Sleep in Children with Neurodevelopmental Disorders
A Focus on Insomnia in Children with ADHD and ASD

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INTRODUCTION

Sleep is important for the healthy development for all children, yet sleep problems are common, affecting approximately 20% to 30% of TD children.1 The most common sleep problems are often primarily behavioral in nature and include bedtime resistance, difficulty falling asleep, night wakings, and early morning awakenings, all of which can shorten sleep duration.2 Collectively, these behavioral problems that have an impact on sleep may be categorized as behavioral insomnia, which is the focus of this article.

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KEY POINTS

- Sleep disturbances affect between 50% and 95% of children with neurodevelopmental disorders (NDD), with behavioral insomnia the most common problem.
- Behavioral insomnia in children with NDD is associated with impairments in daytime functioning, decreased quality of life for the children, and negative effects on caregivers’ health and parenting and adds to the morbidity of NDD; thus, appropriate screening, evaluation, and management of sleep problems can have a significant impact on quality of life in these children and families.
- Behavioral interventions have been shown an effective insomnia treatment strategy in typically developing (TD) children, and there is emerging empiric evidence that they are also effective for children with NDD.
- Children with NDD may require modifications to the ways in which behavioral insomnia is typically assessed and managed.
- Currently, there are no recommended pharmacologic treatments for managing behavioral insomnia in children with NDD, although there is mounting research for the effectiveness of melatonin for treating sleep-onset problems in children with attention-deficit/hyperactivity disorder (ADHD).

KEYWORDS

- Pediatric
- Sleep
- Insomnia
- Assessment
- Treatment

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Sleep problems in children with NDD, such as autism spectrum disorders (ASD) or ADHD, are even more prevalent than in TD children. Between 50% and 95% of children with NDD meet criteria for a sleep disorder, with behavioral insomnia the most common sleep problem in this population. These high rates are extremely concerning, given that poor sleep in children with NDD has been associated with impairments in many areas of functioning, based on caregiver ratings; for example, children with ASD and sleep problems have more severe symptoms of autism and more behavior problems. Research has begun to establish that sleep problems add significantly to the morbidity of NDD and, as such, need to be adequately treated.

Behavioral insomnia is best conceptualized using a biopsychosocial framework. As highlighted in reviews by Reynolds and Malow and Owens and colleagues, there are many biologic and physiologic factors that may contribute to the development of insomnia in children with NDD, including:

- Intrinsic abnormalities in neurobiological and circadian factors (eg, dysregulation of neurotransmitter systems having an impact on sleep and wakefulness and abnormal melatonin synthesis, timing, and regulation)
- Comorbid medical conditions (eg, epilepsy; gastrointestinal reflux disease; and physical concerns that may cause pain, discomfort, or sleep disruption, such as asthma and eczema)
- Comorbid psychiatric disorders (eg, anxiety and depression)
- Medication impact on sleep and wakefulness (eg, psychotropic medications, such as stimulants, and anticonvulsants)
- Other comorbid primary sleep disorders (eg, sleep-disordered breathing; parasomnias, such as sleep terrors, sleep walking, and confusional arousals; sleep-related movement disorders, such as restless legs syndrome and periodic limb movement disorder; and circadian rhythm disturbance, including delayed sleep phase disorder and irregular sleep-wake rhythm)

These are not the only factors, however, that should be targets of intervention. Rather, it is the behavioral factors—such as, inconsistent bedtime routines and poor sleep practices—that often set the stage for insomnia in TD children and also play a significant role in the cause of sleep problems in children with NDD. In addition, some of the core symptoms of NDD (eg, hyperactivity, poor communication skills, and intellectual disability) may increase the risk of sleep problems and pose challenges for intervention. Common behavioral factors thought to contribute to insomnia in children with NDD include:

- Unhealthy sleep practices and patterns
- Hypersensitivity to environmental stimuli
- Hyperarousal/difficulty with self-regulation
- Repetitive thoughts/behaviors that interfere with settling at bedtime
- Inability to benefit from communicative/social cues about sleep

A substantial body of literature demonstrates the effectiveness of behavioral interventions in TD children with insomnia, but there is little research in children with NDD. For example, a recent review of nonpharmacologic/behavioral sleep interventions for youth with chronic health conditions, including children with NDD, such as ASD and ADHD, identified 20 studies, the majority of which were single case studies or small group pre-/postcomparisons. All studies demonstrated improvement in children’s sleep, some studies found improved parental functioning, and none indicated any negative effects of using behavioral interventions to treat sleep problems in this population.

The purpose of this article is to describe behavioral insomnia and the impact of this common sleep problem in children with NDD and their families, with a focus on children with ASD and ADHD, 2 of the most common NDD, and to outline the process of assessing and treating behavioral insomnia using behavioral interventions that are modified to address the challenges of working with this population and to accommodate the needs of children with NDD.

