Chapter 30

Sleep Apnea
Figure 30-1. Obstructive sleep apnea. When the genioglossus muscle fails to oppose the force that tends to collapse the airway passage during inspiration, the tongue moves into the oropharyngeal area and obstructs the airway.
Sleep Apnea

Despite the fact that the clinical manifestations of sleep apnea have been described for centuries, it was not until the early 1965 that it became acknowledged by the medical community.
Normal Sleep Cycles

Two major sleep stages during normal sleep

- Non–rapid eye movement (non-REM) sleep
  - Quiet or slow-wave sleep
- Rapid eye movement (REM) sleep
  - Active or dreaming sleep
<table>
<thead>
<tr>
<th>Stage</th>
<th>Electroencephalogram (EEG)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eyes open—wake</strong>&lt;br&gt;(Stage W)</td>
<td><img src="image" alt="Waveform" /></td>
<td>The EEG shows beta waves, and high-frequency, low-amplitude activity. The electrooculogram (EOG) looks very similar to REM sleep waves—low-amplitude, mixed frequency, and saw-toothed waves. Electrocardiogram (ECG) activity is relatively high.</td>
</tr>
<tr>
<td><strong>Eyes closed—wake</strong>&lt;br&gt;(Drowsy)</td>
<td><img src="image" alt="Waveform" /></td>
<td>The EEG is characterized by prominent alpha waves (&gt;50%). The EOG shows slow, rolling eye movements, and the EMG activity is relatively high.</td>
</tr>
<tr>
<td><strong>Non-REM Sleep</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stage N1</strong>&lt;br&gt;(Light sleep)</td>
<td><img src="image" alt="Waveform" /></td>
<td>The EEG shows low amplitude alpha waves (8-13 Hz) that may be replaced by mixed frequency activity and theta waves (4-7 Hz). Vertex waves commonly appear. Vertex wave are sharp upward deflection EEG waves. The amplitude of many of the vertex sharp waves is greater than 20 μV. Vertex waves are usually seen at the end of stage N1. The EOG shows slow, rolling eye movements. The EMG reveals decreased activity and muscle relaxation. Respirations become regular, and the heart rate and blood pressure decrease slightly. Snoring may occur. If awakened, the person may state that he or she was not asleep.</td>
</tr>
<tr>
<td><strong>Stage N2</strong>&lt;br&gt;(Light sleep)</td>
<td><img src="image" alt="Waveform" /></td>
<td>The EEG becomes more irregular and is composed predominantly of theta waves (4-7 Hz), interspersed with sudden bursts of sleep spindles (12-14 Hz), one or more K complexes. Sleep spindles are a sudden burst of EEG activity in the 1-14 Hz frequency (0 or more distinct waves) with a duration of ≥ 0.5 to 1.5 seconds (not illustrated here). Vertex waves may also be seen during this stage. The EEG shows either slow eye movements or absence of slow eye movements. The EMG has low electrical activity. The heart rate, blood pressure, respiratory rate, and temperature decrease slightly. Snoring may occur. If awakened, the person may say he or she was thinking or daydreaming.</td>
</tr>
<tr>
<td><strong>Stage N3</strong>&lt;br&gt;(Slow wave sleep)</td>
<td><img src="image" alt="Waveform" /></td>
<td>Slow wave activity 0.5 Hz-2.0 Hz and peak to peak amplitude &gt; 75 μV. EOG shows little, if any, eye movement, and the EMG activity is low. Heart rate, blood pressure, respiratory rate, body temperature, and oxygen consumption continue to decrease. Snoring may occur, and there is no eye movement. Dreaming may occur, and the sleeper becomes more difficult to arouse.</td>
</tr>
<tr>
<td><strong>(Deep sleep)</strong></td>
<td></td>
<td>The EEG shows no eye movements, and the EMG has little or no electrical activity. The sleeper is very relaxed and seldom moves. The vital signs reach their lowest, normal level. Oxygen consumption is low. The patient is very difficult to awaken. Bed-wetting, night terrors, and sleepwalking may occur.</td>
</tr>
<tr>
<td><strong>REM Sleep</strong></td>
<td><img src="image" alt="Waveform" /></td>
<td>About 90 minutes into the sleep cycle, there is an abrupt EEG pattern change. The EOG pattern resembles the wakeful state with low-amplitude, mixed frequency EEG activity. Saw-toothed waves are frequently seen. Alpha waves may be seen. The respiratory rate increases, and respiration is irregular and shallow. The heart rate and blood pressure increase. Rapid eye movement occurs, and there is paralysis of most skeletal muscles. Most dreams occur during REM sleep.</td>
</tr>
</tbody>
</table>

