Things that go bump in the night:
An Overview of Pediatric Sleep Disorders

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Today we will review the physiologic evolution of sleep in childhood, and then discuss disorders related to:

- Problems falling asleep
- Problems during sleep
- Excessive daytime sleepiness
DEVELOPMENT OF SLEEP IN CHILDHOOD SLEEP DISORDER ASSESSMENT
Sleep patterns evolve from birth to a typical day/night cycle in 4-6 months

N. Kleitman and TG Engelmann, 1953
Both sleeping and feeding evolve into a clear diurnal pattern over the first six months of life.
Generally, parent reports of sleep duration reduce with time

From Iglowstein et al 2003
Sleep needs change with time

• Pre-school (3 to 5 years)
  – Sleep needs: 11 to 12 hours per 24 hours
  – Naps: Decrease from one a day to none
  – Clinical Issues: Sleep onset and sleep maintenance problems common in this age group

• Pre-pubertal (6 to 12 years)
  – Sleep needs: 9 to 11 hours per 24 hours
  – Naps: Daytime naps are NOT normal at this age
  – Delayed sleep-wake timing – later bed times

• Teenagers
  – Sleep needs: 8.5-9.5 hours
  – Further physiologic delay in sleep onset
There is a two process model to explain why you fall asleep at night

1. Homeostatic sleep drive
2. Circadian drive
The homeostatic sleep drive increases the longer you are awake.
The circadian wakefulness drive keeps you awake in the late PM.
Estimated Prevalence of Sleep Disorders in Children

- Insufficient sleep – 10% (higher in teens – up to 33%)
  - Behaviorally based - 25%
- Sleep related breathing disorders - 2%
- Narcolepsy – 0.05%
- Sleep/wake timing (delayed sleep phase) - 7% teens
- Partial arousals (parasomnias)
  - Night terrors 2 - 3%
  - Sleep walking 5%
- Rhythmic movement disorder 3 -15%
- Restless leg syndrome 1% of children with moderate/severe symptoms 2 days/week
The primary tool of assessing these problems is the history you take in the office.

A useful screening algorithm is BEARS:

B = Bedtime problems

E = Excessive daytime sleepiness

A = Awakenings during the night

R = Regularity and duration of sleep.

S = Snoring

Various tools are used in the assessment of sleep disorders in children

**Sleep diaries**

**Actigraphy**

**Polysomnography**

- Subjective data about sleep wake patterns
- Objective data about sleep wake patterns
- Detailed cardiorespiratory, EEG, and leg movement data for ONE night
# Developmental Overview of Common Sleep Problems

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- **Newborn/Young Infant**: Usually normal development, self-limited, OSA
- **Older Infant & Toddler**: Night wakings, difficulty settling, night terrors, rhythmic movements, bedtime fears, OSA
- **Pre-schooler**: Night wakings, bedtime resistance, night terrors, sleep walking, RLS, rhythmic movements, bedtime fears, nightmares, OSA
- **School Age**: Insufficient sleep, bedtime resistance, sleep walking, enuresis, bruxism, OSA, RLS, psychophysiologic insomnia
- **Teenager**: Insufficient sleep, delayed sleep phase, narcolepsy, OSA, psychophysiologic insomnia
Estimated Prevalence of Sleep Disorders in Children

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PROBLEMS FALLING ASLEEP
Physiologic awakenings are common at night

Normal sleep architecture
Inappropriate sleep onset association disorder is *the* classic pediatric behavioral disorder. 

![Graph showing stages of sleep and sleep cycles with annotations.](image)
The limit setting subtype of behavioral insomnia is characterized by bedtime resistance and curtain calls. Bedtime may take an hour or more. Curtain calls are comprised of requests for attention, water, backrubs, etc. Sleep is not generally not disrupted once onset occurs in the pure limit setting type.
Nocturnal feedings can also lead to significant sleep disruption

N. Kleitman and TG Engelmann, 1953
Extinction is very effective but challenging for parents to implement.

Unmodified: Close the door and say goodnight.

Graduated extinction: The Ferber method.

Extinction with parental presence.
“Camping out” can work as well with slow withdrawal of parental presence.
Bedtime modifications are also important and can help extinction succeed

Positive bedtime routines and bedtime fading both entail transiently moving bedtime later to allow increased sleep drive to help with sleep onset.