SLEEP PROBLEMS IN ADHD

Children with ADHD have one of the highest rates of sleep problems of all children with mental health disorders. Prevalence estimates range between 50% and 95%, depending on how sleep problems are defined and measured. ADHD has consistently been associated with sleep problems, and their presence was considered a diagnostic criterion for ADHD in an previous version of the Diagnostic and Statistical Manual of Mental Disorders. Primary sleep problems, such as sleep-disordered breathing or narcolepsy, can certainly coexist in these children but are not the most common sleep problem in this population. Rather, the most common sleep complaints that parents of children with ADHD report are problems associated with behavioral insomnia (eg, resistance to bedtime and insufficient sleep).
Research to date indicates that modifiable behavioral factors, which are amenable to treatment, play a significant role in the cause of sleep problems in this population.16 These factors include child characteristics (eg, ADHD symptoms), family variables (eg, parent knowledge of healthy sleep practices, household routines, parental mental health, family composition, and family work and school schedules), and environmental factors (eg, child’s bed/bedroom, access to television/computer, and noise level in house).

Children with ADHD and sleep problems have been found to have poorer outcomes than children with ADHD without sleep problems, including negative impact on behavior, cognitive functioning, and family functioning.18,19 This is not surprising, given that sleep restriction in TD children can result in ADHD-like behaviors (eg, inattention and short-term memory problems).20 Research has found that those children who have both ADHD and sleep problems experience increased behavioral problems19,21 and poorer cognitive functioning, especially in executive functioning skills, such as working memory and attention.22,23

SLEEP PROBLEMS IN AUTISM SPECTRUM DISORDERS

Studies have also consistently documented high rates of sleep problems in children with ASD, with prevalence rates ranging from 53% to 78%.24,25 The most common sleep problem in these children is insomnia (bedtime resistance, sleep-onset delay, and night or early morning waking).24,25 The literature suggests that a majority of children with ASD have sleep difficulties, and the co-occurrence between the two is great enough that sleep difficulties may be characteristic of the ASD phenotype.26,27 As discussed previously, there are several different neurophysiologic, medical, sleep, and psychiatric factors that can contribute to sleep problems in children with ASD.7,28,29 Although it is important to address these factors whenever possible (eg, with medication adjustments and treatment of comorbid sleep disorders, such as obstructive sleep apnea), the focus of management of insomnia is most often on those modifiable contributory intrinsic and extrinsic behavioral factors, such as unhealthy sleep habits, inadequate parental limit setting, or hypersensitivity to environmental stimuli.7,29

Sleep problems in children with ASD are associated with deficits in daytime functioning and adaptive skills as well as emotional and behavioral problems. Such daytime behavioral problems may include increased rates of overactivity,30 disruptive behaviors,31 communication difficulties,32 social problems, and difficulties with changes in routines.32 These problems can affect or interfere with daytime learning and cognitive functioning.6 Children identified as poor sleepers typically have a higher prevalence of behavioral problems than good sleepers and tend to have attentional and social interaction problems33,34 and increased anxiety.40 In younger children with ASD, poor sleep may be associated with language problems, aggression, hyperactivity, and poor adaptive functioning (eg, hygiene, toileting, and eating habits).33,34

Moreover, studies have suggested that as the severity of sleep problems increases, so does the severity of sequelae, such as behavioral problems and autism symptoms, sensory deficits, and gastrointestinal problems.35–38 In particular, sleep-onset delay and sleep duration are positively correlated with autism symptoms and autism severity, with less sleep predicting overall autism symptom scores and social deficits.6,38 Sleep-onset delay has been found the strongest predictor of communicative deficits, stereotyped behavior, and autism severity.38 Fewer hours of sleep per night and screaming during the night have been shown to predict stereotypic behavior.5

IMPACT OF CHILDREN’S SLEEP PROBLEMS ON PARENTS

Children’s sleep problems have a direct impact on their parents and families. Levels of stress are typically higher in parents of children with NDD than in parents of children with TD children.39–42 The literature suggests that parents of children with NDD report higher rates of sleep problems than do parents of TD children.13,15 Therefore, it is not surprising that parents of children with NDD and sleep problems have increased parental stress.43,44 A study examining sleep problems in children with ADHD revealed that primary caregivers of children with moderate to severe sleep problems were 3 times more likely to have elevated levels of stress and a higher risk of symptoms of depression and anxiety.19 Likewise, children’s poor sleep is a significant predictor of maternal stress for children with ASD.45

ASSESSMENT OF SLEEP PROBLEMS IN CHILDREN WITH NDD

Because of the high prevalence of sleep problems in this population, all children with NDD should be screened for sleep problems (Fig. 1).25 Screening for sleep issues should be followed by identification of associated medical comorbidities that
Fig. 1. Screening algorithm for children with NDD.

**First Appointment (timeline = 0 weeks)**
A. Determine whether child is on any medications that may interfere with sleep/cause sleep problems. Consult/refer as appropriate adjust medications so that impact on sleep is minimized (e.g., different medication or dosing schedule).
B. Obtain baseline information about child’s sleep (Parent questionnaire [e.g., CSHQ] and Sleep Diary – to be completed daily for duration of 2 weeks)

**Second Appointment (timeline = 2 weeks)**
- Review sleep diary data and questionnaire responses. Plan treatment based on this information, following these 4 steps:
  - Education: Sleep Hygiene & Bedtime Routine → Specific Strategies → Medication if needed
  - Education: Sleep Hygiene and Bedtime Routines should be adapted based on the child’s challenges (see “ABCs of Sleeping” adaptation for children with NDD). For example, visual schedules and motivational strategies may be required. Have parents implement sleep hygiene and bedtime routine changes for minimum of 2 weeks. Have parents continue to complete sleep diary.

