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February 6, 2016



SLEEP APNEA: DEVICE AND DIAGNOSTIC UPDATE

I have no Conflict of Interest





Objectives

- Participants will gain an understanding of the different types of diagnostic sleep studies, their indications and limitations
- Participants will gain an understanding of interpreting sleep studies and troubleshooting the results
- Participants will gain an understanding of the different types of sleep apnea devices available



Lecture Outline

- Definitions
- Pathophysiology
- Diagnosis
 - History
 - Physical Exam
 - Polysomnogram and Home Sleep Tests
- Treatment
 - CPAP
 - OA
 - Alternative Therapies
- Medicare Considerations

Sleep Apnea

- **Apnea/Hypopnea Definition:**
 - **Repetitive cessation or reduction of airflow during sleep**
 - **Associated with arousals and awakenings**
 - **Results in sleep fragmentation and oxygen desaturations**



Types of Sleep Disordered Breathing

- **Apnea**

- Cessation of airflow ≥ 10 seconds

- **Hypopnea**

- \downarrow airflow $\geq 30\%$ from baseline lasting ≥ 10 seconds associated with $\geq 4\%$ desaturation

- **Respiratory Event Related Arousal**

- Repetitive, short arousals caused by the increased work of breathing

Types of Disordered Breathing

- **Obstructive**
 - Collapse of pharyngeal airways during inspiratory effort
- **Central**
 - Respiratory efforts are decreased or absent
- **Mixed**
 - Initial central apnea followed by obstructive apnea

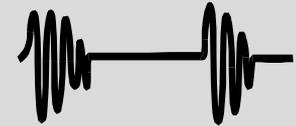
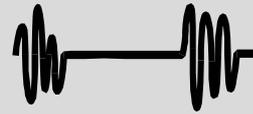
Apnea Patterns

Obstructive

Mixed

Central

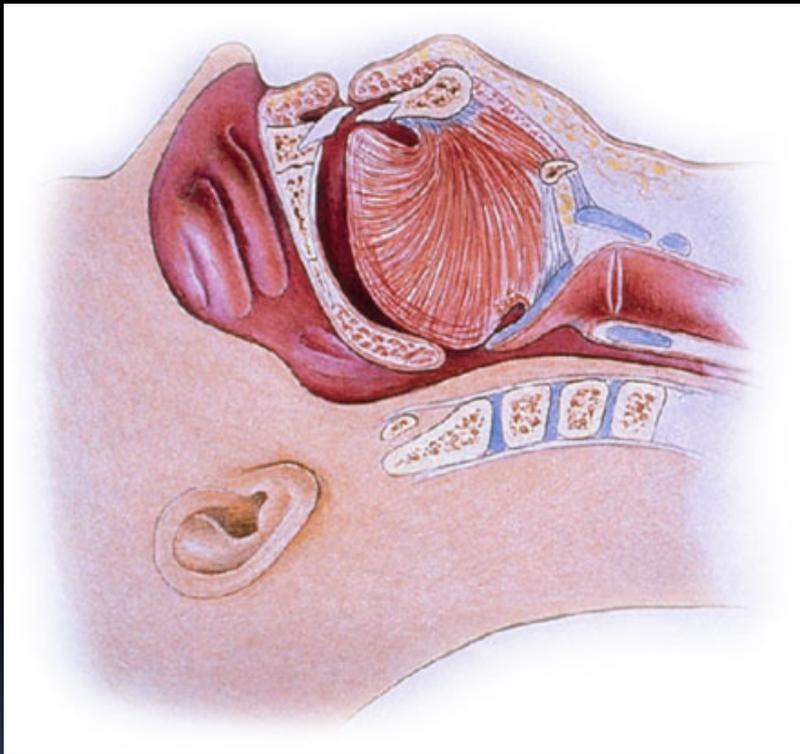
Airflow



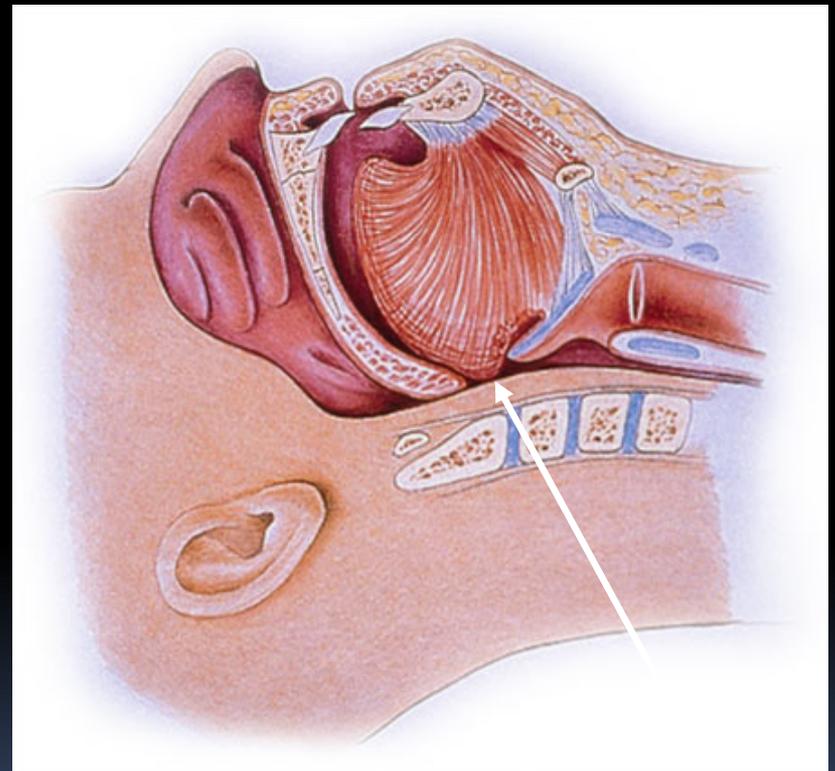
Respiratory effort



Pathophysiology of Obstructive Apnea



Wakefulness



Sleep

Definitions to Know

- **AHI (Apnea Hypopnea Index) =**
Apneas + Hypopneas per hour
 - Mild: AHI 5-15
 - Moderate: AHI 16-29
 - Severe: AHI ≥ 30
- **RDI (Respiratory Disturbance Index) =** apneas + hypopneas + RERAs



Meet Mr. Small

- 55 yo male
 - h/o HTN, atrial fibrillation
 - What symptoms to ask about?
-
- What physical exam findings are relevant?
- 

- Symptoms to review:
 - Snoring
 - Excessive daytime somnolence
 - Witnessed apneas
- Physical Exam Findings:
 - Obesity
 - Big neck
 - ≥ 17" neck – males
 - ≥ 16" neck - females
 - Mandible anatomy
 - Upper Airway Anatomy
 - Mallinpotti Score

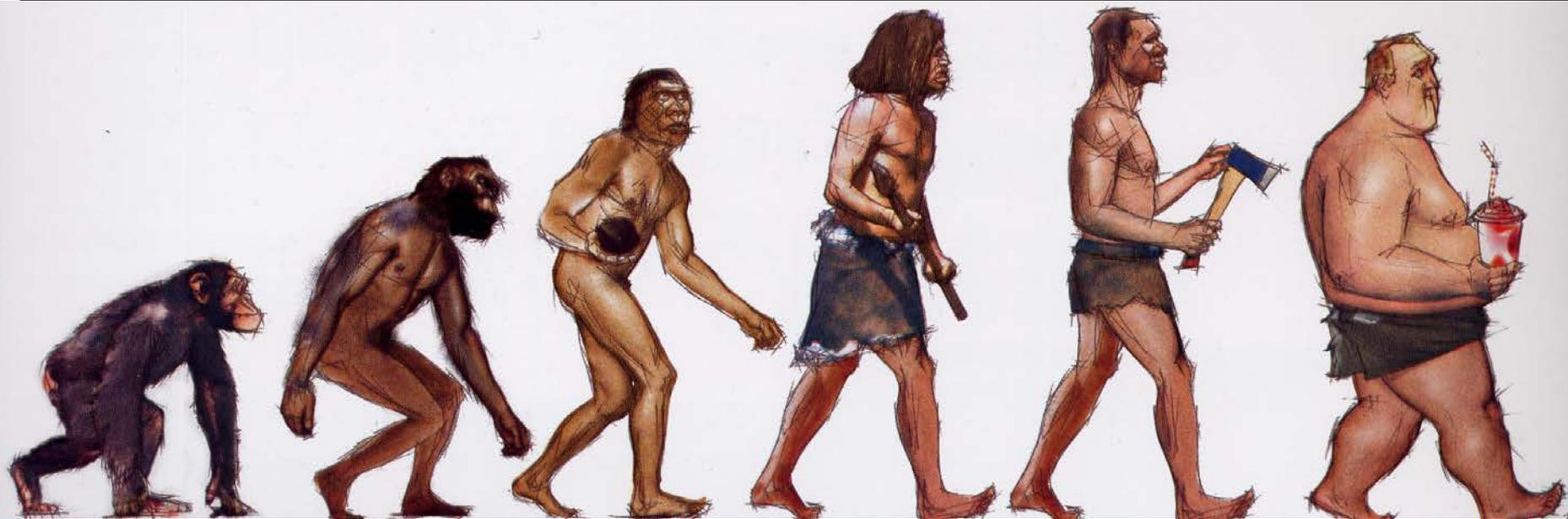


Sleep Apnea Risk Factors

- Increasing age
 - Male gender
 - Family history
 - Alcohol or sedative use
 - Cause myorelaxation → collapse of airway
 - Smoking
- 

