Obstructive Sleep Apnea Syndrome in Children

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Objectives

- Describe the signs and symptoms of obstructive sleep apnea syndrome (OSAS) in children
- Outline the medical conditions predisposing children to OSAS
- Know the diagnostic evaluation of a child with OSAS
- Know the available treatment options for childhood OSAS
### Recommended Hours of Sleep for Children

<table>
<thead>
<tr>
<th>Age</th>
<th>Sleep hours/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 months to 12 months</td>
<td>12 -16</td>
</tr>
<tr>
<td>1 to 2 years</td>
<td>11-14</td>
</tr>
<tr>
<td>3 to 5 years</td>
<td>10-13</td>
</tr>
<tr>
<td>6 to 12 years</td>
<td>9-12</td>
</tr>
<tr>
<td>13 to 18 years</td>
<td>8 -10</td>
</tr>
</tbody>
</table>

*Journal of Clinical Sleep Medicine, Vol. 12, No. 6, 2016*
Spectrum of Sleep Disordered Breathing

Normal Prevalence: Snoring 8-27% UARS ? OSAS 2%
Obstructive Sleep Apnea

- Repetitive upper airway obstruction leading to abnormal ventilation and sleep disruption
- It can be partial or complete
- Abnormal ventilation: hypoxemia and/or hypercapnia
- Arousal or awakening
Childhood Obstructive Sleep Apnea

- Prevalence of OSAS: 1 to 5% in general pediatric population
  - Habitual snoring: 1.5 to 27.6%
- Peak prevalence: 2-8 years of age
- More common in boys, heavier children
- Risk Factors:
  - Prematurity
  - Family History
  - Ethnicity: African-American, Asian
  - Low socioeconomic status
Diagnostic criteria (Criteria A and B must be met):

A. The presence of 1 or more of the following:
   1. Snoring
   2. Labored, paradoxical, or obstructed breathing during sleep
   3. Sleepiness, hyperactivity, behavioral problems, or learning problems
ICSD-3: OSA, Pediatric

B. PSG demonstrates 1 or both of the ff:

1. 1 or more obstructive apneas, mixed apneas, or hypopneas, per hour of sleep OR

2. A pattern of obstructive hypoventilation, defined as at least 25% of TST with hypercapnia (PaCO2 > 50 mm Hg) with 1 or more of the following:
   
a. Snoring

   b. Flattening of the inspiratory nasal pressure waveform

   c. Paradoxical thoracic-abdominal motion
# OSA Differences - Children vs Adults

<table>
<thead>
<tr>
<th></th>
<th>Children</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Age, yrs</td>
<td>Preschool (4-6 y)</td>
<td>50-70 y</td>
</tr>
<tr>
<td>Gender ratio</td>
<td>M=F age &lt;13 yrs</td>
<td>M&gt;F</td>
</tr>
<tr>
<td></td>
<td>M&gt;F if older children included</td>
<td></td>
</tr>
<tr>
<td>Etiology</td>
<td>Adenotonsillar hypertrophy</td>
<td>Obesity or upper airway structure/function</td>
</tr>
<tr>
<td>Weight</td>
<td>Failure to thrive to obese; many normal in size</td>
<td>Obese</td>
</tr>
<tr>
<td>Excessive daytime sleepiness</td>
<td>Less common</td>
<td>Common</td>
</tr>
<tr>
<td>Neurobehavioral</td>
<td>Impulsiveness, aggressiveness, inattention</td>
<td>Impaired vigilance</td>
</tr>
</tbody>
</table>

*Berry and Wagner, eds Sleep Medicine Pearls, 3rd ed. 2015*
Predisposing Factors

- Adenotonsillar hypertrophy
- Obesity
- Craniofacial anomalies
  - Robin sequence
  - Down syndrome
- Neuromuscular disorders
  - Cerebral palsy
- Postoperative disorders
  - Post pharyngeal flap surgery
History of OSAS

- Frequent snoring (> 3 night/wk)
- Labored breathing during sleep
- Gasps
- Observed apneas
- Sleep enuresis (especially secondary enuresis-after at least 6 months of continence)
- Sleeping in a seated position or with neck hyperextended