**Third Appointment (timeline = 4 weeks)**
- Meet with parents and assess situation by reviewing the sleep diary data. Determine what progress has been made and if any specific behavioural strategies are needed beyond psycho-education, sleep hygiene, and bedtime/wake time routines. If no progress is made, or if some progress has been made but more is required, then specific behavioural interventions should be incorporated. We suggest including/using:

**Fourth Appointment (timeline = 6 weeks)**
- Has child’s behavioural insomnia resolved?
  - Yes: Evaluate/treat medical comorbidities
  - No: Try to determine why treatment is not working.
    - Have parents successfully been able to implement behavioural strategies? If not, why not?
    - Have parents successfully implemented strategies, but child is not responding?
      - A. If strategies are not working, consider using different behaviour strategies [e.g., if child/family’s level of impairment is low-medium].
      - B. If strategies are not working and impairment is medium to high, consider recommending use of pharmacological treatment (e.g., supplement melatonin) in conjunction with behavioural strategy.
      - C. If strategies are not working and impairment is high or problems appear to be more complex than parents can handle independently, refer to a sleep specialist

- Follow up in 2 weeks and consult as needed
may affect children’s sleep. A useful tool for this purpose is the Screening Checklist for Medical Comorbidities Associated with Sleep Problems, developed by Reynolds and Malow from the Autism Treatment Network, which can be used by clinicians when interviewing families. Sleep problems in children with NDD can be identified and diagnosed using the same or modified assessment methods as for TD children (discussed later). See the treatment pathway in Fig. 2 for guidelines on screening and assessment.

Children with NDD may be more sensitive to or less tolerant of certain types of assessment, in particular those that involve technological equipment. Therefore, specific adaptations may be required. Table 1 highlights challenges that researchers and clinicians may face in using the most common objective and subjective measures of children’s sleep to assess children with NDD and provides suggestions for how to address these challenges (see Hodge and colleagues for a comprehensive review of methods of assessing sleep problems in children with ASD and Corkum and colleagues for a comprehensive review of assessing sleep problems in children with ADHD). In general, a combination of objective measures (such as actigraphy) and subjective measures (such as parent-reported sleep diaries or questionnaires) is recommended. For those readers less familiar with available sleep diagnostic tools, a brief description is provided later.

**Objective Measures of Sleep**

Polysomnography (PSG) is considered the gold standard for assessment of sleep. PSG involves continuous electrophysiologic recordings of a child’s overnight sleep and typically occurs in a sleep laboratory or hospital setting. PSG provides information on both the stages of sleep and the various physiologic parameters (cardiovascular, respiratory, and so forth) during sleep. It is primarily indicated to identify sleep-related breathing and movement disorders and may also be helpful in diagnosing parasomnias and nocturnal epilepsy in selected cases. Actigraphy, in conjunction with a sleep log, allows for the estimation of 24-hour sleep-wake patterns for extended periods of time in the home setting. An actigraph is a watchlike device that captures and stores data regarding limb movements. Videosomnography involves the use of a portable, time-lapse recording system in a child’s bedroom. Observers review and code the recordings to determine sleep-wake states, total sleep time, and waking after sleep onset (WASO).

**Subjective Measures of Sleep**

Due to the frequency with which communication problems and intellectual disability occur in NDD, clinicians typically rely on parental report measures rather than child self-report measures. Sleep diaries are used frequently and require daily reports from parents on children’s sleep for the prior night. They are usually conducted over at least a 14-day period and should contain detailed information about bedtimes, waking time, sleep-onset time, presence of night waking, returning to sleep, and daytime napping. Sleep diaries may be particularly useful in the assessment of behavioral insomnia in children with NDD; research shows that sleep diaries provide behavioral/environmental information about the presleep period as well as the morning period that may not be captured by objective measures of sleep but may be critical for understanding the contingencies giving rise to or maintaining sleep problems. For example, parents of children with ADHD report more problematic behaviors before bedtime, at bedtime, and in the morning compared with parents of TD children.

Questionnaires are frequently recommended. The Children’s Sleep Habits Questionnaire (CSHQ) is a parent-report survey that was originally validated for children ages 4 through 10 years. It can be used to derive a total sleep disturbance score as well as 8 subscale scores (bedtime resistance, sleep-onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep-disordered breathing, and daytime sleepiness). Recently, the CSHQ was found a clinically useful screening measure for children under 4 years of age as well, including those with ASD. The CSHQ is available free of charge from the authors who developed the measure (JOwens@childrensnational.org).

