Objectives

- Understand the pathophysiology of Obstructive Sleep Apnea (OSA).
- Recognized the Symptoms of OSAS.
- Determine the appropriate Sleep Testing.
- Treatment options for OSA.
- When to refer to a Sleep Specialist.
Ventilation during NREM Sleep

- Decrease ventilatory motor neuron output leading to decrease in tidal volume and minute ventilation
- Upper airway dilatory muscles relaxation leading to reduced luminal caliper and increasing resistance.
- Increase in Paco2 and decreasing in Pao2.
- **breathing becomes more dependant on central chemoresponsiveness.**
Anatomy of the upper airway
Upper-Airway Changes During Sleep

- Reduced muscle activity of upper airway dilators.
- Reduced upper-airway caliber.
- Increase airway resistance.
- Increase pharyngeal collapsibility.

- LEADING TO REDUCED TIDAL VOLUME & HYPOVENTILATION
Upper-airway resistance increases during sleep.

Hypoventilation is a universal finding during sleep caused by upper-airway resistance and decrease central ventilatory motor output.

Ventilation during NREM sleep is critically dependent on chemical stimuli-PaCO2/PaO2.
Types of sleep disordered breathing syndromes

- Obstructive (80%)
  - OSA
  - UARS
- Central (10-15%)
  - Hypocapnic
    - CSR-CSA, high altitude
  - Hypercapnic
    - Pontine lesions, RCB
Obstructive sleep apnea, Adult

- Repetitive episodes of complete (apnea) or partial (hypopnea) upper airway obstruction occurring during sleep lasting 10 seconds or longer.
- Events often result in
  - Decrease SaO2
  - Termination of event with arousal
## Apnea Patterns

<table>
<thead>
<tr>
<th>Airflow</th>
<th>Obstructive</th>
<th>Mixed</th>
<th>Central</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Airflow" /></td>
<td><img src="image2.png" alt="Airflow" /></td>
<td><img src="image3.png" alt="Airflow" /></td>
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<table>
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<tr>
<th>Respiratory effort</th>
<th>Obstructive</th>
<th>Mixed</th>
<th>Central</th>
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<tr>
<td><img src="image5.png" alt="Respiratory effort" /></td>
<td><img src="image6.png" alt="Respiratory effort" /></td>
<td><img src="image7.png" alt="Respiratory effort" /></td>
<td><img src="image8.png" alt="Respiratory effort" /></td>
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</table>
Epidemiology of OSA

- OSA = AHI ≥5
  - 24% men
  - 9% women
- OSA=AHI ≥5 and EDS
  - 4% men
  - 2% women
- Higher prevalence in Asians and Afro-American’s
Upper airway size in OSA

Schwab, R. Clinics in Chest Medicine 1998
Control of Dilator Muscles

Effects On Pharyngeal Muscle Activity

<table>
<thead>
<tr>
<th>Normal Subject</th>
<th>Awake</th>
<th>NREM</th>
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<tr>
<td>Genioglossus EMG</td>
<td><img src="waveform1.png" alt="Waveform" /></td>
<td><img src="waveform2.png" alt="Waveform" /></td>
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<tr>
<td>Tensor Palatini EMG</td>
<td><img src="waveform3.png" alt="Waveform" /></td>
<td><img src="waveform4.png" alt="Waveform" /></td>
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<tr>
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<tr>
<td>Tensor Palatini EMG</td>
</tr>
<tr>
<td>Airflow</td>
</tr>
</tbody>
</table>
Impaired upper airway EMG responses to negative pressure in patients with OSA

Mortimore, I.L. and Douglas, N.J. AJRCCM 1997;156:867-873
Pathophysiology of Sleep Apnea

Awake: Small airway + neuromuscular compensation

- Loss of neuromuscular compensation
  - Decreased pharyngeal muscle activity
- Airway collapses

Sleep Onset

- Hyperventilate: correct hypoxia & hypercapnia
- Airway opens
- Pharyngeal muscle activity restored
- Arousal from sleep