Pediatrics 2012;130;576-584
History: OSAS

- Cyanosis
- Headaches on awakening
- Daytime sleepiness
- Attention deficit/hyperactivity disorder
- Learning problems

*Pediatrics 2012;130;576-584*
Physical Examination: OSAS

- Tonsillar hypertrophy
- Adenoidal facies
- Underweight or overweight
- Nasal septum deviation
- Micrognathia / retrognathia
- High-arched palate
- Pectus excavatum

*Pediatrics 2012;130;576-584*
Table 5. Facial and Airway Features Suggestive of Obstructive Sleep Apnea

- Small triangular chins
- Retro-position of the mandible
- Steep mandibular plane
- High palate
- Long, oval-shaped face
- Long soft palate
- Large tonsils in association with the above facial features

Physical Examination: OSAS

- Large tonsils
- Compromised pharynx
Physical Examination: OSAS
Physical Examination: OSAS

• Malampatti score
Consequences of Childhood OSAS

- Growth Failure
- Behavioral and neurocognitive problems
- Excessive daytime sleepiness
- Impaired quality of life
- Metabolic derangements
- Cardiovascular complications
## Sequalae of Pediatric OSAS

<table>
<thead>
<tr>
<th>Neurocognitive</th>
<th>Metabolic</th>
<th>Cardiovascular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased quality of life</td>
<td>Elevated CRP</td>
<td>Autonomic dysfunction</td>
</tr>
<tr>
<td>Aggressive behavior</td>
<td>Insulin resistance</td>
<td>Systemic hypertension</td>
</tr>
<tr>
<td>Poor school performance</td>
<td>Hypercholesterolemia</td>
<td>Absent BP “dipping “ during sleep</td>
</tr>
<tr>
<td>Depression</td>
<td>Elevated transaminases</td>
<td>LV dysfunction</td>
</tr>
<tr>
<td>Attention deficit disorder</td>
<td>Decreased IGF</td>
<td>Pulmonary hypertension</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>Decreased or altered GH secretion</td>
<td>Abnormal HR variability</td>
</tr>
<tr>
<td>Moodiness</td>
<td>Increased leptin</td>
<td>Elevated vascular endothelial growth factor</td>
</tr>
</tbody>
</table>

*Katz and D’Ambrosio, Clin Chest Med 31:221-234; 2010*
Methods of Diagnosis in Pediatrics

- PSG: Gold standard
- Ambulatory sleep testing - not enough data in children
- Nocturnal oximetry - insufficient for diagnosis
- Video recording
- Nap studies (PPV-100%, NPV-20%)
- Radiologic Studies
Polysomnography

- Gold Standard
- Highly technical and detailed study
- Attended by a sleep technician
- Recording, analysis and interpretation of multiple physiological parameters during sleep
Polysomnography

- EEG-sleep stage
- EMG- record submental and tibial muscle activity
  - Motion sensors can also be used to quantitate movement arousal
- Airflow using either oronasal thermistors or nasal pressure transducer to measure obstructive apnea or hypopnea
Polysomnography

- ECG-presence of arrhythmias associated with respiratory events
- EOG
- Pulse oximetry
- End tidal nasal/Transcutaneous CO2
- Chest and abdominal bands
- Video
- Sleep position (prone, supine or side)
Polysomnography Report

- Total Sleep time, sleep latency, sleep efficiency
- The percentage of sleep stages NREM 1,2,3 and number of REM cycle
- Number of apnea (central, obstructive, hypopnea, mixed per hour)
- Presence of snoring
Normal

Supine
Pulse (72.7)

Bilevel
CPAP

Snore (2.9)

EKG

Airflow

Chest

Abdomen

SpO2 (98.5)
Central apnea: ≥ 20 seconds in duration OR
2 missed breaths with an arousal or ≥ 3% oxygen desaturation or
Decrease heart rate ≤ 50 /min for 5 sec or ≤ 60/min for 15 sec: (infants < 1 year only)
Obstructive Apnea

Flow
Rib Cage
Abdomen

Time
Hypopnea

Reduction in airflow

Flow
Rib Cage
Abdomen

Hypopnea: ≥ 30% drop flow for ≥ the duration of 2 breaths with either ≥ 3% oxygen desaturation or an arousal
AASM Scoring Rules