Epworth Sleepiness Scale

- Eight questions
- Subjective assessment of symptoms
- Answered by 0-3 point response
- Measures Chronic daytime somnolence
- Score >10 strongly associated with daytime sleepiness; >15 marked sleepiness
- May also be used to assess response to treatment



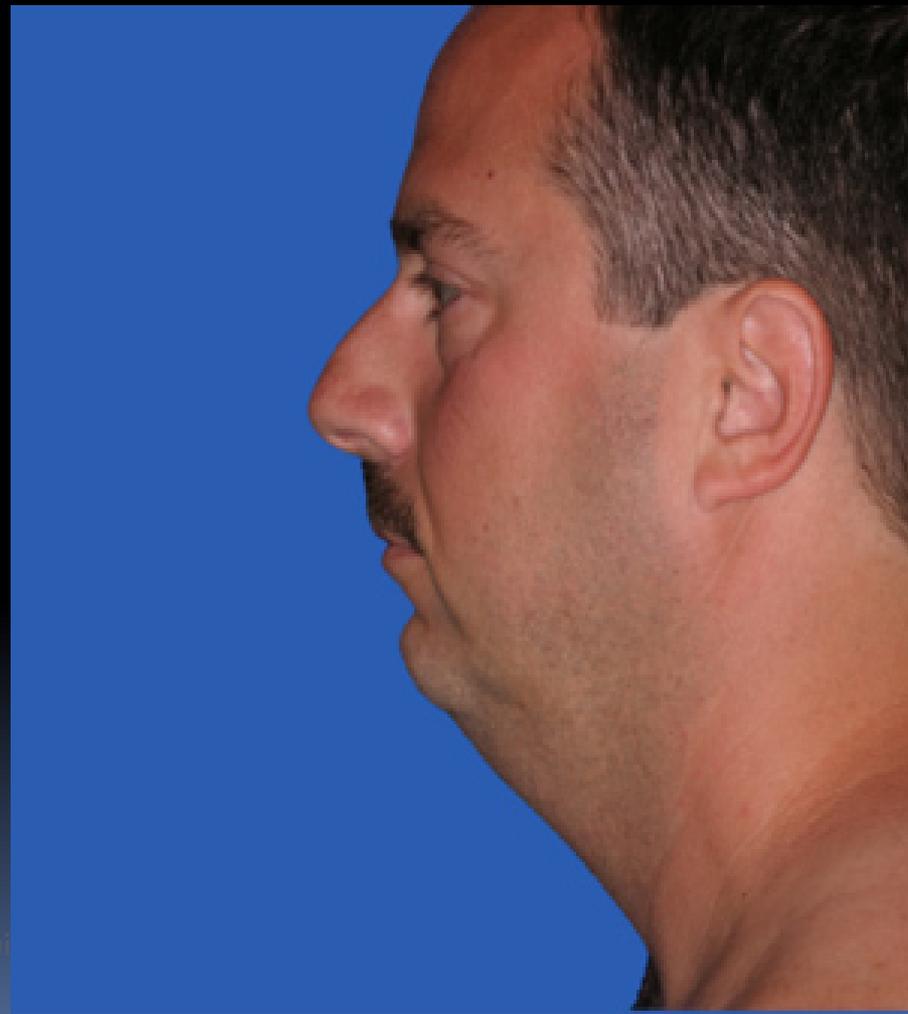
Mr. Small

- Snored “forever”
- Wife complains that he stops breathing
- No symptoms of daily sleepiness- ESS 7
- + Retrognathia and micrognathia
- BMI 37
- Mallinpotti 4



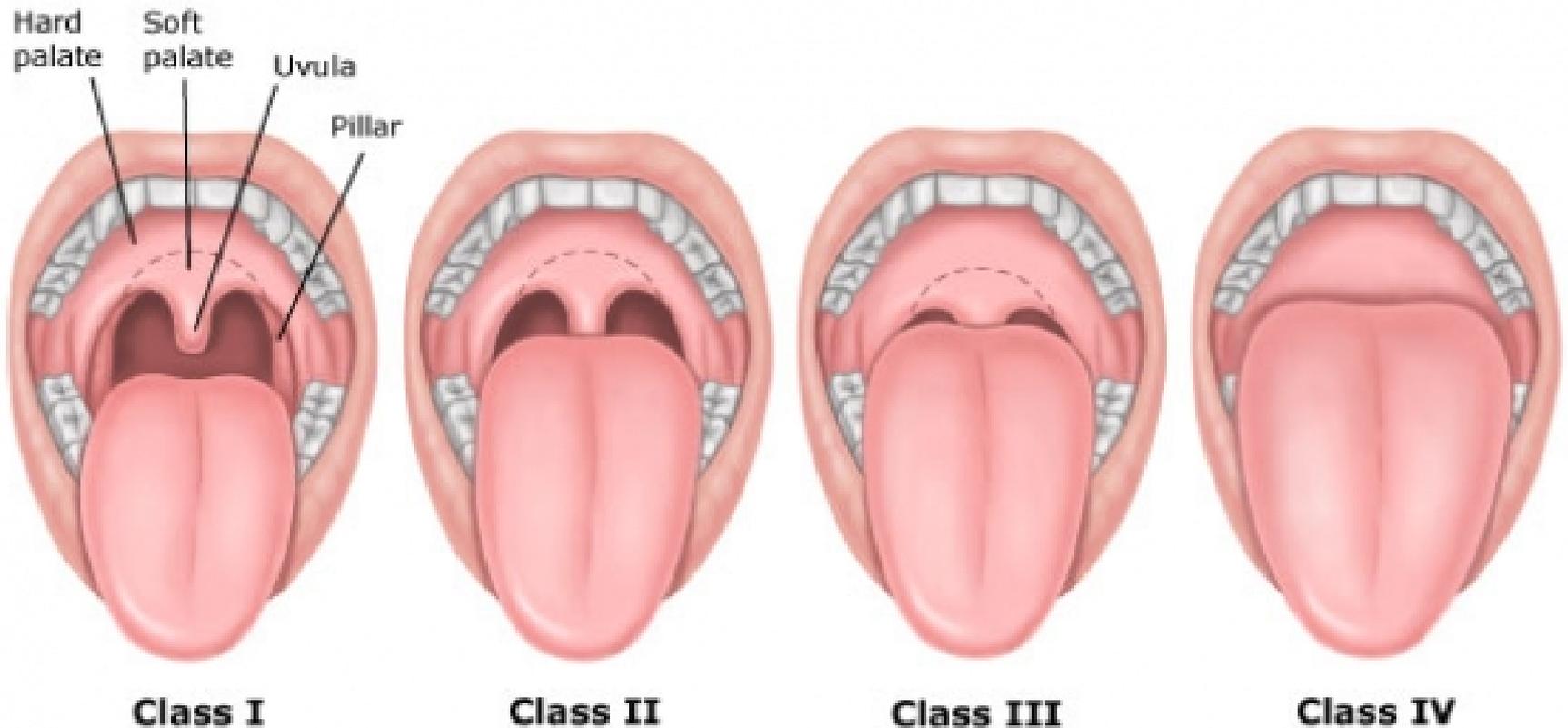
Physical Examination

Structural Abnormalities



- Retrognathia
- Micrognathia

Mallampati Classification



1994-1998 VS 2007-2010

Men

AHI ≥ 5 , ESS score >10

30-49 8.5

50-70 15.3

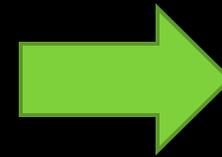
30-70 10.8

AHI ≥ 15 , ESS score >10

30-49 3.1

50-70 5.4

30-70 3.8



11.7

17.6

14.3

4.8

7.0

5.8

Women

AHI ≥ 5 , ESS score >10

30-49 2.1

50-70 6.6

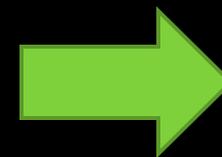
30-70 3.8

AHI ≥ 15 , ESS score >10

30-49 0.55

50-70 2.6

30-70 1.3



2.9

7.5

5.0

Peppard. Am J
Epidemiol
2013;177(9):1006-1014

0.79

3.2

1.9



You Suspect OSA...

