Update on Sleep Apnea Diagnosis and Treatment

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Objectives

• Discuss physiology of sleep and obstructive sleep apnea

• Describe diagnosis and treatment of sleep apnea with recent updates
Characteristics of Sleep Stages

Stage 1 (N1): low voltage, mixed frequency (theta), <50% alpha (wake)

Stage 2 (N2): predominantly theta but with sleep spindles or K complexes

Stage 3/4 (N3): large delta waves, stage 3 with 30-50% delta and stage 4 with >50% delta

REM: characterized by atonia, irregular breathing pattern and phasic eye movements
Respiratory Events

• Apnea: No airflow for 10 seconds or longer

• Central apnea: No airflow and no respiratory effort for 10 seconds or longer

• Obstructive apnea: No airflow with continued respiratory effort for 10 seconds or longer

• Mixed apnea: Combination of central and obstructive apnea

• Hypopnea: Reduction in airflow associated with desaturation and/or arousal
Central versus Obstructive Apnea
OSA Severity

Up to 5 events per hour is “normal”
Mild is AHI 5-15 per hour
Moderate is AHI 15-30 per hour
Severe is AHI >30 per hour

Other relevant data
• Severity of desaturations
• Length of events
• Stage of events
Pharyngeal Anatomy

- Tensor palatini
- Levator palatini
- Genioglossus
- Epiglottis
- Genu of mandible
- Geniohyoid
- Hyoid bone
- Thyrohyoid
- Thyroid cartilage

Nasopharynx
Retropalatal oropharynx
Retroglossal oropharynx
Hypopharynx
OSA
Signs and Symptoms

• Snoring, choking or gasping
• Daytime sleepiness or fatigue
• Problems with concentration, attention, memory or judgment
• Irritability, anxiety or depression may also occur
• Decreased libido or impotence
• Nocturnal or morning headaches
• Nocturia very common
• Associated with hypothyroidism
OSA
Risk factors

• Strongest risks are obesity and older age
• Increased risk in males compare to females
• Female risk increases after menopause
• Family history increases risk by 2-4 fold
• Craniofacial features play significant role in children
• Increased risk in African Americans, Mexican Americans, Pacific Islanders and East Asians
• Additional role of alcohol, sedatives, smoking, sleep deprivation, and supine position
Obesity and OSA Rules

- Distribution of fat is an important correlate.
- Fat accumulation in the central and upper body correlate with metabolic syndrome, atherosclerosis, and OSA.
- Waist circumference more important than BMI, weight, or total fat content.
- Increased waist circumference predicts OSA even in non-obese.
OSA
Clinical Examination

- BMI
- Neck circumference
- Upper Airway
Mallampati Classification

I

II

III

IV
How do we screen these patients?

Questionnaires

- **STOP**- Snoring, Tiredness, Observed (apnea), (high blood) Pressure
  - 2500 surgical patients, 28% classified as high risk, 10% had PSG
  - 74% sensitivity for AHI>15 events/hour
- **BANG**- Body (mass index), Age, Neck (circumference), Gender
  - Increased sensitivity to 92% when added to STOP

Nocturnal oximetry
OSA and Portable Sleep Studies

- Can be performed in the home setting
- Recommended only if high pre-test probability of moderate to severe OSA
- No significant co-morbid medical conditions
- Still may require subsequent in-lab study
- Useful only for suspected OSA
- Portable studies likely to become more common in future
A

OBSTRUCTIVE HYPOPNEA-APNEA

UA Narrowing/Collapse

↑ Surface Forces

↓ UA Dilator Muscle Activity

Hypoventilation

↓ Chemosensitivity
↓ UA Dilator Muscle Activity/Responsiveness
↑ UA Resistance
↓ Lung Volume
↓ PCO₂

Return to sleep

Rapid ↑ PO₂

↑ Breathing Effort/↓PO₂, ↑PCO₂

Arousal

↑ UA Dilator Muscle Activity/Responsiveness
Rapid UA Reopening

Hyperventilation
OSA and Cardiovascular Disease
Cardio/Cerebrovascular Complications of OSA

