Objectives

- To review normal sleep in pediatrics
- To discuss the clinical features and management options for commonly encountered pediatric sleep disorders

Overview

- Normal sleep in Pediatrics
  - Sleep needs
  - Age-related changes
- Insomnia in Pediatrics
- Sleep related breathing disorders
  - Pediatric OSA
- Childhood parasomnias
  - NREM-related parasomnias
  - Confusional arousals
  - Sleep terrors
  - Sleepwalking
  - REM-related parasomnias
  - Nightmares
  - Other parasomnias
  - Sleep enuresis
  - Sleep related movement disorder
  - Restless legs syndrome

Normal Sleep in Pediatrics

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Nocturnal Sleep (Hours)</th>
<th>Daytime Sleep (Hours)</th>
<th>Total Sleep in 24 Hours (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn (0-2 mo)</td>
<td>8-10</td>
<td>8-10</td>
<td>16-20</td>
</tr>
<tr>
<td>Infant (2-12 mo)</td>
<td>9-13</td>
<td>Two 1-2 Hr naps</td>
<td>13-15</td>
</tr>
<tr>
<td>Toddler (12 mo-3 yr)</td>
<td>10-13</td>
<td>0.5-4 (1 nap/d)</td>
<td>12-14</td>
</tr>
<tr>
<td>Pre-School (3-5 yr)</td>
<td>10-13</td>
<td>0.7-3</td>
<td>11-13</td>
</tr>
<tr>
<td>School Age (6-12 yr)</td>
<td>10-11</td>
<td>0</td>
<td>10-11</td>
</tr>
<tr>
<td>Adolescent (13-18 yr)</td>
<td>9-9.5</td>
<td>0</td>
<td>9-9.5</td>
</tr>
</tbody>
</table>

**Age-related Changes of Parent Reported Sleep Duration**

![Graph showing age-related changes in sleep duration](image)


**Polysomnographically Determined Age-related Changes of Sleep Duration and Architecture**

![Graph showing polysomnographically determined changes](image)

Scholle S et al. Sleep Med 2011;12:542-9

**Age-related Changes in Napping Frequency and Duration**

![Graph showing age-related changes in napping frequency](image)


**Polysomnographic Characteristics of Normal Sleep in Young Children**

<table>
<thead>
<tr>
<th>Age</th>
<th>Background EEG Frequency</th>
<th>Sleep Onset Latency</th>
<th>REM cycle Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 5 years</td>
<td>6 – 7 Hz</td>
<td>15 – 30 min</td>
<td>40 – 60 min</td>
</tr>
<tr>
<td>Adult</td>
<td>8 – 12 Hz</td>
<td>15 min</td>
<td>90 min</td>
</tr>
</tbody>
</table>

Child data from Kahn et al 1996
Adult data from Ohayon et al 2004

**Normal Sleep in Children**

“First-night” Effect

- ↑ sleep onset latency
- ↑ wake after sleep onset
- ↓ sleep efficiency
- ↑ REM latency
- ↓ amount of REM sleep
- No significant difference in NREM sleep

Despite the first-night effect, the diagnosis of Obstructive Sleep Apnea in children can usually be reliably confirmed by one night of PSG


**Estimated Prevalence of Sleep Disorders in Children**

- Insufficient sleep – 10% (higher in teens – up to 33%)
- Insomnia – 10-30%
- Obstructive sleep apnea – 1-4%
- Parasomnias
  - Nightmares – 10-50%
  - Sleep terrors – 1-6.5%
  - Sleepwalking – 18.3%
  - Sleep enuresis – 15-20%
- Restless leg syndrome – 2-4%

International classification of sleep disorders. 3rd ed. 2014
Insomnia in Pediatrics