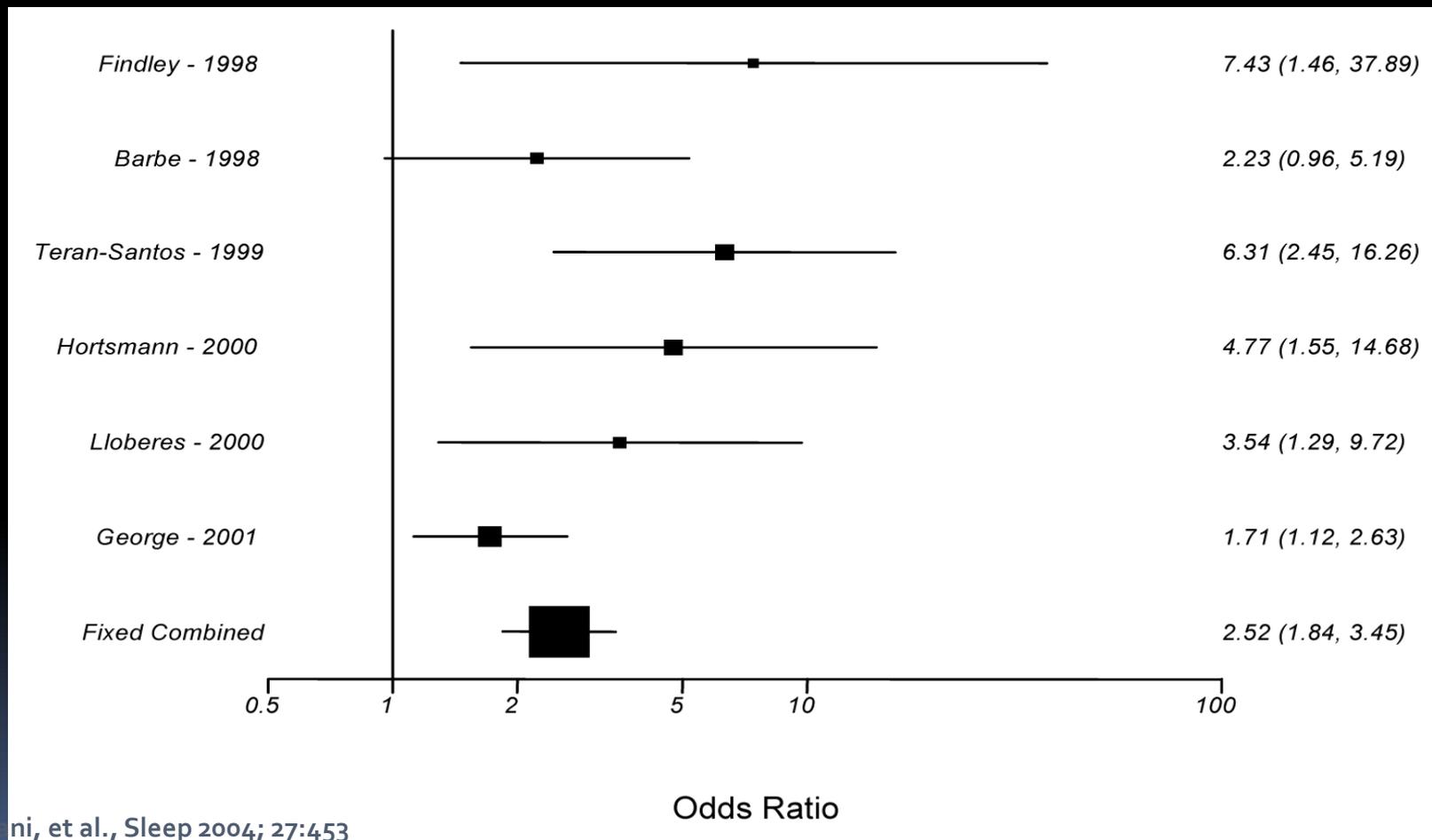
- Mr. Small DOES not want another diagnosis and does not think this is a big deal.
 - What do you tell him ?
- 



Consequences: Excessive Daytime Sleepiness

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

Consequences: Automobile Accidents





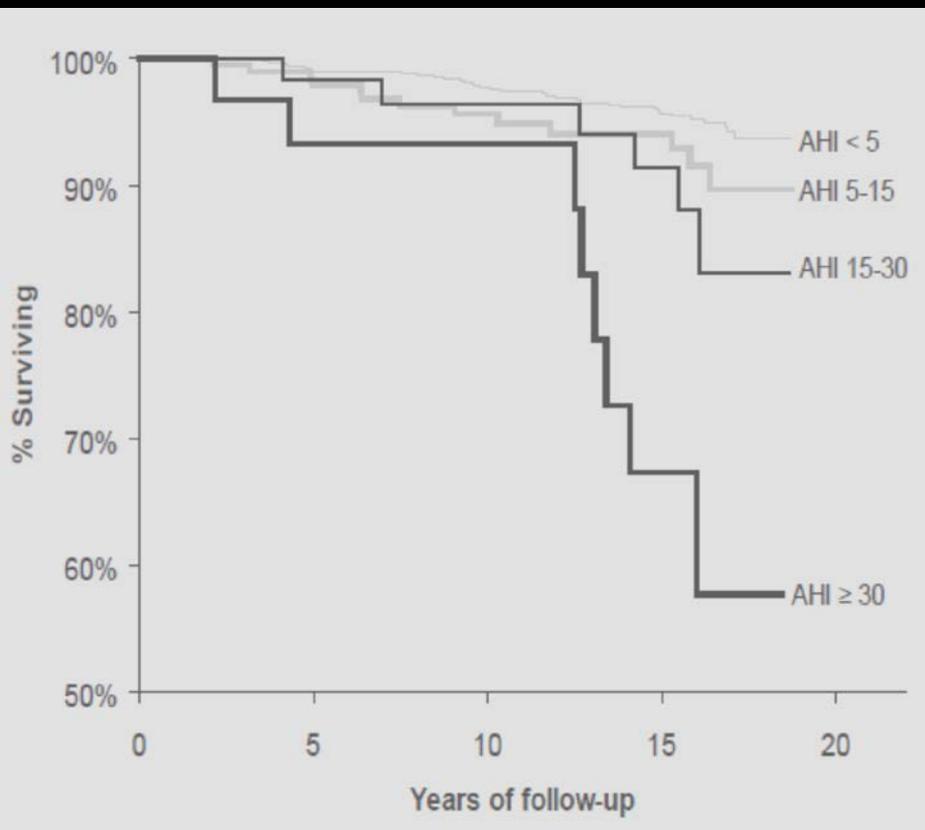
Consequences: Cardiovascular

- Hypertension
 - Cardiac arrhythmias
 - Cardiovascular disease
 - Myocardial ischemic
 - Congestive heart failure
 - Cerebrovascular disease
- 



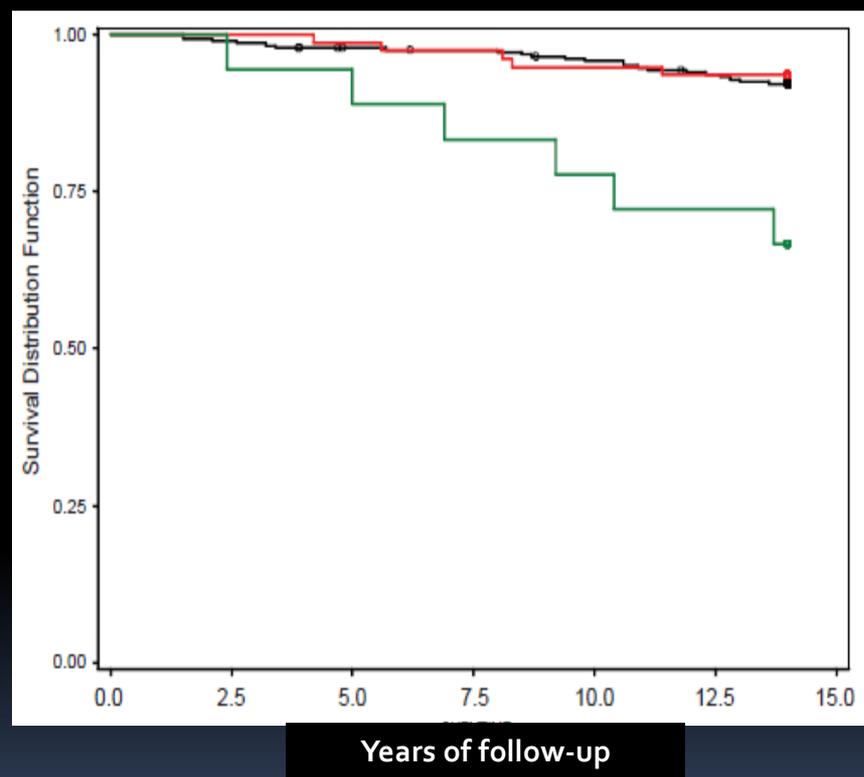
Consequences: Mortality

Wisconsin Cohort



Young et al. Sleep 2008; 31:1071-1078

Busselton, Australia



Marshall et al. Sleep 2008; 31:1079-1085



Differential Diagnosis of Excessive Sleepiness

- Fragmented sleep
 - Insomnia
 - Sleep apnea or UARS
 - PLMD, bruxism
 - Medical conditions (pain, nocturia)
- Circadian rhythm sleep disorder
- Insufficient sleep syndrome
- Medication or substance use or withdrawal
- Narcolepsy
- Recurrent hypersomnia (Kleine-Levin)



Mr. Small Agrees to Pursue a Diagnosis...

