic causes, such as a hypothalamic tumor, localized CNS infection, or vascular accident. The presence of neurologic signs, evidence of increased CNS pressure, abnormalities in temperature regulation, abnormalities in water regulation, or other endocrine abnormalities also point to an organically based problem. Bipolar illness should also be considered if there is a family history of bipolar illness or other signs suggesting early-onset bipolar disorder. Stimulant medications, such as amphetamines, methylphenidate, or pemoline, have been reported to be helpful in individual cases, but typically only for brief periods of a few hours at most. Lithium carbonate also may be used preventatively.

Restless Legs Syndrome and Periodic Limb Movement Disorder

Restless legs syndrome (RLS) is a sleep disorder that manifests itself as uncomfortable sensations in the legs (dysesthesias), with the urge to move the legs. The sensations are worse when inactive and typically are aggravated during the evening or night, with some temporary relief with activity. Adults commonly shake their legs, pace, or "bicycle" their legs. Children, however, may jump or run. Periodic limb movements in sleep (PLMS) typically accompany RLS. These brief repetitive jerks, lasting an average of 2 seconds, typically occur every 5 to 90 seconds during stages 1 and 2 of sleep. When PLMS are accompanied by symptomatic sleep disturbances, the disorder is referred to as *periodic limb movement disorder* (PLMD). Periodic limb movement disorder can occur with or without RLS.

Little has been reported on PLMD and RLS in children and adolescents, but both are disorders that are being recognized more in these populations. Parents often describe their child as constantly fidgeting while awake, whereas others describe RLS as "growing pains." Picchietti and Walters[119] reported on five children with diagnosed RLS. All five children had chronic sleep-onset problems and three of the five had sleep maintenance problems. Restless sleep was commonly reported, and no child was described to have daytime sleepiness, although most "looked tired." The authors noted that these children had both insufficient quantity of sleep (averaged 72 minutes less nighttime sleep) and disturbed sleep quality. Treatment resulted in significant improvement in both sleep quantity and quality, and in improved daytime behavior.

Treatment for RLS and PLMD is typically multifaceted, including establishment of a rigid sleep schedule and use of behavioral management for appropriate sleep behaviors. Caffeine restriction is important, because children and adolescents with RLS may be sensitive to caffeine's effect on sleep. Medication also may be necessary. Clonidine can be an effective agent. Dopamine antagonists, such as levodopa-carbidopa, have been successful with adults, but little is known about their use in children and adolescents.

Delayed Sleep Phase Syndrome

Adolescents often stay up late at night. Delayed sleep phase syndrome (DSPS), however, differs from this developmental trend because it involves a very large and intractable shift in sleep-wake schedule. Delayed sleep phase syndrome may occur at any age, but is most common in adolescents and young adults. It begins with a tendency to stay up late at night, to sleep late in the morning, or to take a late afternoon nap, especially on weekends, holidays, or summer vacations. The pattern becomes problematic when it interferes with waking in the mornings for school or work. Entrainment to the 24-hour day is evident in DSPS. Thus, the timing is consistent from day to day—consistently late.

Adolescents with DSPS may complain of sleep-onset insomnia and extreme difficulty waking in the morning, even for desirable activities. To cope, many adolescents with DSPS take lengthy afternoon naps or catch up with extended and delayed sleep on weekends and days off. With DSPS, even highly motivated adolescents are unable to shift their sleep back to an earlier time without assistance. Their attempts may even run counter to the process, leading to appropriate phase resynchronization. The prevalence of DSPS is approximately 7% for adolescents, and although rare, it can also be found in prepubescent children.

Treatment for DSPS involves shifting circadian rhythms so that sleep occurs at the desirable time. Two methods are possible. The first is to shift bedtimes and waketimes earlier by 15 minutes a day, beginning with the time that the adolescent usually goes to bed without difficulty. The second method, called *chronotherapy,* is used for more difficult cases and involves delaying bedtime and wake time by 2 to 3 hours daily. Thus, if an adolescent usually goes to bed at 4:00 AM, on the first day of treatment bedtime is scheduled for 7:00 AM, the second day 10:00 AM, and so forth until the desired time is achieved. In addition to the change in sleeptimes, a reorganization of all sleep habits is necessary, including such things as developing positive sleep routines and avoiding caffeine. Adolescents typically do well during the first phase of this treatment, as they often perceive initially that they are being allowed to stay up later each day; with sufficient motivation it does not require parental input, the patients are usually tired at the scheduled sleep time, and they receive positive attention for their successes. With either method, naps must be avoided and the adolescent must maintain a consistent sleep schedule both on weekdays and weekends. Additionally, exposure to bright light on waking is beneficial. To both achieve success and maintain changes, a highly motivated adolescent is required. The more difficult aspect of treatment is the maintenance of the new sleep schedule. All it takes is one weekend or vacation in which old habits are resumed to undo all achievements. Behavioral contracts often are necessary and psychological and family issues may need to be addressed if resistance to change is encountered, as is experienced frequently. Once the new schedule is firmly entrenched an occasional late night is permitted, but the adolescent should not sleep more than 1 or 2 hours later than his or her usual weekday wake time.

