Attention-Deficit/Hyperactivity Disorder

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Case Vignette: Ben

Following a comprehensive assessment through an ADHD clinic, Ben, a 10-year-old boy, was started on a long-acting stimulant for the treatment of ADHD-combined type. Even before initiating medication, he already had mild difficulties falling asleep. His routine was to play video games for 1 h before bedtime, identified as being "between 9:00 and 9:30 p.m." Parents acknowledged that Ben would "push the limit," so it was not uncommon that he would not actually be in bed until almost 10:00 p.m. He was still awake when they went to bed at 11:00 p.m. and then would fall asleep soon after. In the morning, Ben rarely woke on his own, but roused quickly when awakened at 7:00 a.m. for school.

Following initiation of stimulant medication, Ben was followed up in clinic 4 weeks later. His parents reported significant improvement in his ability to focus at home. His teacher also commented that Ben was doing well at school, and she had already noticed an improvement in some of his grades. However, Ben was complaining of having a harder time falling asleep: even after his parents went to bed, he would lie awake for another hour or two, until midnight or 1:00 a.m. His parents also noted that Ben was harder to rouse in the mornings. Because of some appetite suppression, they decided not to give his medication until after he had finished his breakfast, so he generally took his medication between 8:30 and 8:45 a.m.

The initial approach was to encourage parents to administer his medication earlier in the morning. They were given the option of giving it to him at 7:00 a.m., when they went in to wake him, or as soon as he started eating breakfast, at 7:30 am. As this particular medication should be effective for 12 h, this would ensure that any rebound effect of the medication would resolve before bedtime. In addition, Ben and his parents were encouraged to move video game use to earlier in the evening and to limit his amount of daily screen time to 60–90 min.

When reassessed 4 weeks later, Ben's family reported that giving the medication with breakfast had been effective in returning him to his previous routine, such that he was usually falling asleep by 11:00 pm. However, he continued to have difficulty waking in the morning. His parents did not view the video games as a contributing factor, so they hadn't changed this activity. The importance of healthy sleep practices was discussed with both Ben and his parents. Considering that an appropriate sleep duration for children between 6 and 12 years of age should be 10–11 h, Ben was clearly not getting enough sleep, either now or before he started medication. After brainstorming with his family about better sleep routines, Ben was agreeable to refraining from watching television, playing video games, or going on the computer after 7:00 p.m. When reassessed 6 weeks later, Ben's sleep was no longer a concern, and he was well rested and easy to rouse in the morning.

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Introduction

For many families, weekdays are packed with work, school, and extracurricular activities. Finding the right balance between all of these *and* getting adequate sleep can be difficult but is tremendously important for both children and adults. In the case above, by changing his evening habits and shifting the balance between stimulating activities and bedtime, Ben and his family remedied his sleep issues. Given that many sleep problems may be the product of busy lives or lack of knowledge regarding how much sleep is needed, it is important to educate parents and children about healthy sleep habits, as with Ben's family. Many children with ADHD have insomnia or other sleep problems, which will be discussed in this chapter. Children with ADHD are more likely to have sleep problems than their typically developing (TD) peers, and these issues can be made worse by the stimulant medications used to treat ADHD, as in Ben's case. This chapter will explore why considering sleep problems is an important part of treating and managing ADHD.

According to the DSM-5, the prevalence of ADHD is about 5% among children and 2.5% among adults, with twice as many boys as girls receiving this diagnosis [1]. ADHD can present as predominantly inattentive, predominantly hyperactive and impulsive, or if both inattentive and hyperactive/impulsive features are prominent, as combined type. The inattentive presentation manifests with symptoms such as difficulty sustaining attention at work/play, not following through on directions, disorganization, distractibility, carelessness, and forgetfulness. Features of the hyperactive/impulsive presentation include fidgeting, constant movement, excessive talking, interrupting, and running about or jumping at inappropriate times. In order to be diagnosed with ADHD, symptoms must be severe enough to interfere with everyday function and be present for at least 6 months. In addition, symptoms must be evident across more than one setting, such as both at home and in school. Symptoms must also present prior to the age of 12 years (diagnoses made in adolescence and adulthood require reflecting on childhood behavior) but are usually apparent earlier. Although symptoms may be suspected in preschool-aged children, they are often difficult to distinguish from typical behaviors for this age group. For this reason, ADHD is often first diagnosed in school-aged children [1].

Sleep problems are very common in children with ADHD, so much so that in the earlier DSM-III-R, they were used as part of the diagnostic criteria [2]. Although sleep problems were subsequently removed from the list of criteria for ADHD in DSM-IV [3], there are clear relationships between ADHD and sleep [1]. Between 25% and 75% of children with ADHD are reported to have problems with sleep [4]. In two separate studies, approximately three-quarters of parents of children with ADHD reported significant sleep problems [5, 6]. In one of those studies [6], the majority of children with sleep problems had sleep problems of moderate to severe intensity. More severe problems were related to lower daily functioning and lower quality of life scores. Additionally, more severe sleep problems were associated with more severe ADHD symptoms [6]. It is likely that this is a reciprocal relationship, in which children with more severe ADHD have more severe sleep problems as a consequence of ADHD, and inadequate sleep, in turn, makes the ADHD symptomology worse. A study found that children with ADHD, as well as controls, when sleep restricted by 1 h per night for six nights, end up displaying more attention problems on a direct measure of attention, the continuous performance task [7].

There are a number of different sleep problems that may present in children with ADHD, such as insomnia, obstructive sleep apnea, circadian rhythm sleep/wake disorders, and restless legs syndrome. While all of these sleep problems can occur in healthy children, they are more common for children with ADHD and most likely have more severe detrimental effects on daytime functioning for this population.