Table 30-1. Stages of Sleep

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Types of Sleep Apnea
Types of Sleep Apnea

- Apnea—the cessation of breathing for 10 seconds or longer
- Sleep apnea—more than five episodes of apnea per hour
  - May occur in either or both non-REM and REM sleep, over a 6-hour period
Types of Sleep Apnea (Cont’d)

- Generally, the episodes of apnea are more frequent and severe during REM sleep and in the supine body position.
- Apnea periods last more than 10 seconds and occasionally exceed 100 seconds in length.
- In severe cases, as many as 500 apnea periods per night may occur.
Types of Sleep Apnea (Cont’d)

- Sleep apneas may appear in all age groups
- In infants, it may play a role in sudden infant death syndrome (SIDS)
Obstructive Sleep Apnea (OSA)

- Most common
- During periods of OSA, the:
  - Patient, initially, appears quiet and still
  - Followed by an increased effort to inhale
Obstructive Sleep Apnea

- OSA often ends only after an intense struggle
- Snorting is often heard during periods of OSA
  - Called “fricative breathing”
- In severe cases, the patient may:
  - Suddenly awaken
  - Sit upright in bed, and
  - Gasp for air
- These events are called confusional arousals
Pickwickian Syndrome

- Named after a character in Charles Dickens’ *The Posthumous Papers of the Pickwick Club* (1837)
  - Joe: the fat boy who snored and had excessive daytime sleepiness
- Charles Dickens’ description of Joe included many of the classic features now recognized as OSA
Pickwickian Syndrome (Cont’d)

However, many patients with OSA are NOT obese, thus clinical suspicion should not be limited to this group
Box 30-1  Signs and Symptoms Associated with Obstructive Sleep Apnea

- Loud snoring
- Observed episodes of breathing cessation during sleep
- Abrupt awakenings accompanied by shortness of breath
- Difficulty staying asleep (insomnia)
- Awakening with a dry mouth or sore throat
- Morning headache
- Nausea
- Excessive daytime sleepiness (hypersomnia)
- Intellectual and personality changes
- Depression
- Nocturnal enuresis
- Sexual impotence
Table 30-2  Risk Factors Associated with Obstructive Sleep Apnea

- Excess weight
- Neck size (large)
- Hypertension
- Anatomic narrowing of upper airway
- Chronic nasal congestion
- Diabetes
- Male sex
- Older than 65 years of age
Table 30-2  Risk Factors Associated with Obstructive Sleep Apnea (Cont’d)

- Under age 35 and being Black, Hispanic, or Pacific Islander heritage
- Menopause
- Family history of sleep apnea
- Alcohol, sedatives, or tranquilizers
- Smoking
Central Sleep Apnea

- Occurs when respiratory centers of the medulla fail to send signals to the respiratory muscles.
- Characterized by cessation of airflow at the nose and mouth with absence of diaphragmatic excursions.
- Associated with cardiovascular, metabolic, or central nervous system disorders.
Central Sleep Apnea (Cont’d)

Diagnosed when the frequency of apnea/hypopnea episodes is more than 30 in a 6-hour period
Box 30-2  Clinical Disorders Associated with Central Sleep Apnea

- Congestive heart failure (Cheyne-Stokes respiration)
- Metabolic alkalosis
- Idiopathic hypoventilation syndrome
- Encephalitis
- Brain stem neoplasm
- Brain stem infarction
- Bulbar poliomyelitis
- Cervical cordotomy
- Spinal surgery
- Hypothyroidism
Mixed Sleep Apnea

