Obstructive Sleep Apnea in the Perioperative Setting
“You snooze, you lose…”

TAPAN – Texas Association of Perianesthesia Nurses Conference
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Won Y. Lee, M.D.
Assistant Professor of Medicine
Division of Pulmonary and Critical Care Medicine
Medical Director, Clinical Center for Sleep and Breathing Disorders

* No financial disclosures to declare.

Clinical Case

• 63 year-old obese man
  – History of hypertension and coronary artery disease
  – Severe excessive daytime sleepiness

• At age 30
  – Sleepiness symptoms started → no problems as child
  – Gained weight up to 255 pounds
  – Falling asleep all the time, even while driving
    • Motor vehicle accidents → multiple fender benders
    • Girlfriend noticed 30-second pauses during sleep

• Evaluated at an outside hospital – Late 1970’s
  – Diagnosed with obstructive sleep apnea (OSA)
    • Based on clinical symptoms and obesity → no polysomnogram performed

Clinical Case

• What was the treatment for obstructive sleep apnea in the 1970’s?

• Weight loss or tracheostomy
  – He declined both options

• “Experimental treatment” including:
  – Daytime stimulant therapy
  – Positional therapy (tennis ball sewn on the back of shirt)
  – Female hormone replacement therapy (progesterone)

• None of these strategies improved his sleepiness
Clinical Case

- Early 1980's
  - Further evaluation at another hospital
  - Polysomnogram confirmed → Severe OSA
  - What was the treatment of OSA in the 1980's?
    - Tonsillectomy, septoplasty, and uvulopalatopharyngoplasty (UPPP)

- Mild improvement initially, but then had recurrence of daytime sleepiness symptoms
  - Worked as a construction worker on high rise buildings (30 to 40 stories)
  - Fired from the job due to safety concerns

- Sleep study in 2008
  - Very severe OSA (AHI 105 and desaturations to 57%)
  - Successfully treated with positive airway pressure therapy

History of the Sleep Apnea Syndrome

Obstructive Sleep Apnea

Past
- Origins of the Pickwickian syndrome
- Mechanisms of obstructive sleep apnea
- Original paper on CPAP

Present
- Adverse cardiovascular consequences of untreated OSA
- Perioperative recognition of OSA
- Anesthesiology literature

Future
- Epidemiology of sleep apnea
- Diagnostic testing
- Out of center sleep testing (OCST) → home sleep studies
- Alternatives to CPAP therapy
• 51 year old business executive
  – Gained significant weight → BMI: 43.8

• Began falling asleep while carrying on his daily routine
  – He played poker once a week, and was dealt "a full house"
  – Because he had dropped to sleep he failed to take advantage of this opportunity

• A few days later, he was admitted to the Peter Bent Brigham Hospital with obesity, fatigue, and somnolence

Burwell CS et al. Amer J Med. 1956;21;811-817

The Pickwickian Syndrome

• "His general contour was strikingly similar to that of the boy shown in (the) figure ... a character in Charles Dickens’ Papers of the Pickwick Club"

Clinical features

• Obesity
• Hypoventilation
• Hypersomnolence
• Secondary polycythemia
• Right ventricular failure

Olson AL and Zwillich C. Am J of Med. 2005; 118(9):948-956

Definition of Obesity Hypoventilation Syndrome (OHS)

"Pickwickian Syndrome"
Pathophysiology of OHS

Obesity
- Leptin resistance
- Increased mechanical load and weak respiratory muscles
- Obstructive sleep apnea
- Upper airway resistance

Chronic hypercapnia

Increased serum bicarbonate

Pathophysiology of Obstructive Sleep Apnea

- Pharynx susceptibility to collapse
  - Little bony/rigid support from posterior end of nasal septum to the epiglottis
- Pharyngeal dilator muscles
  - Geniohyoid muscle
  - Tensor palatini muscle
  - Enervated by the hypoglossal nerve

Pathophysiology of OHS

Mokhlesi B. and Tulaimat A. Chest. 2007; 132:1322-1336

Sagittal and Coronal Upper Airway MR Images

Schwab et al, Am J Respir Crit Care Med. 1995; 152:1673
Risk Factors for Obstructive Sleep Apnea