- What diagnostic study will send Mr. Small for?
- 



Diagnosis

- In-laboratory full night polysomnography (PSG)
 - Diagnostic Studies
 - Split night studies
 - Home diagnostic systems
 - Oximetry
 - Home Sleep Tests
- 

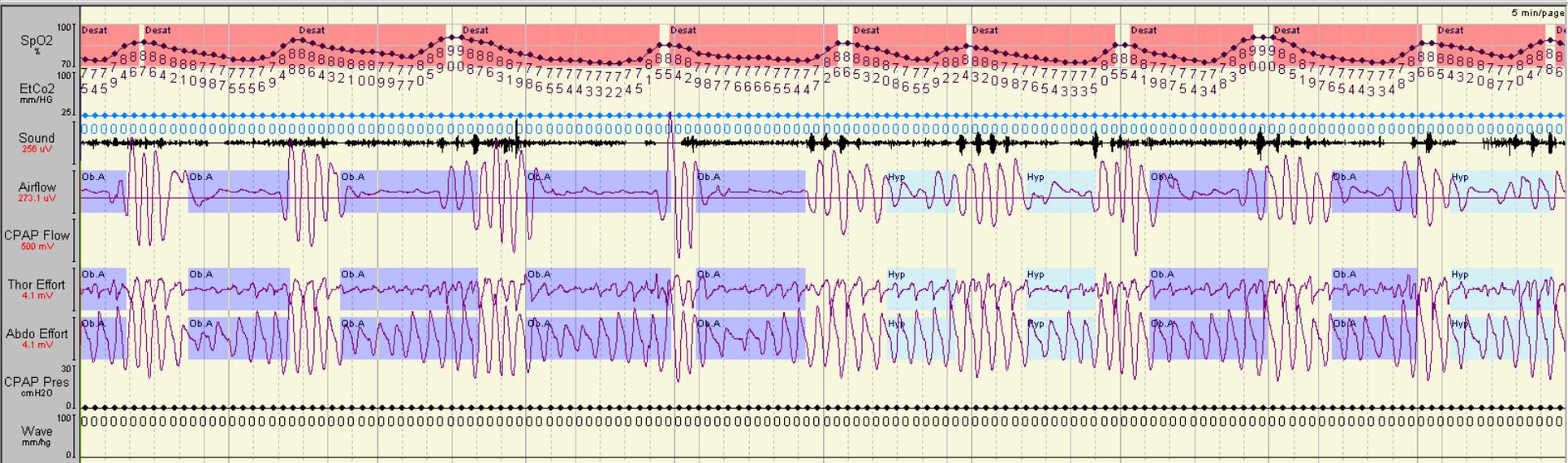
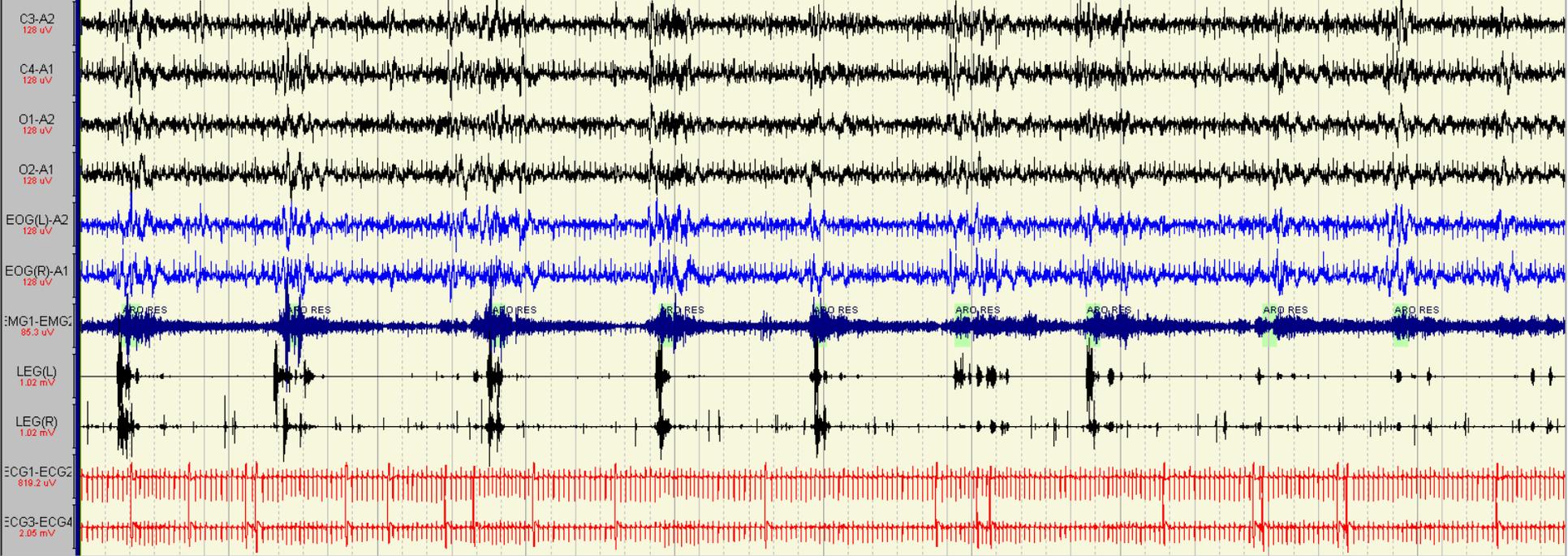
Polysomnogram

- Gold-Standard for Diagnosis
- EEG, EOG, Oximetry, Capnography, Leg muscle activity, Chest and abdominal effort, airflow, observations, sleep position, video monitoring, ECG
- 30 minutes set-up time
- Real-time monitoring/interactions
- Offers possible therapeutic interventions
- Usually well-tolerated and efficient

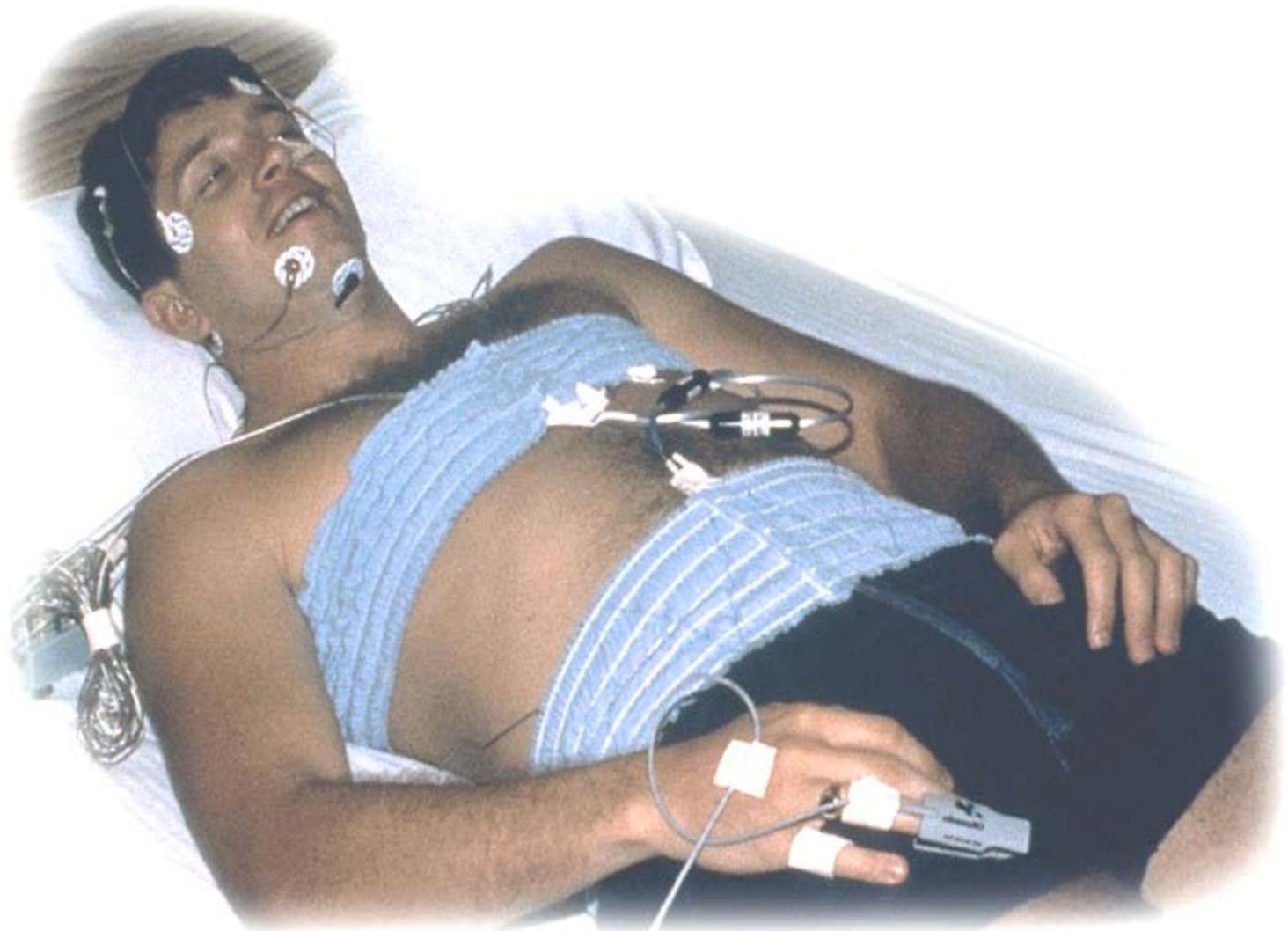


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5 min/page



Polysomnography- Set Up

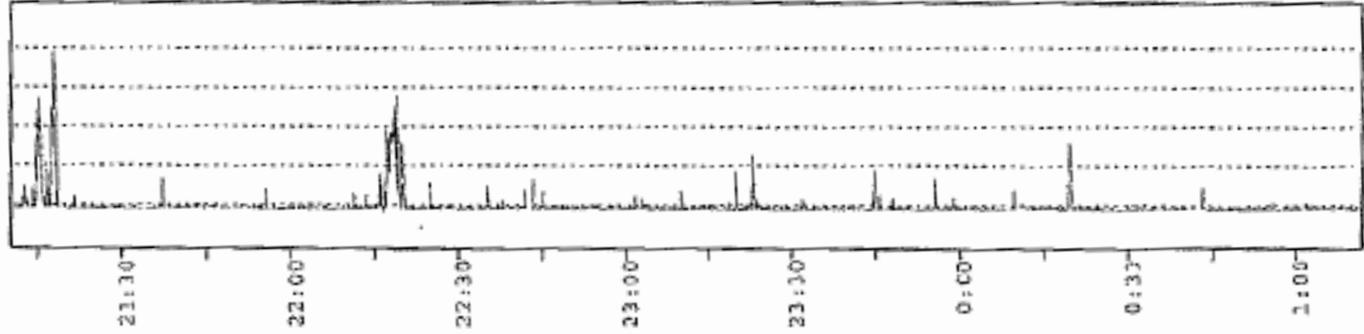


Nocturnal Oximetry

- Can indicate the oxygen desaturation index (ODI)
 - # of 4% desaturations per hours
- Look for pattern of “sawtooth abnormalities”
 - Indicates frequent saturation/ desaturation events that occur with apneic/ hypopneic events