Cardiovascular diseases
  Hypertension
    Systemic
    Pulmonary (Cor pulmonale)
  Heart Failure
  Arrhythmias
  Coronary artery disease

Cerebrovascular diseases
  Stroke and TIA
  Neuropsychological dysfunction
  Dementia
OSA and Treatment Options
Positive Airway Pressure

- CFlex and EPR
- Bilevel PAP versus CPAP
- Newer masks and interfaces
- Still no consistently proven intervention to improve compliance
- Auto-adjusting CPAP may be reasonable option
Effects of Positive Airway Pressure

- Splinting of airway
- Traction on airway
- Positive intrathoracic pressure
- Decreased afterload
- Increased cardiac output
- Increased lung volume
- Decreased venous return

Positive airway pressure
Treatment of OSA

CPAP is the gold standard
Adaptive Servo-Ventilation

• Goal is to avoid central apneas and hyperventilation
• Baseline pressure to avoid airway obstruction
• Adjusts inspiratory pressure to avoid hyperventilation
• Settings
  – expiratory pressure to maintain upper airway patency
  – minimum inspiratory pressure is lower limit during inspiration under which the pressure cannot fall
  – maximum inspiratory pressure is upper limit which the pressure cannot exceed
• Role still undefined
# Positive Airway Pressure Troubleshooting

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause(s)</th>
<th>Possible Solution(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal irritation/congestion/rhinorrhea</td>
<td>Dry air</td>
<td>Heated humidification</td>
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<tr>
<td></td>
<td>Chronic rhinitis</td>
<td>Nasal decongestants</td>
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<td>Nasal allergies</td>
<td>Nasal steroids</td>
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<td>Antihistamines</td>
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<td>Primary-care physician referral</td>
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<tr>
<td>Dry throat and/or mouth</td>
<td>Dry air</td>
<td>Heated humidification</td>
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<td></td>
<td>Mouth leak</td>
<td>Chin strap</td>
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<td></td>
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<td>Full face mask</td>
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<td>Painful pressure in ears</td>
<td>High airway pressure</td>
<td>Verify PAP level</td>
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<td></td>
<td>Nasal congestion</td>
<td>Decrease PAP level</td>
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<td>Trial of automatically titrated or bi-level PAP</td>
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<td>Nasal decongestants</td>
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<td>Nasal steroids</td>
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<tr>
<td>Gastric bloating and/or chest discomfort</td>
<td>Air swallowing</td>
<td>Decrease PAP level</td>
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<td>High airway pressure</td>
<td>Trial of automatically titrated or bi-level PAP</td>
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<tr>
<td>Claustrophobia</td>
<td>Anxiety</td>
<td>Desensitization</td>
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<tr>
<td></td>
<td>Mask interface</td>
<td>Anxiolytic</td>
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<td></td>
<td></td>
<td>Optimize mask fit</td>
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<td>Nasal pressure sores</td>
<td>Poor mask fit</td>
<td>Readjust head-gear</td>
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<td>Change mask size or style</td>
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<td>Apply skin protection</td>
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<td>Reassess patient education on mask fit</td>
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<tr>
<td>Eye irritation</td>
<td>Mask air leak</td>
<td>Readjust head-gear</td>
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<td>Change mask size or style</td>
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<td>Reassess patient education on mask fit</td>
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<tr>
<td>Skin creases</td>
<td>Improperly adjusted head-gear</td>
<td>Readjust head-gear</td>
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<td>Change mask size or style</td>
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<tr>
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<td></td>
<td>Reassess patient education on mask fit</td>
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<tr>
<td>Skin irritation</td>
<td>Sensitivity to mask interface</td>
<td>Trial using nasal pillows</td>
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<tr>
<td></td>
<td>Improperly adjusted head-gear</td>
<td>Readjust head-gear</td>
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<tr>
<td></td>
<td>Heat rash</td>
<td>Lower temperature on humidifier</td>
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<td>Trial using nasal pillows or skin protector</td>
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<tr>
<td>Air leak</td>
<td>Excessive mask/head-gear wear</td>
<td>Replace mask and/or head-gear</td>
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<tr>
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<td>Poor mask fit</td>
<td>Change mask/nasal pillows</td>
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<tr>
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<td>Improperly adjusted head-gear</td>
<td>Readjust head-gear</td>
</tr>
<tr>
<td></td>
<td>Excessive air pressure</td>
<td>Verify pressure setting</td>
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<tr>
<td></td>
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<td>Consider pressure change</td>
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<tr>
<td></td>
<td></td>
<td>Consider auto or bi-level mode</td>
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<tr>
<td></td>
<td>Facial hair interference</td>
<td>Trial with nasal pillows</td>
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<tr>
<td></td>
<td></td>
<td>Shave</td>
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Other Treatment Options