Achieving success in realigning an adolescent's sleep schedule can be difficult. As mentioned previously, it requires a great deal of motivation and the support of a stable home environment. Issues such as the motivation of the child or adolescent, the family resources, and the existence of any psychiatric or substance abuse problems all need to be addressed before success can be expected. Sufficient motives to institute change must be explored. Similar to many other behavioral interventions, a well-developed plan is essential to achieve success.

Parasomnias

As discussed previously, parasomnias are behaviors that occur during sleep. Three such behaviors are addressed, including partial arousals, nightmares, and enuresis.

Partial Arousals

Sleepwalking, confusional arousals, and sleep terrors are all variations of partial arousals from deep sleep, usually Stages 3 and 4. As discussed previously, most children have a deep period of slow-wave sleep 1 to 3 hours after sleep onset, followed by a transition to lighter sleep, REM sleep, or a brief arousal. This transition often is accompanied by brief unusual behaviors, such as a strange movement, mumbling, or grimacing. In more dramatic cases, however, these transition episodes consist of sleeptalking, sleepwalking, confused partial arousals, or a sleep terror. Throughout the event, the child remains essentially asleep and has no memory of the event in the morning. The episodes can last from seconds to 30 minutes, with the majority lasting from 2 to 10 minutes.

These events, particularly sleep terrors, can be distressing for parents, as the child often does not recognize the parents, resists comfort, and is incoherent. In dramatic cases, children appear terrified, scream, thrash wildly, and bolt away from parents. A partial arousal event usually terminates spontaneously, with the child returning to deep sleep.

Partial arousals are quite common in children. Chronic sleepwalking occurs in approximately 1% to 6% of children, with as many as 20% of all children having had at least one such episode.[8, 151] Sleep terrors are less frequent, with estimates ranging from 1% to 6%.[22, 44, 151] The discrepancies among reported rates of partial arousals may result from the difficulty in measuring the occurrence of these events, which the children do not remember and the parents may not observe. Thus, these rates are likely to underestimate the true prevalence of these disorders.

Most partial arousals are a developmental phenomenon, with resolution as the child gets older. As delta sleep declines in adolescence, the frequency of these delta-related events decreases. Studies indicate a familial component to these sleep disturbances, with positive histories common in first- or second-degree relatives.[78] Many parents assume a psychological basis for these events, either an anxiety-provoking event or depression, but such is rarely the case.[10, 50, 153] Partial arousals can be exacerbated in a susceptible individual by environmental factors that fragment sleep, such as fever, intercurrent illness, a full bladder, and certain medications, such as lithium, prolixin, and desipramine.[82] Furthermore, sleep deprivation contributes to the occurrence of partial arousals, demonstrated by a sharp rise in their occurrence in conjunction with chaotic sleep schedules, on the nights of recovery sleep following sleep loss, or in conjunction with a change in schedule or jet lag. These episodes also may occur following stressful episodes, not as a direct result of the stressful event but indirectly from concomitant sleep loss.

Diagnosis of partial arousals can usually be made by clinical history alone. Although parents often identify sleep terrors as "nightmares," the two distinct occurrences are easily discernible (Table 1). The primary differences are that partial arousal events occur early rather than late during the night, are accompanied by confusion rather than clarity, are forgotten by the child rather than carried as a vivid memory, resolve in a quick return to deep sleep rather than prolonged awakening, and are more frequent following sleep loss. Underlying sleep disrupters that may trigger sleepwalking or sleep terrors should also be evaluated. For example, children with obstructive sleep apnea have an increased likelihood of partial arousals. These disturbances can result in sleep deprivation, increased slow-wave sleep, and more frequent arousal. Finally, these events should be differentiated from nocturnal seizures, which are characterized by stereotypic, repetitive movements occurring at any time of night (see Table 1).

