Sleep disorders in children
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Purpose of review
Childhood sleep disorders are one of the most prevalent complaints in the pediatrician’s office. Infant sleep rhythm complaints from new mothers reach 46%, while childhood obstructive sleep apnea has a prevalence of 2% and adolescent insomnia with daily consequences surpasses that percentage.

Recent findings
Each sleep disorder must be considered in context of age, as age influences the presentation and impact on the developing child or adolescent. For example, sleep-disordered breathing resulting in adult sleepiness can contribute to death in infants. The symptoms of narcolepsy are often masked until after adolescence, resulting in psychologically costly misdiagnoses.

Summary
There are no outcome studies that track the long-term consequences of pediatric sleep disorders or their contribution to adult sleep problems, but this is an area of increasing research interest. This review assesses the most recent literature on pediatric sleep disorders from May 1, 2002, until April 30, 2003.

Keywords
obstructive sleep apnea, sudden infant death syndrome, pediatric sleep disorders

Introduction
Infant sleep disorders
Infant sleep-disordered breathing
There are more than 80 ICD-9 classified sleep disorders, and scores of causes for both sleepiness and insomnia. Figure 1 illustrates the enormous variety of intrinsic and extrinsic factors that influence sleep disorder presentations on the developing child. Infant sleep is influenced by gestational age, environment, and parenting skills. Add to that the unique anatomy of an infant [1,2] combined with an immature nervous system [3], and infant sleep develops into a separate science in sleep medicine.

Unlike apnea at other stages of development, sleep-disordered breathing in the infant presents a unique threat to life. Apnea of prematurity, infant apnea, and sudden infant death syndrome (SIDS) are all examples of disordered breathing or possibly disordered arousal during sleep. Extensive diagnostic evaluations of infant apnea and 30 years of apnea monitor use did not change the incidence of SIDS. New guidelines on infant apnea management and monitor use are but partially based on evidence [4] underscoring the lack of mechanistic knowledge regarding vulnerability in these infants.

Sudden infant death syndrome
In the past decade, attention to epidemiological evidence caused the first worldwide decline in the incidence of SIDS [5,6]. Efforts aimed at reducing modifiable risk factors related to SIDS, notably the prone sleeping position, over-bundling, and smoke exposure reduced the SIDS incidence by more than 60% in most parts of the world. Attention to the “new epidemiology” of SIDS cases has now demonstrated a similar risk profile for infants dying unexpectedly but of known causes such as medical disorders [7], with chaotic home environments and parental unemployment increasing the risk.

Sudden infant death syndrome is not a disease, but a symptom or outcome of an underlying problem. As SIDS victims decline, there is renewed focus on what is still killing the vulnerable infant, with both environmental and intrinsic mechanisms suggested. An apparent increase in the incidence of infanticide [8] merely reflects its growing percentage in contrast to the declining post-neonatal deaths. While the possibility of child abuse should no longer be ignored in infant death [9], investigation of the death scene, or more importantly, the sleep
environment, is key to understanding what makes a child vulnerable and perhaps more importantly, what keeps a child alive [10]. Mechanistic studies focusing on the known risk factors have shown that infants sleeping in the prone position re-breathe exhaled gas or have oxygenation problems and decreased arousal [11–13], or a more collapsible pharynx [14], risking obstruction. Genetic alterations in the brainstem [15], cell function [16], or cytokine profile [17] may cause vulnerability in some infants. Cigarette smoke and its apparent causal relation to SIDS has been an area of intense study [18] with evidence for decreased arousal in smoke-exposed infants [19,20].

There is a recent proposal for a new pathologic definition of SIDS [21]. The term “sudden infant death syndrome” is an exclusionary term when a cause for death cannot be found. According to Dr. Beckwith, this term has been used too liberally, allowing deaths to be labeled SIDS when in fact no autopsy or death scene investigation was performed. Other pediatric pathologists agree that it is time for a new definition [22,23], using lessons learned from epidemiological evidence, and also allowing for advances in cell and molecular biology to aid in research.

Infant sleep-onset association disorder
Although not life threatening, infant sleep rhythms affect infant and maternal well being. In a well-designed randomized controlled trial (RCT), infant sleep was reported as abnormal in 46% of visits to the pediatric clinic during the second 6 months of life. Early behavioral intervention decreased both sleep problems and maternal depression [32•]. In a separate RCT, sleep problems in infants were predicted in those infants who had a high number (>11) of feeds per day. A simple preventative behavioral program increased the number who slept through the night [33].

Sleep disorders of pre-pubescent child
Sleep-disordered breathing in childhood
The association of obstructive sleep apnea (OSA) with daytime sleepiness, obesity, hypertension, and increased cardiovascular risk in adults is recognized as a public health problem. The signs and symptoms of OSA in chil-

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**Figure 1. Long-term consequences of untreated childhood sleep problems**

There are an enormous variety of intrinsic and extrinsic factors that influence sleep disorder presentations on the developing child. These factors can influence the subsequent stages of development.
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Adenotonsillectomy has been shown to resolve respiratory disturbance [59] and symptoms [60] in 75 to 100% of otherwise healthy children, and is considered first-line therapy in children with otherwise normal craniofacial features. Continuous positive airway pressure applied nasally has become a good second-line therapy of OSA in children when adenotonsillectomy fails or is contraindicated. A study shows that a period of home acclimatization with the mask may improve acceptance [61] and other desensitization methods have been found useful in young children [62,63].