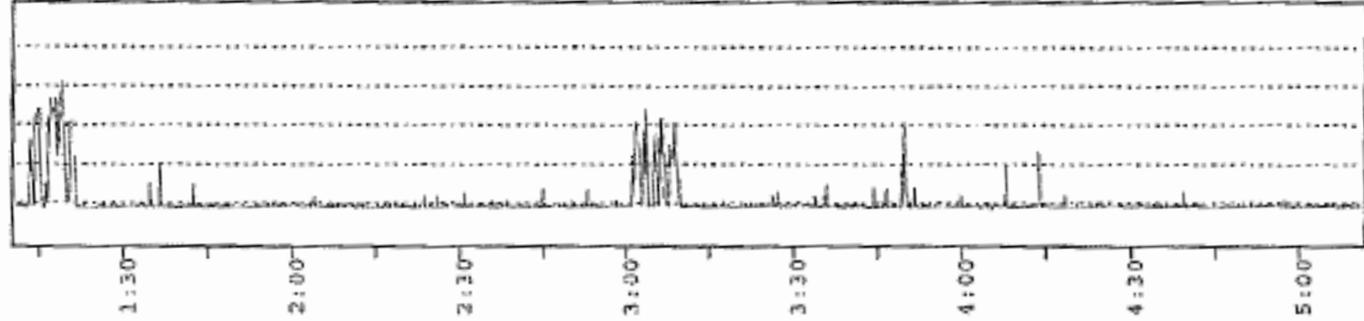
Oximetry: 8 hours per page
Comments: Overnight oximetry on Room Air with CPAP

HOUR 07-03-16

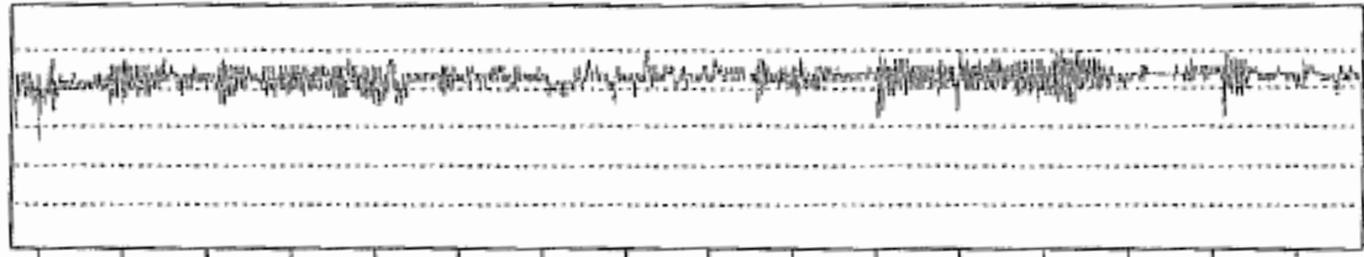


PULSE

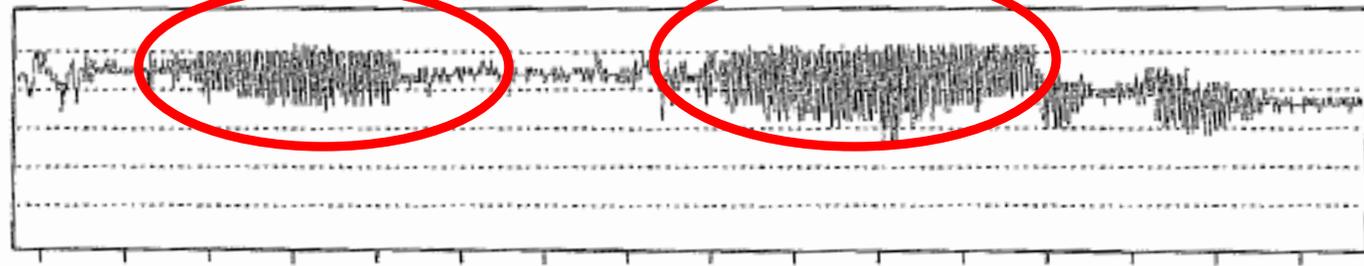
HOUR 07-04-14



PULSE



SATURATION



SATURATION



Home Sleep Test

- Type 3 Device – No technician, usually at home
 - Monitors at least 4 variables –
 - 2 respiratory (flow and effort)
 - Cardiac variable
 - Oxygen saturation
- 



Home versus Inpatient?





Advantages of Home Sleep Tests

- Convenience
 - At home in typical sleeping environment
 - Can be done at altitude
- Cost
- Better patient acceptance

Limitations of HST

- Does not determine sleep or sleep stages.
 - Averages # of events/ recording time (instead of sleep time) → the AHI from HST underestimates severity of disease, leads to false negatives
 - Unable to determine REM
 - Does not assess arousals, therefore can't diagnose RERAs
- Does not determine position
- Not validated for central disease
- Inability to diagnose and determine treatment on the same night

Patient Selection

- High Pretest probability of OSA (moderate to severe disease)
- No comorbid conditions
 - Pulmonary disease
 - Neuromuscular disease
 - CHF
- Do NOT use if other sleep diagnosis are suspected
- Assessment of positional therapy or OA in patients with a known h/o OSA

Study Selection:

- Mr. Small
 - Ideal for a Home Sleep Test
 - No comorbidities
 - No CHF, pulmonary disease, NM disease
 - High pretest probability

Mr. Small's results

- AHI – 33
 - Severe sleep apnea
- Desaturation Index- 30
- Lowest desaturation – 83%
- Spent 12% of the study with an oxygen level < 90%

- 
- Negative HST results in a patient with a high probability of OSA should proceed to an in-lab polysomnogram
- 

But – Mr. Big, his brother

- 65 yo male
- h/o HTN, CAD, COPD with supplemental oxygen, CHF- EF 37%
- BMI 30, Mallinpotti 3, Neck 18cm
- What Type of Study would you order for him?



Mr. Big

- Needs an inpatient polysomnogram
 - Comorbidities
 - CHF
 - at risk for central sleep apnea
 - COPD
 - On supplemental oxygen
 - Will need oxygen at night – but how much
- 



Treatment Objectives

- Reduce morbidity and mortality
 - Reduce sleepiness
 - Decrease cardiovascular consequences
- Improve quality of life



