Disclosures

- I have no financial relationships with commercial entities
Objectives

- Definition of Obstructive Sleep Apnea
- Epidemiology and Pathophysiology
- Impact of OSA in pediatric population
- Diagnosis of OSA
  - Indications for sleep studies
- Management of OSA
Obstructive Sleep Apnea (OSA) (American Thoracic Society)

Disorder of breathing during sleep characterized by prolonged partial upper airway (Uaw) obstruction and/or intermittent complete obstruction (obstructive apneas) that disrupts normal ventilation during sleep and normal sleep patterns

- Sleep fragmentation
- Intermittent hypoxemia
- Intermittent hypercarbia
Spectrum of Obstructive Sleep Disordered Breathing

- APNEA
- HYPOPNEA
- OBSTRUCTIVE HYPOVENTILATION
- RESPIRATORY EFFORT RELATED AROUSAL (UARS)
- SNORING

Degree of Obstruction

LOW to HIGH
OSA: Epidemiology

- Prevalence of snoring: 7-12%

- **Prevalence of OSA**
  - Infants: 1 - 2%
  - Children: 2 - 4%
  - Adults:
    - Women 2 - 4%
    - Men 3 - 7%

- **Gender**
  - Prepubertal: M=F
  - Post pubertal: M>F

- **Peak incidence**
  - 1.5 – 5 years (coincides with ATH)
  - Adolescence

- **Lean vs. Obese**

<table>
<thead>
<tr>
<th></th>
<th>Lean</th>
<th>Obese</th>
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<tbody>
<tr>
<td>Snoring</td>
<td>8 – 10%</td>
<td>50%</td>
</tr>
<tr>
<td>OSA</td>
<td>2 – 3%</td>
<td>36%</td>
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<tr>
<td>OSA</td>
<td></td>
<td>60% (metabolic syndrome)</td>
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</tbody>
</table>

- Risk of OSA increase by 12% for 1 kg/m² BMI
Risk factors for OSA

- Obesity
- Male
- African-American
- Prematurity
- Cigarette smoke exposure
- Adenotonisllar hypertrophy
- Sickle cell disease
- Down syndrome
- Prader Willi syndrome
- Cranio-facial disorders
- Neuromuscular disorders
- Cerebral palsy
- Asthma
- Allergic rhinitis
Pediatric OSA: Overview

**Pathophysiology**

**Anatomy**
- Craniofacial size
- Soft tissues
- Fat distribution
- Ethnicity

**Neuromuscular**
- Airway collapsibility
- Arousal threshold
- Ventilatory control
- Fluid shift
- Lung Volume

**OSA**
- Intermittent Hypoxia
- Sleep Fragmentation
- Hypercarbia
- ↑ Thoracic pressure changes

**Sleep**
- Gene trait, susceptibility
- Environment, diet, exercise

**Consequences**
- Metabolic
- Cardiovascular
- Neurocognitive
- Autonomic
Adenoid facies: Long face syndrome

Features
- ↑ vertical height of upper face
- high–arched palate
- Narrow maxilla, and small mandible
- disuse atrophy of nose
- Cause: Chronic nasal obstruction

Consequences
- Risk for OSA
- Adverse craniofacial development
- Future risk for OSA as adults
Craniofacial Syndromes

- Crouzon
- Treacher Collins
- Apert
- Hemi-hypoplasia

Abnormal dental alignment
Obesity & OSA: Partners in Crime!

- Fatty infiltrates of UAw
- Decreased FRC
- Decrease lung compliance
- Increased resistive load
- Affect upper airway patency

Risk of OSA in obese:
- Odds ratio of 4.5
- ~ 36% - 55% have OSA
- Snoring
- 1% increase in BMI → 12% risk for OSA
- Post-T&A ~ 2/3rd have residual OSA
Infant OSA

- Choanal stenosis
- Laryngomalacia
- Laryngeal lesions
- GERD → UA swelling
- Craniofacial abnormalities
  - Micrognathia (Pierre Robin)
- Hypotonia
- Cerebral palsy
- Genetic disorders
OSA: Adverse Sequelae

Individual *genetic and environmental susceptible factors* influences the ultimate expression of OSA sequelae…. 

