Sleep Problems and Developmental Delay

55

Stacey Bissell, Ashley Liew, Caroline Richards, and Andrew Surtees

Abbreviations

ADHD	Attention Deficit Hyperactivity Disorder
CPAP	Continuous Positive Airways Pressure
CSHQ	Children's Sleep Habits Questionnaire
EEG	Electroencephalogram
GDD	Global developmental delay
ICSD-3	International Classification of Sleep Disorders – third edition
ID	Intellectual disability
SEN	Special Educational Needs
SQ-SP	Sleep Questionnaire – Simonds and Parraga
TD	Typically developing

Introduction

Sleep plays an important role in memory, attention, cognitive functioning, cell repair and health maintenance. When sleep problems occur in children with developmental delay, their impact may be particularly pronounced, as these areas of development are likely to already be compromised in the absence of sleep difficulties. Children with global developmental delay (GDD) experience a significant lag in reaching developmental milestones (e.g. gross motor skills, speech, and language) [1]. When such difficulties continue beyond the age of 5 years, intellectual disability (ID) is diagnosed according to intellectual ability impairment (e.g. academic learning, abstract reasoning), adaptive functioning deficits (e.g. daily living skills, communication) and the need for additional service provision [2]. Here, the term developmental delay is used to refer to both GDD and ID populations. In this chapter, the three subsequent sections will:

1. Profile the biomedical, psychological and contextual comorbid factors that may underlie poor sleep associated with developmental delay and consider the behavioural model of sleep from a psychosocial perspective.
2. Provide an overview of current measures and methodologies used to assess sleep quality in populations with developmental delay and outline how such tools can be used in clinical formulation.
3. Present current behavioural and medical sleep interventions suitable for such populations.

There is good evidence that behavioural and physical sleep difficulties are more prevalent in children with developmental delay compared to their typically developing (TD) peers [3, 4]. Overall, rates of poor sleep in ID populations range from 34–86% [5, 6], compared to 25–43% in TD children [7, 8]. However, the prevalence of 'sleep disorders' likely underestimates broader difficulties often associated with developmental delay. The International Classification of Sleep Disorders – third edition (ICSD-3 [9]) defines sleep disorders according to seven categories: insomnia, sleep-related breathing disorders (e.g. obstructive sleep apnoea), central disorders of hypersomnolence (e.g. narcolepsy), circadian rhythm sleep–wake disorders (e.g. advanced sleep-wake phase), parasomnias (e.g. nocturnal enuresis), sleep-related movement disorders (e.g. restless legs syndrome) and other sleep disorders (e.g. environmental sleep disorder). Like other diagnostic manuals, diagnosed sleep disorders and their descriptors primarily reflect the experience of TD populations and as such, the application of such diagnoses may be challenging to populations of children with developmental delay. It is therefore preferable to adopt the term 'sleep problem' in the current chapter to encompass broader sleep disturbances and behavioural issues that do not necessarily adhere to TD models of sleep (e.g. insomnia occurring in the absence of daytime symptoms, bedtime

S. Bissell (✉) · C. Richards
School of Psychology, University of Birmingham, Birmingham, West Midlands, UK
e-mail: S.L.Bissell@bham.ac.uk

A. Liew
Evelina London Children's Hospital, London, UK

A. Surtees
School of Psychology, University of Birmingham and Birmingham Children's Hospital, Birmingham, West Midlands, UK

D. Gozal, L. Kheirandish-Gozal (eds.), *Pediatric Sleep Medicine*, https://doi.org/10.1007/978-3-030-65574-7_55

Table 55.1 Results from meta-analysis by Surtees et al. [12] reporting poorer sleep quality in heterogeneous ID and genetic syndrome/developmental disorder cohort studies (highlighted in bold) compared to TD control groups

Analysis	Number of studies	Model	Number of experimental groups	Weighted mean difference, [95% CI]	Heterogeneity statistics	
					Cochran's Q (p)	Higgins I^2
All studies	18	REM	27	−4.56[a] [−7.86, −1.26]	21934.67 (< 0.01)	100%
	18	QEM	27	−2.46 [−12.48, 7.57]	21934.67 (< 0.01)	100%
Objective measures only	14	REM	20	−3.81[a] [−5.75, −1.86]	352.69 (< 0.01)	95%
	14	QEM	20	−1.73 [−6.84, 3.37]	352.69 (< 0.01)	95%
Heterogeneous intellectual disability	7	REM	8	*−0.44[a] [−0.86, −0.03]*	13.39 (0.06)	48%
	7	QEM	8	*−0.59[a] [−1.18, 0]*	13.39 (0.06)	48%
Genetic syndromes/developmental disorders	15	REM	19	*−5.98[a] [−9.54, −2.43]*	951.34 (< 0.01)	98%
	15	QEM	19	*−8.98[a] [−17.89, −1.84]*	951.34 (< 0.01)	98%
Only 1 intellectual disability group per study	18	REM	18	−4.76[a] [−8.91, −0.61]	21725.16 (< 0.01)	100%
	18	QEM	18	−2.47[a] [−13.18, −8.23]	21725.16 (< 0.01)	100%

Notes. Results of the meta-analysis of sleep quality: *REM* random-effects model, *QEM* quality effects model
[a]Indicates a significant difference between intellectual disability and control groups
From Surtees et al. [12] with permission. Copyright 2018 by Elsevier Ltd

resistance, evidence for REM-related parasomnias in the absence of verbal report).

Variable prevalence rates for sleep problems associated with developmental delay can be attributed: (1) methodological differences between studies, (2) multiple comorbid disabilities associated with the severity of ID and (3) the inclusion of known genetic syndrome groups (e.g. fragile X syndrome, Down syndrome) in reported samples [10, 11]. One recent meta-analysis reported poorer sleep quality associated with both heterogeneous developmental delay and syndrome-specific ID compared to TD peers [12], as highlighted in Table 55.1. However, shorter sleep duration was specific to comorbid developmental delay associated with neurodevelopmental and genetic conditions. Therefore, it is important to adopt a person-focused approach when considering assessment and treatment options for children presenting with both developmental delay and sleep problems.

Comorbid Factors

As outlined previously, there are a number of co-occurring physical and cognitive characteristics associated with developmental delay that may contribute to the prevalence of specific sleep problems and poor sleep more generally [12]. These factors may be biomedical, psychological or environmentally mediated and should be considered when identifying appropriate treatment choices.

Biomedical Factors

A number of secondary health conditions associated with developmental delay are also found to be associated with poor sleep quality (e.g. constipation, gastro-oesophageal reflux, respiratory tract infections, otitis media and dental caries [13–15]). When health conditions/physical discomfort occurs, pain may be the mediating variable that triggers and/or exacerbates poor sleep [16, 17]. Research specifically exploring the relationship between pain and sleep problems in children with developmental delay by Breau and Camfield [18] found that children experiencing pain had shorter sleep duration and more sleep problems (night waking, parasomnias and sleep-disordered breathing) than children not experiencing pain.

In known neurodevelopmental disorder and syndrome groups associated with developmental delay, there may be syndrome-specific physiological characteristics that exacerbate poor sleep. For example, the inverted circadian release of melatonin in Smith–Magenis syndrome [19, 20] is a strong causal mechanism for the frequency and severity of night wakings, early morning wakings, daytime sleepiness and reduced sleep duration phenotypic of this syndrome [21–23]. In Angelman syndrome, the disrupted sleep architecture characterised by distinctive electroencephalogram (EEG) patterns and dysregulated GABAergic neurotransmission may underlie night-time arousal, parasomnias and daytime sleepiness [24, 25].

Prevalence rates of epilepsy associated with ID are approximately 30 times higher than in TD community populations [26]. Sleep-disordered breathing, obstructive sleep apnoea and daytime sleepiness are commonly reported when epilepsy comorbidity occurs [27, 28], which may be attributed to: which may be attributed to: (1) fragmented sleep architecture, (2) abnormal EEG activity, (3) the presence of nocturnal seizures, or (4) the prescription of anti-epileptic medication fragmented sleep architecture, abnormal EEG activity, the presence of nocturnal seizures, or the prescrip-

tion of anti-epileptic medication [29–31]. Several studies have shown that anti-epileptic drugs can disrupt sleep either as a result of sedative adverse effects inducing daytime sleepiness [32], or by disrupting sleep architecture and time spent in slow wave and rapid eye movement stages of sleep, reducing overall sleep efficiency and quality [33].