The bedtime pass is a good first pass method for limit setting disorders.

Reinforcement e.g. sticker charts

Scheduled awakenings
Bedtime fading helps reduce insomnia and bedtime resistance
Why parents fail

![Graph showing Failure Types with axes for Duration, Temp, Perm, Scope, and None to All.]
Parental inconsistency tends to reinforce the behaviors that they are trying to extinguish.

Inconsistent reinforcement is very potent.
“Sneaky sleep” in the car, stroller, or wherever can reduce sleep drive at bedtime
The extinction burst is a well described behavioral phenomenon where a behavior worsens before it ceases.

The second night is frequently the worst, then things rapidly improve.
There is no evidence that sleep training harms children.

- AMH Price et al *Pediatrics* Sept 2012
  - There was no evidence that children who had sleep training in infancy had more emotional or behavioral problems in the children who were not.
  - There was no difference in the stress response (measured by cortisol) in the two groups.
  - There was no benefit to sleep training at six years of age either
  - For more on this: http://bit.ly/Q5qU2B
Rhythmic movement disorder is a common phenomenon in the first several years of life. There are head banging (jactatio capitis nocturna), rolling, and body rocking phenotypes. Onset is usually in infancy and it resolves by 5 years of age. Movement frequency is 0.5-2 Hz. Injury is rare.

Head banging video: [http://www.youtube.com/watch?v=7MR_2L oKdlg](http://www.youtube.com/watch?v=7MR_2L oKdlg)
Teens have a physiologic delay in their circadian clocks even as school gets earlier.
Inadequate sleep hygiene is most common in adolescents but may occur in small children in chaotic households.

- Late bedtime
- Late "catch up sleep" on weekends
- Caffeine intake/daytime napping
- Daytime sleepiness
- Short sleep during school week

Vicious cycle of adolescent sleep
Long naps reduce sleepiness at bedtime
Sleeping in on weekends can reduce drive for sleep on Sunday night
In delayed sleep phase syndrome, teens have severe delay of sleep onset.
Delayed Sleep Phase Syndrome is a common and under-recognized condition in teenagers.

- Later circadian melatonin phase
- Alert in the evening
- Sleep onset insomnia
- Morning sleepiness
- Difficulty awakening from sleep
- Delayed sleep time and reduced sleep duration during the school week

10 pm
1 am
6 am
Treating Adolescent Delayed Sleep Phase Syndrome

- Bright light exposure /exercise in the morning
- Darkness in the evening
- Pharmacologic treatment in the evening
  - Melatonin: 0.5 mg 4-5 prior to bedtime onset, 3-5 mg 30 min prior to bedtime
  - Hypnotics
- Chronotherapy
- CONSISTENT WAKE TIMES
Wakefulness Drive

Earlier sleep onset:
- Morning light exposure/exercise
- Melatonin several hours before bedtime

Later sleep onset:
- Onset of Puberty
- Evening light exposure
- Evening exercise
Pediatric Restless Leg Syndrome has a prevalence of 1.5-2%

NIH workshop criteria for the diagnosis of definite RLS in children and adolescents (adapted from Allen et al.

Diagnostic criteria for definite RLS in children 2–12 years old:
“Definite 1” RLS
A. All four adult essential criteria are met:
   1. An urge to move the legs;
   2. The urge to move begins or worsens when sitting or lying down;
   3. The urge to move is partially or totally relieved by movement;
   4. The urge to move is worse in the evening or night than during the day or only occurs in
B. The child uses his/her own words to describe leg discomfort.

or
“Definite 2” RLS
A. All four adult essential criteria are met, and
B. 2–3 supportive criteria are met:
   a. sleep disturbance inappropriate for age
   b. biological parent or sibling has definite RLS
   c. the child has a sleep study documenting a periodic limb movement index ≥5h of sleep

Diagnostic criteria for definite RLS in adolescents 13–18 years old:
All four adult essential criteria are met.

Picchietti Sleep Medicine 2010
Aleesha age 13yo. “It feels like I need to stretch my legs. My drawing is showing me being stretched out by ropes because I feel like I need to stretch my legs whenever I go to bed or if it’s late.”