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1. Parental beliefs & sleep education
2. Sleep hygiene & bedtime routines
3. Specific behavioral strategies
4. Medication with behavioral strategies

Fig. 2. Staged approach to the treatment of behavioral sleep problems. (Adapted from Weiss SK, Corkum P. Pediatric behavioural insomnia—“Good Night, Sleep Tight” for child and parent. Insomnia Rounds 2012;1(5):1–6.)
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<th>Measure</th>
<th>Challenges and Limitations</th>
<th>Advantages and Recommendations</th>
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<td>PSG</td>
<td>Children with NDD who have sensory difficulties or sensitivities (eg, ASD) may find the procedure difficult to tolerate, because it requires application of sensors and an overnight stay in a sleep laboratory. Research on children with ADHD specifically has shown that children with ADHD are more active during the night than control children, which may present problems during PSG, in which accurate assessment depends on the electrode sensors remaining connected during sleep. There is also a possibility that children with ASD and ADHD may be more prone to difficulties adapting to sleeping in novel environments, the so-called first night effect. Research has demonstrated that TD children and children with ADHD showed differences between sleep at home and sleep at the sleep laboratory in certain sleep variables (eg, sleep duration) and as such caution must be taken when generalizing results from the sleep laboratory to home.</td>
<td>The availability of a child-friendly sleep laboratory (eg, increased sleep technologist to child ratio [2:1 or 1:1]; sleeping accommodations for parents; adequate preparation, including availability of pre-PSG laboratory visits; and experienced staff) may mitigate the impact of the laboratory environment and diagnostic procedures. Research suggests that given the right accommodations and preparation, some children with NDD can adapt to a sleep laboratory. No similar research exists for children with ASD, but research exists in which PSG was successfully used with children with ASD (see Hodge and colleagues for review). At-home PSG, which has been validated for use in clinical populations, is an option for children with NDD.</td>
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<td>Actigraphy</td>
<td>Although actigraphy is less invasive than PSG, there is concern that a sizable portion of children with NDD may not be able to tolerate wearing an actigraph due to sensory issues. Actigraphy may also underestimate the frequency and duration of WASO in children with ASD, who frequently display contented sleeplessness (lying awake quietly). There is also research showing that actigraphy is less accurate for children with ADHD (who have excessive movements) than for TD children.</td>
<td>Previous research using actigraphy in children with NDD, such as ADHD, has been successful. There is also evidence that actigraphy can be collected for children with ASD. Preliminary research suggests that children who cannot tolerate wrist actigraphy may have the actigraph in a hidden pocket in their pajamas (eg, in the sleeve of the upper nondominant arm).</td>
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<td>Videosomnography</td>
<td>Children may become distracted by or focused on the camera, and cameras are relatively limited to focusing on one location only and cannot keep track of behavior that occurs away from this location. For infants with NDD, the camera may be able to be placed very close to the crib. For older children with NDD, however, it may be necessary or recommended for the camera to be placed at a distance from the bed to be as unobtrusive as possible. This distance, without the use of a telephoto lens, may make it difficult to score sleep states.</td>
<td>In a review of the literature on sleep assessment in children with ASD, Hodge and colleagues suggested that because videosomnography is well tolerated and is relatively sensitive to WASO (which can be common in children with NDD), it may be a preferable way to objectively assess sleep in children with ASD, with or without actigraphy. To the authors’ knowledge, only one study has explicitly examined the feasibility of time-lapse videosomnography in children with ASD and found it a successful technique.</td>
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BEHAVIORAL MANAGEMENT OF SLEEP PROBLEMS IN CHILDREN

The most effective interventions for challenging behavior in children are those that use a behavioral approach. The symptoms of behavioral insomnia are no exception. Because behavioral insomnia takes place within the context of the relationship between a child and a parent, recommended treatment strategies are often based on parent-centered behavior management strategies. The underlying principle of the behavioral approach is that healthy sleep is a learned behavior.

Strategies for treating insomnia do not vary substantially between TD children and children with NDD. The underlying behavioral (eg, extinction and reinforcement) and psychophysiological principles (eg, conditioning, circadian entrainment, and manipulation of sleep pressure/homeostatic processes) are consistent across populations. Considerations, however, such as the rate and scope of changes, external factors (eg, pain and mobility), and methods of implementation (eg, complexity of reward systems and use of visual cues and reminders), need to be incorporated in tailoring these interventions across populations and children.

A staged approach to the treatment of sleep problems is recommended,66 with each stage representing a progressively more intensive intervention (Fig. 2).

Few recommendations for the course of treatment in this population have been developed, with the exception of the practice pathway created by Malow and colleagues67 for children with ASD. Using a similar approach, the authors have developed a comprehensive treatment pathway for the screening of behavioral insomnia in children with NDD and the development and implementation of a behavioral treatment plan over 4 sessions (see appendix).

Parental Beliefs and Sleep Education

Ensuring that parents have accurate information about sleep and that their beliefs and sleep strategies are effective can be helpful both as a prevention strategy for the development of behavioral insomnia and as the first step in treatment.68 Box 1 highlights important aspects of addressing parental beliefs and providing psychoeducation about sleep.

Healthy Sleep Practices and Bedtime Routines

The development of good bedtime routines is one of the key components of any sleep intervention. The basic principles of healthy sleep habits are

Provisioning or creating an optimal sleep environment
Sleep scheduling
Sleep practice
Physiologic sleep-promoting factors

Bessey and colleagues69 published a useful and easy-to-remember mnemonic that captures the essence of healthy sleep practices, called “the ABCs of SLEEPING.” For children with NDD, the ABCs of SLEEPING may require some modifications. Jan and colleagues9 indicated that it may be more challenging to implement healthy sleep practices for children with NDD and that accommodations may need to be made with regard to environmental and sensory hypersensitivity as
### Table 2
The ABCs of SLEEPING