Psychological Factors

Higher rates of psychiatric disorders are reported in individuals with developmental delay and ID compared to typical development, most notably anxiety [34] and depression [35]. Anxiety is associated with increased night-time arousal, decreased slow wave sleep, insomnia, parasomnias and sleep-related anxiety in children and adults without developmental delay or ID [36, 37], and high rates of insomnia and hypersomnia are described in children with depression [38]. Few studies have noted a significant relationship between anxiety and sleep problems [39, 40] and depression and sleep problems [41, 42] specifically in children with developmental delay or adults with ID. This may reflect a larger clinical difficulty in identifying mental health concerns in adolescents and adults with an ID. Clinicians need to be mindful that children with developmental delay or adolescents and adults with ID may present with symptoms of anxiety and depression that evade diagnosis [43] but converge with the profile of poor sleep (e.g. frequent night waking, parasomnias and daytime sleepiness). If comorbid psychiatric disorders are diagnosed in children with developmental delay or adults with ID, clinicians must also consider the adverse effects of benzodiazepines (e.g. daytime sleepiness [44]) and selective serotonin reuptake inhibitors (e.g. treatment-induced insomnia [45]) when used to treat anxiety and depression, respectively.

Prevalence rates for autism amongst children with developmental delay vary between 18%–69% [46, 47]. Poor sleep associated with developmental delay and comorbid autism has been specifically explored in relation to heightened autonomic activity that may underlie purported relationships between sleep difficulties, anxiety and sensory over-responsivity [48]. Cotton and Richdale [49] found that children with autism were more likely to experience settling problems than other known syndrome groups associated with ID. Giannotti et al. [50] found that autistic children with ID, compared to children without ID, were more likely to evidence delayed sleep phase disorder, irregular sleep/wake disorder, later sleep onset, shorter sleep duration, and more frequent bedtime resistance and night wakings. More information about the profile of sleep problems in autism is presented in Chap. 50.

The prevalence of attention deficit hyperactivity disorder (ADHD) in children with developmental delay is approximately 39% [51], but varies depending on: the measure of ADHD used, severity of ID reported and diagnostic classification of ADHD (e.g. hyperactive-impulsive, inattentive and combined subtypes [2]). The prevalence of diagnosed sleep disorders in children with ADHD is estimated at 25–50% [52], with children and adolescents presenting most often with insomnia [53], periodic limb movements [54] and increased bedtime resistance [55]. Children with a combined ADHD subtype present with more night-time arousals, whereas children with inattentive ADHD are more likely to evidence daytime sleepiness [56]. Given the diagnostic overshadowing of ADHD in known neurological conditions [57], there is limited research exploring sleep problems specifically in people with ID and comorbid ADHD, or the influence of methylphenidate- and amphetamine-based stimulants on the presentation of sleep problems, particularly insomnia and delayed sleep phase disorder [58]. A model depicting the association of biomedical and psychological factors with sleep problems in developmental delay is presented in Fig. 55.1.

Contextual Factors

Sleep problems associated with developmental delay do not occur in isolation. For effective treatment, environmental and familial factors should also be considered. There is well-delineated evidence that sleep problems in children with developmental delay predict the frequency and severity of daytime externalising behaviours [59–61], with a likely bi-directional relationship between sleep problems and daytime behaviour. Wiggs and Stores [61] state that the nocturnal responsibility placed on caregivers is compounded by increased daytime behaviour demands. These challenges must be acknowledged when behavioural interventions are proposed by professionals. Similarly, impaired communication abilities can present significant barriers when implementing behavioural or medical interventions [12]. Limited expressive communication skills make it difficult for children with developmental delay to communicate their experiences of poor sleep or responses to medication. Limited receptive communication skills impede the ability to acquire sleep hygiene practices and establish bedtime routines.

Caregivers also experience reduced sleep duration when managing their child's sleep problems [61–63]. In particular, settling difficulties, night-time restlessness and night waking induce feelings of stress, and the association between caregiver stress and night waking is strongest in children with severe ID compared to mild ID [64]. This may be because children with severe ID: (1) experience more health-related difficulties associated with nocturnal medical technologies that require parental monitoring (e.g. assisted

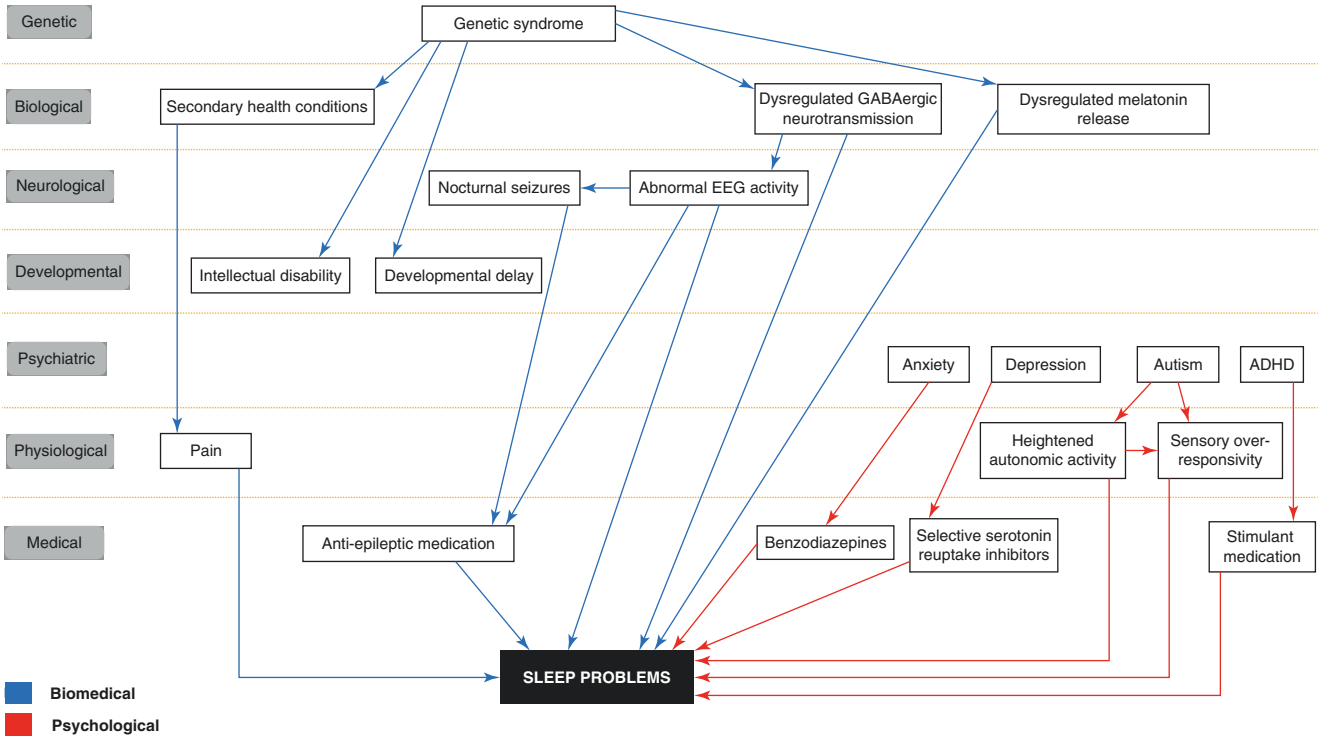

Fig. 55.1 Biomedical and psychological factors that may be associated with sleep problems in children with developmental delay

ventilation and artificial nutrition) [65], (2) experience more pain-related health conditions that evoke disturbed sleep and require a caregiver nocturnal response (e.g. nocturnal seizures) [66], (3) have mobility or adaptive functioning limitations that require caregiver assistance (e.g. toileting, feeding or changing at night) [66] or (4) have less well-developed self-soothing strategies than TD peers [67], leading to challenging night-time behaviours (e.g. self-injurious behaviours and proximity-seeking behaviours). Although these factors are not causative, their influence can exacerbate or prolong sleep problems in children with developmental delay.

Assessment of Sleep Problems Associated with Developmental Delay

It is often difficult to determine the specific profile of a sleep disorder (e.g. sleep onset insomnia, sleep-related anxiety, periodic limb movements and obstructive sleep apnoea) and identify potential underlying causes of presenting sleep problems in children with developmental delay. People with impaired intellectual functioning may struggle to accurately label and communicate their experiences of sleep problems, pain and seizure severity. Therefore, the assessment of sleep problems is often restricted to the use of informant-report questionnaires and direct objective measures as described in the autism literature (Table 55.2 [68]).