- Age (up to mid 60's)
- Male Gender (2:1)
- Women – Menopause
- Craniofacial anatomy
  - Retrognathia
  - Macroglossia
  - Down's syndrome
- Alcohol or nicotine use
- Genetic

Obesity

Clinical Presentation of OSA

- Classic patient – easy to recognized
  - Male, obese, middle aged, snores, etc...
- Not so classic patient
  - Women – menopause, insomnia, depression
  - Asians – lower BMI
  - Thin with excessive daytime sleepiness
- Experienced sleep specialists can diagnose OSA only about 60% of the time, based on clinical symptoms
- A screening test and diagnostic procedure needs to be performed

STOP - Bang
STOP – Bang

- **S** Snoring
  - Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?
- **T** Tired
  - Do you feel tired, fatigued, or sleepy during the daytime?
- **O** Observed
  - Has anyone observed you stop breathing during your sleep?
- **P** Blood pressure
  - Do you have or are you being treated for high blood pressure?
  
  - **B** BMI > 35 kg/m²
  - **A** Age > 50 years old
  - **N** Neck circumference greater than 40 cm
  - **G** Gender male

  - High risk of OSA → answering YES to 3 or more items (sensitivity 93%), low specificity (~43%)
  - Specificity increases to > 90% when 7 or 8 are answered affirmatively
  - High negative predictive value of 90%

  British Journal of Anaesthesia 2012; 108 (5): 768–75

What is a Sleep Study?

- **Polysomnogram** – Diagnostic study or therapeutic study
  - Overnight attended study
    - Come to the sleep lab at 8 pm, stay the night until 6 am
    - Sleep technologist stays with the patient
  - **EEG** – electroencephalogram → stages of sleep / seizure
  - **ECG** – electrocardiogram → arrhythmia
  - **EMG** – electromyogram → periodic limb movements
  - **EOG** – eye movements → rapid eye movements
  - Oronasal airflow
  - Respiratory effort (chest and abdominal belts)
  - Pulse oximetry

Sleep Study (polysomnogram)
Normal Pattern of Breathing

Apnea: 10 seconds, no airflow
Hypopnea: 10 seconds, reduction in airflow, 4% desaturation

What is an apnea hypopnea index (AHI)?
• The number of apneas and hypopneas PER hour
  – Apneas and hypopneas are equally pathologic and clinically important

<table>
<thead>
<tr>
<th>Severity of OSA</th>
<th>Events per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Less than 5</td>
</tr>
<tr>
<td>Mild</td>
<td>5 – 15</td>
</tr>
<tr>
<td>Moderate</td>
<td>15 – 30</td>
</tr>
<tr>
<td>Severe</td>
<td>More than 30</td>
</tr>
</tbody>
</table>

• Highest I’ve seen in Texas?
  – AHI 166
Reversal of obstructive sleep apnoea by continuous positive airway pressure applied through the nares

• Hypothesis: CPAP
  - A pneumatic splint to prevent upper airway occlusion
  - Push the soft palate and tongue forward and away from the posterior oropharyngeal wall

• CPAP was produced by:
  - Connect one end of a wide bore tube to a vacuum-cleaner blower motor with variable speed control

• “We were very tentative going into this, not knowing what would happen, how the patient might respond, or even if we might 'blow the patient up’" Sullivan CE et al. Lancet. April 1981; 1:862-865

Reversal of obstructive sleep apnoea by continuous positive airway pressure applied through the nares

• Results
  - 5 patients (4 adults and 1 child age 13)
    • Mean AHI
    • Mean lowest oxygen saturation 84%
  - Pressure range: 4.5 to 10 cm of water pressure
    - Completely abolished the obstruction in all patients
  - One patient was able to watch television the next day, something he had not been able to do for years.