Developmental Overview of Common Non-respiratory Sleep Problems

<table>
<thead>
<tr>
<th>Newborn/ Young Infant</th>
<th>Older Infant &amp; Toddler</th>
<th>Pre-schooler</th>
<th>School Age</th>
<th>Teenager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually normal</td>
<td>Night wakings</td>
<td>Insufficient sleep</td>
<td>Insufficient sleep</td>
<td></td>
</tr>
<tr>
<td>Developmental</td>
<td>Difficulty settling</td>
<td>Bedtime resistance</td>
<td>Bedtime resistance</td>
<td></td>
</tr>
<tr>
<td>Self-limited</td>
<td>Sleep terrors</td>
<td>Sleep disorders</td>
<td>Sleep disorders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sleep related rhythmic movement disorder</td>
<td>Sleepwalking</td>
<td>Sleepwalking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bedtime fears</td>
<td>Nightmares</td>
<td>Nightmares</td>
<td></td>
</tr>
</tbody>
</table>

Insomnia

- Defined as
  - Persistent difficulty with
    - Sleep initiation (bedtime resistance)
    - Duration, consolidation, or quality that occurs despite adequate opportunity and circumstances for sleep,
  - And results in some form of daytime impairment such as
    - Inattention, mood disturbance
    - Problems with memory and concentration
    - Impaired performance (at school in children)

Chronic Insomnia Disorder

- Symptoms meet criteria of insomnia (previous slide) and
  - The frequency is at least 3 times per week
  - The duration is for at least 3 months
  - And the sleep/wake difficulty is not better explained by another sleep disorder

Evaluation

- History
  - Precise description of the problem
  - Parent response and interaction with child
  - Typical night, not extremes

- Careful description of bedtime routines, including naps
- Evaluate the 24 hour schedule (weekday, weekend, vacation)
Sleep-onset Association Type

- Child begins to associate sleep onset with circumstances that are problematic and demanding of the caregiver
- Child unable to fall asleep without these associations either at initial sleep onset or during nocturnal awakenings

Behavioral Insomnia of Childhood Limit-setting Type

- Refusal to go to bed at an appropriate time or following a nighttime awakening
- Insufficient or inappropriate limit setting demonstrated by the caregiver

Behavioral Insomnia of Childhood Limit-setting Type: Favorite Delay Tactics

“Mommy…”
- I’m hot.
- I’m cold.
- I’m scared.
- I’m not sleepy.
- I’m thirsty.
- My tummy hurts.
- I hear something.
- I have to go to the bathroom.
- Fix my blanket.
- I need to be tucked in again.

“Daddy, I need…”
- A drink.
- One more kiss.
- One more hug.
- The light on.
- The light off.
- To tell you something
- A band-aid.
- My mommy.
- You to cover me up.
- You to rub my back.
- A tissue.
- Some medicine

Treatment

Chronic Insomnia Disorder

- Behavioral interventions
- Specific behavioral therapies
  - Unmodified extinction
  - Graduated extinction
  - Positive routines/faded bedtime with response cost
  - Scheduled awakenings
  - Parent education/prevention

Behavioral Insomnia of Childhood Limit-setting Type

- Bedtime refusals, stalling and repeated demands
- May also occur at naptime and nighttime wakings
- May be straightforward or complex

Treatment

- Parent Education/prevention
  - Awakenings during the night are normal
  - Sleep onset associations are learned
  - Sleep onset associations are present at all ages
  - New sleep onset associations can be taught
Treatment
Other interventions
• Emphasize the importance of limit-setting
• Teach general limit-setting guidelines (day as well as night)
• Specific and individualized techniques (gate, progressive door closure)
• Positive reinforcement (star chart)

Treatment
• If symptoms persist, consider:
  • Instructions not followed
  • Co-existing problems
  • Error in diagnosis
  • More time needed
  • Modifying the specific behavioral intervention

Sleep Related Breathing Disorders

Pediatric Obstructive Sleep Apnea

Sleep Disordered Breathing
Spectrum of conditions determined by relative amount of upper airway obstruction:
(CIRCLES DISPLAY INCREASING UPPER AIRWAY OBSTRUCTION)

- Habitual snoring:
  
- UARS - Upper airway resistance syndrome:
  
- OH - Obstructive hypoventilation:
  
- OSA - Obstructive sleep apnea:

OSA Epidemiology
• Snoring in children:
  • 7% - 10% Habitual snorers
  • 20% Intermittent snorers
• OSA – 1% to 4% of preschool children
• Peaks ages two to five years
• Gender distribution: M:F ratio approximately equal in children
• Prevalence is higher among African Americans
Cross-Section of Oropharynx

- Nasal obstruction
- Tonsillar hypertrophy
- Micro- or retrognathia
- Large tongue

Pathophysiology of OSA

- Structural factors
  - Adenotonsillar hypertrophy
  - Craniofacial abnormalities
  - Obesity
- Neuromotor tone
  - Cerebral palsy
  - Genetic disorders
- Other factors
  - Genetic
  - Hormonal
  - ?

Risk Factors

- Adenotonsillar hypertrophy
- Craniofacial anomalies
- Down syndrome
- Obesity
- Neurologic disorders

Tonsillar Hypertrophy

The degree of tonsillar hypertrophy may not correlate with the presence of OSAS

Clinical Features

Nocturnal Symptoms

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

Diurnal Symptoms

- Daytime somnolence
- Behavioral / school problems
- Difficulty awakening in AM
- Morning headaches
- Nasal congestion
- Mouth breathing

References:

Pediatric Polysomnography

Role of Polysomnography

- Meet diagnostic criteria of pediatric OSA according to ICSD - 3
- Differentiate OSA from primary snoring
- Define severity of OSA
- Differential diagnosis
- Evaluate success of intervention

Diagnostic Criteria of Pediatric OSA

Clinical Criteria

One or more of the following should be present:

1. Snoring
2. Labored, paradoxical or obstructed breathing in sleep
3. Sleepiness, hyperactivity, behavioral problems, or learning problems

Diagnostic Criteria of Pediatric OSA

Polysomnographic Criteria

1. ≥ 1 obstructive apneas, mixed apneas or hypopneas per hour of sleep.
   OR
2. Obstructive hypoventilation (i.e. ≥ 25% of total sleep time with hypercapnia [PaCO₂ > 50 mmHg]) with at least one of the following:
   a) Snoring
   b) Flattening of inspiratory nasal pressure waveform
   c) Paradoxical thoracoabdominal motion.

Obstructive Sleep Apnea

- Hypoxemia following apneic episode

Obstructive Hypoventilation

- Paradoxical rib-cage motion
- Hypercapnia
Pediatric Polysomnography

In contrast to adults, children have:

- Obstructive hypoventilation
- Fewer obstructive apneas
- Desaturation with shorter events
  - Higher respiratory rate
  - Lower functional residual capacity
  - Smaller oxygen stores

Pediatric Polysomnography

In contrast to adults, children have:

- Fewer cortical arousals
- Preservation of sleep architecture
- Varied manifestations of sleepiness
  - Inattentiveness, hyperactivity, etc.

Is There a Role for Limited PSG?

- Nap study
  - Underestimates severity of OSA
  - May not achieve REM sleep
- Home PSG
  - May be less expensive, but some re-testing may be necessary
  - Technical difficulties (children remove leads)
  - False-negatives (may underestimate severity)

Consequences of Pediatric OSA

- Effects on growth
- Neurocognitive morbidity
- Cardiovascular consequences

Effects on growth

Girls Improvement in Weight After Treatment for OSA

Boys

Marcus et al. J Pediatr 1994

Neurocognitive Morbidity

- Hyperactivity, inattention, aggression
- Impaired school performance
- Daytime sleepiness
- Depression

Cardiovascular Consequences

- Pulmonary Hypertension
- Cor Pulmonale
- Systemic Hypertension

Blood Pressure in OSAS


Treatment of Pediatric OSA

- Surgical
  - Adenotonsillectomy
  - Uvulopalatopharyngoplasty
  - Craniofacial surgery
  - Tracheostomy
- Medical
  - Continuous positive airway pressure (CPAP)
  - Weight loss if obese
  - Intranasal steroids
  - Montelukast
  - Nasal expiratory positive airway pressure device – Provent®
- Orthodontic
  - Rapid Maxillary Expansion