Once diagnosed, treatment of partial arousals involves a number of steps. The first step is parental education about what these episodes are and what they are not. Family reassurance is one of the most important roles of the clinician. The next step is to ensure adequate safety for the child. Gates should be erected across stairs, and all windows and doors should be locked and bolted so that the child or adolescent is unable to leave the house. The third step is to evaluate the child's or adolescent's sleep schedule. Maintaining a consistent sleep schedule that includes an adequate amount of time in bed can result in significant diminution in the frequency and severity of sleepwalking or sleep terrors. Fourth, parents should be instructed not to attempt to awaken the child during an event, as this may actually exacerbate or prolong the episode. Last, other

Table 1. CHARACTERISTIC FEATURES OF NOCTURNAL SEIZURES, PARTIAL AROUSALS, AND NIGHTMARES

Parameter	Nocturnal Seizures	Partial Arousals	Nightmares
Time of night	Any time, often at sleep onset	First 1/3 of night	Mid to last 1/3 of night
Behavior	Repetitive, stereotypical, may be violent	Variable	Very little motor behavior
Level of consciousness	Unarousable	Unarousable or very confused if awakened	Fully awake
Memory of event	Amnesia	Amnesia	Vivid recall
Family history	Variable	Yes	No
Potential for injury	High	High	Low
Frequency	Rare	Common	Very common
Stage of sleep	Non-REM > REM	Deep non-REM	REM
Daytime sleepiness	Probable	Little or none	None

sleep disrupters, such as sleep-disordered breathing or other nighttime awakenings, need to be treated.

Other potential treatments for partial arousals include hypnosis, relaxation strategies, and positive reinforcement. Initial success with scheduled awakenings, which involves waking the child for a number of nights prior to the time of a usual event, has been shown.[54, 86] The use of medications, including a benzodiazepine such clonazepam or diazepam or a tricyclic antidepressant such as imipramine, may be warranted.[25, 49, 57, 121, 127] These medications significantly decrease SWA and are indicated in cases in which the events are extremely frequent, cause significant family disruption, or when the child or adolescent is a danger to himself or herself or others. When the medication is stopped, however, there often is rebound delta and an increase in partial arousals[159]; therefore weaning off medications is recommended. The efficacy of pharmacotherapy, relaxation training, hypnosis, and scheduled awakenings, however, is difficult to assess. Few randomized clinical trials have been performed, and spontaneous remission rates are unknown.

Nightmares

Nightmares are commonly experienced by children, and occur in about 10% to 50% of children between 3 and 6 years of age. They typically decrease in frequency over time, with a small percentage of children continuing to have them throughout adolescence and even into adulthood. In contrast to sleep terrors, nightmares occur during REM sleep and thus are much more likely to happen during the second half of the night. When waking from a nightmare, the child is alert and can clearly describe detailed scenes and frightening images. The child usually has difficulty going back to sleep and seeks comfort. Children will remember and talk about their nightmares the following morning. It is usually easy to distinguish nightmares from night terrors (see Table 1) in older children and adolescents, although it is more difficult in younger children who have limited verbal abilities.

The most common images during nightmares involve fears of attack, falling, or death.[79] Stressful periods and traumatic events exacerbate the occurrence of nightmares. For example, distressing or frightening events such as an automobile accident or the death of a relative are associated with increased nightmare incidence. Nightmares also are associated with posttraumatic stress disorder, and thus evaluation for this anxiety disorder should be conducted in children with frequent nightmares. Sleep deprivation also can increase the likelihood of nightmares, because vivid dreams are more common on extended nights of recovery from sleep loss. One study surprisingly found that parents' most common causal attribution for nightmares was "overtiredness," with "stress" not highly rated as a factor.[51] In addition, certain medications are associated with nightmares, including some β-blockers and antidepressants. Other medications, such as alcohol, barbiturates, and benzodiazepines, produce nightmares as withdrawal symptoms.

One aspect of treatment for nightmares is to increase total sleep time and regularize the sleep schedule for children who undergo frequent sleep deprivation. Psychotherapy can also be effective, with treatment focused on the anxiety-provoking events. Effective anxiety reduction techniques include relaxation and imagery, often combined with other behavioral strategies such as systematic desensitization,[33] response prevention,[132] or dream reorganization.[117] Dream reorganization involves systematic desensitization with coping self-statements and guided rehearsal of mastery endings to dream content. For most families, how-

ever, reassurance that nightmares are part of normal child development is all that is necessary.

Enuresis

Enuresis is diagnosed when persistent bedwetting occurs after 5 years of age. Estimates indicate that bedwetting occurs in approximately 25% of boys and 15% of girls at 6 years of age, with 8% of boys and 4% of girls continuing to be enuretic at 12 years of age.[63] The spontaneous rate of remission after 6 years of age is about 15% per year. Primary enuresis, referring to those who have had a continuous enuretic condition, comprises 70% to 90% of all enuresis cases. Secondary enuresis, in which the child has had at least 3 to 6 months of dryness, accounts for the remaining 10%–30% of all cases. Etiologic factors that contribute to enuresis include family history, maturation, and functional bladder capacity. A number of physiopathologic factors can also cause enuresis, such as urinary tract infection, bladder instability, epilepsy, and sleep apnea. In contrast, psychopathology does not contribute to enuresis, although psychological problems may result from consistent bedwetting in an older child.