CPAP Therapy

CPAP Therapy
No CPAP

Inadequate CPAP (6 cm H2O)

Optimal CPAP (16 cm H2O)
CPAP adherence can be objectively monitored

- Patients overestimate their use of CPAP
- Objective compliance?
  - Duration of usage
  - Residual AHI
  - Leakage
  - 4-hour threshold
  - 70% of nights
  - Green
  - Red
  - Black
Obstructive Sleep Apnea

- Cardiovascular disorders associated with OSA
- Perioperative recognition of OSA

Sleep Research Cohorts

- Wisconsin Sleep Cohort
  - Large population based study of Wisconsin state employees
  - Evaluate the consequences and natural history of sleep apnea
  - Epidemiology

- Sleep Heart Health Study, NIH sponsored since 1994
  - Prospective community based cohort, multicenter
  - Asymptomatic men/women, age 40+
  - Incidence: incident cardiovascular

- Mayo Clinic Sleep/Cardiology Clinic Studies
  - Sleep and cardiology clinics
  - Referral bias

- Spanish Sleep and Breathing Cohort
  - Sleep Clinic
  - Referral bias, most representative of clinical practice
OSA and Cardiovascular Disorders

Research Questions

• Question 1
  – Is OSA causal in the development of cardiovascular disease?
    • Causality vs. association

• Question 2
  – Does treatment of sleep apnea (CPAP) result in clinical improvement?
    • Fewer cardiovascular events?
    • Reduced morbidity and mortality?

OSA and Cardiovascular Disorders

Research Limitations

• Limitation 1
  – Close association between obesity and OSA
    • Effect of obesity?
    • Effect of OSA?
    • Synergy?

• Limitation 2
  – Shared co-morbidities between obesity and OSA
    • Cardiovascular disease, metabolic syndrome, and diabetes

• Limitation 3
  – Suboptimal randomization schemes
    • Difficult to perform randomized, double blind, placebo controlled studies
      – technically challenging for the placebo arm (SHAM CPAP)
    • Ethical to withhold CPAP therapy?

What are the adverse cardiovascular implications of untreated OSA?

• Hypertension → strongest data of association
  – OSA is independently associated with development of hypertension
  – OSA is associated with difficult to control hypertension (drug resistant)
  – Dipping phenomenon (dipping is good at nighttime)
    • Dipping is decrease in mean BP by ~10-20% at night
  – CPAP (compliant with therapy) → modest reduction in BP

• Coronary artery disease (ischemia and infarction/revascularization)
  – OSA is independently associated with coronary artery disease
  – Strongest association in men and women with SEVERE OSA (AHI > 30)
  – CPAP therapy (observational data) has shown a decrease in myocardial infarction and all causes of death

• Stroke
  – OSA is independently associated with stroke (AHI > 30)
  – Impact of CPAP (? primary or secondary prevention?)

What are the adverse cardiovascular implications of untreated OSA?

- Congestive heart failure
  - Associated with higher prevalence of OSA

- Cardiac arrhythmias
  - Reasonable evidence linking association
    - Atrial fibrillation, frequent PVC's, ventricular tachycardia, bradycardia (diving reflex)

- Neurocognitive dysfunction
  - Automobile accidents, decreased quality of life, mood disorders

- Diabetes mellitus/insulin resistance
  

Mechanism of OSA on sympathetic neural activity

Mayo Clinic study

- 112 patients who died of "sudden cardiac death"
  - Time period from 1987 to 2003
  - Not attributed to a known cause

- All had sleep studies – Mayo Clinic

- Review of death certificates
  - Evaluated "time of death"

Gami AS et al. NEJM. 2005;352:1206-14
**Patients with OSA have a higher risk of sudden death from cardiac causes during the sleeping hours.**

![Image](image_url)

**Incidence of cardiovascular events in 10 years (events/100 person years)**

![Graph](graph_url)

**Question:**
- What is the cardiovascular outcome of men with OSA?
  - Treated or not treated with CPAP?

**Design:**
- Observational study
- 1651 men referred to a sleep clinic unit in Spain

**What?**
- Evaluate the incidence of new fatal and non-fatal cardiovascular events
  - 10 years
  - Stroke or myocardial infarction
  - CABG and PTCA

Arrhythmias associated with OSA

• Bradyarrhythmias
  – Prolonged apnea and hypoxemia elicits the diving reflex, resulting in cardiac vagal activation
    • AV block and asystole
  – CPAP can reverse these bradyarrhythmias

• Prevalence of arrhythmias in sleep apnea
  – Nocturnal arrhythmias have been reported to occur in up to 50% of OSA patients
    • Sleep Heart Health Study (2006) of 2-4 higher risk of nocturnal complex arrhythmias (comparing AHI > 30 vs. AHI < 5)
      – Atrial fibrillation (4x odds of developing)
      – Nonsustained ventricular tachycardia (3x odds of developing)
      – Complex ventricular ectopy PVC’s (2x odds of developing)

Mehra et al. Am J Respir Crit Care Med 2006;173(8):910-6

Is OSA an independent risk factor for peri-operative complications?