- Combination of obstructive and central sleep apnea
- Usually begins as central sleep apnea, followed by:
  - Ventilatory efforts without airflow—OSA
- Clinically, mixed sleep apnea is usually classified and treated as OSA
Figure 30-2. Patterns of airflow, respiratory efforts (reflected through the esophageal pressure), and arterial oxygen saturation produced by central, obstructive, and mixed apneas.
Diagnosis

- Begins with a careful history
  - Noting presence of snoring, sleep disturbance, and daytime sleepiness
- Followed by examination of upper airway and PFT to determine presence of upper airway obstruction
- Blood is evaluated for:
  - Polycythemia
  - Thyroid function
  - Bicarbonate retention
  - ABGs
Chest radiograph and electrocardiogram are helpful in evaluating the:

- Presence of pulmonary hypertension
- State of right and left ventricular compensation
- Presence of any other cardiopulmonary disease
Diagnosis and Type of Apnea

- Confirmed with the following:
  - Electroencephalogram (EEG)
  - Electrooculogram (EOG)
  - Electromyogram (EMG)
  - Absence or presence of snoring
  - Nasal and oral air flow
  - Chest and abdominal
  - Oxygen saturation
  - Electrocardiogram (ECG)
Figure 30-3. A 30-second epoch of REM sleep (each vertical line equals 1 second). The electroencephalogram records low-voltage, mixed electroencephalographic activity, and frequent saw-toothed waves (brown bar). Alpha waves may be present (purple bar). The electrooculogram (EOG) records rapid eye movements (REM). The electromyogram (EMG) records low electrical activity and documents a temporary paralysis of most of the skeletal muscles (e.g., arms, legs). The breathing rate increases and decreases irregularly. During REM sleep, the heart rate becomes inconsistent, with episodes of increased and decreased rates. Snoring may or may not be present. REM is not as restful as non-REM sleep. REM is also known as paradoxical sleep. Most dreams occur during REM sleep. PTAFT, Pneumotachograph air flow; TNOAF, thermistor nasal/oral air flow.
Apnea is defined as the cessation of airflow—a complete obstruction for at least 10 seconds—with a simultaneous 2% to 4% decrease in the patient’s SaO$_2$.

Hypopnea is defined as a reduction of airflow between 30% and 50%—with a concomitant drop in the patient’s SaO$_2$. 
Apnea-Hypopnea Index (AHI) (Cont’d)

- The **apnea-hypopnea** index is defined as the average number of apneas and hypopneas the patient has per hour of sleep.
- The normal AHI is < 5 episodes per hour.
Apnea-Hypopnea Index (AHI) (Cont’d)

- The AHI score provides the following three severity categories of sleep apnea:
  - Mild—5 to 15 apnea-hypopnea episodes per hour
  - Moderate—15 to 30 apnea-hypopnea episodes per hour
  - Severe—greater than 30 apnea-hypopnea episodes per hour
**Oxygen Desaturation Index (ODI)**

- oxygen desaturation index (ODI) is a measure of the percentage of sleep time spent with an $\text{SpO}_2 \leq 90\%$. 
Oxygen Desaturation Index (ODI) (Cont’d)

- oxygen desaturation index (ODI) is a measure of the percentage of sleep time spent with an $\text{SpO}_2 \leq 90\%$. 
Computed Tomographic (CT) Scan

- Patients diagnosed as having obstructive sleep apnea may also undergo a computed tomographic (CT) scan or a cephalometric head x-ray of the upper airway to determine the site (or sites) and severity of the pharyngeal narrowing.
Wake After Sleep Onset (WASO) Index

- The WASO index is a study of Sleep density, which is derived from the arousals associated with sleep apnea.
- Sleep fragmentation results in nonrefreshing sleep and daytime sleepiness.
Overview
of the Cardiopulmonary Clinical Manifestations Associated with Sleep Apnea
Clinical Data Obtained from Laboratory Tests and Special Procedures
**Pulmonary Function Test Findings**