Evidence Base: ADHD and Sleep Problems – The Not-So-Odd Couple

"He'll sleep well tonight!" is the sort of comment that is often made when we observe a child with seemingly boundless energy – not unlike comments often made about children with ADHD, particularly those with the hyperactive/impulsive or combined subtypes. These children are described as if they are driven by a motor, and it may stand to reason that they would crash into bed at the end of the day and sleep for 10 h straight. Unfortunately, given how commonly children with ADHD suffer from sleep problems, this may not actually be the case.

As mentioned, symptoms of ADHD may contribute to the development of insomnia, while poor sleep can worsen symptoms of ADHD. Moreover, poor sleep can affect memory, attention, concentration, and emotional regulation, which can further intensify symptoms of ADHD [8]. In fact, some of the symptoms of insomnia are closely related to symptoms of ADHD. According to the DSM-5, impairment of cognitive performance, including the areas of attention, concentration, and memory, is a diagnostic feature of insomnia [1]. Cognitive performance is also affected by ADHD [1]. Additionally, physiologic arousal is considered an associated feature of insomnia, which is likewise demonstrated in the tendency of children with ADHD to fidget and have difficulty staying in their seats [1].

There is also a common etiological pathway between ADHD and some physiological sleep problems, with overlap between the neurotransmitters responsible for sleep/wake and those responsible for attention [9, 10]. Table 12.1

Table 12.1 Shared space, shared resources

	Relationship with ADHD	Relationship with sleep
Shared space		
Thalamus	Smaller regional volumes in certain areas associated with lower attentional scores	Responsible for sleep spindles and synchronization
Shared resources		
Dopamine	Management of psychomotor function and reward seeking	Role in wake
Serotonin	Role in the exploration of environment	Role in wake
GABA	Responsible for arousal reduction and emotional regulation	Role in sleep (both REM and NREM)

outlines a few of the shared pathways between ADHD-related behaviors and problems associated with sleep. For instance, the thalamus, which is responsible for sleep spindles and synchronization in sleep, may also play a role in ADHD. A study examining the morphology of the thalamus found that certain regions have a smaller volume in those with higher scores of inattention [11]. There are also some neurotransmitters that play roles in both ADHD and sleep [12–14]. Dopamine and serotonin are both factors in waking [12]. Dopamine is also related to areas of functioning impacted by ADHD, namely, psychomotor function and reward seeking [13]. Likewise, in addition to contributing to the wake state, serotonin is related to exploration of the environment [13]. It is possible that the overstimulated psychomotor functioning, excessive reward seeking, and exploration that are often symptomatic of ADHD could be related in part to dopamine and serotonin levels, which may also interfere with sleep by promoting wakefulness. Another neurotransmitter worth mentioning is GABA, which is responsible for reducing arousal and regulating emotions [13], both of which can be a struggle for children with ADHD. GABA also has a role in sleep [10]. Given the overlap in etiological pathways between ADHD and insomnia, wherein hormones and brain morphology related to sleep function are also related to symptomology of ADHD, sleep issues could potentially make ADHD treatment more complicated. However, on a positive note, this means that there is an opportunity to improve ADHD symptoms by treating the sleep problems and vice versa.

Studies have shown that problematic sleep – in particular, insomnia – is more common in children with ADHD than in TD children [15–17]. Children with ADHD are more likely to suffer from fragmented sleep, lower sleep efficiency, daytime sleepiness, bedtime resistance, prolonged sleep-onset latency, nightmares, restless sleep, nighttime awakenings, and hypersomnia [15–17]. Differences between children with ADHD and TD children in sleep are even more significant when comparing children with ADHD on stimulant medications to TD children. In fact, children with ADHD on stimulant medications had significantly more difficulty with sleep than other children with ADHD who are not on medication (e.g., in waking in the morning and restless sleep) [15]. In addition to stimulant medications, there are other factors that can make a child with ADHD more likely to have sleep problems. For instance, a comorbid disorder, such as anxiety [15], increases the likelihood of sleep problems for TD children and further compounds the already increased chances of sleep problems in children with ADHD. Furthermore, children who have the combined presentation of ADHD, with significant features of both inattention and hyperactivity/impulsivity, are more likely to have sleep problems [15]. Other possible contributors to sleep problems include comorbid medical disorders, such as asthma, and poor sleep practices [9, 18]. While poor sleep practices are not unique to families with children with ADHD, they may be more common as parents themselves may struggle with structure and limit setting given the genetic risk [1] for familial contributions to ADHD.

Assessment and Diagnosis: Things Are Not Always What They Seem

With the knowledge that sleep problems are common among children with ADHD, care must be taken to not simply dismiss any sleep issues in a child diagnosed with ADHD as being simply part of the package. Not only should the sleep problems themselves be targeted for treatment, but consideration of other potential diagnoses should be made as well. Consider the case of Jack, who was referred for an ADHD evaluation but also suffered from sleep deprivation.

Case Vignette: Jack

Jack is a 6-year-old boy who was referred for an ADHD assessment by his parents after his teacher expressed concern about Jack being very inattentive in the class setting. The school psychologist conducted a behavioral observation and noted that Jack presented as inattentive but not hyperactive or impulsive. A psychoeducational assessment found that he was meeting grade-level outcomes and had no learning disabilities. It was noted that Jack was inattentive during testing and also that he mouth breathed and constantly rubbed his eyes and nose. Further questioning of his parents revealed that he was a restless sleeper, had a chronic cough which was worse during sleep, and frequently complained of itchy eyes and nose and itchiness in the back of his throat.