**OSA**
- Intermittent Hypoxemia
- Hypercarbia
- Sleep fragmentation
- ↑ Respiratory Effort

**Cardiovascular**
- BP dysregulation
- Endothelial Dysfunction

**Metabolic**
- Dyslipidemia

**Endocrine**
- Insulin resist

**Neuro-cognitive**
- EDS, ADD, poor memory
- Poor concentration

**Nocturnal Enuresis**
Diagnosis and Management of Childhood Obstructive Sleep Apnea Syndrome

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**OSA**

Sleep Fragmentation

- Intermittent Hypoxia
  - Oxidative stress
    - Nitric Oxide

- Neurohormonal Changes

- Sympathetic Tone

**Inflammation**

- Leptin, Resistin, Adiponectin
- Plasma Adipokines Levels
- IL-6
- CRP
- TNF-α

**Metabolic syndrome**

- Obesity
- Insulin resistance
- Hypertension
- Dyslipidemia

**Sleep Fragmentation/Sleep deprivation**

Gozal et al
Type 1 OSA

Type 2 OSA
Diagnosis of OSA

- Evaluate symptoms and morbidity
  - History, questionnaires
- Assessment for severity of obstruction
  - Polysomnogram (Sleep Study)
- Assessment for site of obstruction:
  - Clinical examination
  - Radiological evaluation
    - Neck films
    - Cine MRI
    - CT nasal cavity
  - Flexible nasopharyngoscopy (bedside)
  - Rigid UA endoscopy under anesthesia
  - Sleep endoscopy
## Clinical features of OSAS

### Night time symptoms
- Snoring
- Apneas
- Mouth breathing
- Choking or snorting arousals
- Paradoxical breathing
- Restless sleep
- Hyper-extended neck
- Frequent awakening
- Recent onset parasomnias

### Daytime symptoms
- Excessive daytime sleepiness
- Morning headaches
- Mid-afternoon dip
- Hyperactivity
- Attention deficits
- Poor school performance
- Aggressive behaviors
- Chronic cough
Physical Examination

- **Weight**
- **BMI**
- **Neck circumference**
- **Mouth**
  - Bite
  - Tonsils
  - Malampatti type
  - Airway crowding
  - Macroglossia
- **Nose:**
  - Deviated septum
  - Turbinates
  - Polyp
  - Adenoids
- **Face**
  - Mid-face hypoplasia
  - Retro/micrognathia
  - Allergic shinners
- **Respiratory**
- **Cardiac:** S2 and murmu
Polysomnography (Sleep Study)

- EEG - For sleep stages
- EMG – for chin tone and leg movements
- EOG – eye movements
- Nasal pressure
- Oro-nasal thermister
- Chest and abdominal belts/summary – respiratory effort
- Oximetry with waveform
- ETCO2 with waveform
- Snoring microphone
- EKG - heart rate and rhythm
- Body position
- Video

Grigg-Damberger et al, JCSM 2007: 3: 201
## Indications for Sleep Studies

<table>
<thead>
<tr>
<th>Indications</th>
<th>Not indicated</th>
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<tbody>
<tr>
<td><strong>Respiratory</strong></td>
<td>Typical Parasomnianias</td>
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<tr>
<td>Sleep related breathing disorders</td>
<td>Insomnia</td>
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<tr>
<td>OSA</td>
<td>Circadian rhythm sleep disorders</td>
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<tr>
<td>Central sleep apnea</td>
<td>Restless legs syndrome</td>
</tr>
<tr>
<td>Sleep Hypoventilation</td>
<td></td>
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<tr>
<td>Periodic breathing</td>
<td></td>
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<tr>
<td>Sleep hypoxemia</td>
<td></td>
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<tr>
<td><strong>Non-Respiratory</strong></td>
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<tr>
<td>Periodic limb movement of sleep (PLMS)</td>
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<tr>
<td>Narcolepsy</td>
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<td>Nocturnal events</td>
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<td>seizures vs. parasomnia</td>
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<tr>
<td>REM behavior disorders</td>
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Obstructive apnea
Snoring and abnormal PSG findings

- TuCASA and Penn State Study
  - Habitual snoring: 15% of population
  - Witnessed apnea: 5.2%
  - PSG criteria
    - AHI > 1/hr: 25%
    - AHI > 5/hr: 1.1%