Adenotonsillectomy

- First-line treatment
- Presence of additional risk factors not a contraindication to adenotonsillectomy
- Re-assessment of high risk groups with post-operative polysomnography is recommended

Groups at High Risk for Postoperative Complications

- Less than three years of age
- Severe OSA by PSG
- Associated medical conditions
  - Craniofacial anomalies
  - Neuromuscular disorders
  - Current respiratory infection
  - Severe obesity / Premature birth
- Complications of OSA already present
  - Failure to thrive
  - Cor pulmonale

Following surgery, high risk patients should be observed overnight in a facility where appropriate monitoring and care are available.
Positive Airway Pressure

Children on CPAP

Special Considerations for CPAP in Children

- Need wide variety of mask sizes and styles to fit children
- Compliance may be enhanced by behavioral techniques
  - Positive reinforcement
  - Desensitization
  - Training parents to avoid resistant behavior
  - Role modeling

Childhood Parasomnias

Parasomnia Classification

- NREM-Related Parasomnias
  - Disorders of Arousal (From NREM Sleep)
  - Sleep Related Eating Disorder
  - Sleep walking
  - Sleep terrors
- REM-Related Parasomnias
  - Nightmare disorder
- Other Parasomnias
  - Sleep enuresis

Childhood Parasomnias

Undesirable events or experiences occurring:
- At entry into sleep
- Within sleep
- During arousal from sleep
Disorders of Arousal

- Includes confusional arousals, sleepwalking, and sleep terrors
- Arousals occur out of NREM sleep
- First half of night, typically short duration
- Prolonged or multiple episodes may occur
- Confusion / automatic behavior
- Difficult to awaken during event
- Fragmented imagery
- Rapid return to sleep after event
- Amnesia of events

Confusional Arousals

**Clinical Characteristics:**
- Occur on arousal from NREM sleep
- May not recognize parents
- May cry, yell, or moan
- Speech often unintelligible, sounds like words
- Most common words: “No, No!”

Sleep Terrors

- Peak age: 5-7 years
- Prevalence rate of 1.0 - 6.5%
- Most will later sleepwalk
- Usual duration in children: 4 years
  - 50% end by age 8 years
  - 36% continue into adolescence

Sleepwalking

- Begin abruptly from NREM sleep
- Episodes of agitation and apparent terror
- Heralded by a blood-curdling scream or cry
- Followed by confusion, agitation and autonomic disturbances
- Patient difficult to arouse
- If patient can be awakened, may describe:
  - Vague sense of terror
  - Isolated or fragmented dream imagery
- Incidence rate in 6-16 year olds: 40%
- Lifetime prevalence: up to 18%

International classification of sleep disorders. 3rd ed. 2014
Sleepwalking

- Quiet wandering (injury unlikely)
- Agitated wandering (injury more likely)
- Behaviors of variable complexity
- Inappropriate behaviors
- Most sleepwalkers have few daytime effects

International classification of sleep disorders. 3rd ed. 2014

Disorders of Arousal: Evaluation

Video-PSG needed if:
- Spells have atypical features
- Spells are stereotyped
- Patients describe potentially injurious behavior or have injured themselves or others

PSG needed if: Obstructive Sleep Apnea is suspected


Disorders of Arousal: Treatment

- Avoid triggers
- Emphasize sleep hygiene
- Allow episodes to run their course
- Secure the bedroom to prevent injury


REM-related Parasomnias

- Nightmare Disorder
- Recurrent Isolated Sleep Paralysis
- REM Sleep Behavior Disorder

Nightmare Disorder

- 75% of children experience nightmares
- 10 - 50% of children have nightmares severe enough to disturb their parents
- Proportion of children reporting nightmares reaches a peak around ages 6-10 years and decreases thereafter

Clinical Characteristics:

- Usually during last half of night
- Complex dream mentation: – “Good dream gone bad”
- Emotional reaction more significant than autonomic response
- Fully alert upon awakening
- Responsive to comforting

Nightmare Disorder

**Precipitating Factors:**
- Anxiety / Stress
- Personality – association with creativity
- Post-traumatic stress disorder (PTSD)

**Nightmares and PTSD**

When there is a history of significant physical or psychological trauma, recurrent nightmares may occur and are likely a symptom of Posttraumatic Stress Disorder (PTSD).