Enuresis requires a multifaceted assessment. Following an interview with the child and parents, a physical examination is conducted to rule out physical anomalies. A urine culture to test for specific gravity, glucose, protein, blood, and any signs of infection is also important. A complete sleep history is necessary to rule out obstructive sleep apnea.

Most physicians treat enuresis pharmacologically. The two most common classes of medications are tricyclic antidepressants and antidiuretics. Imipramine, prescribed in doses between 25 and 75 mg taken at bedtime, is successful in controlling enuresis in up to 70% of cases when taken regularly.[5, 17] On withdrawal from the medication, however, few children stay dry. Furthermore, because of imipramine's potential cardiotoxic effects and the high relapse rate following withdrawal, it is often not recommended for long-term use.[145] Another compound that has been used with success is desmopressin (DDAVP), an analogue of the antidiurectic hormone vasopressin.[98] Approximately 70% of cases have persistent resolution of bedwetting when maintained on desmopressin, with minimal side effects. Unfortunately, it too almost always leads to relapse following discontinuation. Although desmopressin is much more expensive and has higher relapse rates than other treatments, it may be the treatment of choice when used on a short-term or as needed basis (e.g., overnight camp, staying at a friend's house).

Several behavioral treatments have high proven success rates. The most popular and effective technique is an alarm system. The original bell-and-pad system, which sounds a bell or buzzer when bedwetting occurs, was developed by Mowrer and Mowrer in 1938.[108] Many such systems now attach directly to the child's pajamas or underwear, resulting in even more immediate feedback when voiding begins. Reported success rates for this technique have been as high as 75%,[52, 55] with the best results in children over 7 years of age.[96] Relapse rates are also low, at approximately 41%, although relapse rates as low as 17% have been found with intermittent alarm schedules. The alarm has been found to be superior to imipramine, DDAVP, and other skills-based treatments.

Other treatment approaches for enuresis include bladder training,[96, 156] response prevention and contingency management,[91] hypnosis,[113] and dietary control, such as a reduction in caffeine intake.[19] A comprehensive treatment program is typically used, incorporating a number of components such as bladder-stretching exercises, visual sequencing, a nightly waking schedule, positive prac-

tice, and an alarm activated by wetness. Overall, the literature indicates that enuresis is highly amenable to behavioral treatment and should be considered a treatable disorder.

SLEEP AND MEDICAL ISSUES

Children with a variety of medical issues often have concomitant sleep problems. These sleep problems may be the result of the medical problem, may be the cause of the presenting symptomatology, or the two conditions may exacerbate each other.

Tourette's Syndrome

Tourette's syndrome is a disorder of multiple motor or vocal tics with a childhood onset. Data indicate that approximately 50% of children with Tourette's syndrome have sleep disturbances.[73, 109] In addition, this movement disorder results in movements throughout all stages of sleep. Thus, children and adolescents with Tourette's syndrome are at risk for parasomnias, including sleep walking and sleep terrors, and they have a higher incidence of enuresis. Treatment of Tourette's syndrome can reduce sleep disturbances. In addition, treatment with clonidine or clonazepam near bedtime can improve sleep with a decrease in EEG arousals, and behavioral interventions to increase nighttime sleep are also of utility.[38]

Respiratory Disease

Children and adolescents with respiratory diseases are at increased risk for sleep-disordered breathing. Asthma (reactive airways diseases) and cystic fibrosis (CF) are two such respiratory diseases. Asthma is a common childhood disease, and many children experience exacerbations at night during sleep. This effect is primarily related to circadian variations in lung function rather than a direct impact of sleep. The end result, however, is significant sleep disruption. Reductions in Stage 4 sleep and increased awakenings and arousals during sleep are found in children with asthma compared with controls.[77] Thus, medical treatment of asthma needs to take into account the likelihood of increased severity during sleep. A thorough sleep evaluation, with an emphasis on sleep fragmentation and symptomatology consistent with sleep-disordered breathing, is important. Medication management needs to include a plan for nighttime control of asthma symptoms. This plan should incorporate longer-acting medications for nighttime control, but ones that do not interfere with sleep itself. Theophylline is sometimes recommended as the best medication for nighttime asthma symptoms, although the propensity for significant side effects must be taken into consideration.[11] The use of prophylactic medications, however, such as Cromolyn, which have few behavioral side effects, is more common. Corticosteroids, also used frequently for asthma, may also disrupt sleep.[70] Control of environmental allergens should also be considered, as well as treatment of any other underlying sleep disrupters. Finally, children with atopic dermatitis (e.g., eczema), frequently associated with asthma, tend to have increased sleep-onset difficulty, night wakings, decreased sleep duration, and increased daytime sleep-

iness related to pruritus and treatment medications such as antihistamines and corticosteroids.[40]