Goodwin JL et al J Clin Sleep Med 2005
Goodwin JL et al Sleep 2003
Severity of OSA

Children

- Mild OSA
  - AHI 1.5 – 5/hour
- Moderate OSA
  - 5-10/hour
- Severe OSA
  - > 10/hour

Mild degree of Sleep disordered breathing in children
- Persistent snoring
- Flow limitation seen on NAP signals
- Persistent mouth breathing

Adults

- AHI > 5/hour with Symptoms
- AHI > 15/hour (without Sx)
  - Mild: 5-15/hour
  - Moderate: 15-30/hour
  - Severe: > 30/hour
Treatment of OSA in children

- Life style changes
  - Weight loss
  - Positional
  - Alcohol avoidance

- Pharmacological treatment
  - Inhaled steroids
  - Leukotriene antagonist
  - Oxygen

- ORL surgical treatment
  - Adenoidectomy
  - Tonsillectomy
  - Supraglottoplasty

- Positive airway pressure therapy
  - CPAP
  - Bi-PAP
Adeno-tonsillectomy

- First line of therapy
- Recent data: 25-60% have residual OSA
- Discrepancy between tonsil size severity of OSA
- No consensus AHI cut-off to perform T&A, (mostly AHI > 5)
  - Jury is still out for AHI > 1 but < 5
- Adenoidectomy: 30% chance for 2nd surgery within 3 yr
- Complications: pain, bleeding and death

Medical treatment

- Inhaled steroids
- Montelukast antagonist
- Oxygen
Effect of Intranasal Budesonide on Mild OSA

Randomized double blind placebo controlled trial with the cross over design on children with mild OSA

Kheirandish-Gozal et al, Pediatrics 2008
Effect of a High-Flow Open Nasal Cannula System on Obstructive Sleep Apnea in Children

Brian McGinley, MD\textsuperscript{a}, Ann Halmower, MD\textsuperscript{b}, Alan R. Schwartz, MD\textsuperscript{c}, Philip L. Smith, MD\textsuperscript{c}, Susheel P. Patil, MD, PhD\textsuperscript{c}, and Hartmut Schneider, MD, PhD\textsuperscript{c}
Positive airway pressure therapy (CPAP and BiPAP)
Positive airway pressure therapy

- First described use in OSA in 1981
- Considered the "gold standard" of therapy
- Treatment, not cure
- Stents UAw open, preventing dynamic collapse
- Increases FRC, pulmonary reserve
CPAP mask

Resmed Infant Bubble Mask   Respironics Small Child Profile   LiteSleepNet “Mini-Me”
Successful CPAP therapy

- Pre-titration mask fitting and habituation
- Use of ramp, heated humidification
- Attention to air leak and skin irritation
- Adjuvant medications (nasal steroids, montelukast)
- Sleep scheduling modification
- Monitoring compliance & efficacy with smart cards
AAP Clinical Practice Guidelines - 2012

Diagnosis and Management of Childhood OSAS

1) All children/adolescents should be screened for snoring as part of routine health maintenance (R)

2) In-lab attended PSG should be performed in children with snoring and symptoms of and/or risk factors for OSAS to determine presence and severity (R)

3) Adenotonsillectomy is recommended as the first-line treatment of patients with adeno-tonsillar hypertrophy without surgical contraindications (R)

4) Continuous positive airway pressure is recommended as treatment if adenotonsillectomy is not performed or if signs/symptoms or objective evidence of OSAS persists postoperatively (R)  

Marcus et al; Pediatrics Vol 30(3) 2012
Consider referral to sleep center

- Very severe OSA
- Residual OSA after surgery
- Children on CPAP/BiPAP
- Associated central sleep apnea
- OSA in Craniofacial /syndromic and neuromuscular disorders
- With other co-morbid sleep disorders
  - Circadian sleep disorders, Insomnia
  - Restless legs syndrome & periodic limb movements
OSA is very common in children, but under recognized & under treated

Carries many short & long term health risks, some of which are unique to children and may be irreversible

Consider medical management for mild OSA

Although A&T is effective, recent data shows increasing number of children with residual OSA despite surgery

Consider referral to pediatric sleep specialist when indicated
Thank you