• Weight loss
  – Low success rate
• Bariatric surgery
  – Surgical risk
• Positional therapy
  – Only effective for positional apnea
• Oral appliance
  – Only effective in mild to moderate
• Upper airway surgery
  – Response unpredictable and only partially effective
• Modafinil
  – Only approved in patients compliant with treatment
Oral Appliances

- Mandibular advancement devices main type
- Indicated for mild to moderate OSA
- 65% of patients have decrease AHI >50%
- 35-40% of patients are “cured”
- Certain characteristics predict success
- Compliance likely same or better than CPAP
- Few long term side effects
- Cost is significant limiting factor
Provent Sleep Apnea Therapy

Inhalation

Exhalation

<table>
<thead>
<tr>
<th>Table 2—Week 1 and month 3 AHI results (ITT group)</th>
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<tr>
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<tr>
<td><strong>Device-off</strong></td>
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<td>---------------------------------</td>
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<tr>
<td><strong>EPAP Week 1 (N = 119)</strong></td>
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<tr>
<td>AHI 13.8 (5.3, 22.6)</td>
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<tr>
<td><strong>EPAP Month 3 (N = 100)</strong></td>
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<tr>
<td>AHI 14.4 (5.5, 21.4)</td>
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<tr>
<td><strong>Sham Week 1 (N = 110)</strong></td>
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<tr>
<td>AHI 11.1 (4.8, 21.8)</td>
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<tr>
<td><strong>Sham Month 3 (N = 95)</strong></td>
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<td>AHI 10.2 (3.4, 19.3)</td>
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OSA and Bariatric Surgery

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<th>Baseline</th>
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<th>Follow-up</th>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean (SD)</td>
<td>Range</td>
<td>n</td>
</tr>
<tr>
<td>Male (%)</td>
<td>62</td>
<td>31 (50%)</td>
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<td>54</td>
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<tr>
<td>Age</td>
<td>62</td>
<td>43.6 (10.0)</td>
<td>20-65</td>
<td>47</td>
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<td>Follow-up days</td>
<td>32</td>
<td>523 (342)</td>
<td>181-1811</td>
<td>80</td>
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<tr>
<td>Weight (kg)</td>
<td>54</td>
<td>227.8 (98.9)</td>
<td>92-47</td>
<td>54</td>
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<tr>
<td>BMI</td>
<td>47</td>
<td>49.7 (10.1)</td>
<td>32-73</td>
<td>47</td>
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<tr>
<td>AHI</td>
<td>80</td>
<td>67.8 (40.2)</td>
<td>5-190</td>
<td>80</td>
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<tr>
<td>CPAP</td>
<td>32</td>
<td>10.9 (3.3)</td>
<td>7-20</td>
<td>28</td>
</tr>
</tbody>
</table>

BMI = body mass index; AHI = apnea-hypopnea index; CPAP = continuous positive airway pressure; SD = standard deviation.

*Mean days from bariatric surgery to follow-up polysomnography.

*Measurement refers to CPAP pressures in millimeters of mercury required to ablate apneic events.

Top 10 Responses if Found Asleep at Your Desk by the Boss

Man! Come in at 6 in the morning and look what happens
I was trying to pick up my contact lens without my hands
I was testing the keyboard for drool resistance
Gee, I thought you were gone for the day
It worked well for Reagan, didn’t it?
Just pacing myself for the all-nighter tonight
Whew! Guess I left the top off the liquid paper
It’s OK…I’m still billing the client
I get credit for the hours last night I dreamed about work
…and I especially thank you for my excellent boss, Amen!