Common parasomnias

Sleep walking, talking, and night terrors are so common in children that they are often considered normal by pediatricians. As disorders of arousal, they can be induced by severe fatigue or illness. A retrospective study on a group of children referred to sleep clinic (with its obvious referral bias) suggested that many children with chronic sleep terrors should be investigated for sleep-disordered breathing. They saw an association between chronic sleep terrors and sleep disordered breathing in 61% of cases [64]. The parasomnias disappeared after surgical management of obstructive apnea.

A brief mention of other childhood sleep disorders in the literature of the past year should include a nice review on childhood rhythmic movement disorders with treatment suggestions provided by Timothy Hoban [65]. An interesting complex segregation analysis suggested an autosomal dominant gene involved in patients with restless leg syndrome.
legs syndrome in people presenting with symptoms before the age of 30 [66]. Nightmares, common before the age of 10 years, were found to be associated with trait anxiety in school-aged children [67], indicating the need to observe these children. Seizure disorders often present in childhood or adolescence and are frequent findings in the pediatric sleep lab due to the close association of certain sleep states with epilepsy. An updated review of this childhood phenomenon was provided by D. Dinner of the Cleveland Clinic Foundation [68].

Sleep disorders of adolescents

It is no wonder that adolescent medicine has branched off as a separate area of pediatrics. Not only is the obvious change in puberty a factor in disease and psychological health, but several sleep disorders, circadian preference, and changes in lifestyle all impact adolescent sleep, or the lack of it. There can be long-term consequences of untreated childhood sleep problems that affect the adolescent, as illustrated in Figure 1. A well-done longitudinal study on 490 children demonstrated that sleep problems at age 4 years predicted behavioral/emotional problems in mid-adolescence. The correlation of sleep problems with depression, anxiety, and attention problems increased with time [69].

Insomnia

Insomnia has been considered the most common sleep disorder in adolescents, with a prevalence ranging between 2.2 and 17% depending on whether the dysfunction is non-restorative sleep, sleep disruption, difficulty initiating sleep, or disturbed sleep impacting on daytime functioning [70]. Indeed, pediatricians were found to be more likely to prescribe clonidine for sleep problems than child psychiatrists (67 vs. 50%) [71]. In a prospective study of more than 4000 adolescents, insomnia was linked to impaired daytime function [70]. Insomnia was linked to current or past mental disorders in another study [72]. The obvious question, “Does insomnia cause mental disturbance and dysfunction, or the reverse?”, has not been determined. Unfortunately, the reviews [73] and longitudinal studies of the past year only underscore the questions. Whether early treatment of pediatric insomnia can disrupt its negative impact on adolescent mental health remains to be studied.

Excessive sleepiness: circadian rhythm disorder

A fascinating update on the regulation of sleepiness in adolescents was recently published by Mary Carskadon, who spearheaded a longitudinal study on adolescent sleep patterns as they change through puberty [74]. She shows MSLT and biochemical data across adolescence on circadian rhythm delays that cause conflict with forced wake-up times. The school wake-up time is close to the sleeptest circadian time point, and thus, a sleepy adolescent goes to school. In a separate review, sleepiness was linked to learning, memory, and attention problems, but the review did not always separate sleepiness caused by sleep-disordered breathing, which may cause learning problems via other mechanisms [75].

Excessive sleepiness: narcolepsy

Narcolepsy in children may present merely with excessive daytime sleepiness, without demonstrating cataplexy or other symptoms until after adolescence [76]. Children can be misdiagnosed with psychiatric disorders or labeled as lazy. Cerebrospinal fluid for hypocretin levels in addition to HLA typing and the MSLT now aids in the diagnosis [77,78].

Excessive sleepiness: Kleine-Levin syndrome

The rare Kleine-Levin syndrome typically presents in adolescents and a recent systematic investigation sheds new light on what should be considered “typical” in the presentation. There is a predominance of males, 25 males to 5 females, with a mean age of onset of 15 years. The episodes of severe hypersomnia and mood disturbance were present in all patients but variability was observed in the exact mood change, between aggressive-ness to reduced psychomotor activity. Hyperphagia was present in 57% and sexual disinhibition in 47%, so that they were not necessary to meet the criteria for diagnosis. For the first time, an association with HLA-DQB1*0201 was noted by the authors [79].

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:
* Of special interest
** Of outstanding interest

11. Patel AL, Paluszynska D, Harris KA, et al.: Occurrence and mechanisms of...


33 Important results from a randomized controlled trial of 156 mothers of infants 6 to 12 months of age demonstrate that behavioral intervention performed early in the course of sleep problem development can have impacts on child and maternal depression.


56 Very well done study demonstrating the importance of PTT as a new technology to improve accuracy on arousal scoring, with some specificity limitations described.