After completing the comprehensive evaluation, it was found that Jack met criteria for ADHD-inattentive presentation based on both parent and teacher semi-structured diagnostic interviews. He did not reach criteria for any other mental health problems. However, he was also suspected to be sleep deprived, and in light of his significant allergy symptoms, it was recommended that he be evaluated for environmental allergies prior to having a diagnosis of ADHD formalized. Allergy testing revealed allergies to trees, grasses, dust mites, cats, and dogs, all of which he was exposed to regularly. Environmental changes and regular treatment with an antihistamine medication were successful in treating his allergy symptoms. His sleep improved and he appeared better rested. His attention span and school performance also improved. One year later, questionnaires filled out by his teacher and parents no longer supported an ADHD diagnosis.

As in Jack's case, assessment can be complicated by the overlap in symptoms and features between ADHD and sleep problems. Recall that impairment in cognitive performance, specifically *attention, concentration,* and *memory* are features of insomnia. These impairments could easily mimic or exacerbate certain symptoms of ADHD, such as difficulty sustaining *attention*, avoidance of activities requiring *sustained mental effort*, and being *forgetful* about routines. In Jack's case, allergies resulted in restless sleep, and the subsequent sleep loss led to difficulty paying attention. In this way, it appeared that ADHD was present even when it was not, and had Jack not been assessed for allergies before diagnosing ADHD, time could have been wasted treating the wrong problem, possibly using unnecessary (and potentially ineffective) medications.

It is also possible for ADHD-related behaviors to make it *appear* as if a sleep disorder is present. For example, see Fig. 12.1. Children with ADHD often struggle with school and may be prone to school avoidance. These children may resist bedtime because they associate it with having to get up for school and may also struggle to fall asleep because of school-related worries and anxieties. A combination of the sleep loss and desire to avoid school can make rousing in the morning difficult for these children, and they may then be tired throughout the day. This daytime sleepiness, in turn, could make concentration and attention even more challenging, making school more difficult, and exacerbating the entire problem [19]. In this case, the main problem is ADHD, but without fully understanding the motivations behind the child's behaviors, a sleep disorder such as insomnia or circadian rhythm disorder might be misidentified.

It is necessary to rule out primary sleep disorders on the list of differential diagnoses when conducting an ADHD assessment, as in Jack's case [20, 21]. When assessing a child's sleep, it is important to gather information about timing (i.e., going to bed, getting up), snoring, daytime behaviors, sleep refusal/resistance, and anxieties (e.g., dark, separation) [22]. A brief and easy way to administer screening measure for sleep problems in children was developed by

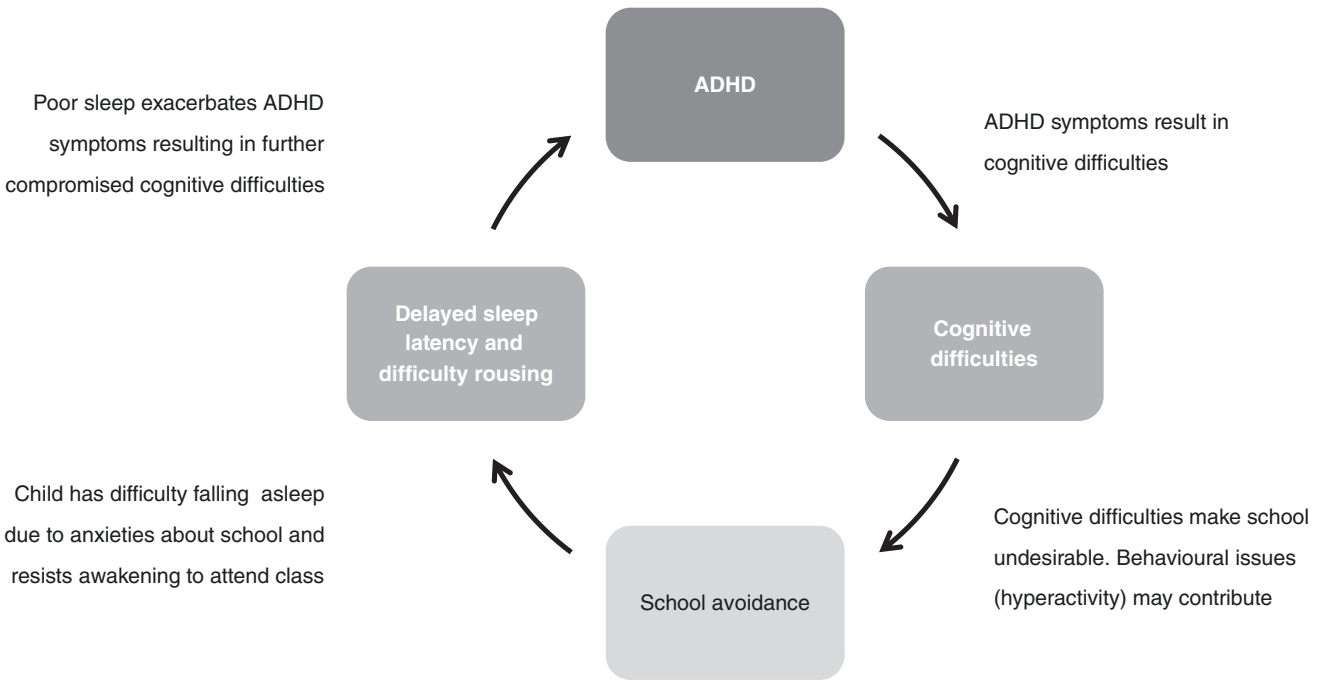

Fig. 12.1 Reciprocal influence

Owens and Dazell and is known by its mnemonic, BEARS. This screening tool involves asking both parents and school-aged children about *B*edtime problems, *E*xcessive daytime sleepiness, *A*wakenings during the night, *R*egularity of sleep/wake times and sleep length, and *S*noring and nighttime breathing [10]. If there are concerns, then sleep diaries are a good way to collect data on children's sleep, with free and downloadable versions available online. For an example, see Fig. 12.2. This specific comprehensive, child-friendly diary collects information about what activities the child did before bed, caffeine consumption, sleep-onset latency, night awakenings, sleep duration, daytime energy and wakefulness, ability to concentrate, nodding off, and naps. It also includes age-appropriate information about the importance of sleep. For any sleep diary, it is recommended that 2 weeks of sleep data be collected in order to observe patterns that may help to determine the type of sleep problem as well as to identify any predisposing, precipitating, and perpetuating factors.