Courtesy of the RLS Foundation
Jacob age 9: “Bugs crawling in my legs.”

Courtesy of the RLS Foundation
Sarah, age 10: “What I drew was saying that my top part of my body is relaxed and calm, but the bottom wants to run really bad.”
Pediatric RLS: Treatment

• Strict sleep hygiene is necessary to avoid sleep deprivation
• Limiting setting often required (day and at bedtime)
• Treatment of iron deficiency (ferritin <50-75 ng/mL)
• Medications:
  – Melatonin
  – Acetaminophen for growing pains
  – Clonidine
  – Gabapentin
  – Ropinerole/pramipexole
  – Benzodiazepenes
Psychophysiologic insomnia is characterized by anxiety about following asleep.

• DDx includes mood disorders, anxiety
• Treatment includes
  – Stimulus control
  – Bedtime restriction
  – +/- medication
Stimulus control is eliminating all activities in bed besides sleep

“To Keep Teenagers Alert, Let Them Sleep In” NY Times 3/13/14 http://nyti.ms/1dfDF5X
Sleep restriction is limiting time in bed to actual sleep time then slowly extending it

STRICT adherence to the schedule is necessary during the treatment period
Problems during sleep are also common in children.

Medical issues must be considered (e.g. asthma, reflux, pain, fever)

Disorders of sleep fragmentation such as PLMs or OSA may be a factor.

Sleep onset association problems are a frequent cause.

Episodic behaviors emerging from sleep are called parasomnias.
Parasomnias are divided into NREM and REM subtypes.

NREM based parasomnias tend to occur in the first half of the night. SLEEPWALKING, NIGHT TERRORS

REM based parasomnias (e.g. NIGHTMARES) tend to occur in the second half of the night.

Hill CM. Arch Dis Childhood 2007
Obstructive sleep apnea (OSA) is a very common disorder in children

- Snoring in children:
  - 7% - 10% Habitual snorers
  - 20% Intermittent snorers
- OSA – 1% to 3% of preschool children
- Peaks ages two to five years
- Gender distribution: M:F ratio approximately equal in children
- Prevalence is higher among African Americans
Obesity has a significant effect on OSA incidence and treatment

- Obesity and overweight are increasingly common (Ogden JAMA 2006)
  - BMI > 95% 16.3%
  - BMI > 85% 30.7%
- Obesity increases OSA is risk 4.5 times
- 1/3 of obese children have OSA
- >50% snoring obese children have OSA
- *Obesity and OSA track into adulthood*
Clinical Features

Nocturnal Symptoms

- Loud snoring
- Observed apneic pauses
- Snorting / gasping / choking
- Restless sleep
- Diaphoresis
- Paradoxical chest wall movement
- Abnormal sleeping position
- Secondary enuresis
Clinical Features

Diurnal Symptoms

- Daytime somnolence
- Behavioral / school problems
- Difficulty awakening in AM
- Morning headaches
- Nasal congestion
- Mouth breathing
Anatomical causes of ↑ airway resistance

Courtesy of Dr. Eliot Katz
Mallampati Classification
Pediatric Polysomnography

Documents arousals, parasomnias, abnormal sleeping position, and attends to any technical problem.
Central apnea

Obstructive Apnea

Hypopnea

Arousals

No Flow

Partial flow

Nasal pressure

Chest

Abdomen

Oximetry

No effort

Effort
Episodic obstruction | Gas exchange abnormalities | Sleep fragmentation
---|---|---
Diagnosis | AHI (events/h) | AHI, adult | SpO2 Nadir (%) | P_{ET}CO2 peak (torr) | P_{ET}CO2>50 torr (% TST) | Arousals (events/h)
Primary snoring | 1 | >92 | 53 | <10 | EEG<11
Upper Airway Resistance Syndrome | 1 | >92 | 53 | <10 | RERA>1 EEG>11
Obstructive Hypoventilation | 1 | 91 | >53 | >10 | Elevated
Mild OSA | 2-5* | 5-15 | 86-91 | >53 | 10-24 | EEG>11
Moderate OSA | 5-10 | 15-30 | 76-85 | >60 | 25-49 | EEG>11
Severe OSA | >10 | >30 | 75 | >65 | 50 | EEG>11

Each diagnosis requires one or more criteria to the right.