Informant-Report Measures

Spruyt and Gozal [69] provide a comprehensive overview of measures in the literature that are currently used to assess sleep. However, many of these measures are not validated in populations of children with developmental delay, with the exception of the Sleep Questionnaire – Simonds and Parraga (SQ-SP) [70], which has been modified for use [61] and directly validated in populations with ID [71, 72]).[1] Although the Children's Sleep Habits Questionnaire (CSHQ) is perhaps more widely used in recent studies [73–75], professionals should still exercise caution when it is used in clinical practice until psychometric properties in populations of children with developmental delay have been established.

Professionals should also consider the specific information they wish to gather from informant-report questionnaires. For example, informant-report measures cannot capture the more biologically intrinsic precursors to some sleep behaviours (e.g. whether abnormal EEG activity preceded night waking). Subscale structures also differ slightly between measures, and factors relating to sleep onset and duration may not be measured if the focus is on sleep behaviours as opposed to sleep routines. If this information is

[1]Psychometric properties were only established for part four of the SQ-SP, which explores the frequency of 45 sleep behaviours within the last 3 months (e.g. reluctant to go to bed, heavy or loud breathing).

Table 55.2 Outline of measures used to identify sleep problems in individuals with autism, as presented by Moore et al. [68]

Subjective sleep measures				
	Age range	*Population characteristics*	*Items (No.)*	*Subscales/content*
The Children's Sleep Habit Questionnaire (CSHQ)	4–10 years	Typically developing ASD (modified)	Total: 45 Subscale: 33	Bedtime resistance Sleep onset delay Sleep duration Sleep anxiety Night wakings Parasomnias Sleep disordered breathing Daytime sleeping
The Modified Simonds & Parraga Sleep Questionnaire (MSPSQ)	5–18 years	ASD, other developmental delays (modified)	Total: 51 Likert: 36	*Part 1:* sleep quantity and quality *Part 2:* sleep disorders *Likert-item subscales:* Bedtime resistance/struggles Sleep onset delay Parasomnias Sleep-disordered breathing Sleep anxiety Daytime sleepiness
The Family Inventory of Sleep Habits (FISH)	3–10 years	ASD	Total (V1): 12 Total (V2): 22	Daytime habits Pre-bedtime habits Bedtime routine Sleep environment Parental behaviours around bedtime
Sleep Diaries	N/A	Typically-developing ASD	N/A	Time at which child goes to bed Time at which child falls asleep Night waking information Morning waking time Daytime nap information Antecedents, behaviours, and consequences
Objective sleep measures				
	Setting	*Procedures*		*Sleep variables/disorders*
Actigraphy	Portable	Watch-like device placed on wrist (or leg) to detect limb movement as proxy for sleep; data collected from device using computer software with age-adjusted algorithms		Total sleep time Sleep onset time Morning waking time Frequency of night wakings Longest sleep period Sleep efficiency
Polysomnography	Laboratory Portable	Electrodes placed on scalp and face throughout sleep duration		Sleep latency Total sleep Sleep paralysis Sleep disordered breathing Narcolepsy
Videosomnography	Portable	Time-lapse video recording equipment used to provide visual and auditory data on participant sleeping behaviours		Sleep–wake states Frequency and duration of night wakings Parent–child bedtime interactions

Notes. ASD Autism Spectrum Disorder, *N/A* Not Applicable, *V1* Version 1, *V2* Version 2

important to clinicians, the use of sleep diaries may be preferred. An example sleep diary is presented in Fig. 55.2.

Sleep diaries are useful in capturing night-to-night variability in daytime behaviours as well as night-time behaviours (e.g. externalising behaviours and daytime naps), more specific information relating to sleep efficiency and sleep duration, and antecedents and consequences of particular sleep-related behaviours. Although a richer level of detail may be acquired from sleep diaries, they rely heavily on caregiver input, availability and objectiveness of interpretation (e.g. exact timings, caregiver observing night wakings) and require a minimum of 14 diary entries to ensure validity [68]. To reduce caregiver burden, a more objective short-term method of sleep assessment may be appropriate.

Sleep Diary

Child's Name: Parent/carer's Name:

CEREBRA
Working wonders for children with brain conditions

Date							
Time of waking in morning							
Mood upon waking							
Times of naps during the day							
Times started preparing for bed							
What time did the child go to bed?							
What time did the child got to sleep?							
Time(s) of waking during the night (e.g. 2:30am, 4am etc.,)							
What did you (parent/corer) do?							
Length of time(s) taken to fall asleep again							
Total no. of hours sleep							

Fig. 55.2 An example sleep diary. (Reprinted with permission from Agar et al. [120]. Copyright 2017 by the authors http://www.findresources.co.uk/uploads/Guides%20for%20parents/sleep-guide-june17-web.pdf)

Direct Objective Measures

The use of direct objective sleep measures needs to be person-focused and will greatly depend on how well sleep equipment is tolerated. As previously outlined [48], children with developmental delay and comorbid autism may present with heightened physiological arousal and sensory over-responsivity that not only predispose sleep difficulties (e.g. sleep onset insomnia), but also an aversion to sensory aspects of the sleep environment (e.g. noise, temperature). This is especially pertinent in relation to the three direct measures of sleep most widely used in ID research (actigraphy, polysomnography and videosomnography) [68], as the level of sensory tolerance required increases with the complexity of the methodology used.

Actigraphy uses an accelerometer worn on the wrist or ankle to measure movement, as a proxy measure of sleep parameters (e.g. sleep onset). Although actiwatches may not be well tolerated in some cases (e.g. child cohorts diagnosed with autism [76]), they are fairly well tolerated in a number of studies involving syndrome group populations, such as Down syndrome, Williams syndrome [77], Prader–Willi syndrome [78] and Angelman syndrome [63, 79]. Therefore, the utility of actigraphy may to some extent depend on factors that are person-specific (e.g. sensory over-responsivity). Best practice guidelines have been developed by Fawkes et al. [80] outlining the use of actigraphy in children with developmental delay, which advocate the use of event markers, comprehensive parent training, and a practice night of data collection to increase actiwatch tolerance. As a proxy measure of sleep, a key limitation of actigraphy is its capacity to overestimate sleep and underestimate wakefulness in paediatric and neurodevelopmental disorder populations [81, 82]. However, one study [83] recently reported that actigraphy identified more wakefulness than informant-report sleep diaries in a group of autistic children.

The use of actigraphy with people diagnosed with autism and/or ADHD is sometimes supported by videosomnography, in an effort to minimise caregiver burden [84, 85]. In particular, the use of portable time-lapse video recording is beneficial in identifying certain aspects relating to diagnosed sleep disorders (e.g. wake after sleep onset) that are difficult to infer using actigraphy alone [84]. Ipsoriglu et al. [85] developed a

comprehensive home videosomnography protocol to record bedtime behaviours and observable sleep problems in individuals with neurodevelopmental disorders, with recommendations relating to: suitable software options, confidentiality, obtaining consent, and practical considerations regarding bedroom environment, clothing and shared sleeping arrangements. Videosomnography also has particular merit in identifying child–caregiver interactions and models of behaviour that may be maintaining poor sleep, with a view towards intervention and behavioural sleep management [68].

Polysomnography is considered a standalone 'gold standard' sleep assessment [85], as it adopts a multifaceted approach (e.g. electroencephalogram, electrooculogram, electromyogram, electrocardiogram, phasic muscle activity and pulse oximetry [68, 86]). Polysomnography can confirm aspects relating to a disrupted sleep architecture that are more nuanced than actigraphy (e.g. slow wave sleep activity [86]) and has been used effectively to uncover sleep phenotypes in a number of specific groups, particularly autism [87], Down syndrome [88] and fragile X syndrome [89]. However, its widespread utility is limited by: (1) level of tolerance in individuals with sensory over-responsivity, (2) overestimation of sleep problems due to the unfamiliarity of the laboratory setting [90, 91] and (3) participant burden from spending multiple nights within the unfamiliar laboratory setting [92].

Assessment of impact is often as important as assessment of the sleep problem itself. In the context of developmental delay, biological factors may sometimes be less amenable to treatment, and behavioural patterns often reflect a functional need of the person or their family. Assessment of sleep should not occur in isolation. Consideration of challenging behaviours, interpersonal conflict, family sleep loss and stress to the person and their family is crucial. Thorough clinical interview is always recommended. Similarly, clinicians primarily focused on these additional difficulties should consider the role of sleep in their formation and maintenance.