While many children with ADHD have insomnia as discussed above, there are some other sleep disorders that are

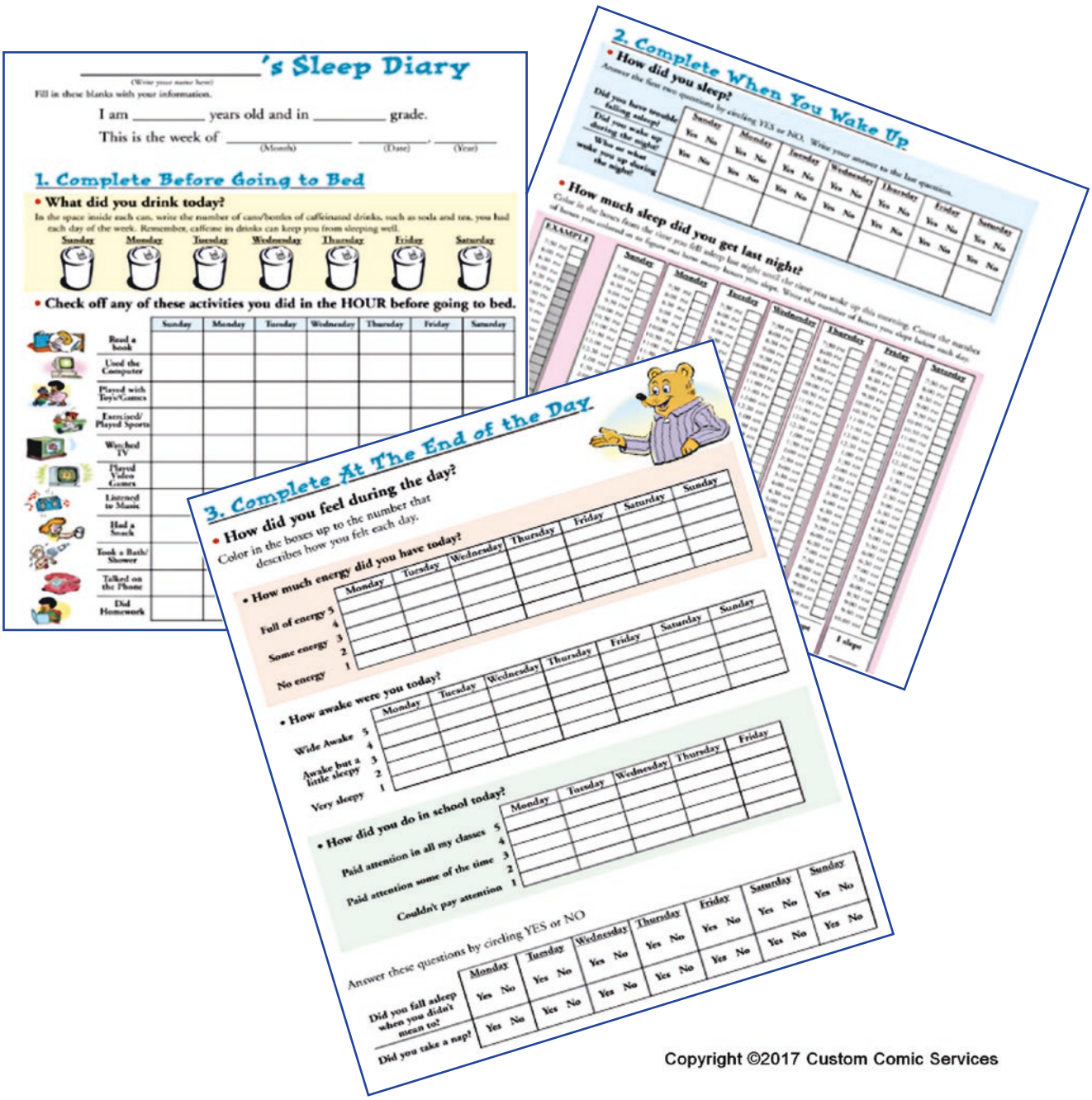

Fig. 12.2 Example sleep diary. (From SleepForKids.org. For further information, visit the National Sleep Foundation at SleepForKids.org or SleepFoundation.org)

particularly common in children with ADHD. Children with ADHD are more likely than TD children to have restless legs syndrome (RLS) and periodic limb movement disorder (PLMD) [21, 23]. RLS causes the individual to feel an urge to move their legs in periods of inactivity/rest in order to counter unpleasant sensations. RLS often results in difficulty initiating and maintaining sleep and daytime sleepiness [1]. While the prevalence of RLS in children in general is around 2% [24], nearly half of adults with ADHD also have RLS, and a quarter of adults with RLS also have ADHD [25]. It is suspected that in most adult cases, RLS has been present since childhood, although it may have been dismissed as "growing pains." Studies have shown that nearly half of children with ADHD have at least *symptoms* of RLS [26]. Thus, it is fair to assume that RLS is quite common among children with ADHD and may be a lifelong problem. The most commonly reported symptoms for children aged 8–11 with definite RLS based on diagnostic criteria are an inability to stay still, inability to get comfortable, poor/interrupted sleep, pain, inadequate sleep quantity, and difficulty rousing. The reported symptoms are similar in adolescence, only pain is less likely to be reported, while daytime sleepiness and difficulties concentrating are more common [24]. PLMD is a disorder that is closely related to RLS. Children with PLMD experience involuntary, repetitive leg movements while they sleep, resulting in disrupted sleep and possible arousals [20]. PLMD occurs in about 90% of people with RLS, so it is no surprise that PLMD also occurs in a large number of children with ADHD despite only being present in just over 1% of the general population of children [1, 27, 28].