<table>
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<th>Core Concept</th>
<th>Details and Recommendations</th>
<th>Modifications for NDD</th>
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<tr>
<td><strong>A</strong> Age appropriate</td>
<td>It is important that children go to bed and wake up at times that ensure that they receive an age-appropriate amount of sleep. For children who have outgrown naps (which usually occurs during the preschool age period), napping during the day could be an indication that children are not getting sufficient quality and/or quantity of sleep at night.</td>
<td>Children with NDD often have intellectual disabilities as well as physical disabilities. It is important to consider these factors when determining what constitutes an age-appropriate amount of sleep. Generally, however, chronologic age is the best way to estimate how much sleep a child needs.</td>
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<td><strong>B</strong> Bedtimes</td>
<td>Having set bedtimes and wake times as well as routines in the evening and morning are key to good sleep. It is recommended that bedtimes be no later than 9:00 PM across childhood.</td>
<td>When setting bedtimes and wake times for children with NDD, clinicians and parents must consider the timing of medication (eg, stimulant medication) and impact on sleep. One of the best ways to help children with NDD (especially those who are nonverbal or intellectually delayed or easily distracted) stick to routines is by using visual schedules, or visual, picture-based depictions of routines. This may take the form of a picture schedule or picture chart.</td>
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<td><strong>C</strong> Consistency</td>
<td>Bedtimes and wake times must be consistent, even on weekends (ie, no more than 30–60 min difference between weekday and weekend bedtimes and wake times).</td>
<td>For children with NDD, ensuring that bedtimes and wake times are consistent is critically important because they may have more difficulty regulating their behavior and settling at night.</td>
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<td><strong>S</strong> Schedule and routines</td>
<td>Children's schedules in general are 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, etc.</td>
<td>Children with NDD may need to take extra time for transitions between activity and sleep and may require increased verbal prompts and reminders. Although children with NDD typically respond well to routines, sometimes they can become overly fixated on routines and refuse to go to sleep unless routines are followed very specifically (eg, as with ASD). Introducing a small amount of variability into the bedtime routine each night (eg, reading a different book or wearing different pajamas each night) may help prevent this and promote flexibility.</td>
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<td><strong>L</strong> Location</td>
<td>It is important that a child's location for sleep includes a comfortable bed; the room is quiet, dark, and cool; and the location should be consistent and familiar. Also, children's bedrooms should be used only for sleeping—children should not be sent to their bedroom for a time out. Their bedroom also should not be too exciting or distracting and should be conducive to relaxation.</td>
<td>Children with NDD may have motor disabilities, sensory sensitivities, and hypersensitivity to environmental stimuli, all of which can influence how to arrange the bedroom (eg, lighting, physical comfort of bed, placement of bed, and temperature). Therefore, it is important to 1. Reduce opportunities for distractions in the bedroom 2. Consider any sensory issues, pain, or discomfort that may affect sleeping</td>
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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 (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. Many children with NDD enjoy electronics, such as video or computer games or television. As previously indicated, parents should reduce opportunities for distractions in the bedroom by removing such devices.

Exercise and diet are both important factors that should be considered when evaluating sleep practices—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 h to 4 h prior to bedtime). Diet concerns around sleep include caffeine consumption—children should limit or totally eliminate intake of caffeinated foods or beverages—as well as the timing of meals. Children should not be going to bed hungry, but they also should not be consuming a large meal right before bedtime.

Ensuring that children with NDD get sufficient opportunities for exercise is critical, in particular children who prefer sedentary activities. Physical activity, however, should not take place too close to bedtime. Heavy meals should be avoided at bedtime.

Positivity surrounding sleep is also an important aspect of sleep practices. Parents should have a positive attitude toward sleep and the bedtime/wake time routine, and the atmosphere in the house should be positive to be conducive to creating a positive mood in children. It is important that this positive mood is relaxing and calming, rather than fun and exciting—children should be winding down before bedtime. Also, doing frustrating activities right before bed (eg, math problems for a child who struggles with math) is not recommended, because this may interfere with children's ability to fall asleep.

Positive reinforcement from parents is important for children with NDD, especially during potentially stressful times, such as the bedtime routine. Children with NDD may require additional assistance with unwinding or reducing stimulation before bed. Bedtime activities should be calming and simple. Activities that involve new or unexpected events (which can be frustrating or challenging), excessive noise, or vigorous exercise may be overstimulating and either make the bedtime routine too stimulating or wind children up too much to relax to sleep.

Independence is also important. Once children reach an age where they are capable of settling into sleep without their parents, independence when falling asleep should be encouraged to discourage dependence on someone else to fall asleep. For children, independence means no calling out and no getting out of bed, and for parents, no responding to children calling out and returning children to their room if they do get out of bed.

Although children with NDD may sometimes require help or supervision from their parents or caregivers in other areas of daily functioning, sleep is an aspect of their lives where developing independence is critical. For children with NDD, sleep independence means staying in bed and not calling out, and for their parents, this means unbroken and peaceful sleep.

Given that there are often many demands on parents during the day, it is often harder to meet all of a child’s needs in the daytime. Children with NDD work hard to regulate themselves and it is important for parents to recognize this and provide love and support. Having positive time with parents should be a feature of both daytime and bedtime routines.

Finally, the needs of children should be met throughout the day. This refers to both children's emotional needs (love, support, hugs, etc.) and basic physiologic needs (thirst, hunger, etc.).

