Updates in Sleep Medicine for the Internist

Robert Geck, MD
Assistant Professor of Medicine
Division of Pulmonary, Critical Care and Sleep
USF Morsani College of Medicine
Disclosures/Conflicts

• None
Objectives

• Understand the role of out of center sleep testing in the diagnosis of sleep disordered breathing.

• Become comfortable with Auto Titrating Positive Airway Pressure in the treatment of sleep disordered breathing.

• Become familiar with alternative treatments for sleep disordered breathing and the indications for each.
Out of Center Sleep Testing

• AASM guidelines for portable monitoring
  – Published in 2007
  – Initial evaluation by a Board Certified Sleep Specialist
  – Testing appropriate for those individuals with a high pretest probability
  – May also be used in those who cannot undergo an in-lab study or to monitor response to non-CPAP therapy
Out of Center Sleep Testing

• Contraindications to portable monitoring
  – Any evidence of a sleep disorder other than OSA
    • Limb movements, insomnia, central apnea, parasomnias, narcolepsy, or circadian rhythm disorders
  – Obesity (BMI>50), age <18, significant cardiac disease, neuromuscular disease, prior indeterminate portable study, stroke, need to rule OSA out, or inability to perform test at home
Out of Center Sleep Testing

• Equipment widely variable
  – Types
    • Type I- in lab full PSG
    • Type II- out of lab full PSG
    • Type III- 4 variables, airflow x2, saturation, heart rate
    • Type IV- 3 variables

• Minimum requirements
  – Airflow, respiratory effort, oxygen saturation
  – Display raw data to allow for manual scoring, editing, and review
Out of Center Sleep Testing

• AASM approved providers
• Nationally, only 2 providers
• Established Standards for Accreditation
  – Related to business practice, ethics, trained personnel, patient education, technical support, HIPAA protocol, and equipment
• To remember
  – Utilize for high pretest probability only
  – Provide patient education lost during in-lab PSG
  – If negative, should undergo confirmatory in-lab PSG
Other Options To CPAP

• PAP therapy
  – AutoPAP
  – Adaptive Pressure Support
  – Nasal Expiratory Positive Airway Pressure

• Ventilation
  – Average Volume Assured Pressure Support

• Oral appliance
AutoPAP

• Autoadjusting PAP therapy
• Titrates pressure to eliminate detected respiratory events
• Initially developed to improve compliance by utilizing lowest effective pressure
• Algorithm is proprietary and manufacturer dependent
• Optimally should be titrated and adjusted accordingly
AutoPAP Patients

• Utilized often in patients after home testing
• Patients are generally moderate to severe OSA without significant co-morbidities especially arrhythmias or severe hypoxia
  – AASM: Heart failure, COPD, Central Sleep Apnea, or Hypoventilation Syndromes
AutoPAP Pro/Con

Pro
• Less expensive than in lab titration
• At least as well tolerated as CPAP, possibly better
• May adjust for position changes, alcohol, or weight changes

Con
• May not be as effective at reducing AHI/RDI to <10
• More expensive device
• Allows respiratory events to occur
Adaptive Pressure Support

- ResMed, VPAP AdaptSV
- Respironics, BiPAP AutoSV
- Essentially a self titrating BPAP
  - Proprietary software determines either the average peak flow or average ventilatory assistance over a 3-4 minute moving window
  - Software then increases IPAP/PS to approximate desired target
  - Rate is also determined/set and in the event of central apnea the device will assume a backup rate
Why treat CSR/CSA or Complex Sleep Apnea differently?

• CANPAP trial
  – Subset analysis by Arzt et. al. in 2007 showed improvement in transplant free survival and LVEF

• Morgenthaler and colleagues in 2007
  – 21 pts with CSA/CSR, complex sleep apnea, and mixed sleep apnea, ASV and NPPV were effective at reducing AHI and RAI.
  – ASV lowered AHI and RAI more than NPPV

• Aurora et. al. in 2012 published guidelines and a meta-analysis regarding central sleep apnea syndromes
  – Meta-analysis revealed a 6% (3.9-8.4%) increase in LVEF and reduction of AHI by 31 (25-36) with ASV over baseline in CSR/CSA which performed better than CPAP
  – Additionally, BPAP-ST was found to be helpful as well but recommended after failure of CPAP and ASV
ASV in CSA/CSR

• Kasai et. al. in 2010 compared ASV and CPAP in patients with CSA/CSR and reported:
  – No change in PaO2, but significant increase in PaCO2 from 37 to 40 Torr
  – No change in Epworth Sleepiness score
  – More significant change in AHI 37.4±19.5/h at the baseline, 4.7±5.5/h at the titration study, and 1.9±2.1/h 3 months later
  – In contrast, CPAP 38.6±13.9/h at the baseline, 9.6±10.0/h at the titration study, and 15.4±12.8/h at 3 months later. P<0.01
  – Also, there was a significant difference in the LVEF changes between the 2 groups (+9.1±4.7% in the ASV group, +1.9±10.9% in the CPAP group). P<0.05.
  – Improved compliance (by 1 hour) and reduction in BNP
Flow Augmentation