The upper limit of “normal” in AHI is not well defined. We use an obstructive AHI>2 to define OSA in our laboratory.
When to get polysomnography


1. PSG recommended for children with complex medical conditions including **obesity**, Down syndrome, craniofacial disorders, sickle cell disease, or mucopolysaccharidoses AND
2. Children where the need for surgery is unclear e.g. there is a discrepancy between tonsil size and symptoms
3. Polysomnographic results should be communicated to anesthesiologist prior to induction
4. Children with age <3 OR AHI >10 OR SpO2 nadir <80 should be observed overnight.
5. Laboratory polysomnography is preferable.

**Children age 3-6 with snoring and daytime symptoms should proceed directly to surgery.**
How well do current PSG parameters predict neurocognitive morbidity?

- Study of 113 children did not show that SDB measures predicted parent reported hyperactivity (Chervin RD et al. *SLEEP* (24) 2001)
- SDB on PSG present in subjects with mild but not severe hyperactivity (O’ Brien LM. *Pediatrics* (111) 2003).
How well do current PSG parameters predict neurocognitive morbidity?
How effective is adenotonsillectomy?

• Guilleminault prospectively studied 207 children who had TNA for OSA; 199 had follow up polysomnography.
• 94 had some degree of residual sleep apnea.
  – Correlates of residual disease included Mallampati 3 and 4, deviated septum, and enlarged nasal turbinates

A larger study of 578 patients also showed that OSA resolved in only 27.2% of patients.

In non-obese children, pre-AT AHI and asthma were mildly predictive of residual OSA.

Positive Airway Pressure
Rapid maxillary distraction improves OSA in patients in concert with adenotonsillectomy

Pirelli et al Sleep 2004
Figure 3—Posteroanterior cephalograms and cephalometric tracings before and after rapid maxillary expansion. The left image presents the anatomic structures before any distraction. As can be seen, the maxillary arch is narrow, the midpalatal suture cannot be seen, and the image of the inferior turbinate on the left is very close to the septum (*). On the right of the figure, the results at the end of the distraction can be seen: Note the anatomic changes—the skeletal expansion, caused by the maneuver, has opened the maxillary arch. The wide-open distractor (+) can be seen, and the midpalatal structure (*** is open. The inferior turbinate (**) on the left side is further apart from the septum compared to before treatment, indicating the changes that also occur in the nasal cavity. The drawing in between the 2 radiographs superimposes the 2 images to emphasize the pyriform opening and the widening of the nasal cavity with lateral and external displacement of the inferior nasal turbinates. The anatomic change occurs not only in the maxillary arch, but also in the nasal cavity.
DAYTIME MANIFESTATIONS OF SLEEP DISORDERS
Excessive daytime sleepiness is a major issue, especially in teenagers.

- Insufficient Sleep
- Fragmented Sleep
- Excessive sleep drive
- Circadian Rhythm Disorders

Other consequences of sleep deprivation include: decreased academic performance, increased appetite and insulin resistance, mood symptoms, etc.
Drowsy Driving and Auto Accidents

- The peak age for fall-asleep driving accidents is 20
- Drivers under 30 account for 2/3 of drowsy-driving crashes.
- The only “fixes” are naps and caffeine.
Although daytime sleepiness is common, primary disorders of increased sleep drive are rare.

Narcolepsy

Idiopathic hypersomnia

Post-concussive syndrome

Kleine-Levin syndrome
Narcolepsy

• Intrusion of sleep and REM sleep into wakefulness
  – Excessive daytime sleepiness
  – Cataplexy
  – Hypnagogic hallucinations
  – Sleep paralysis
  – Fragmented sleep

• Symptoms usually occur in the second decade

• Treatment includes stimulants, napping, and sodium oxybate
Narcolepsy Incidence by Age

Data from Silber et al 2002

In summary, sleep problems in childhood represent a heterogeneous group of disorders with substantial daytime morbidity

Careful history taking is often the key to diagnosis

Sleep studies are helpful to evaluate for disorders of sleep fragmentation not insomnia

Referral to a subspecialist may be helpful if the issues are complex or chronic

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Questions?