Given that there are often many demands on parents during the day, it is often harder to meet all of a child’s needs in the daytime. Children with NDD work hard to regulate themselves and it is important for parents to recognize this and provide love and support. Having positive time with parents should be a feature of both daytime and bedtime routines.

All of the above equals a Great sleep!

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Primary Use</th>
<th>Adaptation for Children with NDD</th>
<th>Research Examples</th>
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</table>
| Sleep scheduling | Sleep scheduling: this is the essence of healthy sleep practices and behavioral treatment. It is vital to schedule regular, age-appropriate sleep and wake times that allow children the opportunity to have adequate sleep. | Children with NDD may require increased support as their parents implement new routines and bedtimes in the form of  
- Increased transitional warnings ("10 more minutes until it's time to get ready for bed...5 more minutes...2 more minutes," etc.)  
- Additional prompts and reminders about bedtimes  
- Use of visual supports and schedules | Moon et al, 2011 (3 children with ASD, age 8–9 y, integrated with FBRC)  
Mullane and Corkum, 2006 (3 children with ADHD, age 8–9 y, integrated with FBRC) |

| Extinction | Standard (unmodified) extinction: a child is put to bed while awake and left alone until he or she falls asleep. Any night wakings are ignored by parents. A child learns to self-soothe once he or she realizes that crying at night or calling for parents does not result in getting parental attention.  
Graduated extinction: like standard extinction, a child is put to bed while awake and left to fall asleep. In this case, however, the parents ignore the child’s negative behaviors (eg, crying, night waking, and calling out) for a specified amount of time before they check in on  
Child frequently calls out at night, disturbs parents, and causes disruptions. Child is not independent at night. | Parents should be aware that using an extinction technique may result in a temporary increase in negative behaviors (called an extinction burst), which can be distressing and especially problematic in children with self-injurious behavior. It is important for clinicians to educate parents about extinction bursts and provide support as the extinction technique is implemented.  
If children with NDD have sensory, motor, or other | Weiskop et al, 2005 (5 children with ASD + 5 children with fragile X syndrome, ages 3–7 y old, problems with night wakings)  
Wolf et al, 1964 (in-patient child with ASD, violent tantrums associated with night waking)  
Durand et al, 1996 (2 children with ASD, bedtime disturbances, and problems initiating sleep)  
Moore, 2004 (1 child with ASD, cosleeping, problems initiating sleep) |
the child. Gradually, the parent increases the amount of time between hearing crying and responding (coming to check on the child). Parents provide reassurance through their presence but only for short duration and with minimal interaction.

Variation: extinction with parent presence. The child is put to bed while awake. The parent remains in the room until he or she falls asleep, acting as a reassurance. The parent, however, provides little interaction or attention for crying, etc. The parent’s presence is the child’s comfort.

Extinction—stimulus fading: the goal of stimulus fading is to reduce cosleeping with parents, and the main focus is to gradually reduce and then eliminate a parent’s presence from the child’s room. For example, on night 1, the parent might sleep on mattress beside the child’s bed, and on successive nights, the mattress is moved farther away from the bed until it is out of the room.

Child requires parents to be present in bedroom or while sleeping. Child cosleeps with parents.

 leave their child in distress or let them “cry it out.”

disabilities, it may be important not to leave them entirely alone—parents may want to unobtrusively check in by leaving a door open or keep track of their child using baby monitors, video camera, etc.

With any extinction technique, positive reinforcement of desired behaviors is especially helpful. Using strategies, such as a token economy (described later), may be a good way to do this.

If children have severe behavioral problems in addition to sleep problems (eg, disruptive/externalizing-destructive behaviors), extinction may not be the best option for them.

• Mullane & Corkum, 2006 (2 children with ADHD + primary insomnia + cosleeping —use of systematic ignoring)56

• Howlin, 1984 (case study of 5 y old with ASD with night wakeings and cosleeping)83

• Reed et al, 2009 (21 children with ASD, multicomponent intervention, including stimulus fading, extinction, and group parent education workshop)84
Faded bedtime: parents identify a target bedtime or goal (the time at which they want their child to fall asleep). They then proceed to delay or fade the actual bedtime over a period of days or weeks, moving it closer to the target bedtime. The goal is for the child to develop a positive association between being in bed and falling asleep quickly—for children to learn to fall asleep when they are tired. Bedtimes can gradually be moved earlier.

Typically, the child is awakened at the same time each morning and is not allowed to sleep outside of the set sleep times.

This technique can be used in conjunction with sleep restriction.

FBRC: this technique takes the faded bedtime strategy (as described directly above) and adds a response cost component, which is generally a desired or enjoyable, but not overly stimulating, activity. A sample FBRC plan might be

1. Putting child to bed at a specific time. If child does not fall asleep within 20 min, he or she is removed from bed and must spend 20 min engaging in a quiet, nonrewarding activity.
2. After the 20-min activity, the child is placed back to bed. If he or she is unable to fall asleep within 20 min, he or she again is removed from bed for 20 min.