ResMed VPAP AdaptSV
Servo Ventilation Algorithm – Decreased Flow

IF: Peak flow falls below target
THEN: autoSV Advanced increases pressure support

Respironics BiPAP AutoSV
Auto EPAP

Max pressure

EPAPmax

EPAPmin

S = Snore  H = Hypopnea  OA = Obstructive apnea

SV algorithm works ‘on top’ of Auto EPAP

Respironics BiPAP AutoSV
ASV Pro/Con

**Pro**
- Autoadapting
- Addresses the principal difficulty
- Improvement noted in LV function and survival

**Con**
- Expense
- A portion of patients with CSA/CSR and Complex Sleep Apnea will respond to CPAP alone
Nasal Expiratory Positive Airway Pressure

• Resistance valves inserted into the nares and adherent to the outer edge

• Low resistance to inspiratory flow with increased expiratory flow resistance
Ideal Patient for Nasal EPAP

• Mild to moderate OSA, snoring
• Frequent traveler
• Claustrophobic patients
• Frequent position changes
Nasal EPAP Effectiveness

Table 3—Week 1 and month 3 results (mITT group)

<table>
<thead>
<tr>
<th>Device-off</th>
<th>Device-on</th>
<th>Median of % change</th>
<th>Device-off</th>
<th>Device-on</th>
<th>Median of % change</th>
<th>P Value EPAP vs Sham (% change)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AHII</strong></td>
<td></td>
<td></td>
<td><strong>AHII</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPAP Week 1 (N = 92)</td>
<td>16.7 (9.5, 26.3)</td>
<td>-55.1 (83.3, -21.3)</td>
<td>15.1 (10.3, 24.1)</td>
<td>13.6 (6.5, 25.8)</td>
<td>-13.8 (-50.5, 30.4)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>EPAP Month 3 (N = 77)</td>
<td>14.5 (8.4, 23.5)</td>
<td>-12.3 (5.9, 25.0)</td>
<td>13.3 (5.9, 25.0)</td>
<td>-12.3 (-42.7, 77.9)</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
</tbody>
</table>

EPAP Device-on vs Device-off *P < 0.001. Values are medians (25, 75 quartiles). TST, total sleep time.

Table 4—Oxygenation data week 1 and month 3 (mITT group)

<table>
<thead>
<tr>
<th>Device-off</th>
<th>Device-on</th>
<th>Median of % change</th>
<th>Device-off</th>
<th>Device-on</th>
<th>Median of % change</th>
<th>P Value EPAP vs Sham (% change)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ODI</strong></td>
<td></td>
<td></td>
<td><strong>ODI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPAP Week 1 (N = 92)</td>
<td>13.7 (7.8, 23.6)</td>
<td>-43.2 (66.1, -2.2)</td>
<td>14.6 (8.7, 22.3)</td>
<td>12.2 (6.5, 21.9)</td>
<td>-15.5 (-40.9, 19.7)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>EPAP Month 3 (N = 77)</td>
<td>12.6 (7.1, 23.8)</td>
<td>-35.2 (64.1, 2.5)</td>
<td>13.3 (7.5, 23.1)</td>
<td>12.7 (6.4, 21.2)</td>
<td>-15.6 (-39.8, 29.6)</td>
<td>0.025</td>
</tr>
</tbody>
</table>

EPAP Device-on vs Device-off *P < 0.001, **P = 0.004. Values are medians (25, 75 quartiles). TST, total sleep time; ODI, oxygen desaturation index; SpO₂, arterial oxygen saturation.

Berry et.al. Sleep. 2011
## Nasal Expiratory Positive Airway Pressure

**Pro**
- Provides PAP
- No electrical needed
- Portable
- Reported better compliance
- May have a role in patients that do not meet Medicare criteria

**Con**
- Variable effectiveness
- Not titratable
- Not covered by insurance
Average Volume Assured Pressure Support

- Respironics, BiPAP AVAPS
- ResMed S9 VPAP ST-A
- Noninvasive home ventilation, of sorts
  - Given a desired target tidal volume, 8ml/kg (ideal body weight), and parameters like IPAP max and min, EPAP, back-up respiratory rate, inspiratory time, and rise time
  - Will self adjust according to proprietary algorithm to achieve target tidal volume
AVAPS

Respironics BiPAP AVAPS
AVAPS Indications

- Obesity hypoventilation
- Restrictive chest wall disease
- Acquired or central chronic alveolar hypoventilation
- Neuromuscular disease
# AVAPS Pro/Con

<table>
<thead>
<tr>
<th>Pro</th>
<th>Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Non-Invasive Ventilation for home</td>
<td>• No alarms</td>
</tr>
<tr>
<td>• Minimal whistles and bells</td>
<td>• Expensive</td>
</tr>
<tr>
<td>• Fewer parameters to set</td>
<td>• Limited PS range limits use</td>
</tr>
<tr>
<td>• Attached humidifier</td>
<td>• No battery backup</td>
</tr>
<tr>
<td>• Easily portable for travel</td>
<td></td>
</tr>
</tbody>
</table>
Oral Appliances
Oral Appliances