Obstructive sleep apnea (OSA) is a sleep-related breathing disorder in which the affected individual has complete or partial obstruction of breathing during sleep [20]. As with RLS, statistics show that OSA is found more commonly among children with ADHD [1], although this needs to be interpreted with some caution, as a review of reviews concluded that while there is an increase in sleep apnea index in ADHD samples, it is present at a non-pathological level [29]. One of the main indicators of OSA is snoring. Snoring appears to be more common in children with ADHD than TD children. In fact, children with ADHD symptoms who also have OSA and are treated with adenotonsillectomy may no longer meet the criteria for ADHD at follow-up [30]. Children with OSA may also have symptoms such as daytime mouth breathing, difficulty swallowing, and poor speech articulation [1]. Also as with RLS, OSA often results in daytime sleepiness [1].

Another relevant sleep disorder for children with ADHD is circadian rhythm disorder and, in particular, delayed sleep phase syndrome. This disorder is characterized by out-of-sync sleep/wake cycles resulting in difficulty falling asleep and rousing at culturally expected times. However, if allowed to follow one's own schedule, a child with a circadian rhythm disorder could sleep for an appropriate duration [1, 18]. A study was conducted in which children with ADHD and sleep-onset problems were randomly assigned to either receive melatonin or placebo [31]. Melatonin is a supplement with soporific effects (e.g., induces sleepiness) and can also be used to help adjust the timing of the circadian clock. In the abovementioned study, approximately half of those receiving melatonin began falling asleep more than 30 min earlier, and less difficulty falling asleep was reported. Very few children reacted negatively to the melatonin (e.g., headaches, dizziness) [31]. This is evidence that, although children with ADHD may be more prone to issues with their sleep/wake cycles, these issues may be corrected with melatonin as opposed to prescription medications. (Note that the potential for melatonin to help with sleep disturbances in children with ADHD extends beyond those with circadian issues and will be further discussed in the *Insomnia Management and Treatment* section.)

If there is a clinical indication of one of the sleep disorders described above, it may be necessary to send the child for polysomnography (PSG) testing [21]. A PSG test records information on sleep stages and physiological measures (e.g., respiration) via electrophysiological measures and is useful in testing for a number of sleep disorders, including sleep disordered breathing and sleep-related movement disorders. While PSG is the gold standard for sleep assessment, there are less intrusive options for assessing some types of sleep problems. An actigraph is a movement capturing device that is worn by the child, but it does not measure respiration or EEG and, as such, cannot be used to diagnose all sleep disorders. However, actigraphs can be useful for diagnosing circadian rhythm disorders and insomnia (e.g., long sleep onset, night awakenings, early morning awakenings). Another measure is videosomnography which involves video-recording a child to assess sleep. This sleep assessment tool may be useful in assessing abnormal sleep behaviors [18].

Like insomnia, the above described sleep disorders may exacerbate ADHD symptoms and treatment of these sleep problems could make ADHD more manageable. It is also possible that other factors may make both a sleep disorder and ADHD worse. For instance, on average, children with ADHD have significantly lower serum ferritin levels than TD children, and there is a nonsignificant trend suggesting even lower levels are associated with comorbid RLS [23]. Comorbid RLS is associated with more severe ADHD symptoms, and low iron can exacerbate both ADHD and RLS symptoms [23, 32]. It is hypothesized that early iron deficiency may be related to decreased dopamine receptors [23]. As stated previously, dopamine plays a role in the sleep/wake cycle, and, thus, there is potentially a complex relationship between sleep problems, RLS, and iron deficiency and the increased risk in children with ADHD.

Because of the many ways that sleep problems and ADHD can be intertwined, it is clearly important to evaluate sleep when first assessing for ADHD and to ensure ongoing monitoring of sleep problems and changes throughout treatment for ADHD. This is important in order to minimize detrimental effects of sleep problems on ADHD symptomology and to properly address any sleep problems that may be present and interfering with treatment of ADHD.

ADHD Medication and Sleep: A Stimulating Conundrum

Stimulant medications are often used in the treatment of ADHD. It is well documented that children on stimulant medications have more sleep difficulties [15, 33–35]. Children with ADHD taking stimulant medication are also more likely to be taking medication for sleep than children with ADHD who were not taking medication for their ADHD symptoms. This relationship may be a reflection of more severe sleep problems related to more severe ADHD symptoms, or more severe sleep problems related to taking ADHD medication, and/or a parental preference for pharmacological treatments [18].