Behavioral Interventions

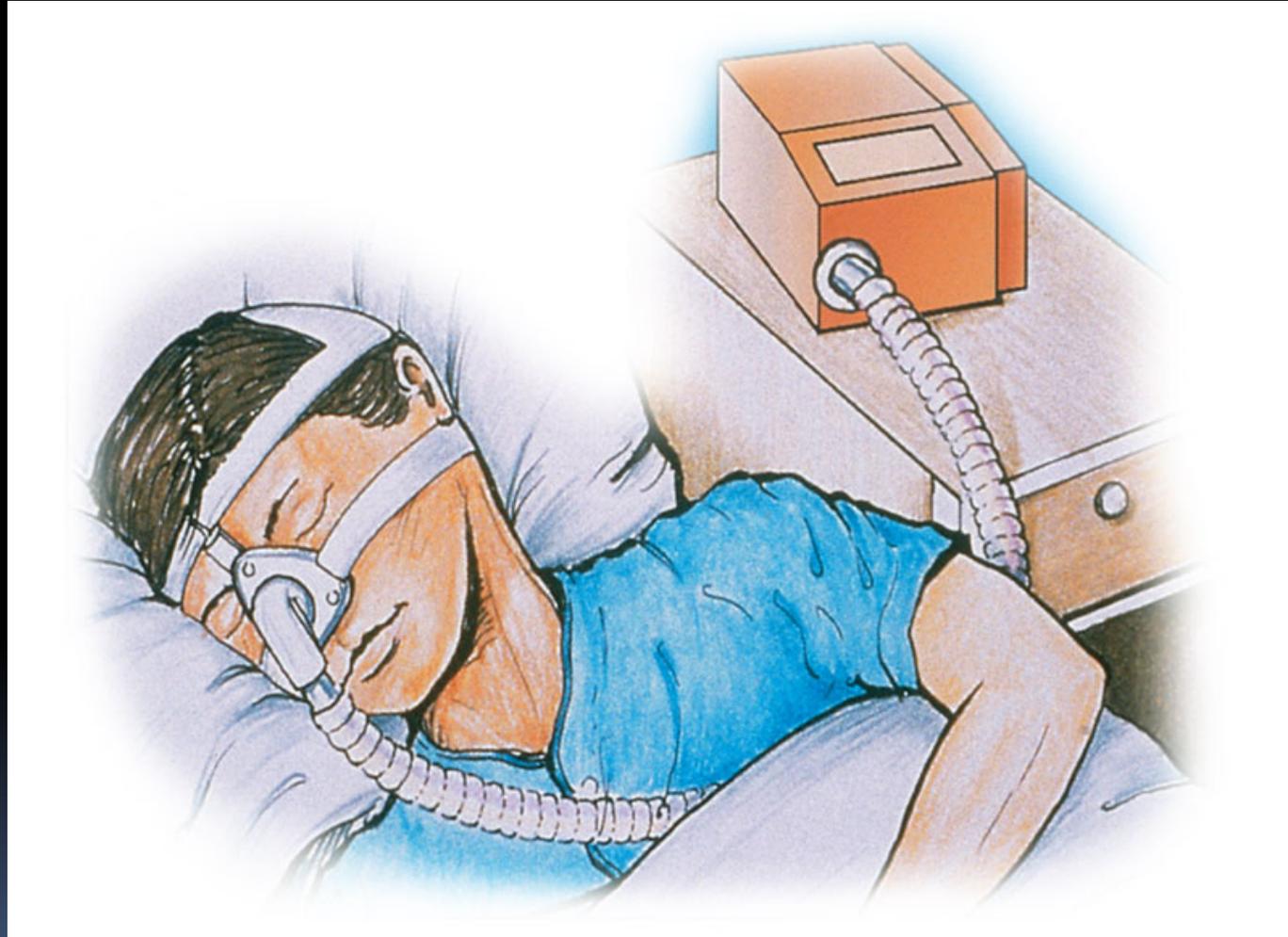
- Encourage patients to:
 - Lose weight
 - Avoid alcohol and sedatives
 - Avoid sleep deprivation
 - Avoid supine sleep position
 - Stop smoking



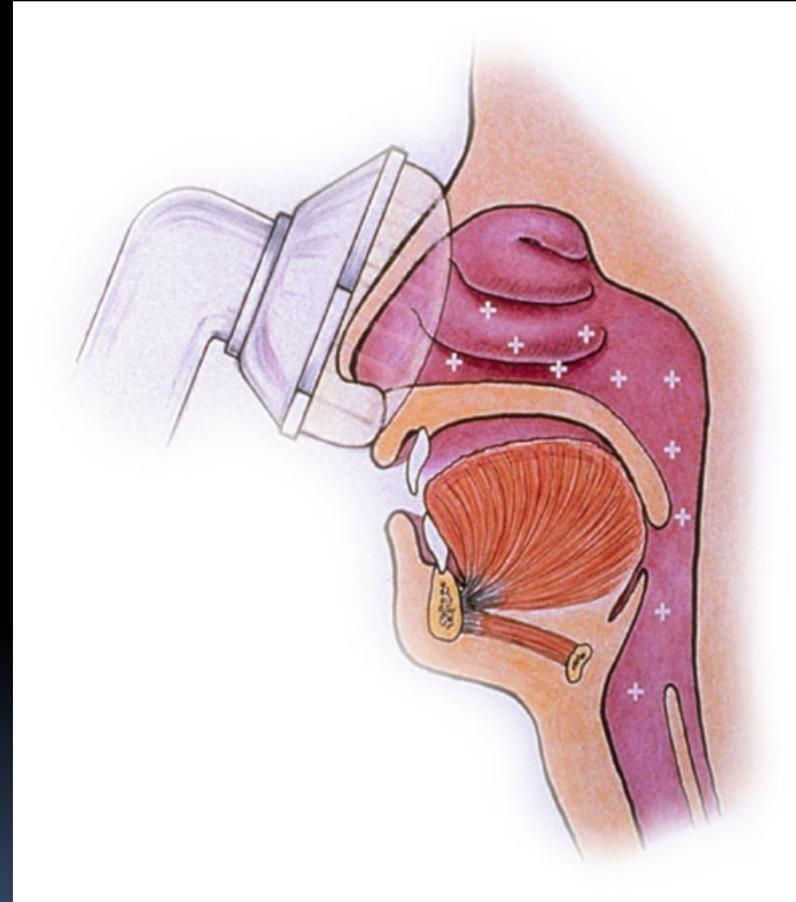
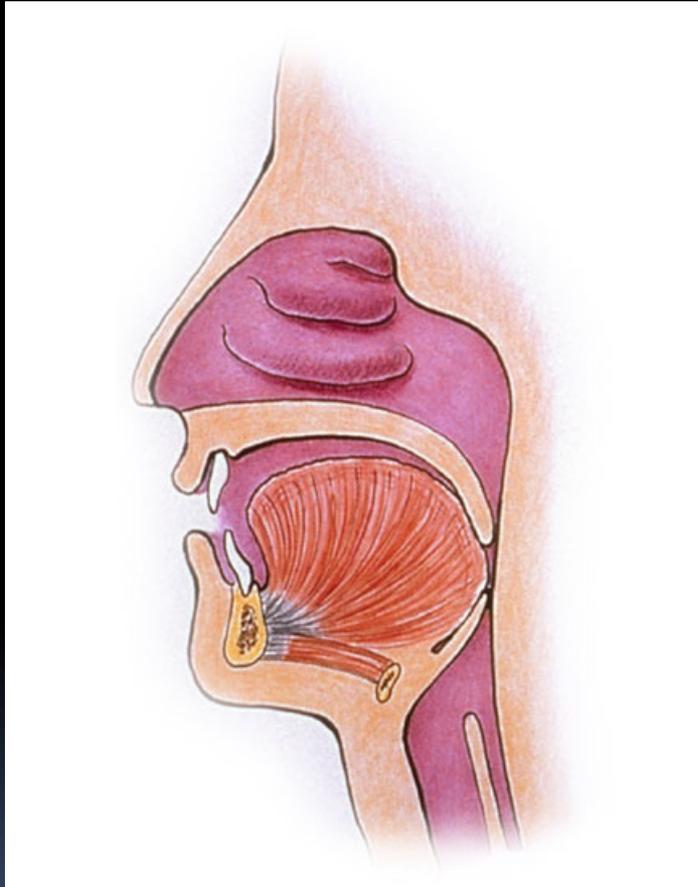
Medical Interventions

- **Positive airway pressure**
 - Continuous positive airway pressure (CPAP)
 - Bi-level positive airway pressure
 - Auto Servo Ventilation (ASV)
 - **Oral appliances**
 - **Other (limited role)**
 - Medications
 - Oxygen
- 