In patients who are obese or who have congestive heart failure—i.e., Restricted Lung Pathophysiology

### Lung Volume & Capacity Findings

<table>
<thead>
<tr>
<th>VT</th>
<th>IRV</th>
<th>ERV*</th>
<th>RV</th>
<th>VC</th>
</tr>
</thead>
<tbody>
<tr>
<td>N or ↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IC</th>
<th>FRC</th>
<th>TLC</th>
<th>RV/TLC ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>N</td>
</tr>
</tbody>
</table>

* A decreased ERV is the hallmark of centripetal obesity.
# Arterial Blood Gases

## Severe Obstructive Sleep Apnea

### Severe Stage

Chronic Ventilatory Failure with Hypoxemia  
(Compensated Respiratory Acidosis)

<table>
<thead>
<tr>
<th>pH</th>
<th>PaCO(_2)</th>
<th>HCO(_3^-)</th>
<th>PaO(_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>↑</td>
<td>↑ (Significantly)</td>
<td>↓</td>
</tr>
</tbody>
</table>
Arterial Blood Gases

Acute Ventilatory Changes Superimposed On Chronic Ventilatory Failure

Because acute ventilatory changes are frequently seen in patients with chronic ventilatory failure, the respiratory care practitioner must be familiar with and alert for the following:

- Acute alveolar hyperventilation superimposed on chronic ventilatory failure
- Acute ventilatory failure (acute hypoventilation) superimposed on chronic ventilatory failure.
### Oxygenation Indices

**Severe Stages of Obstructive Sleep Apnea**

<table>
<thead>
<tr>
<th><strong>Q_s/Q_T</strong></th>
<th><strong>DO_2</strong></th>
<th><strong>VO_2</strong></th>
<th><strong>C(a-v)O_2</strong></th>
<th><strong>O_2ER</strong></th>
<th><strong>SvO_2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>↑</td>
<td>↓</td>
<td>N</td>
<td>N</td>
<td>↑</td>
<td>↓</td>
</tr>
</tbody>
</table>
### Hemodynamic Indices

**Severe Obstructive Sleep Apnea**

<table>
<thead>
<tr>
<th>CVP</th>
<th>RAP</th>
<th>PA</th>
<th>PCWP</th>
<th>CO</th>
<th>SV</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>N or ↑</td>
<td>N of ↓</td>
<td>N or ↓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SVI</th>
<th>CI</th>
<th>RVSWI</th>
<th>LVSWI</th>
<th>PVR</th>
<th>SVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>
## Radiologic Findings

- **Chest Radiograph**
  - Often normal
  - Right-or left-sided heart failure
Cardiac Arrhythmias

- Sinus arrhythmia
- Sinus bradycardia
- Sinus pauses
- Atrioventricular block (second degree)
- Premature ventricular contractions
- Ventricular tachycardia
- Atrial fibrillation
General Management of Obstructive Sleep Apnea

- Continuous positive airway pressure (CPAP)
  - CPAP titration polysomnogram
  - Auto-titrating CPAP device (AutoPAP)
  - CPAP compliance
Figure 30-4. **A**, Normal airway. **B**, Obstructed airway during sleep. **C**, Nasal CPAP generates a positive pressure and holds the airway open during sleep.
General Management of Central Sleep Apnea

- VPAP Adapt SV and Adaptive Servo-Ventilation
Figure 30-5. The VPAP Adapt SV responds to apnea by increasing the pressure support.
Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea

| Weight Reduction | Many patients with obstructive sleep apnea are overweight, and although the excess weight alone is not the cause of the apnea, weight reduction clearly leads to a reduction in apnea severity. The precise reason is not known. Because weight reduction may take months and because maintaining weight loss is often difficult, weight reduction as a single form of therapy often fails. |
Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont’d

| Sleep Posture | It is generally believed that most obstructive apnea is more severe in the supine position and, in fact, may be present only in this position (positional sleep apnea). Apnea and daytime hypersomnolence have significantly improved in some patients who have been instructed to sleep on their sides and avoid the supine posture. Others may benefit from sleeping in a head-up position (e.g., in a lounge chair). The effect of this change in sleeping habits can be documented by recording oximetry in the supine and lateral decubitus positions. |