Clinical Considerations

Formulation: Biological and Behavioural Models of Sleep

A clinical case formulation aims to explain the development and maintenance of particular difficulties and the complex interplay with other co-occurring contextual and individual factors based on psychological theories and processes with a view towards intervention [93]. Sleep problems associated with developmental delay are often underpinned by a complex array of biological, psychological and behavioural factors [94]. In the real world, these factors often interact and should be considered in combination. Although a sleep problem in itself may be governed by biological or psychological origins (e.g. inverted circadian release of melatonin, abnormal EEG activity, restless legs syndrome, sleep-related anxiety and nocturnal seizures), problems with settling at night or high levels of arousal during night waking may be maintained and exacerbated by behavioural reinforcement cycles. Using autism as an example, both biological and behavioural models can facilitate our understanding of the individual and environmental factors that contribute to the complex presentation of sleep problems in a known neurodevelopmental disorder (Fig. 55.3).

Thomas is a 14-year-old male diagnosed with autism and severe ID. Thomas is non-verbal, incontinent during the night and suffers from tonic-clonic seizures. Thomas frequently wakes during the night from 11pm onwards. Upon waking at 11pm, Thomas does not appear sleepy and will cry out for his mother. These cries are difficult to ignore, as Thomas will often need to have his incontinence pad changed at this time, and his mother is becoming increasingly concerned about night-time seizures. He often comes downstairs to play with his toys and watch television but will then refuse to go back upstairs to sleep. Trying to encourage a bedtime routine for Thomas to stay in his bedroom when he wakes at 11pm has been difficult. If Thomas is discouraged from leaving his bedroom, this results in tearful outbursts, banging furniture, slamming doors and disturbed sleep for Thomas's older brother. Thomas's parents no longer encourage a bedtime routine after waking and will allow Thomas to stay downstairs with them until he falls asleep. At this point, Thomas is carried upstairs to bed by one of his parents, which is becoming increasingly difficult to manage as Thomas is getting bigger and older. Remaining downstairs after waking is reinforcing for Thomas as he enjoys this additional time playing downstairs. Positive reinforcement has increased the likelihood of Thomas showing bedtime resistance whenever his parents initiated a bedtime routine after waking. By allowing Thomas to fall asleep downstairs, his parents may have unintentionally reinforced bedtime resistance. This reinforcement cycle is also mutually reinforcing for them, as Thomas does not destroy his bedroom every night, and his older brother can sleep relatively undisturbed upstairs. Via means of negative reinforcement, Thomas's bedtime resistance removes the demands of a bedtime routine and in turn, leads to a reduction in externalising behaviours. A learned association has been established that it is rewarding for Thomas and his parents but will become increasingly difficult to maintain into his adult years.

Formulation: Priorities for Intervention

Case formulations are particularly useful when the relationship between diagnosis and intervention is not necessarily apparent. For children with developmental delay experienc-

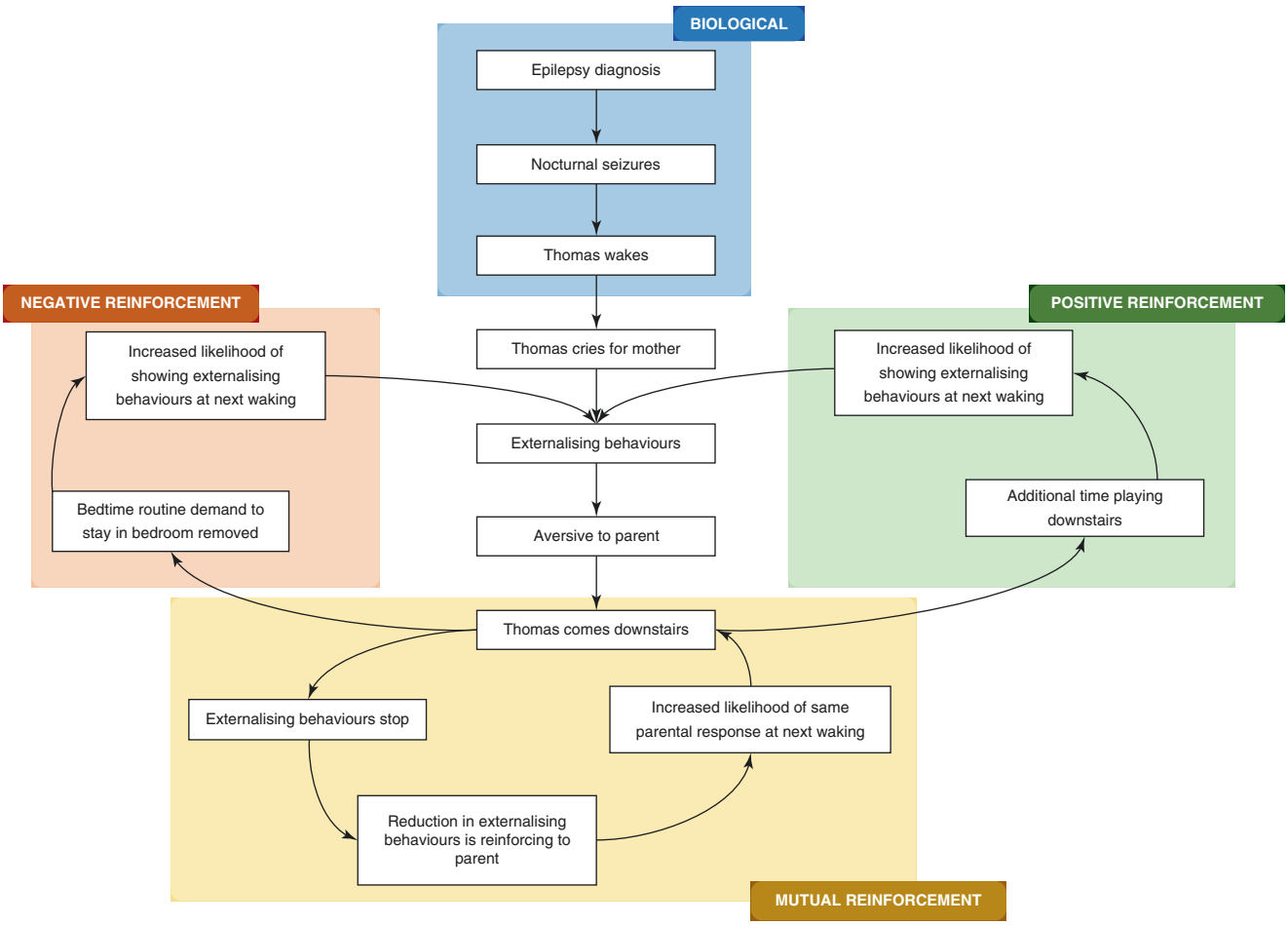

Fig. 55.3 Potential biological and behavioural models for Thomas's presenting sleep problems

ing sleep problems, a case formulation links probable causes, contextual factors and intervention pathways. Clinicians should consider which perpetuating factors are present and absent in an individual case when determining priorities for treatment, and equally which protective factors could be successfully implemented into an effective treatment programme for sleep. There are a number of important aspects that will influence the therapeutic benefit to both the individual and their caregivers in a sleep formulation. Clinicians should aim to:

1. Establish realistic goal setting and treatment aims with families to manage the overall complexity of the sleep problem and intervention programme (e.g. reducing wake after sleep onset as opposed to increasing overall sleep duration).
2. Determine capacities in the system to implement a suggested intervention (e.g. caregiver availability, service provision and educational support) and potential barriers to treatment in relation to both access to services and demands within the family setting (e.g. prescription of melatonin, sleeping arrangements within the family home).
3. Consider which factors are exacerbating or maintaining poor sleep (e.g. early morning waking, settling difficulties and self-injurious behaviours) as an initial focus for treatment interventions.
4. Assess and treat comorbid health conditions as a matter of priority, to alleviate the potential underlying role pain and respiratory factors may be having in relation to poor sleep.

Additional information for Thomas is presented below, which may be important when formulating treatment objectives. Some goal-setting targets and treatment priorities are presented in Fig. 55.4, as a guide for researchers and clinicians to use when initially confronted with a complex presentation of sleep problems and adaptive functioning deficits.