**Nightmares of PTSD**

- Trauma-related nightmares are the most consistent problem reported by Posttraumatic disorder (PTSD) patients
- Nightmares are present in up to 80% of PTSD patients (usually beginning within three months of the trauma)

**Nightmare Disorder**

**Treatment:**
- Explanation and reassurance
- Sleep hygiene
- Behavioral therapies

**Nightmare Disorder & Sleep Terrors**

**Nightmare Disorder**
- REM sleep
- Most common parasomnia
- 2nd half of night
- Delayed return to sleep
- Easily comforted
- Detailed narrative description of episode
- Mild autonomic activity
- Alert upon awakening

**Sleep Terrors**
- NREM sleep
- 1.0 - 6.5% prevalence
- 1st half of night
- Rapid return to sleep
- Resists comforting
- Fragmented recall / amnesia
- Intense autonomic activity
- Confusion on waking

**Sleep Enuresis: Definition**

- Persistent bedwetting more than twice a month past the age of five years for at least 3 months
  - **Primary sleep enuresis:**
    Patient has never been dry on a regular basis
  - **Secondary sleep enuresis:**
    Patient becomes enuretic after being dry for at least six months

Sleep Enuresis: Declines with Age

Sleep Enuresis: Theories

Sleep Enuresis: Other Theories
- Functionally small bladder capacity
- Dysfunctional detrusor activity
- Higher arousal threshold

Sleep Enuresis and Pediatric Obstructive Sleep Apnea
- Obstructive sleep apnea should be considered in the differential diagnosis of sleep enuresis in children
- Frequent sleep enuresis is more common in children with a higher apnea hypopnea index (AHI)

Sleep Enuresis: Evaluation
- History
  - Developmental milestones
  - Family history
- Physical / neurological exam
- Urinalysis
- Evaluation of urinary stream and bladder capacity

Sleep Enuresis: Behavioral Treatment
- Limit fluids and caffeine near bedtime
- Positive reinforcement
- Hypnosis and imagery
- Bladder stretching
- Sphincter training
- Scheduled awakenings
- Urine alarms
Sleep Enuresis: Pharmacologic Treatment

- DDAVP (Desmopressin)
  - Effective in most patients
  - Tablets and nasal spray
  - Low frequency of side effects:
    - Concern for diabetes insipidus
    - Hyponatremia
- Imipramine
  - ECG abnormalities
  - Possible behavior problems

Sleep Related Movement Disorder

Pediatric Restless Legs Syndrome: Prevalence

- "Night-Walkers" Survey
  - 138 adults with RLS (mean age 60 years)
    - 18% reported symptoms began before age 10 years
    - 25% reported symptoms began before age 20 years
  - Prevalence of pediatric RLS: 2-4 %
    (UK, US and Turkish studies)

Pediatric Restless Legs Syndrome: Prevalence

- Moderate to severe: 0.5-1% (adolescents more than children)
- Boys affected as often as girls until late teens or twenties
- Increased rates of ADHD

Pediatric RLS: Clinical features

- Attention sought for "growing pains"
- These present as:
  - Sleep onset problems
  - Sleep maintenance problems
  - Daytime irritability and attention problems may occur, likely due to sleep deprivation
  - Family history is positive for RLS
  - Iron deficiency may play a role as in adults

Pediatric RLS

- An urge to move leg, caused by discomfort as described in child’s own words
  - Begins or worsens during periods of inactivity
  - Partially or totally relieved by movement
  - Worse in the evening or night
  - Biological parent / sibling with definite RLS
  - Periodic limb movements of 5 or more per hour of sleep on PSG
Pediatric RLS: Treatment

- Strict sleep hygiene is necessary to avoid sleep deprivation
- Limit setting often required (day and at bedtime)
- Treatment of iron deficiency
- Avoid caffeine
- Medications