Positive Airway Pressure

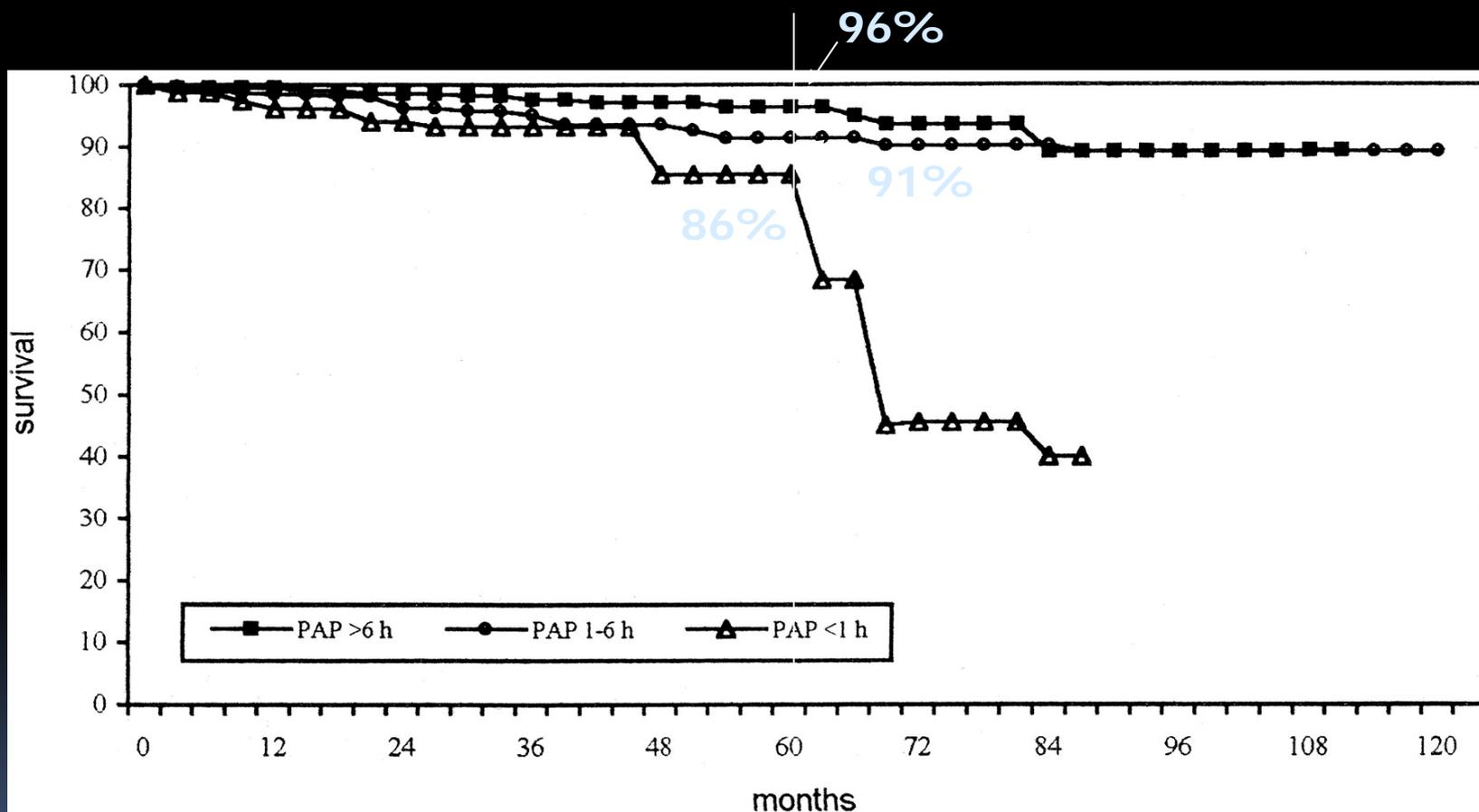


Positive Airway Pressure

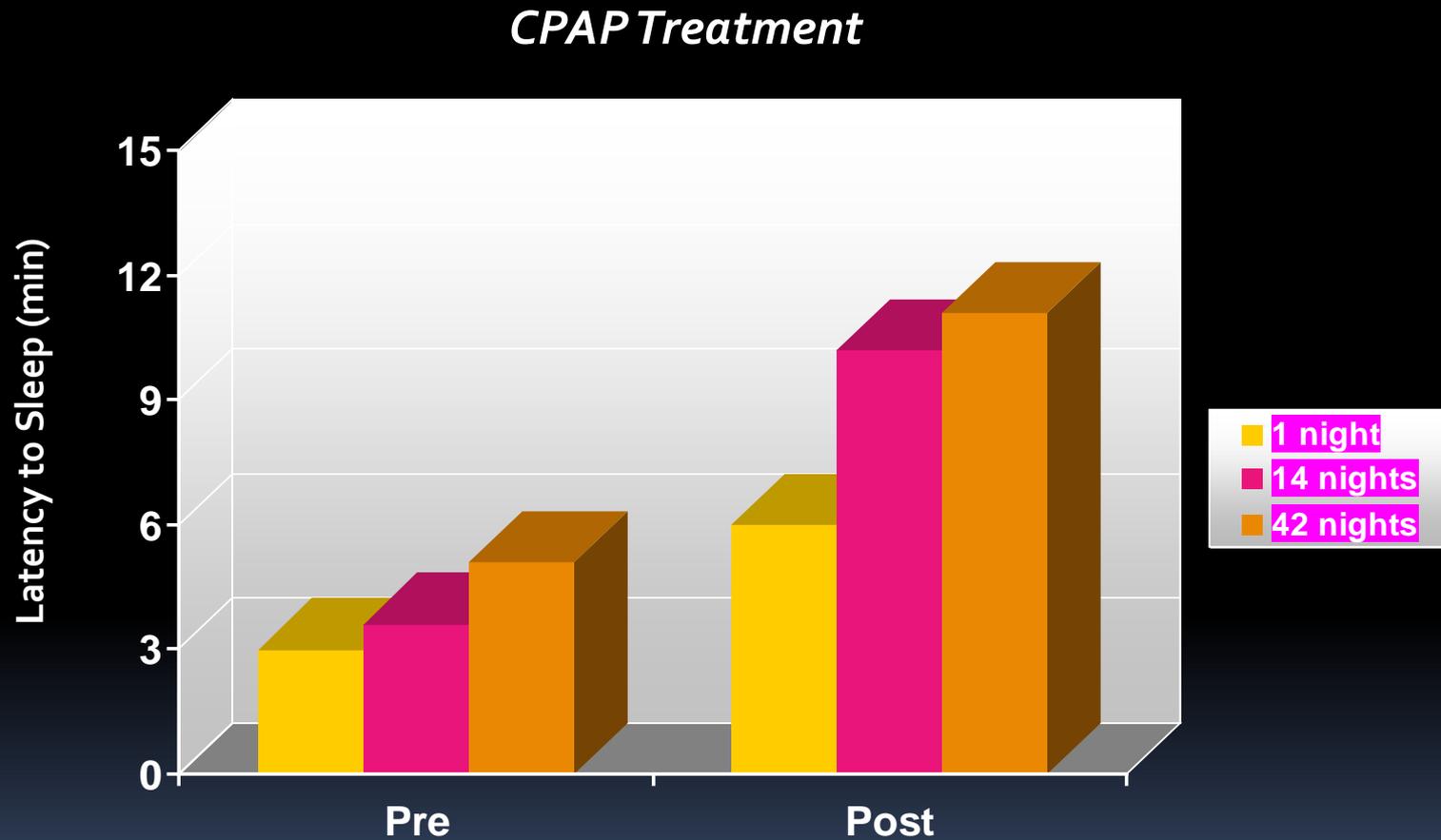




Benefits of CPAP: Mortality

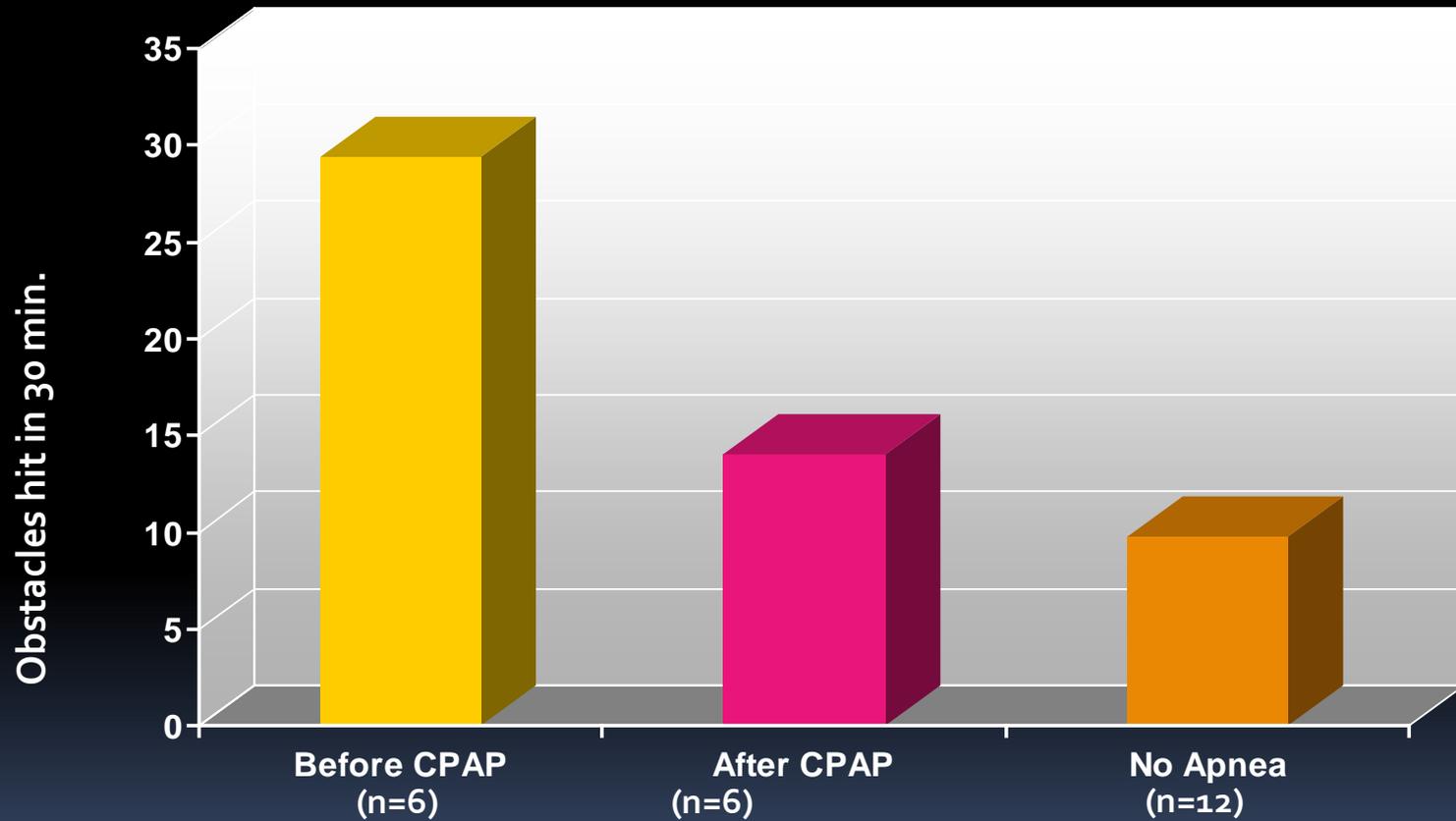


Benefits of CPAP: Sleepiness



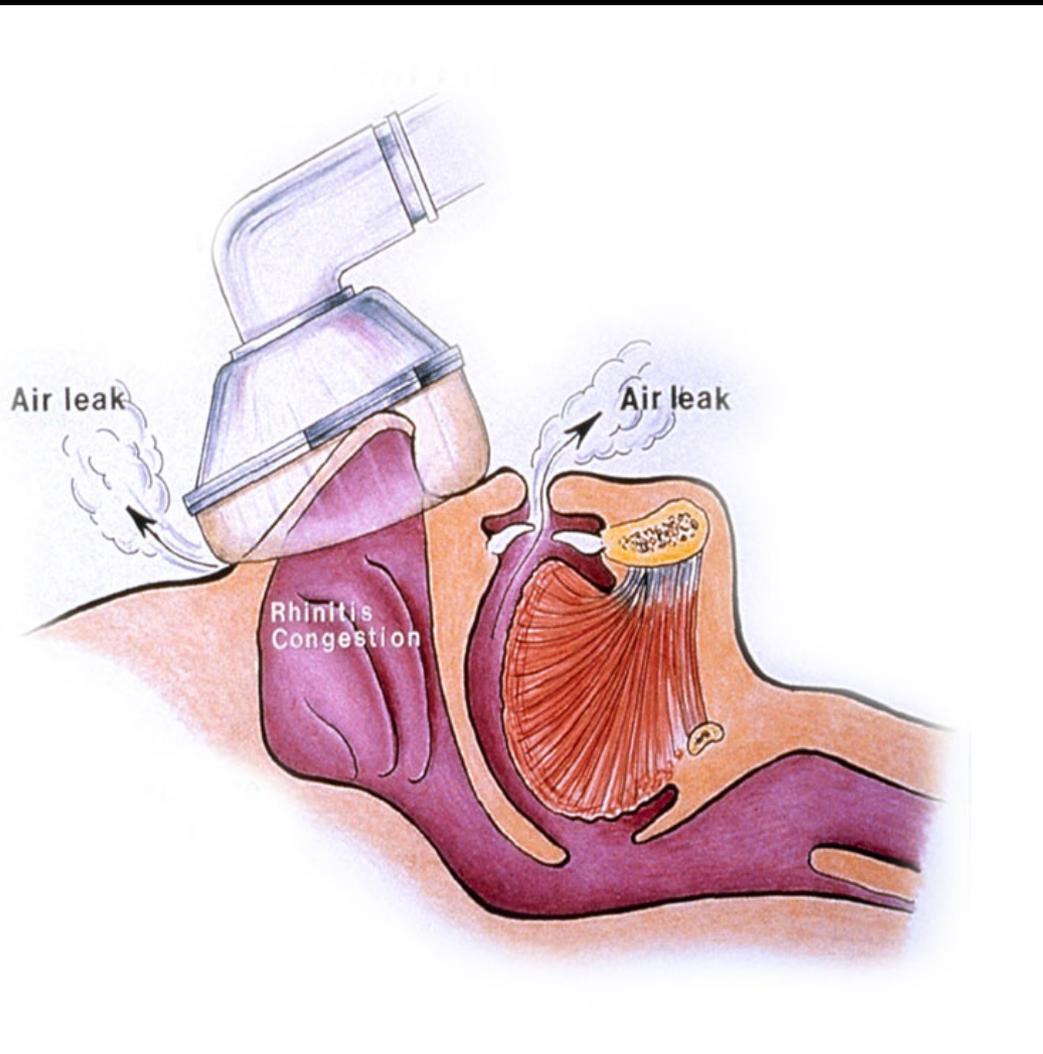
Adapted from Lamphere J et al. Chest 1989;96.

Benefits of CPAP: Performance



Adapted from Findley L et al. Clin Chest Med 1992;13.

Complications of CPAP



- Mask Leak
- Claustrophobia
- Skin Issues
- Dry Mouth
- Aerophagia
- Rhinitis



CPAP compliance

- Patient report: 75%
- Objectively measured use
 - 4 hrs for ≥ 5 nights / week: 46%
- Largest study of long-term adherence, 68% of patients were still using CPAP at 5 years.

Kribbs . Am Rev Respir Dis 1993;147(4):887-95.



CPAP Compliance: Predictors

- Predict Good Compliance
 - Increased AHI
 - Increased daytime sleepiness
 - Perception of benefit
- Predict Poor Compliance
 - Lack of EDS
 - Lack of perceived benefit
 - Nasal obstruction
 - Side effects
 - Claustrophobia



Desensitization

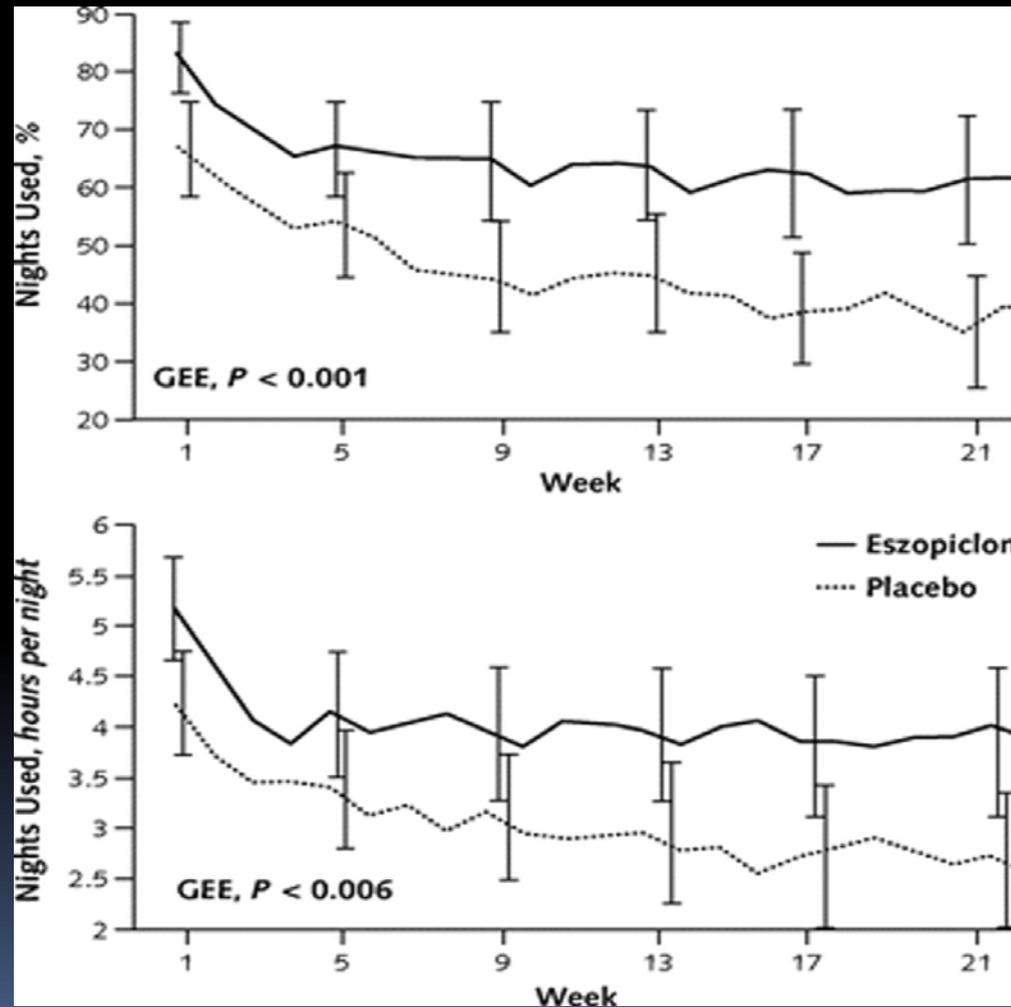
- 1- Wear the mask alone, **while awake**, until it becomes comfortable