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**Oxygen Therapy**

Because of the hypoxemia-related cardiopulmonary complications of apnea (arrhythmias and pulmonary hypertension), nocturnal low-flow oxygen therapy is sometimes used to offset or minimize the oxygen desaturation, particularly in central sleep apnea (see Oxygen Therapy Protocol, Protocol 9-1). The reasoning behind the use of nasal oxygen therapy’s effectiveness is that the airway is continually “flooded” with oxygen, which will be inspired during the non-apneic episodes—in effect, “pre-oxygenating” the patient in anticipation of apnea events. Usually, no improvement in sleep fragmentation or hypersomnolence occurs with the use of supplemental oxygen.
| Drug Therapy | Drugs used to treat central sleep apnea include REM inhibitors such as protriptyline (Vivactil). Acetazolamide (Diamox) is a carbonic anhydrase inhibitor that causes a bicarbonate diuresis and mild metabolic acidosis, which in turn stimulates respiration. It occasionally is also helpful in cases of central sleep apnea.  
   Now that VPAP therapy is so successful in central sleep apnea, these drugs are rarely used. |
| Surgery | Some non-obese patients with obstructive sleep apnea benefit from surgical correction or bypass of the anatomic defect or obstruction that is responsible for the apneic episodes. The procedures described in the following slides are presently available. |
Table 30-3  
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

| **Uvulopalatopharyngoplasty** | Uvulopalatopharyngoplasty (UPPP) is the surgical procedure most commonly used to treat snoring and sleep apnea. During this surgery, the soft palate tissue is shortened by removing the posterior third, including the uvula. The pillars of the palatoglossal arch and the palatopharyngeal arch are tied together, and the tonsils are removed if they are still present. As much excess lateral posterior wall tissue is removed as possible. UPPP is effective in a small proportion of cases, especially in patients who are not obese. The success of this type of surgery is between 30% and 50%. |

Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

<table>
<thead>
<tr>
<th>Laser-Assisted Uvulopalatoplasty</th>
<th>Laser-assisted uvulopalatoplasty (LAUP) is performed to eliminate snoring. This surgical procedure entails using a laser to remove tissue from the back of the throat.</th>
</tr>
</thead>
</table>
Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

| Nasal Surgery | Nasal surgery may be performed to remove nasal polyps or straighten a deviated nasal septum. |

Nasal Surgery
| Tracheostomy | Tracheal intubation with or without tracheostomy is often the treatment of choice in emergency situations and in patients who do not respond satisfactorily to drug therapy or other treatment interventions. |
### Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

<table>
<thead>
<tr>
<th>Mandibular Advancement Surgery</th>
<th>Approximately 6% of patients with obstructive sleep apnea have a mandibular malformation. For example, patients who have obstructive sleep apnea because of retrognathia or mandibular micrognathia may benefit from surgical mandibular advancement. The surgery is not often performed, and carries considerable risks.</th>
</tr>
</thead>
</table>

### Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

<table>
<thead>
<tr>
<th>Mechanical Ventilation</th>
<th>Continuous Mechanical Ventilation</th>
<th>Intubation and continuous mechanical ventilation may be used for short-term therapy when acute ventilatory failure develops in central or obstructive sleep apnea</th>
</tr>
</thead>
</table>

Continuous Mechanical Ventilation
Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

<table>
<thead>
<tr>
<th>Mechanical Ventilation</th>
<th>Negative-Pressure Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In patients with central sleep apnea, the noninvasive approach of negative-pressure ventilation without an endotracheal tube may be useful. For example, a negative-pressure cuirass, which is applied to the patient’s chest and upper portion of the abdomen, may effectively control ventilation throughout the night. A negative-pressure cuirass is convenient for home use. It is contraindicated in obstructive sleep apnea.</td>
</tr>
<tr>
<td>Phrenic Nerve Pacemaker</td>
<td>The implantation of an external phrenic nerve pacemaker may be useful in patients with central sleep apnea resulting from the absence of a signal from the central nervous system to the diaphragm by way of the phrenic nerve. This procedure has not received wide application.</td>
</tr>
</tbody>
</table>
## Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