There is evidence to suggest that stimulant medications for ADHD directly interfere with sleep. An experimental study of children with ADHD, with no reported sleep difficulties, demonstrated that when taking immediate-release methylphenidate, children had later sleep onset and shorter total sleep time (TST) by approximately 57 min per night! [34]. This brought the average sleep time down to 8 h and 20 min for these children, 40 min less than the National Sleep Foundation's (NSF) recommended minimum sleep time for children of this age [34, 36]. Similar findings were reported in another study where children taking ADHD stimulant medication fell asleep significantly later and had significantly shorter TST as compared to TD controls and children with ADHD not on medication [34]. Interestingly, in a recent study, children with pre-existing sleep problems had significantly higher levels of sleep disturbance on placebo and low dose, but did not differ from children without pre-existing sleep problems on moderate to high doses of methylphenidate. In fact, a number of the children with pre-existing sleep problems no longer met the criteria of having moderate to severe sleep disturbances once on the higher dose of methylphenidate, while nearly a quarter of the children who did not have a pre-existing sleep problems went on to develop moderate to severe sleep disturbances when taking methylphenidates. Thus, it is extremely important to closely monitor the impact on sleep when starting a child on stimulant medication and to continue to monitor the impact on sleep whenever dosing is changed [37]. As shorter total sleep time alone can have a detrimental impact on performance on executive functioning tasks [38], the potential sleep loss associated with stimulant medication use can be costly. Recall the case of Ben, whose initial mild sleep problems intensified once he started a stimulant-type medication.

Due to the complications stimulant medications can present, it is prudent to consider the pros and cons of using them before prescribing or, in the case where they are already being given, whether daytime benefits outweigh the sleep difficulties that result [39]. While it has been suggested that additional dosing of a stimulant medication later in the day might serve to counter "rebound effects" assumed to be the cause of sleep problems, there is not sufficient evidence to support giving additional doses [21].

Insomnia Management and Treatment: Putting Sleep Problems to Bed

While sleep problems such as RLS and OSA may occur in children with ADHD, the most common sleep problem is insomnia, defined as difficulty getting sleep of adequate quality and/or quantity due to problems with initiating and/or maintaining sleep. In children, this can mean difficulties maintaining and/or initiating sleep *without parental presence*. The DSM-5 does not report prevalence rates of insomnia for children, citing a lack of data; however, it is stated that sleep difficulties in children are likely a product of conditioning, inconsistency, and psychological and medical factors. Insomnia is comorbid with another disorder about 50% of the time [1]. So it becomes very important to conduct assessments to determine whether the child has both ADHD and insomnia and to consider the reciprocal relationship the two share. When discussing insomnia issues in children, the terminology "behavioral insomnia of childhood" (BIC) may be used. There are three types of BIC: limit-setting type, sleep-onset association type, and combined type. In the sleep-onset association type, the child has come to rely on specific associations to fall asleep and to get back to sleep when waking. For instance, he may need his parent present in his room. In the limit-setting type, the child tends to show bedtime resistance, most often because of inconsistent bedtimes being set by parents [40].

Depending on the type of BIC the child is experiencing, different behavioral approaches would be most appropriate. For instance, for children with sleep-onset association type, the best treatment would be graduated extinction methods, in which parents gradually remove their presence (or whatever it is the child has come to associate with falling asleep). If a child has the limit-setting type of BIC, a token system in which the child gets rewarded for staying in bed and gets one pass that allows him to get up out of bed per night can be helpful [41]. Essentially any behavioral interventions aimed

at TD children can be used with children with ADHD, though they may require some individual adaptions or take longer to fully implement.

There are no approved pharmacological treatments for children with insomnia [21, 32]. However, according to a national survey of psychiatrists, one in four children between the ages of 6 and 12 with complaints of insomnia were given pharmacological treatments. The most common pharmacological treatment for children with insomnia was sedative/hypnotic medications, which comprised 45% of cases where medication was prescribed. An additional 23% of treatments included a sedating/hypnotic medication in conjunction with an existing psychotropic medication [42]. For children with ADHD in particular, the most common prescribed medications (either to treat insomnia and ADHD collectively or to target insomnia specifically) are alpha agonists, such as clonidine and guanfacine, and sedating antidepressants, such as trazodone and mirtazapine [42, 43]. An important consideration regarding pharmacological treatments is the danger in equating sedation with sleep [32]. When sleep medications are used, it is important to carefully weigh the pros and cons and to consider the impact of the sedating effect of these treatments. While sleep medication can successfully minimize the effects of poor sleep on the primary diagnosis (e.g., ADHD) and may improve daytime functioning, they commonly result in a "hangover" effect and are actually detrimental to daytime functioning [42]. In other words, while sleep medication may be given with the goal of improving daytime functioning, the resulting impact of eliciting sedation, rather than a natural sleep state, can actually worsen daytime functioning. Finding the proper balance regarding timing and dosage of medication can also be difficult, and there is scant sufficiently rigorous research examining the use of pharmaceuticals to treat insomnia in children with ADHD [32, 44]. Furthermore, in much of the research, while subjective measures of sleep demonstrate improvements when using sleep medications, more objective measures do not reflect any actual change [44]. Given all this, it seems wise that other options for treating sleep problems should trump the use of sleep medications.