Apnea

- Hypoxia & Hypercapnia
- Increased ventilatory effort
Clinical Consequences

Sleep Apnea

Sleep Fragmentation
Hypoxia/ Hypercapnia

Excessive Daytime Sleepiness

Cardiovascular Complications

Morbidity
Mortality
Consequences: Excessive Daytime Sleepiness

- Increased motor vehicle crashes
- Increased work-related accidents
- Poor job performance
- Depression
- Family discord
- Decreased quality of life
Consequences: Cardiovascular

- Systemic hypertension
- Cardiac arrhythmias
- Myocardial ischemia
- Cerebrovascular disease
- Pulmonary hypertension / cor pulmonale
Mechanisms of CV dysfunction in OSA

- Arousals and/or hypoxemia
  - Sympathetic hyperactivity
  - Increased catecholamine's
  - Increased adhesion molecule activity
  - Endothelial injury
  - Suppressed circulating nitric oxide
  - Exaggerated pressor responses
  - Insulin resistance

- All improved by treatment of OSA
Arrhythmia and OSA

• Diurnal arrhythmia is not common
• Nocturnal arrhythmias are common
  - Usually occur during the apneas
  - Sinus bradycardia most common
    ▶ 75% of all OSA
  - High grade AV blocks in 4% to 8%
    ▶ Pacemaker?
  - PVC more often when SaO2 < 60%
• Therapy aimed at eliminating OSA
Consequences: Pulmonary hypertension

- **Prevalence**
  - 10-30% if pulmonary function is normal
  - 73% if airflow obstruction present
- **Pathogenesis**
  - Mechanical factors
  - Hypoxia
- **Improves with NCPAP and tracheostomy, not with O2**
Mortality and OSA

Sleep Apnea Risk Factors

- Obesity
- Increasing age
- Male gender
- Anatomic abnormalities of upper airway
- Family history
- Alcohol or sedative use
- Smoking
- Associated conditions
Risk Factor: Associated Conditions

- Hypothyroidism
- Acromegaly
- Amyloidosis
- Vocal cord paralysis
- Marfan syndrome
- Down syndrome
- Neuromuscular disorders
Diagnosis: History

- Snoring (loud, chronic)
- Nocturnal gasping and choking
  - Ask bed partner (witnessed apneas)
- Automobile or work related accidents
- Personality changes or cognitive problems
- Risk factors
- Excessive daytime sleepiness

Diagnosis: Assessing Daytime Sleepiness

- Often unrecognized by patient
  - Ask family members
- Must ask specific questions
  - Fatigue vs. sleepiness
  - Auto crashes or near misses
  - Sleep in inappropriate settings
    - Work
    - Social situations
Diagnosis:
Physical Examination

* Upper body obesity / thick neck
  > 17-18” males
  > 16” females
* Hypertension
* Obvious airway abnormality
Septal Deviation causing Nasal Resistance
Tonsillar hypertrophy in OSA

Normal

Patient
Palatomegaly in OSA

Lateral Narrowing

Schellenberg, J ARRCCM 2000;162:740-748
Tongue size in OSA

Schellenberg, J ARRCCM 2000;162:740-748
Retrognathia in OSA

Schellenberg, J ARRCCM 2000;162:740-748
What Test Should be Used?

- In-laboratory full night polysomnography
  - Split night studies
- Home diagnostic systems
  - Oximetry to full polysomnography
Diagnostic Conclusions

* Signs and symptoms
  * Excessive daytime sleepiness
  * Hypertension and other cardiovascular outcomes.

* Sleep study results
  * Apnea / hypopnea frequency
  * Sleep fragmentation
  * Oxyhemoglobin desaturation
Typical Features on Polysomnography

Apneas may be:
- Position dependent, e.g. mainly on back
- Sleep stage dependent, e.g. during REM sleep only, or only in Stage 1 and 2.
FIG. 8-9 Polysomnogram: Standard montage; 30-second page.

Clinical: Forty-year-old woman with obstructive sleep apnea.

Staging: Stage REM sleep with an arousal.

Respiratory: Apnea followed by an arousal and an oxygen desaturation. The oxygen desaturation on this page was caused by an apnea from the preceding page of the record.

