Obstructive Sleep Apnea: An Overview

Clinical Committee
Society of Anesthesia
and Sleep Medicine
Obstructive Sleep Apnea

- Describe what obstructive sleep apnea (OSA) is
- Review the prevalence and pathophysiology of OSA
- Discuss medical consequences of OSA
- Distinguish between different tests used to diagnose OSA
- Describe treatment options for OSA
What is OSA?

Diagnostic Criteria require (A and B) or C

A. The presence of one or more of the following:
   - excessive sleepiness, nonrestorative sleep, fatigue or insomnia symptoms
   - awakening breath holding, gasping or choking
   - bed partner reports loud snoring and/or breathing interruptions during sleep
   - diagnosis of HTN, a mood disorder, cognitive dysfunction, coronary artery disease, stroke, congestive heart failure, atrial fibrillation, or type 2 diabetes

B. Polysomnography (PSG) or Home Sleep Apnea Test (HSAT) demonstrates:
   - 5 or more predominantly obstructive respiratory events (apneas, hypopneas or respiratory effort related arousals (RERAs)/hr of sleep (PSG) or /hr of monitoring (HSAT)

C. PSG or HSAT demonstrates:
   - 15 or more predominantly obstructive respiratory events (as defined above) /hr of sleep (PSG) or /hr of monitoring (HSAT)

International Classification of Sleep Disorders (3rd edition)
# Sleep Apnea Definitions

<table>
<thead>
<tr>
<th>Apnea:</th>
<th>Cessation of airflow $\geq 10$ sec</th>
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<tbody>
<tr>
<td><strong>Hypopnea:</strong></td>
<td>CMS: $&gt; 30%$ reduction in airflow for $&gt; 10$ sec with a $&gt; 4%$ desaturation</td>
</tr>
<tr>
<td></td>
<td>AASM: CMS definition or a $&gt; 30%$ reduction in airflow for $&gt; 10$ sec with a $&gt; 3%$ desaturation or an arousal</td>
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<tr>
<td><strong>AHI:</strong></td>
<td>Number of apneas + hypopneas per hour</td>
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</tbody>
</table>
| **Severity:**       | Normal $=$ AHI $< 5$  
|                     | Mild $=$ AHI 5-15  
|                     | Moderate $=$ AHI 15-30  
|                     | Severe $=$ AHI $> 30$  |
| **Sleep Apnea-Hypopnea Syndrome:** | AHI $\geq 5$ with symptoms  
|                     | (*CMS – AHI $\geq 5$ with sxs or HTN, CAD or CVA) |
Sleep Apnea Events

**Obstructive Apnea**
- Air flow
- Effort
- O₂ Sat
- 90%
- 80%
- Ongoing effort to breathe

**Central Apnea**
- Air flow
- Effort
- O₂ Sat
- 90%
- 80%
- No effort to breathe

**Hypopnea**
- Air flow
- Effort
- O₂ Sat
- 90%
- 80%
Prevalence of OSA

- **Middle aged adults** (*Wisconsin Sleep Cohort Study*)
  
<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>M</th>
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<tbody>
<tr>
<td>OSAS</td>
<td>5%</td>
<td>14%</td>
</tr>
<tr>
<td>(AHI&gt;5 + sx)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSA</td>
<td>6%</td>
<td>13%</td>
</tr>
<tr>
<td>(AHI&gt;15)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

  *Peppard et al, Am J Epidemiol 2013*

- **Up to 26%** of the adult American population is considered at “high risk” for OSA

  *Phillips et al, Chest 2006*
Pathophysiology of OSA

- Collapse may occur at multiple levels
  - posterior pharyngeal, hypopharyngeal, subglottic

- Factors likely important:
  - Posterior pharyngeal size and compliance
  - “Balances-of-forces” theory
    - the balance between the intraluminal negative airway pressures/extraluminal positive pressures (promoting airway collapse) and the airway muscle dilators (promoting airway patency)
  - Reduced ventilatory motor output from central respiratory centers
  - Periodic breathing risk
    - likely some genetic risk for this
Pathophysiology of OSA

- Decreased respiratory drive
  - Airway narrows or collapses
    - Hyperpnea
    - Arousal
      - Increased respiratory effort
        - Hypercapnia and hypoxia

Consequences of OSA: Cardiovascular

- HTN
- Coronary artery disease
- Arrhythmias
  - Atrial fibrillation, NSVT, PVCs
- Heart failure
  - Systolic heart failure, Diastolic heart failure
- CVA
OSA and HTN