<table>
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<tr>
<td>Faded bedtime/sleep restriction</td>
<td>Faded bedtime techniques are most useful for children who have problems initiating and/or maintaining sleep. They can also be used to deal with bedtime disturbances, for example, when children are reluctant to go to bed, stay in bed, or stay awake for long periods of time after being put into bed. Adding a response cost component may be especially helpful if a child has poor motivation to return to sleep after waking up. Including a sleep restriction component may be helpful, especially if it is believed that less sleep may help the child become sleepier and therefore fall asleep faster. Positive bedtime routines can be used additionally to reduce bedtime disturbances and night waking.</td>
<td>When using faded bedtime or sleep restriction techniques, it may be helpful to provide a child with positive reinforcers. Parents should be aware that reinforcers can be idiosyncratic and may not always work. It can be difficult to find appropriately motivating positive reinforcers for children with NDD (especially those with ASD). Activity-based reinforcers may be more effective. It is important to ensure that activity-based reinforcers are not too rewarding, not overly stimulating, not electronics-based (eg, no TV, video games, or smartphone). Equally important is to ensure that response cost activities are relatively boring and relaxing, not dependent on parent presence. Children with NDD may have a tendency to become overaroused (ADHD) or overly fixated on an activity (ASD). For example, children with ASD tend to find their own special interests or preoccupations.</td>
<td>DeLeon et al, 2004 (case study of 4-year-old boy with ASD and developmental delay, and self-injurious behavior associated with night waking) Moon et al, 2011 (3 children with ASD between ages 5 and 9 y with difficulty initiating sleep) Piazza et al, 1997 (3 children with ASD between ages 5 and 9 y on inpatient ward with difficulty initiating sleep + severe behavior problems) Mullane &amp; Corkum, 2006 (3 children with ADHD + primary insomnia, bedtime resistance).</td>
</tr>
</tbody>
</table>
3. This procedure is repeated until the child is able to fall asleep within 20 min of being placed back in bed.
4. Once a child is able to fall asleep within 20 min at a specific bedtime for a few consecutive nights, the bedtime is moved earlier (in 15–30-min increments) until the target bedtime is achieved.
   This technique can be used in conjunction with sleep restriction.

Sleep restriction: this technique involves fading bedtime and is similar to FBRC. It is based, however, on sleep duration, instead of bedtime. Parents limit the time that a child spends in bed to 90% of the child’s baseline total sleep duration. This restricts the total amount of time the child spends awake in bed. The parents and clinician determine a target in terms of how much they would like sleep disturbances to decrease; if the child achieves this target, then the bedtime is faded 15 min earlier each week. Should the child remain awake in bed, the response cost technique is used.

Sleep restriction techniques should be used in conjunction with positive bedtime routines, to decrease night waking and bedtime disturbances. It is important for parents to know that sleep restriction can result in some increased difficulty implementing bedtime routines due to problematic behavior (e.g., Christodulu and Durand, 2004).87

• Christodulu & Durand, 2004 (4 y old with ASD, bedtime disturbance, and night waking)87
• Durand et al, 2004 (4 y old with ASD, cosleeping, bedtime disturbance, and night waking)88
• Gruber et al, 2011 (1 h of nightly sleep restriction on 11 children with ADHD, ages 7–11 y)22

(continued on next page)
Cognitive strategies: cognitive strategies can be used to help both children and parents. For example, cognitive strategies can address unhelpful or unproductive beliefs about sleep (e.g., the child cannot change his/her sleep difficulty). They can also include coping strategies, such as learning relaxation skills (e.g., deep abdominal breathing). Cognitive strategies can also help children learn how to handle anxiety, which can cause sleep problems.

Cognitive behavior therapy for sleep problems can include a combination of cognitive therapies, relaxation training, stimulus control therapy, and sleep restriction.\(^\text{89}\)

Working with children: children with NDD often have comorbid anxiety, but anxiety might not look like anxiety—it may look like acting out or disruptive behavior. Cognitive strategies and teaching relaxation skills do not cure anxiety but can help children manage their feelings and gain some control. Techniques, such as guided imagery, can help reduce anxiety and psychological arousal at bedtime.\(^\text{10}\)

Working with the parent(s): it is important to help parents maintain their motivation for implementing treatment, especially when they are sleep-deprived. It may be helpful to focus with parents on what their in-the-moment thoughts are (e.g., when a child is crying at night), especially if they are having trouble sticking to treatment guidelines (e.g., not responding to child crying). Furthermore, clinicians may need to reassure parents that sleep problems can be treated, because parents of children with NDD may have specific

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**Table 3 (continued)**

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<tr>
<td>Cognitive strategies</td>
<td>May be helpful for children who have co-occurring anxiety, especially anxiety about sleep. Can also be useful to help prepare parents for treatment and to stop and deal with negative thoughts about sleep problems. Cognitive interventions differ based on the age of the child having sleep problems. For infants and toddlers, cognitive strategies usually focus on changing parental cognitions and behaviors to affect a child’s sleep. For preschool and school-age children, cognitive strategies can target age-specific developmental issues (e.g., nighttime fears or bedtime refusal) and a clinician can work with the child directly. Likewise, for adolescents, cognitive behavior therapy for insomnia may be helpful in addressing the stress associated with sleep problems and how to cope with other areas of worry.(^\text{90})</td>
<td>Working with children: children with NDD often have comorbid anxiety, but anxiety might not look like anxiety—it may look like acting out or disruptive behavior. Cognitive strategies and teaching relaxation skills do not cure anxiety but can help children manage their feelings and gain some control. Techniques, such as guided imagery, can help reduce anxiety and psychological arousal at bedtime.(^\text{10}) Working with the parent(s): it is important to help parents maintain their motivation for implementing treatment, especially when they are sleep-deprived. It may be helpful to focus with parents on what their in-the-moment thoughts are (e.g., when a child is crying at night), especially if they are having trouble sticking to treatment guidelines (e.g., not responding to child crying). Furthermore, clinicians may need to reassure parents that sleep problems can be treated, because parents of children with NDD may have specific</td>
<td>• Malow et al, 2014 (parent-based sleep education, group and individual therapy—for parents of 80 children with ASD ages 2–10 y old)(^\text{13})</td>
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</table>
Cognitive strategies may be helpful in eliminating cosleeping (especially when cosleeping is due to anxiety or nighttime fears).