Cystic fibrosis, a chronic lung disease that begins in infancy, leading to premature death, can result in nocturnal hypoxemia.[89] In addition, those with CF can have decreased sleep efficiency, increased sleep state changes, increased awakenings, and decreased REM sleep. Some of these changes in sleep may result from coughing. The development of nasal polyps that may obstruct airflow may also contribute to increased prevalence of obstructive sleep apnea. Treatments that improve physiologic functioning and sleep include supplemental oxygen during sleep, nasal CPAP, and adequate treatment of infection and coughing.

Seizures

As many as 20% to 40% of seizures occur during sleep,[23] with another significant portion present at sleep-wake transitions. Some seizure disorders, such as benign rolandic epilepsy and frontal-lobe epilepsy, usually occur during sleep. Not only do seizures commonly occur during sleep, but sleep deprivation can trigger a seizure. Furthermore, antiepileptic medications can also significantly affect sleep.[75] Whereas some anticonvulsants cause drowsiness and reduced sleep latency, other medications (e.g., felbamate, adrenocorticotropic hormone, and carbamazepine) can lead to complaints of insomnia with sleep onset and sleep maintenance problems. Phenobarbital is known to reduce sleep latency, nighttime arousals, and REM sleep, with no effect on slow-wave sleep. Restlessness also occurs during the second part of the night.

Differentiating sleep problems from epilepsy can be difficult. For example, seizure disorders are known to result in daytime sleepiness, as sleep is often disrupted by seizure activity. Thus, if a child or adolescent presents with daytime sleepiness with no apparent underlying sleep disrupter or narcolepsy, a seizure disorder should be considered. Seizures may also be difficult to differentiate from parasomnias. Table 1 provides the most common distinguishing factors between seizures and partial arousal disorders. It should also be noted that a seizure disorder cannot be diagnosed from overnight PSG; another study that includes additional EEG channels is required.

Blindness

Sleep problems are frequently experienced by children and adolescents who are blind. Sleep disturbances include difficulty falling asleep at a desired time, frequent nighttime awakenings, daytime fatigue, and frequent naps. The majority of sleep problems in the blind are attributed to circadian rhythm disturbances. Although no studies have been conducted with blind children between the ages of 5 and 18, prevalence studies have been conducted with both younger children and adults. In preschool-age children, sleep disturbances were more common in a group of blind children compared with a control group.[100] Furthermore, in a survey of blind adults, 75% reported sleep-wake disturbances.[97]

Attempts to regulate the sleep-wake cycle by maintaining a strict day-night routine have produced mixed results. Mindell et al[102] found a strict routine to be beneficial with a totally blind 2-year-old child, but attempts with older children and adults have had more limited success. Medications such as chloral hydrate or benzodiazepines can be helpful, primarily to promote sleep onset at

bedtime. Initial success has also been achieved with melatonin in this population, although the majority of studies have been conducted with adults. An important cautionary note is that the long-term effects of melatonin on children and adolescents are unknown.

Chronic Illness

Children with chronic illnesses or acute medical disturbances can also experience sleep difficulties.[45, 104, 105] For example, children with severe burns often experience nightmares.[111, 154] Several preliminary studies have addressed the issue of sleep disturbance in children with juvenile rheumatoid arthritis (JRA) and other rheumatologic conditions. These studies have documented increased arousals from sleep, leading to sleep fragmentation and daytime sleepiness in JRA,[7, 163] similar to what has been found in adults with rheumatoid arthritis.[94] The sleep disturbances and impairment in daytime functioning appeared to correlate more closely with reported pain levels than with disease activity. Chronic fatigue syndrome, which includes a variety of rheumatologic and somatic complaints in association with debilitating fatigue, has been reported in children and adolescents, as well as in adults, to be associated with a variety of sleep complaints, including insomnia, hypersomnolence, and excessive daytime sleepiness,[85] and with objective PSG findings of increased sleep onset latency and decreased sleep efficiency.[107]

Excessive daytime fatigue has been reported in children with sickle cell disease.[162] In addition, the significant medical complications of comorbid OSAS in sickle cell disease has been described in several studies.[92, 144] Hypoxemia and hypercarbia associated with OSAS in these children may lead to increased frequency and severity of vaso-occlusive crises, as well as to an increased risk of perioperative morbidity with adenotonsillectomy.[81] There is also increased morbidity as well as an increased prevalence of sleep-disordered breathing in children with a variety of neuromuscular diseases, including Duchenne's muscular dystrophy and congenital myopathies.[150] The underlying pathophysiology likely relates to a combination of extrapulmonary restrictive lung disease resulting from such associated conditions as scoliosis, from respiratory muscle weakness, and from reduced central ventilatory drive.