Three Sudden Postoperative Respiratory Arrests Associated with Epidural Opioids in Patients with Sleep Apnea

Andreas M. Ostermeier, MD, Michael F. Roizen, MD, Martin Hautakope, MD,
P. Allan Knick, MD, and Jerome M. Kalfus, MD
Department of Anesthesia and Critical Care, University of Chicago, Chicago, Illinois

• Description of 3 overweight patients
  – Known history of sleep apnea, not on treatment
  – Underwent uneventful surgeries
    • 2 orthopedic surgeries
    • 1 ventral hernia repair
  – All were treated with epidural analgesia for pain control
  – All died from sudden, unexpected cardiac and respiratory arrest
    • Autopsy showed no alternative reasons for death
    • Presumed death due to acute cardiopulmonary arrest from untreated sleep disordered breathing

Postoperative Complications in Patients With Obstructive Sleep Apnea Syndrome Undergoing Hip or Knee Replacement: A Case-Control Study

- Hip or knee replacement at Mayo Clinic 1995 – 1998
  - Retrospective study

- 101 patients with OSA
  - 65 patients had known OSA before surgery (Only 33 were using CPAP)
  - 36 undiagnosed before surgery, eventually diagnosed within 3 years

- 101 patients without OSA
  - matched patients (BMI, type of surgery, amount of medications)

- Research question
  - Compare postoperative complications between the 2 groups


Complication rates were higher in OSA patients

- Total complication rate
  - Hypercapnia, oxygen desaturations
  - Arrhythmia, myocardial ischemia or infarction
  - Delirium
  - 39% of OSA patients vs. 18% of non OSA patients

- Serious complications
  - Unplanned transfer to the intensive care unit
  - management of acute cardiac ischemia or arrhythmia
  - urgent need for respiratory support (ventilator or CPAP)
  - 24% of OSA patients vs. 9% in the non OSA patients


Most complications occurred on post operative day #1

- OSA patients → in hospital longer (6.8 vs. 5.1 days)
- Pre-surgery CPAP usage associated with improved complication rate
  - Very few patients used CPAP postoperatively

Kaw R et al. CHEST. 2006; 129:198-205
Adverse Outcomes in OSA Patients Undergoing Surgery

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of patients</th>
<th>Types of surgery</th>
<th>Impact of anesthetics, analgesics, and sedatives on OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrospective matched cohort</td>
<td>240 OSA 240 matched controls</td>
<td>Cardiothoracic, Gastrointestinal, Otolaryngology, Plastic, Urology</td>
<td>Decreased response to hypoxia or hypercapnia, Decreased respiratory drive, Prolonged apneas → worse desaturation</td>
</tr>
<tr>
<td>Gupta et al. Mayo Clin Proc. 2001</td>
<td>74 OSA 98 matched controls</td>
<td>Cardiothoracic, Gastrointestinal, Otolaryngology</td>
<td>Unplanned ICU transfers, Cardiac events, Longer hospital length of stay</td>
</tr>
<tr>
<td>Hwang et al. Chest. 2008</td>
<td>37 OSA 185 matched controls</td>
<td>Cardiothoracic</td>
<td>Equaphalapy, Postoperative infections (mediastinitis), ICU length of stay</td>
</tr>
</tbody>
</table>

The impact of anesthetics, analgesics, and sedatives on OSA

- Impaired arousal reflex
  - Central nervous system depression
  - Decreased response to hypoxia or hypercapnia
  - Decreased respiratory drive
  - Prolonged apneas → worse desaturation