beliefs about sleep problems in their children.\textsuperscript{91} Research has shown that parental behaviors during bedtime and the night are influenced by their cognitions and emotions\textsuperscript{90} and that sleep problems affect family functioning and parenting sensitivity.\textsuperscript{92}

Reward and reinforcement programs: using reward and reinforcement programs can help motivate children, increase wanted behaviors (e.g., sleeping soundly, not disturbing parents) and decrease unwanted behaviors (e.g., crying or calling out).

One useful technique that can be used in conjunction with the behavior strategies is the token economy. Children earn tokens (such as stickers), which can be traded or cashed in for larger prizes once a parent-decided number of tokens has been earned. Opportunities to earn tokens may include:

- Completing their bedtime routines
- Trying to fall asleep quietly and
- Staying in bed without calling out to parents

Rewards/reinforcement may be particularly indicated in cases where a child has problematic behaviors or bedtime disturbances.

Helpful NDD modifications:
- Having a visual reminder of what the expectations are for a token economy
- Placing a sticker chart where children can see it may increase motivation
- Stickers or tokens may need to be cashed in more often to maintain a child’s motivation
- Token economies may not work as well for children with poor verbal skills

- Weiskop et al, 2005 (children with ASD, 3–7 y old; sticker charts, visual representations of bedtime routines + extinction)\textsuperscript{79}
well as the potential for overadherence to routines. Table 2 lists the original ABCs in the left column, with suggested modifications for children with NDD in the right column.

**Specific Behavioral Strategies**

Behavioral interventions are based on applied behavioral analysis and can include techniques, such as token economies, extinction, graduated extinction, fading, and response cost. There has been little research on which behavioral strategies for sleep problems work for children with NDD. A recent review of treatment strategies for complex behavioral insomnia in children with NDD endorsed the use of these behavioral interventions as a first-line treatment of children with ASD, followed by supplements, such as oral melatonin or other medications, should problems remain (discussed below in the next section). Above all, the review emphasized that the foundation of insomnia therapy in NDD is caregivers as agents for change of problematic sleep behaviors.

Several specific behavioral interventions have been found effective in reducing sleep problems in TD children in several studies, and there is a growing body of research demonstrating that these interventions can be extended to children with NDD. Table 3 highlights these interventions, with suggestions for adapting them to children with NDD.

**Medication as an Adjunct to Behavioral Therapy**

Although the topic of use of sedative/hypnotic medication in children with NDD is beyond the scope of this review, medication may be considered as an adjunct to behavioral management of insomnia in selected cases. In particular, several studies have suggested that use of synthetic melatonin either as a chronobiotic (small dose 4–7 hours before sleep onset) or mild hypnotic (larger dose just before bedtime) may be effective in reducing sleep-onset delay in children with ADHD and ASD. For a systematic review of melatonin use in children with neurodevelopmental disabilities, see Phillips and Appleton; for a review of melatonin use in children with ASD, see Rossingnol and Frye or Guénoël and colleagues; and for a review of melatonin use in children with ADHD, see Bendz and Scates or Hoebert and colleagues. Medication should never be the first or sole treatment choice and a medication trial (including over-the-counter drugs) should be initiated only after consultation with a health care professional (eg, pediatrician or sleep specialist). For more information on how medications for sleep disorders in NDD can be used in conjunction with behavioral interventions, see review by Ahmareen and colleagues or Hollway and Aman. For a thorough review of pharmacology for sleep problems in ASD, see Johnson and Malow, and for a review of pharmacotherapy for sleep problems in ADHD, see Corkum and colleagues and Barrett and colleagues (Box 2).

**SUMMARY**

Sleep problems represent a real and troubling aspect of the lives of many children with NDD. As with TD children, the most common sleep problem among children with NDD is behavioral insomnia. Prevalence rates of sleep problems in general range between 50% and 95% for children with NDD. Given that poor sleep in children with NDD has been associated with impairments in daytime functioning, decreased quality of life for the children, increased NDD symptoms and morbidity, and negative effects on caregivers’ health and parenting abilities, these high rates are concerning and underscore the need for appropriate screening, diagnostic evaluation, and management. Behavioral interventions have considerable empiric support and should be recommended as first-line treatment of sleep problems in this population. Additional research is needed to establish the effectiveness.
of specific behavioral strategies, including psycho-education, healthy sleep practices, and techniques, such as faded bedtime with response cost (FBRC) or extinction, for treating behavioral insomnia in children with NDD.

REFERENCES