- N=709
- PSGs at baseline
- 4 year followup
- Odds ratio for having HTN at f/u assessment

Odds Ratio of HTN

Peppard et al, NEJM 2000
OSA and AFib

- Prospective study of 118 pts referred for DC cardioversion for afib
- 43 with OSA (39 completed study) and 79 controls
- Followed for 1 yr for afib recurrence

Kanagala et al, Circulation 2003
Consequences of OSA

- Pulmonary HTN / Cor Pulmonale
- Insulin sensitivity
- GERD
- Seizures
- Panic attacks
Consequences of OSA

- Psychiatric / mood
  - depression, anxiety, irritability

- Social and sexual dysfunction

- Neurocognitive impairment
  - general intellectual ability, learning and memory, attention, information processing efficiency, visual and psychomotor performance
Consequences of OSA: QOL and OSA

AHI and SF-36 Domain Scores

MH = mental health
VT = vitality
PF = physical function
SF = social function
RP = physical role function
GH = general health

Finn et al, Sleep 1998
Consequences of OSA

- Increased traffic accidents
  - case-controlled study found those with AHI > 10 had OR of 6.3 for MVA
  - Teran-Santos et al, NEJM 1999

- Increased utilization of Health Care Services

- *All of these adverse outcomes can be improved by treatment*
Risk Factors for OSA

- Obesity
  - individuals with BMI > 30 kg/m²
  - central obesity
  - narrows the upper airway lumen and “loads” the abdomen (requires greater inspiratory force to move air in)
  - 10% increase in wght = 6 x increase in sleep apnea
  - 1 kg/m² increase in BMI = 1% increase in AHI

Peppard et al, JAMA 2000
Risk Factors for OSA

- Male gender
  - though risk in postmenopausal women approaches that of men

- Age
  - very high rates in those >65 years of age

- Craniofacial abnormalities
  - nasal obstruction, enlarged uvula / tongue / tonsils, long soft palate, retrognathia, micrognathia, brachycephaly

- Ethnicity (African American > Caucasian)

- Family History
Symptoms of OSA

- Breathing disturbances in sleep (snoring, choking, observed apneas)
- Difficulty maintaining sleep (awakenings, restlessness)
- Daytime symptoms: AM HAs, AM dry mouth, sleepiness and fatigue
- Mood effects (depression, irritability)
- Impairment of daily function and quality of Life
- Others: GERD, HTN, panic attacks, seizures
Screening for OSA: History and Physical

| DS= disruptive snoring; A= apneas; EDS= excessive daytime sleepiness; BMI= body mass index; DBP= diastolic blood pressure; HTN= hypertension |
|---|---|
| Disruptive snoring (DS) | 71 | 32 |
| DS + apneas (A) | 23 | 94 |
| DS, A, EDS, BMI, gender, age | 50-70 | 60-80 |
| A, BMI, age, DBP | 92 | 51 |
| DS, A, Neck, HTN | 50-85 | 30-70 |

Screening for OSA: Questionnaires

- A recent meta-analysis of all questionnaires and clinical predictive models was performed

- Only included studies that used **in-lab PSG** as the gold standard to verify the diagnosis of sleep apnea

- Came up with 6 questionnaires and 18 clinical prediction models that met criteria

  Ramachandran et al, Anesth 2009
Screening for OSA: Questionnaires

- Test accuracy was variable, suggesting heterogeneity in presentations or measured parameters

- *All tools had high false negative rates*
  
  Ramachandran et al, Anesth 2009

- However, screening is better than not!
  - the vast majority of patients with OSA are undiagnosed
  - it is frequently missed in the outpatient setting
  - implementing a screening protocol captures many of these patients
Screening for OSA: Questionnaires

1) STOP-Bang Questionnaire (www.stop-bang.ca)

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Snoring: Do you snore loudly (loud enough to be heard through closed doors)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Tired: Do you often feel tired, fatigued, or sleepy during daytime?</td>
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<td></td>
</tr>
<tr>
<td>3. Observed: Has anyone observed you stop breathing during your sleep?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Blood Pressure: Do you have or are you being treated for high blood pressure?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. BMI: BMI more than 35 kg m(^{-2})?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Age: Age over 50 yr old?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Neck circumference: Neck circumference &gt;40 cm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Gender: Male?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

High risk of OSA: Yes to 5-8 questions.
Intermediate risk of OSA: Yes to 3-4 questions.
Low risk of OSA: Yes to 0-2 questions.