• Criteria for infants and children can be used for children < 18 years, but one can choose to score children ≥ 13 years using adult criteria
• Same rules with adult except for duration of events: ≥ 2 missed breaths instead of ≥ 10 seconds
• Scoring Hypoventilation
  – ≥ 25% total sleep time with pCO2 > 50 mm Hg

AASM Manual for Scoring Sleep, 2011
## Pediatric OSAS

<table>
<thead>
<tr>
<th>Severity of OSA</th>
<th>Obstructive Apnea Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>1.0 - 4</td>
</tr>
<tr>
<td>Moderate</td>
<td>≥5 - 10</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt; 10</td>
</tr>
</tbody>
</table>

Marcus, C. *Pediatrics* 2012
Traeger N, *Ped Pulm* 2005
Uliel S, *Chest* 2004
Witmans, MB *Am J Respir Crit Care Med* 2003
### OSAS in Adults

<table>
<thead>
<tr>
<th>Severity of OSA</th>
<th>Obstructive Apnea Index</th>
</tr>
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<tbody>
<tr>
<td>Mild</td>
<td>5-15</td>
</tr>
<tr>
<td>Moderate</td>
<td>15 - 30</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt; 30</td>
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</table>
Pediatric OSAS: Treatment

- Surgical
  - Adenotonsillectomy - first line of treatment, even for obese
  - Uvuloplasty
  - Mandibular advancements or other bony reconstruction
  - Tracheostomy
Pediatric OSAS: Treatment

- Positive Airway Pressure Device
  - CPAP
  - BIPAP
- Pharmacologic—limited in success to milder patients
  - Nasal steroids
  - Monteleukast
Non-surgical Treatment Options

- Non-surgical
  - Positioning-Body, tennis ball method if positional OSAS
  - Oral appliances not well studied in kids
  - Supplemental Oxygen
  - Weight reduction for obese patients
Treatment Goals in OSAS

- Normal respiratory pattern during sleep
- Normal gas exchange during sleep
- Normal sleep architecture
- Resolution of associated complications
CPAP

- CPAP is effective even in young children.
- Indicated for those who do not respond to surgery or surgery is contraindicated.
- Adherence is a major barrier
Guidelines for Titration of PAP

- All potential titration candidates should receive PAP education prior to titration
  - careful mask fitting
  - hands on demonstration
  - acclimatization prior to titration
Indications for PAP

- Most common indications: Down Syndrome, obesity
- When surgery is contraindicated
- Transient OSAS in the peri-operative period after T and A
- Residual OSAS after T and A
- Peri-operative stabilization for severe OSAS prior to T and A
Side Effects of PAP Treatment

- Conjunctivitis
- Discomfort
- Skin breakdown
- Nasal congestion/rhinitis; Epistaxis
- Mouth dryness
- Claustrophobia
- Potential for midface hypoplasia from CPAP mask when used at an early age
Mandibular Distraction
Oral Appliances

Mandibular repositioning appliance (MRA)

Holds the upper and lower teeth and hold the mandible in a forward position.
Oral Appliances

*Tongue retaining device* (four views) When inserted into the suction cavity of this oral appliance, the tongue is held forward to maintain airway patency. (Tongue Retaining Device, Professional Positioners, Inc, Racine, WI).
Weight Loss

- 5-10% weight reduction can significantly improve severity of OSAS.

- In CPAP dependent patients, may decrease pressure required to maintain upper airway patency.
Tracheostomy

- Used when other treatment strategies have failed
- Most common underlying conditions are craniofacial abnormalities and cerebral palsy.
- Has significant impact on Speech and Language
- Associated with morbidity of URI’s
Summary

- OSAS is common and is associated with significant morbidities
- Conditions that predispose to a small airway can result in OSA
- Adenotonsillar hypertrophy is the most common cause in children
- Increasing prevalence of obesity lead to increase prevalence of OSAS
Summary

- Polysomnography is the gold standard for diagnosing OSAS and assessing severity and likely risks associated with surgery.
- Adenotonsillectomy is the treatment of choice in children with proven OSAS.
- Not all children with OSA are cured by adenotonsillectomy and will need ongoing evaluation and further treatment.