- Unstable upper airway
  - Relaxed pharyngeal muscle tone
  - Increased collapsibility of the upper airway
  - Increases upper airway resistance

- Physiologic impact of obesity
  - Compromised lung mechanics (decrease in FRC)
  - Challenging airway management

- RESPIRATORY COMPLICATIONS
  - Hypoventilation and hypoxia

OSA and Perioperative Setting

- Cardiovascular impact of OSA
  - Arrhythmia (afib, PVCs, SVT, bradycardia)
  - Hypertension
  - Coronary artery disease
  - Congestive heart failure

- Supine positioning may exacerbate obstructive respiratory events

- REM Rebound
  - Patients with severe OSA, may be chronically sleep deprived
  - May experience significant REM rebound upon receiving opioids
  - Exacerbates obstructive respiratory events
  - May contribute to hemodynamic instability, myocardial ischemia
• What is the prevalence of undiagnosed OSA in the surgical population?

• 1 academic tertiary care hospital in St. Louis, MO

• 2877 patients (elective surgery) screened for OSA using a questionnaire
  – ARES (apnea risk evaluation system)
  – Combination of Berlin questionnaire, Flemons index, and Epworth sleepiness score

  – 23.7% were high risk for OSA (661 patients)
  – Most were not previously diagnosed
  – Portable sleep study detected OSA in 62% of these individuals (534 patients)

  – Overall prevalence of OSA was ~ 22%

  Finkel KJ et al. Sleep Medicine. 2009; 10: 753-758

• Guidelines → not standards or absolute requirements

  – Improve perioperative care
  – Reduce the risk of adverse outcomes in patients with OSA
  – Develop clinical screening tools to identify undiagnosed OSA patients

  Anesthesiology. 2006; 104:1081-93

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Perioperative Management of OSA

Preoperative Management → Intraoperative Management → Postoperative Management

PERIOPERATIVE CPAP USAGE
Preoperative Evaluation

• What screening questionnaires are available to diagnose OSA?
  – Gold standard — attended, polysomnogram
    • Limitations of resources, expense, and time constraints of arranging the study before surgery
  – A non sleep trained physician (anesthesiologist, primary care physician, or surgeon) may be the first health professional to inquire about sleep disordered breathing
    • STOP Bang

• When is it appropriate to defer elective surgery?
  – Sleep medicine consultation timing?
    • Severe untreated OSA with a major elective surgery

• High risk patients should be steered away from the ambulatory surgical arena
  – Consideration of in-hospital monitoring

• Optimize other comorbidites associated with obesity and OSA
  – HTN, DM, CHF, arrhythmias, CAD


Intraoperative Management

What can be done to reduce complications?

• Few studies address anesthetic management of OSA patients

• Anticipation of difficult airway
  – ASA difficult airway management guidelines

• Consideration of regional anesthesia, if feasible
  – Minimize opioids, or use of short acting agents
  – Use of nerve block or epidural catheters

• Careful extubation parameters
  – The patient is conscious, alert, and breathing spontaneously
  – Full reversal of neuromuscular blocking agents
  – Upright and > 30 degrees
    • Supine position can exacerbate OSA

Anesthesiology 2006; 104:1081-93

Postoperative Management

What should be done in the post anesthesia care unit (PACU)?

• Close monitoring until level of consciousness improves and analgesic requirements are minimized
  • Hypoxemia (oxygen may or may not be helpful)
  • Hypercapnia

• What type of monitoring should be performed after leaving the post anesthesia recovery room?
  • ICU, step down unit, or telemetry floor
  • Close monitoring should be performed for the 1st 24 hours
    – Highest risk of complications
      – Continuous pulse oximetry (remote pulse oximetry)

• Can we assess what happened in the post anesthesia recovery room as a guide to triage patient disposition?
Could a combined preoperative and postoperative management plan PREDICT patients at highest risk for hypoxemia at 24-48 hours?