Questionnaire reproduced with permission from Dr. Chung. 

Chung et al, Br J Anesth 2012
Diagnosing OSA

• Polysomnogram
  • attended study remains the gold standard
  • monitor 15 channels
  • **Advantages**
    • comprehensive data
    • determine interrelationships (e.g. sleep stages, body position)
    • observation (technician)
    • trouble shooting/adjustments
  • **Disadvantages**
    • costly
    • limited access in some areas
    • sleep in a foreign environment
Diagnosing OSA

• **Polysomnogram**
  • **Indications**
    • anyone with suspected OSA
  • **Contraindications**
    • clinically unstable patients
Diagnosing OSA

- **Home Sleep Apnea Test (HSAT)**
  - AKA home studies or portable monitors
  - typically monitor 2-8 channels outside of the lab
  - **Advantages**
    - less costly (for the payor)
    - can be done in-home
  - **Disadvantages**
    - limited data (does not measure sleep)
    - no technical support
    - many are not standardized
    - nontrivial false negative rate (10-20%)
Diagnosing OSA

• **Home Sleep Apnea Test (HSAT)**
  
  **Indications**
  
  • suspected OSA only (not central sleep apnea or hypoventilation)
  • recommended for patients be at moderate to high risk for OSA to reduce the false (-) rate

  **Contraindications**
  
  • those with significant cardiopulmonary or NM disease
    • risk for central apnea and/or hypoventilation
  • those unable to follow instructions
Diagnosing OSA

- **Oximetry studies**
  - limited unattended studies
  - typically monitor 2 channels (heart rate, O₂ sat)
- **Advantages**
  - cheap
  - can be performed about anywhere
- **Disadvantages**
  - very limited data
  - no technical support
  - interpretation not standardized
  - nontrivial false negative rate
Diagnosing OSA

- **Oximetry studies**
  - **Indications**
    - suspected sleep apnea?
    - risk stratification for sleep apnea?
    - assessing nocturnal oxygenation
  - **Contraindications**
    - those unable to follow instructions
## Oximetry: Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Study Population No.</th>
<th>AHI/ODI Cutoff Point</th>
<th>Screening Specificity %</th>
<th>Screening Sensitivity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ryan et al 1995</td>
<td>69</td>
<td>≥ 15</td>
<td>100</td>
<td>31</td>
</tr>
<tr>
<td>Levy et al 1996</td>
<td>301</td>
<td>≥ 15</td>
<td>94</td>
<td>77</td>
</tr>
<tr>
<td>Rodriguez Gonzalez-Moro et al 1996</td>
<td>96</td>
<td>NA</td>
<td>69</td>
<td>91</td>
</tr>
<tr>
<td>Schafer et al 1997</td>
<td>114</td>
<td>NA</td>
<td>41</td>
<td>94</td>
</tr>
<tr>
<td>Lacassagne et al 1997</td>
<td>329</td>
<td>≥ 15</td>
<td>57.8</td>
<td>89</td>
</tr>
<tr>
<td>Sano et al 1998</td>
<td>40</td>
<td>≥ 15</td>
<td>83.3</td>
<td>73.5</td>
</tr>
<tr>
<td>Olson et al 1999</td>
<td>113</td>
<td>≥ 15</td>
<td>70</td>
<td>88</td>
</tr>
<tr>
<td>Golpe et al 1999</td>
<td>116</td>
<td>≥ 10</td>
<td>97</td>
<td>84</td>
</tr>
<tr>
<td>Brouillette et al 2000</td>
<td>349</td>
<td>NA</td>
<td>96</td>
<td>58</td>
</tr>
<tr>
<td>Nuber et al 2000</td>
<td>70</td>
<td>NA</td>
<td>77.8</td>
<td>85.2–91.8</td>
</tr>
<tr>
<td>Vazquez et al 2000</td>
<td>246</td>
<td>≥15</td>
<td>88</td>
<td>98</td>
</tr>
</tbody>
</table>

Netzer et al, Chest 2001
Treatment of OSA

- Conservative measures
  - Avoid alcohol and sedatives
  - Avoid tobacco
  - Lateral positioning, elevating the HOB
  - Weight loss
- CPAP / bilevel pressure support
- Surgery
- Oral Appliances
- Medications
- Newer options
Treatment of OSA: CPAP