• Typically molded acrylic mouth pieces
• Anchor on upper teeth (Maxilla) and advance lower teeth (Mandible)
• Tongue retaining device, negative pressure holds tongue in device and is anchored to mandible and maxilla
• Works primarily by enlarging the velopharyngeal or retropalatal space
Oral Appliance Effectiveness

- Most effective in young patients with mild to moderate disease and normal BMI with retrognathia or CPAP intolerance

| Study (First Author, Year) | Treatment interval | OSA SEVERITY
AHI (l/hr) | Most efficacious treatment (MAS vs. CPAP p <0.05) | Patient treatment preference |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clark, 1996 [70]</td>
<td>2 weeks</td>
<td>38.9 ± 14.3</td>
<td>19.9 ± 12.7 *</td>
<td>MAS</td>
</tr>
<tr>
<td>Ferguson, 1996 [69]</td>
<td>4 months</td>
<td>19.7 ± 13.8</td>
<td>3.5 ± 1.6 *</td>
<td>CPAP</td>
</tr>
<tr>
<td>Ferguson, 1997 [68]</td>
<td>4 months</td>
<td>25.3 ± 15.0</td>
<td>4.0 ± 2.2 *</td>
<td>MAS</td>
</tr>
<tr>
<td>Engleman, 2002 [28]</td>
<td>8 weeks</td>
<td>31 ± 26</td>
<td>8 ± 6 *</td>
<td>CPAP</td>
</tr>
<tr>
<td>Randerath, 2002 [40]</td>
<td>6 weeks</td>
<td>17.5 ± 7.7</td>
<td>3.2 ± 2.9 *</td>
<td>MAS</td>
</tr>
<tr>
<td>Tan, 2002 [41]</td>
<td>2 months</td>
<td>22.2 ± 9.6</td>
<td>3.1 ± 2.8 *</td>
<td>MAS</td>
</tr>
<tr>
<td>Barnes, 2004 [25]</td>
<td>3 months</td>
<td>21.3 ± 1.3</td>
<td>4.8 ± 0.5 *</td>
<td>CPAP</td>
</tr>
<tr>
<td>Hoekema, 2008 [67]</td>
<td>2-3 months</td>
<td>39 ± 4.3</td>
<td>2.4 ± 4.2 *</td>
<td>NS</td>
</tr>
<tr>
<td>Gagnadoux, 2009 [26]</td>
<td>8 weeks</td>
<td>34 ± 13</td>
<td>6 (1-8)</td>
<td>CPAP</td>
</tr>
</tbody>
</table>

AHI – Apnoea Hypopnoea Index (OSA defined as AHI >5/hr), NS – No significant difference between treatments. *p <0.05 compared to baseline. AHI values = Mean ± SD except Gagnadoux, 2009 = median (interquartile range)

Sutherland and Custulli Swiss Med Wkly. 2011
Oral Appliances Pro/Con

**Pro**
- Easy for travel
- No electrical
- Well tolerated
- Adjustable/Titratable

**Con**
- Need intact dentition
- Slower titration process
- Up to 1/3 of patients who are candidates initially are excluded for dental reasons
Medicare/Medicaid Criteria

• NPPV or BPAP device
  – Indicated for baseline PaCO₂ ≥45mm Hg
  – Indicated for sleep oximetry with saturation ≤88% for ≥ 5 minutes
  – Or neuromuscular disease with MIP <60cm H₂O or FVC <50% predicted
  – CPAP proven ineffective
  – If patient has COPD then PaCO₂ must be ≥52mm Hg and oximetry must be on 2LPM or baseline home O₂ if higher
  – Back-up rate only covered in COPD if PaCO₂ worsens by ≥7mm Hg overnight during study on BPAP or remains ≥52mm Hg after 61 days of therapy

• ASV device
  – Must have PSG evidence of CSR or complex sleep apnea and show that ASV titration resolved events
  – Fail CPAP
Summary

• There are several new therapies available to patients
• AutoPAP when used appropriately reduces costs associated with in-lab titrations
• Adaptive Pressure Support (ASV) is indicated for the treatment of CSA/CSR, Complex Sleep Apnea, and Mixed Sleep Apnea, particularly if CPAP has failed
• AVAPS is indicated for hypoventilation related to obesity, chest wall restriction, acquired, central, or neuromuscular diseases.
• Nasal Expiratory Positive Airway Pressure and Oral Appliances offer an alternative when CPAP is undesirable, not tolerated, or contraindicated
Questions
References

- Berry RB, Kryger MH, Massie CA. A novel nasal expiratory positive airway pressure (EPAP) device for the treatment of obstructive sleep apnea: a randomized controlled trial. Sleep 2011; 34:479-485
- Fong YF, Sforza E, Janssens JP. Respiratory sleep in obesity-hypoventilation patients treated with nocturnal pressure support: a preliminary report. Chest 2007; 131:1090-1099
- Sutherland K, Cistulli P. Mandibular advancement splints for the treatment of sleep apnea syndrome. Swiss Med Wkly 2011; 141:w13276