Hospitalization

Not only do children with chronic illnesses experience sleep problems, but so do those who are hospitalized. Hospitalized children often experience an adjustment sleep disorder. Hospitals, and all that goes with a hospitalization, can be a major disrupter of sleep, and not surprisingly hospitalized children often develop sleep problems.[13, 125, 160] Hospitalization also may exacerbate preexisting sleep difficulties.[9] Hagemann[68] found that hospitalized children, 3 to 8 years of age, lose up to 25% of their normal sleep time because of difficulties falling asleep and delays in sleep onset. Methods to help hospitalized children get more sleep include instructing the nursing staff to institute structured bedtimes for the children and to modify the hospital environment (e.g., dimmed lights, reduced noise, television off) to reduce sleep interference. Surprisingly, several studies have found that parental presence and reminders of home can

lead to greater difficulty falling asleep.[161] Mild sedatives also may be useful for hospitalized children experiencing sleep problems.[14]

Medications

Though less well documented in children than in adults, many psychiatric medications have been shown to have significant effects on sleep, most often insomnia or daytime sedation. Table 2 lists sleep disturbances commonly associated with psychotropic medications that are frequently used in children and adolescents. The distinction between sleep disturbances related to the underlying psychiatric disorder and those secondary to the medication used to treat the disorder is not always clear, however. For example, the prolonged sleep onset latency frequently described by parents of children with ADHD may be, in some children, part of the ADHD syndrome itself, rather than the effect of psychostimulant-induced arousal or rebound resulting from withdrawal of a psychostimulant.[2, 12]

Some of the psychotropic medications listed in Table 2 have actually been used to treat sleep disorders in children, for example, antihistamines and benzodiazepines used for sleep induction in insomnia.[35] Trimeprazine has been used on a short-term basis in conjunction with behavioral techniques in several studies for both sleep-onset delay[53] and night waking[149] in infants and young children. The rationale for use in sleep-onset delay is the attenuation of the extinction-burst crying often occurring at the beginning of a behavioral treatment program.[53] Chloral hydrate, a commonly used drug for sedating children prior to diagnostic procedures, is occasionally prescribed by pediatricians for children with severe sleep-onset delay; however, reports of possible risks of hepatotoxicity and respiratory complications in the setting of comorbid sleep-disordered breathing[15] raises concerns about the safety of this policy. Clonidine has been used successfully for ADHD-associated sleep disturbances[124] owing to its highly sedating effect and reduction of ADHD symptoms, but concerns about the safety of clonidine-psychostimulant combinations have been raised.[122] In general, the use of hypnotics and sedatives to treat sleep disturbances in children is problematic and should be discouraged. Potential concerns include the development of tolerance to sedating effects, paradoxic reactions, issues of dependence and withdrawal, and lack of information about long-term side effects. At best, these medications should be used as an adjunct to, and not in lieu of, behavioral techniques.

Finally, the recent upsurge in interest in melatonin as a treatment for conditions ranging from insomnia and jet lag to aging has led to its increased unsupervised use in children and adolescents.[31] Although melatonin has been successfully used for circadian rhythm disorders in blind and severely neurologically impaired children,[118] its use as a preventative treatment for jet lag and for sleep induction in children has not been well studied. Possible interaction with other drugs, impure preparations, and the possibility that sudden withdrawal could trigger the onset of precocious puberty in light of melatonin's effects on the reproduction axis[32] are just some of the cautionary notes that should be attached to the use of melatonin for sleep disturbances.