Insomnia in children is often also treated with over-the-counter (OTC) medications. The most common OTC medications psychiatrists reported administering to children with insomnia and ADHD were antihistamines (such as those containing diphenhydramine) and melatonin [42, 43]. While there does not appear to be any strong evidence to support the use of antihistamines [44], a study of children with ADHD and insomnia found that 81% of participants responded to either melatonin or a combination of behavioral therapy and melatonin [21]. One explanation of how melatonin works is that it lets the brain know that it is time to slow down and rest to induce sleep onset, and when an individual's chronobiology is working effectively, it is released naturally at nighttime [45]. As children with ADHD can have delays in the timing of natural melatonin secretion, they may benefit from taking OTC melatonin before bed [10, 18, 32, 44–46]. Studies focused on children with ADHD and insomnia tended to administer doses between 3 and 6 mg, often based on child's weight [45, 46]. Commonly available melatonin preparations are often fast release, taking less than an hour to be absorbed and are usually taken approximately 20 min before bed [45, 47]. Immediate-release, sublingual forms that can be taken during night awakenings, as they are immediately absorbed, and slow-release forms that may also help with not only sleep onset but also night awakenings should be taken 1–3 h before bed [47]. However, the bulk of the research in children with ADHD has focused on the standard, fast-release melatonin, and studies are needed to examine whether the slow-release and/or sublingual forms could successfully treat night awakenings. While melatonin is a promising treatment, there are potential minor aversive effects such as dizziness, headaches, nausea, bedwetting, nightmares, and daytime drowsiness. However, these effects are uncommon and often resolve without discontinuing melatonin. In some studies, no differences were found between children taking melatonin and children taking a placebo. An increased risk for seizures in children with neurological disorders and comorbid seizure disorders has been questioned; however, more often the number of seizures remains the same or decreases. Finally, it is recommended to use melatonin with caution in children taking antihypertensive or sedative-hypnotic medications due to the potential for lowering blood pressure [46].

Currently there do not to appear to be any well-designed studies to compare and contrast behavioral and pharmacological interventions in isolation. However, given that there are no FDA-approved medications to treat insomnia in children, and that studies focusing on behavioral interventions have noted significant improvements, it seems best to use behavioral interventions as a first line of treatment [21, 22, 32, 39, 45, 48]. In cases where behavioral intervention alone is not successful or only marginally helpful, melatonin is the most supported pharmaceutical treatment. Studies have found promising results regarding the use of behavioral treatments for insomnia in children with ADHD specifically [21, 48]. One of the most common behavioral interventions for school-aged children with sleep problems is to improve upon healthy sleep practices (also known as "sleep hygiene"). This may involve addressing diet and timing of meals/snacks, amount and timing of physical activity, the bedroom environment (e.g., lighting), and the use of electronics [21]. The use of electronics may be an important intervention point for children with ADHD in particular, as demonstrated with Ben. Children with ADHD have been found to spend more time watching television and to be more likely to have a television in their bedroom [49]. Other important interventions may include focusing on positive bedtime routines: having consistent bedtimes, using quiet "winding down" activities, and ensuring positive interactions occur between child and

parent/caregiver. Children with ADHD may require clearly defined, structured schedules to help them prepare for bedtime. A posted list of the steps may be useful [21].

Regardless of the choice of behavioral treatment, it is important that it is tailored to the child's symptomology and developmental abilities [21, 39, 48]. There are also important familial considerations, such that it may be necessary to provide parents with education about healthy sleep practices. (Recall that Ben's parents did not initially believe electronics were a contributing factor to his sleep problems.) It is also important to know about family composition: for instance, if the child's parents have separated and share custody, treatment will be more successful if both homes are willing to follow the same treatment plan. Thus, it is important to gather information about family background and context. Cultural background and parent-child relationships will also come into play in tailoring the behavioral treatment [32, 49]. Many behavioral insomnia problems are contextually based in the parent-child relationship and are addressed through this relationship. It is important to understand the parents' sleep beliefs, how easily they can be modified, the potential negative impacts, and the misconceptions about sleep. Parents should be provided with good strategies for improving sleep and encouraged to implement consistent sleeping schedules [22, 48]. Sleep education for the entire family is the most important intervention [22]. Table 12.2 contains the

Table 12.2 ABCs of SLEEPING

	Core concept	Details and recommendations
A	**Age appropriate**	It is important that children go to bed and wake up at times that ensure that they receive an age-appropriate amount of sleep (see NSF guidelines: https://sleepfoundation.org/press-release/national-sleep-foundation-recommends-new-sleep-times/page/0/1). For children who have outgrown naps (which they usually do during the preschool age period), napping during the day could be an indication that they are not getting sufficient quality and/or quantity of sleep at night
B	**Bedtimes**	Having set bedtimes and wake times, as well routines in the evening and morning, is key to good sleep. It is recommended that bedtimes be no later than 9 PM across childhood
C	**Consistency**	It is very important that these bedtimes and wake times are consistent, even on weekends (i.e., no more than 30–60 min difference between weekday and weekend bedtimes and wake times)
S	**Schedule**	The child's schedule in general is important. In addition to having routines at bedtime and wake time, it is also important that they have consistency throughout their day, including the timing of homework, extracurricular activities, and so forth
L	**Location**	It is important that the child's location for sleep includes a comfortable bed; the room is quiet, dark, and cool; and the location is consistent and familiar. Also, the child's bedroom should only be used for sleeping. Children should not be sent to their bedroom for a time out. The bedroom also should not be too exciting or distracting and should be conducive to relaxation
E	**No Electronics in the bedroom or before bed**	The use of electronics, including both the timing of use and the location, should also be considered – children should not be using stimulating electronic devices (i.e., iPods, cell phones, laptops, etc.) too close to bedtime (most commonly defined as 1 h prior to going to bed), and it is recommended that these items not be placed in the bedroom
E	**Exercise and diet**	Exercise and diet are both important factors that should be considered when evaluating sleep hygiene. Physical activity during the day is important to healthy sleep, but should not be undertaken too close to bedtime (defined in the literature as anywhere from 1 to 4 h prior to bedtime). The child's day should be organized so that there is time for a cooldown period before bedtime, where he slowly comes down from his regular level of activity into a quiet, more restful state. Diet includes caffeine consumption – children should limit or totally eliminate caffeine consumption (i.e., soda) – as well as the timing of meals. Children should not be going to bed hungry, but also should not be consuming a large meal right before bedtime. A healthy balanced diet is also important to the child's sleep as well as to overall health
P	**Positivity**	Positivity surrounding sleep is also an important aspect of sleep hygiene. Parents should have a positive attitude toward sleep and the bedtime/wake time routine, and the atmosphere in the house should be positive, in order to be conducive to creating a positive mood in the child. It is important that this positive mood is relaxing and calming, rather than fun and exciting; we want the child to be winding down before bedtime. Also, tackling frustrating activities right before bed (i.e., math problems for a child who struggles with math) is not recommended, as this may interfere with the child's ability to fall asleep
I	**Independence when falling asleep**	Independence is also important. Once the child reaches an age where she is capable of settling into sleep without her parents, independence when falling asleep should be encouraged, in order to discourage dependence on someone else in order to fall asleep. For children, independence means no calling out and no getting out of bed and, for parents, no responding to their child calling out and returning the child to her room if she does get out of bed
N	**Needs met during the day**	Finally, the needs of the child should be met throughout the day. This refers to both the child's emotional needs (i.e., love, support, hugs, etc.) and basic physiological needs (i.e., thirst, hunger, etc.)
G	**All of the above equals a Great sleep!**	