- Step 1: Preoperative screening tool for OSA
  - SACS (sleep apnea clinical score) \( \Rightarrow \) > 15 is high risk for OSA

- Step 2: Postoperative monitoring of respiratory episodes (PACU)
  - 30, 60, and 90 minutes after extubation
  - number of apneas
  - need for supplemental oxygen
  - pain/edema mismatch (high pain score with high edema score)
  - episodes of desaturation

- Step 3: Followed patients discharged to the hospital with continuous pulse oximetry
  - Followed ODI (oxygen desaturation index \( \Rightarrow \) 4% desats for 10 seconds)

Post operative hypoxia noted for highest risk group

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Low risk (n=25)</th>
<th>Group 2</th>
<th>Moderate risk (n=92)</th>
<th>Group 3</th>
<th>Highest risk (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODI &lt; 10</td>
<td>88%</td>
<td>63%</td>
<td>43%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ODI &gt; 10</td>
<td>12%</td>
<td>37%</td>
<td>57%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the role of perioperative CPAP treatment on perioperative complications?

- CPAP is the most efficacious immediate noninvasive treatment for OSA

- What is the potential benefit of PREOPERATIVE CPAP usage?
  - Preoperative CPAP use (not postoperative use) resulted in improvement of postoperative complications \( \Rightarrow \) retrospective data
  - Preoperative CPAP for 4-6 weeks may reduce upper airway edema, increase pharyngeal space, decrease tongue volume

- BUT \( \Rightarrow \) ~30-40% of patients are INTOLERANT to CPAP therapy

Jan SS and Dhand R. Curr Opin Pulm Med. 2004; 10:482-488
Postoperative Use of CPAP Therapy?

- No consensus agreement on whether CPAP should be administered if there is evidence of apneas and desaturation or if hypoxia persists
  - Insufficient evidence from the literature to evaluate whether the perioperative use of CPAP may reduce adverse events in OSA patients undergoing surgery
    - Well designed research studies are lacking
- Those patients compliant with CPAP preoperatively should probably continue CPAP usage postoperatively
  - Cardiovascular benefits
- May be difficult for those who have never used CPAP therapy or those who were non compliant with CPAP therapy to use CPAP therapy perioperatively
  - The post operative setting is not really the ideal time to start a patient on CPAP therapy, if he/she has not been on positive pressure therapy before
  - CPAP may cause agitation or pain

Obstructive Sleep Apnea

Future

• Epidemiology of sleep apnea
  • Increasing obesity rates
  • Undiagnosed OSA

• Diagnostic testing
  • Out of center sleep testing (OCST) → portable/home sleep studies
  • Alternatives to CPAP therapy

Epidemiology of OSA

• Obstructive sleep apnea syndrome
  – OSA and daytime sleepiness
  – Common sleep disorder → multiple studies
    • 4% of men
    • 2% of women

• Largely unrecognized in the general population
  – Up to 80% of patients are not diagnosed
    • Poor awareness of OSA
    • Lack of routine screening
    • Limited number of diagnostic sleep study facilities

~ 1 in 5 adults have mild OSA
~ 1 in 15 adults have moderate or severe OSA
Obesity Trends* Among U.S. Adults  
BRFSS, 1990, 2000, 2010  
(*BMI ≥ 30, or about 30 lbs. overweight for 5’4” person)  

Source: Behavioral Risk Factor Surveillance System, CDC.

Portable Monitoring
53 year old obese man
Hypertension and hyperlipidemia
STOP Bang → 5/8 questions positive

- AHI 42
- Total recording time 225 minutes
- Desaturations to 80%
Portable Monitoring vs. Laboratory Testing

**Portable testing**

- **Pros**
  - Less expensive
  - Improve access to care
  - Less discomfort for patients

- **Cons**
  - Suboptimal monitoring
    - Can’t assess sleep (no EEG)
  - Loss of airflow or pulse oximetry data
  - Other markers (arrhythmias, legs)

- **CPAP adherence?**

**Laboratory testing**

- **Pros**
  - Detailed, comprehensive testing
  - Monitoring, safety
  - Recognition of complex breathing
    - Arrhythmias

- **Cons**
  - More expensive, more cumbersome
  - Limited access → depending on geographic area

- **CPAP adherence?**

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### Recent trials comparing home vs. lab testing