In addition to bedtime resistance, Thomas wakes very early each morning around 4am. He is often unable to return to sleep upon waking, and will damage furniture, climb fur-

1. Realistic goal-setting and treatment aims

- Need to take into account severe ID and level of verbal ability when introducing behavioural interventions
- Feasibilty of prolonging sleep until 6am as a treatment objective
- Suitability of proposed intervention for initial waking at 11pm (Thomas does not appear sleepy)
- Specificity of caregiver attention directed towards the mother at initial waking needs to be taken into account
- Interventions need to be appropriate for an older male transitioning through adolescence

2. System capacities and potential barriers to treatment

- Additional support from behavioural services has not targeted all aspects of waking behaviour (Thomas's vocal outbursts)
- Family do not currently have access to overnight respite
- Treatment objectives need to take into account the sleep needs of Thomas's older brother
- Treatment objectives need to take into account Thomas's safety (risk of overnight seizures) and level of caregiver burden (family work full-time)

3. Factors exacerbating or maintaining poor sleep

- Some aspects of bedtime resistance may be maintained by behavioural reinforcement cycles
- Suitability of prescribed melation use and dose
- Incontinence at night may be considered atreatment priority
- Possibility of sleep-related abxiety at initial waking underlying self-injurous behaviours and vocal outbursts

4. Treatment of comorbid health conditions

- Consult Thomas's neurologist to explore changes in epilepsy profile and current suitability of anti-epileptic medication and dose
- Need to rule out the possibility of comorbid painful health conditions with paediatrician or general practitioner, such as reflux, constipation, or ear infections
- Explore possibility that discomfort associated with incontinence rash may be linked to initial waking

Fig. 55.4 Priorities for intervention in a treatment formulation for Thomas's presenting sleep problems

niture, hit his head against the walls and floor and cry out for his mother. The family has been advised to remove all furniture and toys to reduce levels of behaviour and self-injury. However, Thomas's vocal outbursts and crying upon final waking are difficult to ignore. Thomas's mother uses video recording to monitor his night-time activity, and will wake with him at 4am, to limit waking of other family members. This arrangement is becoming increasingly difficult to manage, as his mother works full-time, and the family does not currently have access to overnight respite. Although Thomas is on a 3mg prescription of melatonin, this has not improved Thomas's early morning waking time. The family has been referred to social services for additional support, given the complexity of Thomas's night-time behaviours and daytime aggressive outbursts both at home and at school. Thomas's SEN school have a good relationship with the family and incorporate a daytime nap into his school routine at 11am. The family is keen to establish a routine that would allow the family to sleep until 6am, although it is unlikely that Thomas's sleep cycle will stretch to this.

Intervention

Sleep Hygiene

Promotion of good sleep hygiene practices facilitates the onset of sleep, specifically in relation to increasing predictability of bedtime routines and decreasing external environmental stimulation, outlined in more detail by Jan et al. [95]. It is important to note that a specific sleep disorder that is biological in nature (e.g. inverted circadian release of melatonin) may not in itself be adequately treated with behavioural sleep hygiene practices [95]. A meta-analysis of cohort and case studies pre- and post-intervention found structured bedtime routine practices to be most successful in relation to managing co-sleeping arrangements and improving sleep onset latency as opposed to improving total sleep duration or reducing the frequency of night-time wakings [96]. However, pharmacological interventions and psychological strategies may prove to be less effective if poor sleep habits are not first addressed [97, 98].

Sleep positioning (e.g. elevation of the head in a propped position to alleviate gastro-oesophageal reflux), breathable absorbent bedding, enclosed safety beds, limited access to electronic devices before bed, a sleep-conducive environment and bedtime routine, increased daytime physical exercise, reduced caffeine intake, and a consistent sleep/wake routine should be thoroughly considered as coherent sleep hygiene practices [95, 99]. However, clinicians need to be aware of the importance of modifying such behavioural techniques in children with developmental delay when they are based on TD sleep parameters and expectations. For example, the inverted melatonin secretion in Smith–Magenis syndrome evokes a significant need for daytime napping around mid-afternoon [100]. However, late afternoon naps are strongly discouraged in the TD sleep literature [99]. Therefore, some sleep hygiene strategies may not be successfully implemented without some degree of flexibility or adaptation. Individualised sleep programmes are preferred [101], and on a case-by-case basis, the potential benefits of accompanying behavioural programmes and medical interventions should be comprehensively explored.

Behavioural Interventions

Bedtime Fading

This is particularly useful when addressing problems relating to sleep onset latency and bedtime resistance and works by formulating an establishing operation for sleep by setting bedtime later in the evening when the individual is naturally tired, and gradually initiating bedtime earlier over time [101]. An establishing operation is formulated whereby tiredness increases the motivation to initiate the bedtime routine (e.g. being taken to the bedroom, being settled into bed), utilising sleep as the reinforcer with some efficacy in children with developmental delay [101].

Extinction and Graduated Extinction

Ignoring all nocturnal caregiver-seeking behaviours (extinction) and ignoring caregiver-seeking behaviours after a delayed interval that gradually increases over time (graduated extinction) are effective in response to settling and night-waking difficulties [101], and have been used with moderate success (see reviews by Lancioni, O'Reilly, & Basili [102] and Priday, Byrne, & Totsika [103]). However, practitioners need to be aware of the difficulties with implementing extinction-based approaches (e.g. caregiver distress in response to endured crying, caregiver availability and additional risks implementing a nocturnal behavioural intervention [104]). These are even more pertinent in children with developmental delay where additional health-related and physical considerations need to be taken into account (e.g. nocturnal seizures, monitoring night-time feeding equipment, toileting needs), as well as the increased risk of an extinction burst associated with severe self-injurious behaviours [105]. Under such circumstances, the combination of bedtime fading and extinction-based approaches may be beneficial to both increase the homeostatic drive for sleep and decrease the presentation of severe challenging behaviours.

Medical Interventions

As discussed previously, pain and discomfort may underlie the presentation of poor sleep [18] and, thus, the use of appropriate interventions should be considered early in the treatment process (e.g. the use of analgesics such as paracetamol to treat pain and a proton pump inhibitor to treat gastro-oesophageal reflux). However, practitioners should be aware that medication to treat some comorbid health conditions have side effects relating to sleep disturbance, such as the use of anti-epileptic medications [106]. If certain medications are known to exacerbate sleep problems, practitioners should also consider regularly reviewing medication use and doses in concordance with measures of sleep quality (e.g. actigraphy). In certain situations where sleep difficulties may be related to a physical disorder, such as obstructive sleep apnoea in Down syndrome [107], other medical interventions like Continuous Positive Airways Pressure (CPAP) or an adenotonsillectomy may be indicated [108]. Likewise, restless legs syndrome that may cause sleep disturbance can be treated with oral iron supplementation [109].

Although over-the-counter non-prescribed antihistamines are commonly used in the treatment of paediatric insomnia [110], there is limited literature exploring their utility in known syndrome groups. The long-term administration of antihistamines as a sleep aid is strongly discouraged [111], as common adverse side effects of antihistamines include: blurred vision, constipation, urinary retention, headaches and nausea [112]. These may be particularly difficult to monitor and treat in children with developmental delay. Other medications used to treat insomnia in children with developmental delay, such as clonidine and benzodiazepines, have been rated as having moderate effectiveness and very weak effects, respectively [96]. Additionally, children with developmental disabilities are at higher risk for paradoxical disinhibition when taking benzodiazepines [113].

Much of the recent literature has focused on the potential benefits of melatonin as a pharmacotherapy to aid sleep. A number of clinical reviews, meta-analyses and randomised controlled trials have explored its effectiveness (see [114] for a review of the literature), with significant reductions in sleep onset latency reported, but minimal improvements to overall sleep duration when using the immediate-release form of melatonin [115]. General consensus appears to suggest that the use of melatonin in children with developmental delay and adults with ID: (1) is more effective in cohorts experiencing severe sleep problems [116], (2) does not appear to cause severe adverse side effects, but should be closely monitored when co-administered with other medications [117] and (3) is particularly effective when targeting settling problems and delayed sleep phase disorders, but demonstrates little efficacy for night waking or early morning waking when using the immediate-release form of melatonin [115]. More recently, a clinical trial investigating the efficacy and safety of a specific paediatric prolonged-release form of melatonin demonstrated improvements in sleep latency and total sleep time without inducing early morning waking [118]. Importantly, almost half of caregivers reported a significant improvement in their quality of life.