Not only do prescription medications affect sleep, but so do other types of drugs. Alcohol, which often facilitates sleep onset, can lead to decreased REM sleep and sleep disruption. Withdrawal from stimulants, alcohol, and marijuana can lead to severe, although short-lived, sleep disturbances. Caffeine, which

Table 2. SLEEP DISTURBANCES ASSOCIATED WITH PSYCHOTROPIC MEDICATIONS

Medication	Sleep Effects	Comments
Psychostimulants		
Methylphenidate	↑ Sleep onset latency	Tolerance to sleep effects may increase over time; pemoline has the least effect on sleep
Dextroamphetamine	↑ REM latency	
Pemoline	↓ TST, ↑ REM	
Heterocyclic antidepressants		
Amitriptyline	Daytime sedation	Listed most to least sedating[136]
Imipramine	REM supression	
Doxepin	↑ Stage 2 sleep	
Nortriptyline		
Desipramine		
Selective serotonin-reuptake inhibitors		
Paroxetine	Daytime sedation[130,142]	Paroxetine most activating
Fluvoxamine	Middle insomnia	
Fluoxetine	↓ TST, ↓ SE	
Sertraline	↓ REM	
Other antidepressants/mood stabilizers		
Venlafaxine	Daytime sedation[114]	
	Insomnia	
Trazadone	Daytime sedation	
	↑ REM, ↑ SWS	
Bupropion	Insomnia	
Monoamine oxidase inhibitors	Insomnia	
	↓ REM	
Lithium	Daytime sedation	
	REM suppression	
	↑ TST	
α-Agonists		
Clonidine	Daytime sedation	10% of children discontinue due to sedation side effects
	Nightmares	
	Midsleep awakenings	Sedation may improve after 2–4 weeks
		Sedation often worse in afternoon[72]
Guanfacine		Guanfacine less sedating[36]
		Transdermal patch form of clonidine may be less sedating
Neuroleptics	Daytime sedation	Low-potency agents (chlorpromazine, thorydazine)[155] most sedating, moderate potency (perphenzaine) intermediate; high-potency (haloperidol) weakly sedating; haloperidol more sedating at treatment initiation
	↑ TST	
	↓ Sleep onset latency	
Anxiolytics		
Benzodiazepines	High-level daytime sedation	Used to treat Stage IV arousal disorders (night terrors, sleep walking)

Table 2. SLEEP DISTURBANCES ASSOCIATED WITH PSYCHOTROPIC MEDICATIONS *Continued*

Medication	Sleep Effects	Comments
Antihistamines	High-level daytime sedation	May develop tolerance; may have paradoxic excitatory effect
β-Blockers	Daytime fatigue Insomnia ↑ Nightmares	
Buspirone	Daytime sedation Sleepwalking, nightmares reported[147]	30% less sedating than benzodiazepines

TST = Total sleep time; SE = Sleep Efficiency; SWS = Slow-wave sleep

people often use to counteract daytime sleepiness, can cause difficulties falling asleep.

SLEEP AND PSYCHIATRIC ISSUES

As in adults, sleep disturbances and psychiatric disorders show complex relationships in children and adolescents.[38] One reason for this complexity is the bidirectional nature of the relationship. That is, sleep disruption is strongly associated with emotional and behavioral problems, and many psychiatric problems are associated with sleep disturbances. Four psychiatric issues are addressed, including depression, stress, anxiety disorders, and ADHD.

Depression

Reports of sleep disturbances are extremely common in children and adolescents with depression. One study found that 75% of children and adolescents with major depressive disorder (MDD) reported insomnia, with 30% describing severe insomnia.[137] In addition, about 25% of the depressed adolescents complained of hypersomnia. Many of these complaints, however, appear to be subjective in nature, with limited objective supporting evidence. One study indicated that although a group of depressed adolescents took 30 minutes to fall asleep in comparison with 15 minutes in a group of controls, 30% of the depressed adolescents reported sleep-onset durations of greater than 30 minutes. In addition to the impact of MDD on sleep, symptoms of depression can be linked to lack of sleep. That is, feelings of fatigue, irritability, and sluggishness may simply be the result of sleep deprivation.

It is essential in these cases to treat both the mood disorder and the sleep disturbance. Regularization of the sleep-wake cycle in some children and adolescents will lead to improvements in mood and decreases in depressive symptomatology. Additionally, treatment of depression is likely to improve sleep, both objectively and subjectively.

Stress and Anxiety Disorders

Stressful and traumatic experiences can have significant effects on the sleep-wake cycle.[138] Such experiences can run the gamut from war and natural disasters to such common events as changes in school or separation from siblings or parents.[48, 93] Concomitant sleep problems have been documented as they relate to a number of these stressors. For example, sleep disturbances are frequently experienced by children and adolescents following abuse, especially sexual abuse.[58, 131, 139, 140] Following both the San Francisco Bay area earthquake and the Hurricane Hugo disaster, refusal to go to bed or sleep alone were the most frequent symptoms reported by parents.[157] Nightmares are also common after natural disasters, although more so in younger children.

