PAP Modalities

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Financial Disclosures:

UptoDate Royalties
Positive Airway Pressure (PAP) Modalities

- CPAP
- APAP
- Bilevel
- Advanced bilevel modalities
  - Bilevel ST, Adaptive Servo Ventilation, Volume Assured Pressure Support
• Continuous Positive Airway Pressure

• CPAP delivers pressurized air at a constant pressure through a mask to keep the airway open during inhalation.
UpToDate.com

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CPAP Acts as an Airway Stent

Richard Schwab, M.D. UPENN

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Effects of PAP

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

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Adherence With CPAP

- Definition of adherence
  - > 4 hours/night on 70% of nights

- Adherence probably about 50 - 60%
  - Patients overestimate nightly use.

- Adherence patterns are determined early

- Few clear predictors of adherence:
  - Daytime sleepiness
  - More severe disease
CPAP: Complications

- Rhinorrhea
- Nasal congestion or dryness
- Epistaxis
- Skin abrasions/rashes
- Chest discomfort
- Claustrophobia
- Air swallowing
- Inconvenient
- “Not sexy”
Examples of Common CPAP Devices

- Respironics Dreamstation
- DeVilbiss IntelliPaP
- Resmed Airsense
- Fisher & Paykel

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Common CPAP Interfaces: Masks

- Nasal
- Nasal Pillows
- Full Face
APAP

• Auto Positive Airway Pressure
• (autotitrating positive airway pressure)
• APAP works similarly to CPAP but the pressure can adjust within a range of pressures to maintain an open airway
**Auto-CPAP Summary**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-CPAP Mean Pressure</td>
<td>8.7 cmH2O</td>
</tr>
<tr>
<td>Auto-CPAP Peak Average Pressure</td>
<td>11.1 cmH2O</td>
</tr>
<tr>
<td>Average Device Pressure &lt;= 90% of Time</td>
<td>11.3 cmH2O</td>
</tr>
<tr>
<td>Average Time in Large Leak Per Day</td>
<td>0 secs.</td>
</tr>
<tr>
<td>Average AHI</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Device Settings as of 1/17/2019

**Device Mode**

- AutoCPAP - A-Flex

**Device Settings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min Pressure</td>
<td>6 cmH2O</td>
</tr>
<tr>
<td>Max Pressure</td>
<td>16 cmH2O</td>
</tr>
</tbody>
</table>
Pressure (cmH2O) Mode: Auto CPAP with A-Flex

90% Pressure: 13.3
Average CPAP: 11.0

Sleep Therapy Flags

Indices
0.0 % of Night in PB
CA: 0.0
OA: 2.1
H: 2.1
FL: 2.1
VS: 13.3
RE: 0.4
AHI: 4.2

Unintentional Leak (LPM)

Min in Large Leak: 0.0 mins.
% of Night in Large Leak: 0.0 % of Night
Average Unintentional Leak: 10.0
Bilevel

- Normal breathing
- CPAP
- + Bilevel PAP
- IPAP
- Bilevel PAP support
- EPAP

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Antonescu-Turcu et al. Respir Care. 2010 Sep; 55(9): 1216–1229.
Can bilevel in spontaneous mode treat central sleep apnea?

A. Yes
B. No
Can bilevel in spontaneous mode treat central sleep apnea?

A. Yes

B. No
Bilevel Spontaneous vs Spontaneous Timed

Central Apnea

Flow

Bilevel S Pressure
Bilevel Spontaneous vs **Spontaneous Timed**

Central Apnea

Flow

Bilevel ST Pressure
Which of the following PAP modalities should be avoided in patients with hypoventilation?

A. Bilevel ST
B. Volume Assured Pressure Support (VAPS)
C. Bilevel S
D. Adaptive Servo Ventilation (ASV)
Which of the following PAP modalities should be avoided in patients with hypoventilation?

A. Bilevel ST
B. Volume Assured Pressure Support (VAPS)
C. Bilevel S
D. Adaptive Servo Ventilation (ASV)
<table>
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<tr>
<th></th>
<th>Hypoventilation</th>
<th>Central Sleep Apnea with Periodic Breathing</th>
<th>Central Sleep Apnea with Hypoventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilevel S</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Bilevel ST</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Adaptive Servo Ventilator (ASV)</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Volume Assured Pressure Support (VAPS)</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
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Adaptive Servo Ventilation (ASV)

Maintains a the patient’s recent flow/ventilation by adjusting the pressure support, and providing a backup rate.
Theory of Operation

Breath by breath, the algorithm adjusts pressure support if....

1. Peak Flow/Minute Ventilation is at target → No additional* IPAP is given
2. Peak Flow/Minute Ventilation is reduced below target → IPAP is increased
3. Peak Flow/Minute Ventilation is increased → IPAP is decreased
Warning:

ASV is currently contraindicated in patients with predominant central sleep apnea (CSA) and reduced left ventricular ejection fraction (LVEF ≤45%).
Volume Assured Pressure Support (VAPS)

- Designed to maintain a **preset target ventilation** by monitoring ventilation, adjusting the pressure support, and providing a backup breath automatically.

- Non-inferior to Bilevel-ST in management of:
  - obesity hypoventilation syndrome
  - chronic obstructive pulmonary disease
  - neuromuscular disease
Volume Assured Pressure Support (VAPS)

- AVAPS (volume assured pressure support; Respironics)
  - targets expiratory tidal volume

- iVAPS (intelligent volume assured pressure support; ResMed)
  - targets alveolar ventilation (minute ventilation minus dead space ventilation)
<table>
<thead>
<tr>
<th>Device Type</th>
<th>Mechanism</th>
<th>Main Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPAP</td>
<td>Continuous positive pressure to stent open airway</td>
<td>OSA</td>
</tr>
<tr>
<td>Bilevel S</td>
<td>Inspiratory and expiratory pressures to augment breaths that are patient initiated</td>
<td>OSA, hypoventilation</td>
</tr>
<tr>
<td>Bilevel ST (timed mode)</td>
<td>Inspiratory and expiratory pressures to augment breaths that are patient or device initiated if patient rate falls below set rate</td>
<td>CSA, hypoventilation,</td>
</tr>
<tr>
<td>Adaptive Servo Ventilator (ASV)</td>
<td>Maintains a the patient’s recent flow/ventilation by adjusting the pressure support, and providing a backup rate</td>
<td>CSA</td>
</tr>
<tr>
<td>Volume Assured Pressure Support (VAPS)</td>
<td>Maintains a set target ventilation by adjusting the pressure support, and providing a backup rate</td>
<td>hypoventilation</td>
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