In the UK, this paediatric prolonged-release formulation of melatonin has recently been licensed to treat insomnia in children and adolescents aged 2–17 with autism and/or Smith–Magenis syndrome, where sleep hygiene measures have been insufficient [118]. In the USA, there are concerns that over-the-counter formulations vary markedly in their

melatonin content and bioavailability [119]. Therefore, there is currently limited available literature on the effective dose or recommended longevity of treatment for melatonin as a sleep aid for children and adolescents. Clinicians should consider its use on an individual basis, taking into account co-existing health problems and medication use, and its potential usefulness in combination with behavioural interventions where possible.

Conclusions

The presentation of sleep problems associated with developmental delay is complex and depends on a multitude of comorbid and contextual factors, in addition to known biological mechanisms. Although some diagnosed sleep disorders are more prevalent in certain syndrome groups, comorbid and contextual factors increase the heterogeneity of sleep disorder symptomatology. Clinicians should therefore be mindful of the contribution of clinical and psychological diagnoses, but also consider the relative contribution of individual factors that may influence sleep architecture and associated behaviours. Both biological and behavioural models are important when formulating treatment options, and a particular emphasis should be given to the needs, expectations and capacities of caregivers and families when treatment plans are introduced. It is often the case that the child with developmental delay may not themselves perceive their sleep to be problematic (e.g. caregiver-seeking behaviours during night-time waking), but it is recognised as particularly detrimental to caregivers and families. With this in mind, the importance of realistic goal setting and collaborative treatment objectives with families should not be underestimated.

References

1. Moeschler JB, Shevell M. Comprehensive evaluation of the child with intellectual disability or global developmental delays. Pediatr. 2014;134(3):e903–18.
2. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Arlington: American Psychiatric Publication; 2013.
3. Krakowiak P, Goodlin-Jones BE, Hertz-Picciotto IR, Croen LA, Hansen RL. Sleep problems in children with autism spectrum disorders, developmental delays, and typical development: a population-based study. J Sleep Res. 2008;17(2):197–206.
4. Polimeni MA, Richdale AL, Francis AJ. A survey of sleep problems in autism, Asperger's disorder and typically developing children. J Intellect Disabil Res. 2005;49(4):260–8.
5. Bartlett LB, Rooney V, Spedding S. Nocturnal difficulties in a population of mentally handicapped children. Brit J Ment Subnorm. 1985;31(60):54–9.
6. Clements J, Wing L, Dunn G. Sleep problems in handicapped children: a preliminary study. J Child Psychol Psyc. 1986;27(3):399–407.
7. Owens J. Classification and epidemiology of childhood sleep disorders. Sleep Med Clin. 2007;2:353–61.
8. Kahn A, Van de Merckt C, Rebuffat E, Mozin MJ, Sottiaux M, Blum D, Hennart P. Sleep problems in healthy preadolescents. Pediatr. 1989;84(3):542–6.
9. American Academy of Sleep Medicine. International classification of sleep disorders. 3rd ed. Darien: American Academy of Sleep Medicine; 2014.
10. Maas AP, Didden R, Korzilius H, Curfs LM. Exploration of differences in types of sleep disturbance and severity of sleep problems between individuals with Cri du Chat syndrome, Down's syndrome, and Jacobsen syndrome: a case control study. Res Dev Disabil. 2012;33(6):1773–9.
11. Richdale AL, Baker EK. Sleep in individuals with an intellectual or developmental disability: recent research reports. Curr Dev Disord Reports. 2014;1(2):74–85.
12. Surtees AD, Oliver C, Jones CA, Evans DL, Richards C. Sleep duration and sleep quality in people with and without intellectual disability: a meta-analysis. Sleep Med Rev. 2018;40:135–50.
13. Hartshorne TS, Heussler HS, Dailor AN, Williams GL, Papadopoulos D, Brandt KK. Sleep disturbances in CHARGE syndrome: types and relationships with behavior and caregiver Well-being. Dev Med Child Neurol. 2009;51:143–50.
14. Mannion A, Leader G, Healy O. An investigation of comorbid psychological disorders, sleep problems, gastrointestinal symptoms and epilepsy in children and adolescents with autism spectrum disorder. Res Autism Spectr Disord. 2013;7:35–42.
15. Weckwerth SA, Weckwerth GM, Ferrairo BM, Chicrala GM, Ambrosio AM, Toyoshima GH, et al. Parents' perception of dental caries in intellectually disabled children. Spec Care Dentist. 2016;36:300–6.
16. Long AC, Krishnamurthy V, Palermo TM. Sleep disturbances in school-age children with chronic pain. J Pediatr Psychol. 2007;33:258–68.
17. Moldofsky H. Sleep and pain. Sleep Med Rev. 2001;5:385–96.
18. Breau LM, Camfield CS. Pain disrupts sleep in children and youth with intellectual and developmental disabilities. Res Dev Disabil. 2011;32:2829–40.
19. De Leersnyder H, de Blois MC, Claustrat B, Romana S, Albrecht U, von Kleist-Retzow JC, et al. Inversion of the circadian rhythm of melatonin in the Smith-Magenis syndrome. J Pediatr. 2001;139:111–6.
20. Potocki L, Glaze D, Tan DX, Park SS, Kashork CD, Shaffer LG, et al. Circadian rhythm abnormalities of melatonin in Smith-Magenis syndrome. J Med Genet. 2000;37:428–33.
21. Gropman AL, Duncan WC, Smith AC. Neurologic and developmental features of the Smith-Magenis syndrome (del 17p11. 2). Pediatr Neurol. 2006;34:337–50.
22. Smith AC, Dykens E, Greenberg F. Sleep disturbance in Smith-Magenis syndrome (del 17 p11. 2). Am J Med Genet. 1998;81:186–91.
23. Trickett J, Heald M, Oliver C, Richards C. A cross-syndrome cohort comparison of sleep disturbance in children with Smith-Magenis syndrome, Angelman syndrome, autism spectrum disorder and tuberous sclerosis complex. J Neurodev Disord. 2018;10:9.
24. Bruni O, Ferri R, D'Agostino G, Miano S, Roccella M, Elia M. Sleep disturbances in Angelman syndrome: a questionnaire study. Brain and Development. 2004;26:233–40.