| Medical Devices | Oral appliances that optimally position the tongue and jaw are the most successful alternatives to surgery and CPAP by mask or “nasal pillows.” The devices are best used in patients with mild- to-moderate obstructive sleep apnea. Patients who have mandibular overbites, who clench or grind their teeth (bruxism), and who have temporomandibular joint dysfunction (TMJ) may benefit from these devices as well. |
| Neck Collar | A small number of patients have used a collar (similar to those used to stabilize cervical fractures) to increase the diameter of the airway and reduce the apnea. The therapeutic success of this procedure is questionable. |
### Table 30-3
Therapeutic Strategies Used to Treat Sleep Apnea, Cont'd

<table>
<thead>
<tr>
<th>Other Therapeutic Approaches</th>
<th>Patients should be advised to avoid alcohol and drugs that depress the central nervous system. Alcohol and sedatives have been shown to increase the severity and frequency of sleep apnea. All obese patients with sleep apnea should be encouraged to lose weight.</th>
</tr>
</thead>
</table>

Patients should be advised to avoid alcohol and drugs that depress the central nervous system. Alcohol and sedatives have been shown to increase the severity and frequency of sleep apnea. All obese patients with sleep apnea should be encouraged to lose weight.
## Table 30-54
Therapeutic Modalities for Sleep Apnea and their Effectiveness

<table>
<thead>
<tr>
<th>Type of Apnea</th>
<th>Therapy</th>
<th>Obstructive Sleep Apnea (OSA)</th>
<th>Central Sleep Apnea (CSA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oxygen therapy</strong></td>
<td>Rarely therapeutic. But is used in addition to CPAP in severe cases.</td>
<td>Sometimes therapeutic</td>
<td></td>
</tr>
<tr>
<td><strong>Carbonic anhydrase inhibitor drugs</strong></td>
<td>Contraindicated</td>
<td>Possibly indicated</td>
<td></td>
</tr>
<tr>
<td>Acetazolamide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Surgical</strong></td>
<td>Therapeutic (100%)</td>
<td>Not indicated by itself</td>
<td></td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>Occasionally therapeutic</td>
<td>Not indicated</td>
<td></td>
</tr>
<tr>
<td>Palatopharyngoplasty</td>
<td>Occasionally therapeutic</td>
<td>Not indicated</td>
<td></td>
</tr>
<tr>
<td>Mandibular advancement</td>
<td>Occasional therapeutic</td>
<td>Not indicated</td>
<td></td>
</tr>
<tr>
<td>Therapy</td>
<td>Obstructive Sleep Apnea (OSA)</td>
<td>Central Sleep Apnea (CSA)</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous positive airway pressure (CPAP)</td>
<td>Therapeutic</td>
<td>Not indicated</td>
<td></td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>Short-term</td>
<td>Short-term</td>
<td></td>
</tr>
<tr>
<td>Negative-pressure ventilation</td>
<td>Contraindicated</td>
<td>Therapeutic</td>
<td></td>
</tr>
<tr>
<td>Adaptive Servo-ventilation (VPAP)</td>
<td>Not indicated</td>
<td>Therapeutic</td>
<td></td>
</tr>
<tr>
<td>Therapy</td>
<td>Obstructive Sleep Apnea (OSA)</td>
<td>Central Sleep Apnea (CSA)</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------</td>
<td></td>
</tr>
<tr>
<td>Endotracheal tube at night</td>
<td>Short-term</td>
<td>Not indicated</td>
<td></td>
</tr>
<tr>
<td>Phrenic nerve pacemaker</td>
<td>Not indicated</td>
<td>Experimental</td>
<td></td>
</tr>
<tr>
<td>Medical devices (e.g., mandibular</td>
<td>Possible indicated</td>
<td>Not indicated</td>
<td></td>
</tr>
<tr>
<td>advancement devices)</td>
<td></td>
<td></td>
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</tbody>
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