<table>
<thead>
<tr>
<th>Study design</th>
<th>Number of patients</th>
<th>Methods</th>
<th>No difference in nightly CPAP adherence, sleepiness severity, quality of life, CPAP satisfaction at 3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berry RB et al. Sleep 2008 31(10): 1423-1432</td>
<td>105 patients – LAB</td>
<td>LAB attended diagnostic and CPAP titration study, split study if indicated</td>
<td>No difference in sleepiness scores, quality of life, blood pressure, or CPAP adherence at 6 weeks</td>
</tr>
<tr>
<td>Skomro RP et al. Chest 2010 138(2): 257-263</td>
<td>102 patients – LAB</td>
<td>LAB attended diagnostic and CPAP titration study, split study if indicated</td>
<td>No difference in sleepiness scores, quality of life, blood pressure, or CPAP adherence at 4 weeks</td>
</tr>
<tr>
<td>Kuna ST et al. AJRCCM. 2011. 183(9): 1238-1244</td>
<td>156 patients – LAB</td>
<td>LAB attended diagnostic and CPAP titration study, split study if indicated</td>
<td>No difference in acceptance of PAP therapy, titration pressures, effective titrations, time to treatment</td>
</tr>
<tr>
<td>Rosen CL et al. SLEEP. 2012;35(6):757-767</td>
<td>196 patients – LAB</td>
<td>LAB attended diagnostic study and CPAP titration study, split study if indicated</td>
<td>3 month PAP adherence was higher in the HOME arm</td>
</tr>
</tbody>
</table>

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### Top Reasons Patients Hate Wearing CPAP

- Reminds me of an anesthesia mask – bad childhood experience
- I look like Hanibell Lector
- CPAP is simply not seductive
- CPAP pressure is too high
- Difficulty breathing out against the machine
- Mask is uncomfortable

Personal communication – many patients
What are alternatives to CPAP therapy? How effective are they?

- Surgical options
  - UPPP (uvulopalatopharyngoplasty)
    - Success rates of around 40%
  - MMA (maxillomandibular advancement) and tracheostomy
    - Both are very effective

- Oral appliance — retrognathia patients
  - Can be effective, but in mild OSA

- Positional therapy
  - May be effective, but can’t follow compliance to therapy

- Weight loss, most effective therapy
  - 10% reduction in weight = 30% reduction in AHI

Hypoglossal Nerve Stimulator

- Surgical implantation of hypoglossal nerve stimulator (HGNS) system

- Stimulates the hypoglossal nerve during inspiration sleep (sensed by change in thoracic impedance)

Nasal EPAP

- Mechanical valve with very low inspiratory resistance but high expiratory resistance
- Positive pressure throughout exhalation and splints the upper airway

- Applied to each nostril with band-aid adhesive

- Randomized, double-blind, sham-controlled study

- 3 months (77 patients using EPAP)
  - Median AHI 14.4 → 5.6
  - Oxygenation slightly improved also
  - Reported nightly adherence rates of 88%
  - No serious adverse events

SLEEP 2011;34(4):479-485
Future of Sleep Medicine

- Obesity epidemic
  - Screening for OSA in outpatient and peri-operative settings

- Increase portable monitoring
  - Appropriate patient selection (exclude cardiopulmonary disorders)
  - Appropriate review of raw data by board certified sleep physician

- Increase emphasis on longitudinal CPAP care, OSA as a chronic disease
  - Sleep Centers > Sleep Laboratories
    - Multidisciplinary care
      - Physicians trained in sleep (pulmonary, neurology, psychology, and internal medicine)
      - Physician extenders (NP, PA)
      - Ancillary staff (RRT, RPSGT, RN)
    - Preventative care: primary and secondary cardiovascular events
    - Other sleep conditions
      - Narcolepsy, RLS/PLMD, insomnia, parasomnias

- Research on alternative treatments for OSA → ongoing efforts

- Noninvasive positive pressure ventilation → expanding role chronic hypercapnic respiratory failure
  - Neuro muscular populations (chronic respiratory failure → ALS, diaphragm disorders)
  - Expertise in bilevel NIV, advanced ventilation, tracheostomy management
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Won Y. Lee, M.D.
Assistant Professor of Medicine
Division of Pulmonary and Critical Care Medicine
Medical Director, Clinical Center for Sleep and Breathing Disorders