Conflicting prevalence data have been reported regarding sleep problems in children exposed to war and terrorist activities. One study investigating the aftermath of an event in which 86 children were held hostage, with 22 killed and 60 injured during a release operation, found that 75% of survivors suffered from persistent nightmares and insomnia.[126] In contrast, another study reported fewer bad dreams and longer sleep times in children living in an area subject to intermittent terrorist activities compared with those living in safe areas.[133] It has been proposed by Sadeh[138] that in these types of situations the actual proximity or level of exposure to the disaster may be the important issue. Furthermore, the lack of sleep problems during long-term stressful events, such as living in a war zone, may be the result from habituation or the development of successful coping strategies.

As mentioned previously, life events may not need to be as dramatic as sexual abuse or war to result in sleep problems. For example, sleep problems can be seen in toddlers on graduating to a new class in preschool.[48] Stress reactions may not only result in nightmares and insomnia, but also in bruxism, grinding, or clenching teeth during sleep. Although there is little direct evidence for an underlying psychological disorder, bruxism often increases during times of stress, such as the night prior to a major test or during problems with friends.[56]

Not only may stress result in sleep disturbances, but anxiety disorders may also contribute to sleep problems in children and adolescents. Posttraumatic stress disorder, as discussed previously, has been associated with a variety of sleep problems, including recurrent nightmares, difficulty falling asleep, and fragmented night sleep.[138] Another anxiety-related problem that affects sleep is nighttime fears. Fear of the dark is a normal, developmental occurrence in young children, and can significantly affect a child's ability to fall asleep. Many such sleep-disrupting fears are learned through simple conditioning.[71] For example, the bedroom may be a source of anxiety for some children, especially if the bedroom is the place where the child is sent as punishment. Also, if the child has a nightmare or awakens distressed in the middle of the night, a parent typically comes into the room and turns on the light. Thus, a child may associate light with comfort and darkness with distress or nightmares.

Several studies have successfully treated nighttime fears in children using cognitive-behavioral techniques, by incorporating relaxation training, self-monitoring of nighttime behavior, verbal self-control training, and positive reinforcement to decrease severe nighttime fears.[60, 61] Ollendick et al[112] found that reinforcement for engaging in appropriate nighttime behavior and self-control procedures were successful in reducing nighttime fears in two children. In their study, they found that the most important component of treatment was contingent reinforcement. Although most children will outgrow their fears, in severe cases psychological treatments are effective.

It is important to understand that some sleep problems that appear to be anxiety-related are not. Particularly in the case of sleep terrors or nightmares, just because a child looks anxious does not indicate that the primary contributing factor for the sleep problem is psychological. In most cases, such sleep problems are not the result of underlying psychopathology but are physiologically or behaviorally based. A careful evaluation of the sleep problem and daytime functioning will help differentiate the contributing factors.

Attention Deficit-Hyperactivity Disorder

Many have speculated on the relationship between ADHD and sleep disturbances, particularly given the consistent parental reports of significant sleep disturbances in comparison to controls.[80] Controlled studies using objective measures of sleep, however, find few differences.[24, 62, 80] Several studies have noted, however, that sleep deprivation can exacerbate ADHD symptoms, particularly irritability, distractibility, and difficulties with focused attention.[40, 42, 67] As in the case of childhood and adolescent depression, sleep complaints in ADHD may reflect phenomena requiring better characterization of the participants and of the sleep assessment.

Specific sleep disorders may also be more prevalent in children and adolescents with ADHD. For example, children with ADHD have been reported to have high rates of RLS and PLMS.[119] Furthermore, higher prevalence rates for obstructive sleep apnea have also been found in this population.[34, 148] Following treatment of the primary sleep disorders, improvements in ADHD symptoms were observed.[67]

In evaluating a child or adolescent with ADHD, it is worth considering sleep issues as an underlying disrupter of daytime functioning, as well as potentially exacerbating daytime behavior. Thus, increasing or improving nighttime sleep may help in the management of daytime symptoms of ADHD.

SUMMARY

In sum, sleep disorders are common problems for children and adolescents, with estimates indicating that approximately 20% to 25% of the pediatric population experiences some type of sleep disturbance. Furthermore, clinicians should be aware that sleep disturbances may not only exist in isolation, but can be related to psychiatric or medical issues. Although much appears to be known about sleep disorders in the pediatric population, our knowledge of this area is still in its infancy. Additional research is still needed to investigate differences in clinical presentation of specific sleep disturbances among different age groups (i.e., children, adolescents, adults, and elderly), to develop the most appropriate treatments for given populations, and to study the effects of sleep disturbances on functioning.

Given the prevalence of these problems in the child and adolescent population and its likely impact on cognitive and behavioral functioning, health professionals need to become increasingly aware of and knowledgeable about sleep and sleep disorders. We all spend about one third of our lives sleeping, or trying to sleep; thus, we should understand as much as we can about it.

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