- First-line therapy for OSA
- Can eliminate sleep disordered breathing in almost all patients
- Produces a “pressurized” upper airway to maintain airway patency
- Typically titrated during an attended PSG, though in some cases empiric pressures or autoadjusting devices can be considered
Treatment of OSA: CPAP

- **Benefits**
  - decreases sleep apnea and daytime sleepiness
  - improves oxygenation, exercise function, HCT
  - appears to improve cardiovascular outcomes
  - decreases MVAs and hospitalizations
  - appears to decrease mortality

- **Problems**
  - acceptance suboptimal
  - compliance poor
## Treatment of OSA: Issues with CPAP

<table>
<thead>
<tr>
<th>Problem</th>
<th>Potential Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion</td>
<td>Humidification, nasal sprays, address oral leak</td>
</tr>
<tr>
<td>Air leaks</td>
<td>Assess interface</td>
</tr>
<tr>
<td>Claustrophobia</td>
<td>Assess interface, desensitization exercises</td>
</tr>
<tr>
<td>Pressure intolerance</td>
<td>ACPAP, exhalation relief, Bipap</td>
</tr>
<tr>
<td>Aerophagia</td>
<td>ACPAP, simethicone</td>
</tr>
<tr>
<td>Refusal</td>
<td>Seek alternative therapies</td>
</tr>
</tbody>
</table>

ACPAP = autoadjusting CPAP
Treatment of OSA: AutoCPAP and Bilevel PS

- **Autoadjusting CPAP**
  - adjusts pressure continually in response to flow tracing
  - does not significantly improve compliance when compared head-to-head with fixed pressure CPAP

- **Bilevel Pressure Support (often referred to as BiPAP)**
  - splits inspiratory and expiratory pressure
  - does not improve compliance much over CPAP
  - some find it more comfortable to breathe with
  - may be used as “salvage” therapy for patients failing CPAP
  - may be useful if hypoventilation coexists
Treatment of OSA:
Surgery

- Numerous approaches have been tried
- Surgical data limited in terms of controlled data and long-term outcomes
- Procedures in general use:
  - Nasal surgery – septoplasty, turbinate reduction
  - Tonsillectomy / adenoidectomy – mostly in kids, but of some benefit in select adults
  - UPPP - typically not effective
  - Genioglossus advancement
  - Maxillomandibular Advancement (MMA)
  - Tracheotomy

*Surgery does not always = cure (significant OSA may persist)*
Treatment of OSA: Oral Appliances

- Two categories:
  - Mandibular Advancing Devices
  - Tongue Retaining Devices

- Work by enlarging pharyngeal cross-sectional area

- Consider in patients with mild / moderate OSA

- RCTs suggest about equal efficacy to CPAP with better tolerance

- Controlled data regarding other outcomes is emerging
Treatment of OSA: Medications

- Little success at this point in time

- “Some” efficacy may be present for medications as **adjunctive therapy** in the following situations:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic rhinitis</td>
<td>Nasal steroids</td>
</tr>
<tr>
<td>OHV</td>
<td>Medroxyprogesterone</td>
</tr>
<tr>
<td>Myxedema</td>
<td>Thyroid replacement</td>
</tr>
</tbody>
</table>
Treatment of OSA: Newer Therapies

• Nasal resistive valves
  • small one-way valves that fit over the nostrils during sleep
  • limited data on outcomes

• Oral negative pressure therapy
  • creates a vacuum in the oropharynx to pull pliable post tissues out of the airway
  • effectiveness highly variable and limited outcomes data

• Hypoglossal nerve stimulator
  • activation of the pharyngeal dilators during inspiration
  • highly select patients, variable efficacy, outcomes?
When is a Repeat Study Indicated?

- **PAP devices:**
  - If the original titration was suboptimal and there are ongoing symptoms
  - Persistent symptoms despite good compliance and lack of other treatment issues
  - Change in PAP therapy
  - After “significant” (i.e. 10-15%) weight gain or loss

- Following recovery from surgery for OSA
- Following final adjustment of an oral appliance
Summary

- OSA is common and associated with numerous health consequences
- Diagnosing OSA requires a clinical evaluation and objective testing
- Screening for OSA should be performed in high risk patients
- Therapy for OSA should be individualized and requires long term care as for any chronic medical condition