ABCs of SLEEPING, a useful mnemonic for remembering the elements of healthy sleep practices and for educating parents about the importance and purpose of these practices. By focusing on concepts such as getting an age-appropriate amount of sleep, having consistent bedtimes and wake times, ensuring the bedroom is appropriately prepared for sleep (dark, comfortably cool, quiet) and free of electronics, having the child eat a healthy diet, promoting proper exercise, working to make the bedtime experience positive and independent, and attending to the ABCs of SLEEPING can help a child achieve great sleep [8, 50].

Improving sleep practices may be sufficient to improve sleep problems when stimulant medications are being given. However, if this alone is insufficient, it may be useful to consider altering the dosage, timing, and/or type of medication [19, 39]. As is demonstrated in Ben's case, both alterations to the timing of his medication and practice of healthy sleep habits were needed to fully improve his sleep issues.

Future Directions: Are There Sweet Dreams Ahead?

While children with ADHD are at increased risk for sleep problems, there are effective treatments that have been successfully implemented with this population. Continued research into treatments for sleep problems in children with ADHD will be extremely valuable. While some sleep problems common to children with ADHD such as RLS may require other treatments, education around healthy sleep habits and other such behaviorally based interventions can still be helpful. In order to reduce the barriers to access to these treatments, eHealth (web-based) interventions would be ideal.

As for pharmacological treatments for sleep problems in children with ADHD, in particular for those with insomnia, evidence base is limited for prescription medications. Iron supplements, for RLS, and melatonin for sleep rhythm and insomnia, more generally, do have empirical support. However, it would be useful to see some large-scale studies comparing behavioral interventions to these over-the-counter treatments in order to determine which treatments are superior and under which circumstances a child may be better suited to one, the other or both.

The most important message to emerge from the current knowledge base is that symptoms of poor sleep and symptoms of ADHD are so intertwined that it makes thorough assessment and evaluations extremely important in order to implement appropriate treatment plans and that behavioral interventions are the best first course of action (and may be sufficient in many cases).

Guidelines to Assessment and Treatment: Pay Attention! Stay Awake!

1. Be aware that some sleep problems may mimic ADHD symptoms. Because poor sleep has a negative impact on cognitive abilities such as memory, attention, and concentration, children who have poor sleep may appear to have issues with inattention and even hyperactivity/impulsivity associated with ADHD.
2. Be aware of the reciprocal relationship between sleep problems and ADHD. Just as poor sleep can mimic or worsen symptoms of ADHD, ADHD can lead to poorer sleep due to arousal, lower iron, difficulty following routines, etc.
3. If there is reason to believe there may be a physiological sleep disorder present, such as OSA or RLS, testing should be done in a sleep lab to rule in or out this sleep disorder. Treating these disorders when present should make ADHD treatments (*if* the child does have ADHD) more successful.
4. If the child with ADHD has trouble initiating or maintaining sleep, consider behavioral interventions and education in healthy sleep practices (see the ABCs of SLEEPING). Useful behavioral interventions include extinction, graduated extinction, and token systems with response cost.
5. If sleep problems persist even after ruling out sleep disorders such as OSA and RLS/PLMD and implementing healthy sleep practices and appropriate behavioral interventions, consider using melatonin as a sleep aid with continued behavioral intervention.
6. Sleep should be evaluated before starting any stimulant medications for the treatment of ADHD. In the case of medication-induced insomnia, consider changing dose quantity, timing, or type of medication. The daytime advantages of the medication should be weighed against the effects on sleep.

Conclusions and Recommendations: Thoughts to Sleep On

Sleep problems are a common complaint for children with ADHD. It is important to first ascertain whether the child does in fact have ADHD and whether there is a comorbid sleep disorder. Consideration of sleep disorders in the differential diagnosis of ADHD is important. In the case of insomnia, whether it is a primary diagnosis or a byproduct of ADHD, behavioral intervention is recommended as the best treatment option because it is safe and, with the proper modifications for the child's ability and symptoms, can be effective. In cases where behavior intervention and modifications

for healthier sleep practices alone are not sufficiently effective, melatonin could be considered alongside continued behavioral intervention. Again, there is scant evidence of any other approved, effective pharmaceutical treatments for sleep problems in children with ADHD. By identifying and treating sleep problems, their negative effects on ADHD symptomology can be minimized or completely eliminated. Further, having a well-rested child may help make treatments for the ADHD easier to implement and more effective.

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