25. Miano S, Bruni O, Leuzzi V, Elia M, Verrillo E, Ferri R. Sleep polygraphy in Angelman syndrome. Clin Neurophysiol. 2004;115:938–45.
26. Espie CA, Watkins J, Curtice L, Espie A, Duncan R, Ryan JA, et al. Psychopathology in people with epilepsy and intellectual disability; an investigation of potential explanatory variables. J Neurol Neurosurg Psychiatry. 2003;74:1485–92.
27. Espie CA, Paul A, McFie J, Amos P, Hamilton D, McColl JH, Tarassenko L, Pardey J. Sleep studies of adults with severe or profound mental retardation and epilepsy. Am J Ment Retard. 1998;103:47–59.
28. Miano S, Bruni O, Aricò D, Elia M, Ferri R. Polysomnographic assessment of sleep disturbances in children with developmental disabilities and seizures. Neurol Sci. 2010;31:575–83.
29. Bazil CW. Epilepsy and sleep disturbance. Epilepsy Behav. 2003;4:39–45.
30. Malow BA. Sleep disorders, epilepsy, and autism. Ment Retard Dev Disabil Res Rev. 2004;10:122–5.
31. Shouse MN, Scordato JC, Farber PR. Sleep and arousal mechanisms in experimental epilepsy: epileptic components of NREM and antiepileptic components of REM sleep. Ment Retard Dev Disabil Res Rev. 2004;10:117–21.
32. Perucca P, Gilliam FG. Adverse effects of antiepileptic drugs. Lancet Neurol. 2012;11:792–802.
33. Legros B, Bazil CW. Effects of antiepileptic drugs on sleep architecture: a pilot study. Sleep Med. 2003;4:51–5.
34. Cooray SE, Bakala A. Anxiety disorders in people with learning disabilities. Adv Psychiatr Treat. 2005;11:355–61.
35. Cooper SA, Smiley E, Morrison J, Williamson A, Allan L. An epidemiological investigation of affective disorders with a population-based cohort of 1023 adults with intellectual disabilities. Psychol Med. 2007;37:873–82.
36. Alfano CA, Ginsburg GS, Kingery JN. Sleep-related problems among children and adolescents with anxiety disorders. J Am Acad Child Adolesc Psychiatry. 2007;46:224–32.
37. Fuller KH, Waters WF, Binks PG, Anderson T. Generalized anxiety and sleep architecture: a polysomnographic investigation. Sleep. 1997;20:370–6.
38. Liu X, Buysse DJ, Gentzler AL, Kiss E, Mayer L, Kapornai K, et al. Insomnia and hypersomnia associated with depressive phenomenology and comorbidity in childhood depression. Sleep. 2007;30:83–90.
39. Mazurek MO, Petroski GF. Sleep problems in children with autism spectrum disorder: examining the contributions of sensory over-responsivity and anxiety. Sleep Med. 2015;16:270–9.
40. Rzepecka H, McKenzie K, McClure I, Murphy S. Sleep, anxiety and challenging behaviour in children with intellectual disability and/or autism spectrum disorder. Res Dev Disabil. 2011;32:2758–66.
41. Maaskant M, van de Wouw E, van Wijck R, Evenhuis HM, Echteld MA. Circadian sleep–wake rhythm of older adults with intellectual disabilities. Res Dev Disabil. 2013;34:1144–51.
42. Mayes SD, Calhoun SL. Variables related to sleep problems in children with autism. Res in Autism Spectr Disord. 2009;3:931–41.
43. Flynn S, Vereenooghe L, Hastings RP, Adams D, Cooper SA, Gore N, et al. Measurement tools for mental health problems and mental well-being in people with severe or profound intellectual disabilities: a systematic review. Clin Psych Rev. 2017;57:32–44.
44. Pagel JF, Parnes BL. Medications for the treatment of sleep disorders: an overview. Prim Care Companion J Clin Psychiatry. 2001;3:118.
45. Grimsley SR, Jann MW. Paroxetine, sertraline, and fluvoxamine: new selective serotonin reuptake inhibitors. Clin Pharm. 1992;11:930–57.
46. Chakrabarti S, Fombonne E. Pervasive developmental disorders in preschool children. JAMA. 2001;285:3093–9.
47. Tonnsen BL, Boan AD, Bradley CC, Charles J, Cohen A, Carpenter LA. Prevalence of autism spectrum disorders among children with intellectual disability. Am J Intellect Dev Disabil. 2016;121:487–500.
48. Souders MC, Zavodny S, Eriksen W, Sinko R, Connell J, Kerns C, et al. Sleep in children with autism spectrum disorder. Curr Psychiatry Rep. 2017;19:34.
49. Cotton S, Richdale A. Brief report: parental descriptions of sleep problems in children with autism, Down syndrome, and Prader–Willi syndrome. Res Dev Disabil. 2006;27:151–61.
50. Giannotti F, Cortesi F, Cerquiglini A, Miraglia D, Vagnoni C, Sebastiani T, et al. An investigation of sleep characteristics, EEG abnormalities and epilepsy in developmentally regressed and non-regressed children with autism. J Autism Dev Disord. 2008;38:1888–97.
51. Baker BL, Neece CL, Fenning RM, Crnic KA, Blacher J. Mental disorders in five-year-old children with or without developmental delay: focus on ADHD. J Clin Child Adolesc Psychol. 2010;39:492–505.
52. Wajszilber D, Santiseban JA, Gruber R. Sleep disorders in patients with ADHD: impact and management challenges. Nat Sci Sleep. 2018;10:453.
53. Van der Heijden KB, Smits MG, Someren EJ, Boudewijn Gunning W. Idiopathic chronic sleep onset insomnia in attention-deficit/hyperactivity disorder: a circadian rhythm sleep disorder. Chronobiol Int. 2005;22:559–70.
54. Picchietti DL, Walters AS. Restless legs syndrome and periodic limb movement disorder in children and adolescents: comorbidity with attention-deficit hyperactivity disorder. Child Adolesc Psychiatr Clin N Am. 1996;5:729–40.
55. Gaultney JF, Terrell DF, Gingras JL. Parent-reported periodic limb movement, sleep disordered breathing, bedtime resistance behaviors, and ADHD. Behav Sleep Med. 2005;3:32–43.
56. Mayes SD, Calhoun SL, Bixler EO, Vgontzas AN, Mahr F, Hillwig-Garcia J, et al. ADHD subtypes and comorbid anxiety, depression, and oppositional-defiant disorder: differences in sleep problems. J Pediatr Psychol. 2008;34:328–37.
57. Simonoff E, Pickles A, Wood N, Gringras P, Chadwick O. ADHD symptoms in children with mild intellectual disability. J Am Acad Child Adolesc Psychiatry. 2007;46:591–600.
58. Stein MA, Weiss M, Hlavaty L. ADHD treatments, sleep, and sleep problems: complex associations. Neurotherapeutics. 2012;9:509–17.
59. Adams HL, Matson JL, Jang J. The relationship between sleep problems and challenging behavior among children and adolescents with autism spectrum disorder. Res Autism Spectr Disord. 2014;8:1024–30.
60. Didden R, Korzilius HP, Aperlo BV, Overloop CV, Vries MD. Sleep problems and daytime problem behaviours in children with intellectual disability. J Intellect Disabil Res. 2002;46:537–47.
61. Wiggs L, Stores G. Severe sleep disturbance and daytime challenging behaviour in children with severe learning disabilities. J Intellect Disabil Res. 1996;40:518–28.
62. Gallagher S, Phillips AC, Carroll D. Parental stress is associated with poor sleep quality in parents caring for children with developmental disabilities. J Pediatr Psychol. 2009;35:728–37.
63. Goldman SE, Bichell TJ, Surdyka K, Malow BA. Sleep in children and adolescents with Angelman syndrome: association with parent sleep and stress. J Intellect Disabil Res. 2012;56:600–8.
64. Richdale A, Francis A, Gavidia-Payne S, Cotton S. Stress, behaviour, and sleep problems in children with an intellectual disability. J Intellect Develop Disabil. 2000;25:147–61.
65. Keilty K, Cohen E, Ho M, Spalding K, Stremler R. Sleep disturbance in family caregivers of children who depend on medi-