EKG: Bradycardia with the apnea. There is a 3-second asystole at the end of the apnea.
Portable monitoring devices can be useful for assessing sleep-related breathing disorders in patients who are unable to undergo standard in-lab polysomnography. Many devices are available and most differ in the parameters measured.
Diagnostic Conclusions

* Signs and symptoms
  * Excessive daytime sleepiness
  * Hypertension and other cardiovascular outcomes.

* Sleep study results
  * Apnea / hypopnea frequency
  * Sleep fragmentation
  * Oxyhemoglobin desaturation
Why treat OSA?

- Improve bed partners sleep
- Improve patients sleep
- Alleviate daytime sleepiness
- Reverse cognitive impairment
- Improve diurnal blood pressure
- Minimize cardiovascular risk
- Reverse pulmonary hypertension and/or hypercapnia
Therapeutic Approach

* Risk counseling
  * Motor vehicle crashes
  * Job-related hazards
  * Judgment impairment

* OSA and comorbidity treatment
  * Behavioral
  * Medical
  * Surgical
Treatment of obstructive sleep disordered breathing

* Behavioral
  * Weight loss
  * Postural therapy
  * Avoid ethanol and tobacco
* Mechanical
  * Positive airway pressure
  * Oral appliance
* Surgical
Medical Interventions

- Positive airway pressure
  - Continuous positive airway pressure (CPAP)
  - Bi-level positive airway pressure (BiPAP or Bi-level PAP)
  - Self adjusting positive airway pressure
  - Expiratory pressure release

- Oral appliances
- Other (limited role)
  - Medications
  - Oxygen
Indications for positive airway pressure therapy

- RDI $\geq 30$ regardless of symptoms
- RDI 5-30
  - EDS
  - Impaired cognition
  - Mood disorder
  - Insomnia
  - ASCVD

Consensus Statement in Chest 1999;115:863-866
Positive Airway Pressure
CPAP Compliance

* Patient report: 75%

* Objectively measured use

  > 4 hrs for > 5 nights / week: 46%

* Asthma-medicine compliance: 30%
Strategies to Improve Compliance

- Machine-patient interfaces
  - Masks
  - Nasal pillows
  - Chin straps
- Humidifiers
- Ramp
- Desensitization
- Pressure modification strategies
Oral Appliances

- **Indications**
  - Snoring and apnea (not severe)

- **Efficacy**
  - Variable

- **Side effects**
  - TMJ discomfort, dental misalignment, and salivation
The PM Positioner functions as a mandibular repositioner and may be laboratory constructed from thermoplastic material allowing for easy insertion and removal when warmed. It is tooth retained via friction grip and may be constructed with unique acrylic projections located in the cervical areas of the posterior teeth to aid retention. Protrusive adjustability is quick, easy and accurate by movement of two expansion screws located bilaterally.
Staging of Surgical Procedures

1. Diagnosis of Sleep Apnea
2. Upper Airway Evaluation
3. Phase I Surgery
   - Type I: UPPP
   - Type II: UPPP + GA
   - Type III: GA
4. Post Operative Polysomnogram (+ Sleep Apnea)
5. Phase II Surgery - MMA

Adapted from Riley RW et al. Otolaryngol Head Neck Surg 1993;108.
Sites of Airway Narrowing

- Collapse at soft palate only: 18%
- Multiple sites of collapse: 82%

Uvulopalatopharyngoplasty (UPPP)
UPPP success in OSA

<table>
<thead>
<tr>
<th>Author</th>
<th>Reported</th>
<th>Adjusted</th>
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Staged Surgical Procedures
Why treat OSA?

- Improve bed partners sleep
- Improve patients sleep
- Alleviate daytime sleepiness
- Reverse cognitive impairment
- Improve diurnal blood pressure
- Minimize cardiovascular risk
- Reverse pulmonary hypertension and/or hypercapnia
When to refer to a Sleep Specialist

* When the case does not respond to therapy or intolerant to treatment.
* Complex Sleep History- OSA plus RLS, RBD, Insomnia.