cal technology: a systematic review. J Pediatr Rehabil Med. 2015;8:113–30.
66. Hemmingsson H, Stenhammar AM, Paulsson K. Sleep problems and the need for parental night-time attention in children with physical disabilities. Child Care Health Dev. 2009;35:89–95.
67. Clements J, Wing L, Dunn G. Sleep problems in handicapped children: a preliminary study. J Child Psychol Psychiatry. 1986;27:399–407.
68. Moore M, Evans V, Hanvey G, Johnson C. Assessment of sleep in children with autism spectrum disorder. Children. 2017;4:72.
69. Spruyt K, Gozal D. Pediatric sleep questionnaires as diagnostic or epidemiological tools: a review of currently available instruments. Sleep Med Rev. 2011;15:19–32.
70. Simonds JF, Parraga H. Prevalence of sleep disorders and sleep behaviors in children and adolescents. J Am Acad Child Adolesc Psychiatry. 1982;21:383–8.
71. Johnson CR, Turner KS, Foldes EL, Malow BA, Wiggs L. Comparison of sleep questionnaires in the assessment of sleep disturbances in children with autism spectrum disorders. Sleep Med. 2012;13:795–801.
72. Wiggs L, Stores G. Sleep patterns and sleep disorders in children with autistic spectrum disorders: insights using parent report and actigraphy. Dev Med Child Neurol. 2004;46:372–80.
73. Owens JA, Spirito A, McGuinn M. The Children's sleep habits questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. Sleep. 2000;23:1043–52.
74. Annaz D, Hill CM, Ashworth A, Holley S, Karmiloff-Smith A. Characterisation of sleep problems in children with Williams syndrome. Res Dev Disabil. 2011;32:164–9.
75. Doo S, Wing YK. Sleep problems of children with pervasive developmental disorders: correlation with parental stress. Dev Med Child Neurol. 2006;48:650–5.
76. Hering E, Epstein R, Elroy S, Iancu DR, Zelnik N. Sleep patterns in autistic children. J Autism Dev Disord. 1999;29:143–7.
77. Ashworth A, Hill CM, Karmiloff-Smith A, Dimitriou D. Cross syndrome comparison of sleep problems in children with down syndrome and Williams syndrome. Res Dev Disabil. 2013;34:1572–80.
78. Gibbs S, Wiltshire E, Elder D. Nocturnal sleep measured by actigraphy in children with Prader-Willi syndrome. J Pediatr. 2013;162:765–9.
79. Anderson KN, Pilsworth S, Jamieson S, Ray J, Shneerson JM, Lennox GG. Sleep disturbance in adults with Angelman syndrome. Sleep Biol Rhythms. 2008;6:95–101.
80. Fawkes DB, Malow BA, Weiss SK, Reynolds AM, Loh A, Adkins KW, Wofford DD, Wyatt AD, Goldman SE. Conducting actigraphy research in children with neurodevelopmental disorders – a practical approach. Behav Sleep Med. 2015;13:181–96.
81. Sadeh A. The role and validity of actigraphy in sleep medicine: an update. Sleep Med Rev. 2011;15:259–67.
82. Tryon WW. Issues of validity in actigraphic sleep assessment. Sleep. 2004;27:158–65.
83. Surtees AD, Richards C, Clarkson EL, Heald M, Trickett J, Denyer H, Crawford H, Oliver C. Sleep problems in autism spectrum disorders: a comparison to sleep in typically developing children using actigraphy, diaries and questionnaires. Res Autism Spectr Disord. 2019;67:101439.
84. Honomichl RD, Goodlin-Jones BL, Burnham MM, Hansen RL, Anders TF. Secretin and sleep in children with autism. Child Psychiatry Hum Dev. 2002;33:107–23.
85. Ipsiroglu OS, Hung YH, Chan F, Ross ML, Veer D, Soo S, et al. "Diagnosis by behavioral observation" home-videosomnography – a rigorous ethnographic approach to sleep of children with neurodevelopmental conditions. Front Psych. 2015;6:39.
86. Jafari B, Mohsenin V. Polysomnography. Clin Chest Med. 2010;31:287–97.
87. Thirumalai SS, Shubin RA, Robinson R. Rapid eye movement sleep behavior disorder in children with autism. J Child Neurol. 2002;17:173–8.
88. Dyken ME, Lin-Dyken DC, Poulton S, Zimmerman MB, Sedars E. Prospective polysomnographic analysis of obstructive sleep apnea in down syndrome. Arch Pediatr Adoles Med. 2003;157:655–60.
89. Elia M, Ferri R, Musumeci SA, Del Gracco S, Bottitta M, Scuderi C, et al. Sleep in subjects with autistic disorder: a neurophysiological and psychological study. Brain and Development. 2000;22:88–92.
90. Malow BA, Marzec ML, McGrew SG, Wang L, Henderson LM, Stone WL. Characterizing sleep in children with autism spectrum disorders: a multidimensional approach. Sleep. 2006;29:1563–71.
91. Miano S, Bruni O, Elia M, Trovato A, Smerieri A, Verrillo E, et al. Sleep in children with autistic spectrum disorder: a questionnaire and polysomnographic study. Sleep Med. 2007;9:64–70.
92. Van De Water AT, Holmes A, Hurley DA. Objective measurements of sleep for non-laboratory settings as alternatives to polysomnography–a systematic review. J Sleep Res. 2011;20:183–200.
93. Crowe M, Carlyle D, Farmar R. Clinical formulation for mental health nursing practice. J Psychiatr Ment Health Nurs. 2008;15:800–7.
94. Richdale AL, Schreck KA. Sleep problems in autism spectrum disorders: prevalence, nature, and possible biopsychosocial aetiologies. Sleep Med Rev. 2009;13:403–11.
95. Jan JE, Owens JA, Weiss MD, Johnson KP, Wasdell MB, Freeman RD, et al. Sleep hygiene for children with neurodevelopmental disabilities. Pediatr. 2008;122:1343–50.
96. Cuomo BM, Vaz S, Lee EA, Thompson C, Rogerson JM, Falkmer T. Effectiveness of sleep-based interventions for children with autism spectrum disorder: a meta-synthesis. Pharmacotherapy: J Hum Pharmacol Drug Ther. 2017;37:555–78.
97. Weiss MD, Wasdell MB, Bomben MM, Rea KJ, Freeman RD. Sleep hygiene and melatonin treatment for children and adolescents with ADHD and initial insomnia. J Am Acad Child Adolesc Psychiatry. 2006;45:512–9.
98. Morin CM, Culbert JP, Schwartz SM. Nonpharmacological interventions for insomnia: a meta-analysis of treatment efficacy. Am J Psychiatr. 1994;151:1172–80.
99. Heussler HS. Common causes of sleep disruption and daytime sleepiness: childhood sleep disorders II. Med J Aust. 2005;182:484–9.
100. Girirajan S, Elsas LJ, Devriendt K, Elsea SH. RAI1 variations in Smith–Magenis syndrome patients without 17p11. 2 deletions. J Med Genet. 2005;42:820–8.
101. Didden R, Sigafoos J. A review of the nature and treatment of sleep disorders in individuals with developmental disabilities. Res Dev Disabil. 2001;22:255–72.
102. Lancioni GE, O'Reilly MF, Basili G. Review of strategies for treating sleep problems in persons with severe or profound mental retardation or multiple handicaps. Am J Ment Retard. 1999;104:170–86.
103. Priday LJ, Byrne C, Totsika V. Behavioural interventions for sleep problems in people with an intellectual disability: a systematic review and meta-analysis of single case and group studies. J Intellect Disabil Res. 2017;61:1–5.
104. Etherton H, Blunden S, Hauck Y. Discussion of extinction-based behavioral sleep interventions for young children and reasons why parents may find them difficult. J Clin Sleep Med. 2016;12:1535–43.

105. Pace GM, Iwata BA, Cowdery GE, Andree PJ, McIntyre T. Stimulus (instructional) fading during extinction of self-injurious escape behavior. J Appl Behav Anal. 1993;26:205–12.
106. Jain SV, Glauser TA. Effects of epilepsy treatments on sleep architecture and daytime sleepiness: an evidence-based review of objective sleep metrics. Epilepsia. 2014;55:26–37.
107. Marcus CL, Keens TG, Bautista DB, von Pechmann WS, Ward SL. Obstructive sleep apnea in children with down syndrome. Pediatrics. 1991;88:132–9.
108. Dehlink E, Tan HL. Update on paediatric obstructive sleep apnoea. J Thorac Dis. 2016;8:224–35.
109. Wang J, O'Reilly B, Venkataraman R, Mysliwiec V, Mysliwiec A. Efficacy of oral iron in patients with restless legs syndrome and a low-normal ferritin: a randomized, double-blind, placebo-controlled study. Sleep Med. 2009;10:973–5.
110. Owens JA, Moturi S. Pharmacologic treatment of pediatric insomnia. Child Adolesc Psychiatr Clin N Am. 2009;18:1001–16.
111. Simons FE. Non-cardiac adverse effects of antihistamines (H1-receptor antagonists). Clin Exp Allergy. 1999;29:125–32.
112. Howland RH. Potential adverse effects of discontinuing psychotropic drugs - part 1: adrenergic, cholinergic, and histamine drugs. J Psychosoc Nurs Ment Health Serv. 2010;48:11–4.
113. Paton C. Benzodiazepines and disinhibition: a review. Psychiatr Bull. 2002;26:460–2.
114. Sajith SG, Clarke D. Melatonin and sleep disorders associated with intellectual disability: a clinical review. J Intellect Disabil Res. 2007;51:2–13.
115. Gringras P, Gamble C, Jones AP, Wiggs L, Williamson PR, Sutcliffe A, et al. Melatonin for sleep problems in children with neurodevelopmental disorders: randomised double masked placebo controlled trial. BMJ. 2012;345:e6664.
116. Turk J. Melatonin supplementation for severe and intractable sleep disturbance in young people with genetically determined developmental disabilities: short review and commentary. J Med Genet. 2003;40:793–6.
117. Arendt J. Safety of melatonin in long-term use (?). J Biol Rhythm. 1997;12:673–81.
118. Schroder CM, Malow BA, Maras A, Melmed RD, Findling RL, Breddy J, et al. Pediatric prolonged-release melatonin for sleep in children with autism spectrum disorder: impact on child behavior and caregiver's quality of life. J Autism Dev Disord. 2019;49:3218–30.
119. Laforce R, Rigozzi K, Paganetti M, Mossi W, Guainazzi P, Calderari G. Aspects of melatonin manufacturing and requirements for a reliable active component. Neurosignals. 1999;8:143–6.
120. Agar G, Trickett J, Oliver C, Richards C. Sleep: a guide for parents. Carmarthen: Cerebra; 2017. p. 14.