- 2- Use the mask with the CPAP machine, **while awake**, until it becomes comfortable
- 3- Put on the mask prior to bed & attempt to sleep with it

It is ok if you can only tolerate it for a short period of time

Repeat this every night

Hypnotics & CPAP Adherence

- Single center parallel designed RCT
- Eszopiclone 3mg- for 2 weeks
- Assessed at 3 and 6 months with data card downloads
- Open label sedatives allowed after 4 weeks





Measuring Compliance

- Data Card Download
 - Measures “mask on” time
 - Residual AHI
 - Leak
- Pulse oximetry
- Objective monitoring required by CMS

Therapy Data Summary - All Data

Compliance Summary

Date Range	4/4/2014 - 7/2/2014 (90 days)
Days with Device Usage	86 days
Days without Device Usage	4 days
Percent Days with Device Usage	95.6%
Cumulative Usage	22 days 23 hrs. 40 mins. 3 secs.
Maximum Usage (1 Day)	11 hrs. 52 mins. 19 secs.
Average Usage (All Days)	6 hrs. 7 mins. 46 secs.
Average Usage (Days Used)	6 hrs. 24 mins. 53 secs.
Minimum Usage (1 Day)	40 mins. 24 secs.
Percent of Days with Usage \geq 4 Hours	88.9%
Percent of Days with Usage \leq 4 Hours	11.1%
Total Blower Time	23 days 1 hrs. 32 mins. 56 secs.

Auto CPAP Summary (Philips Respironics)

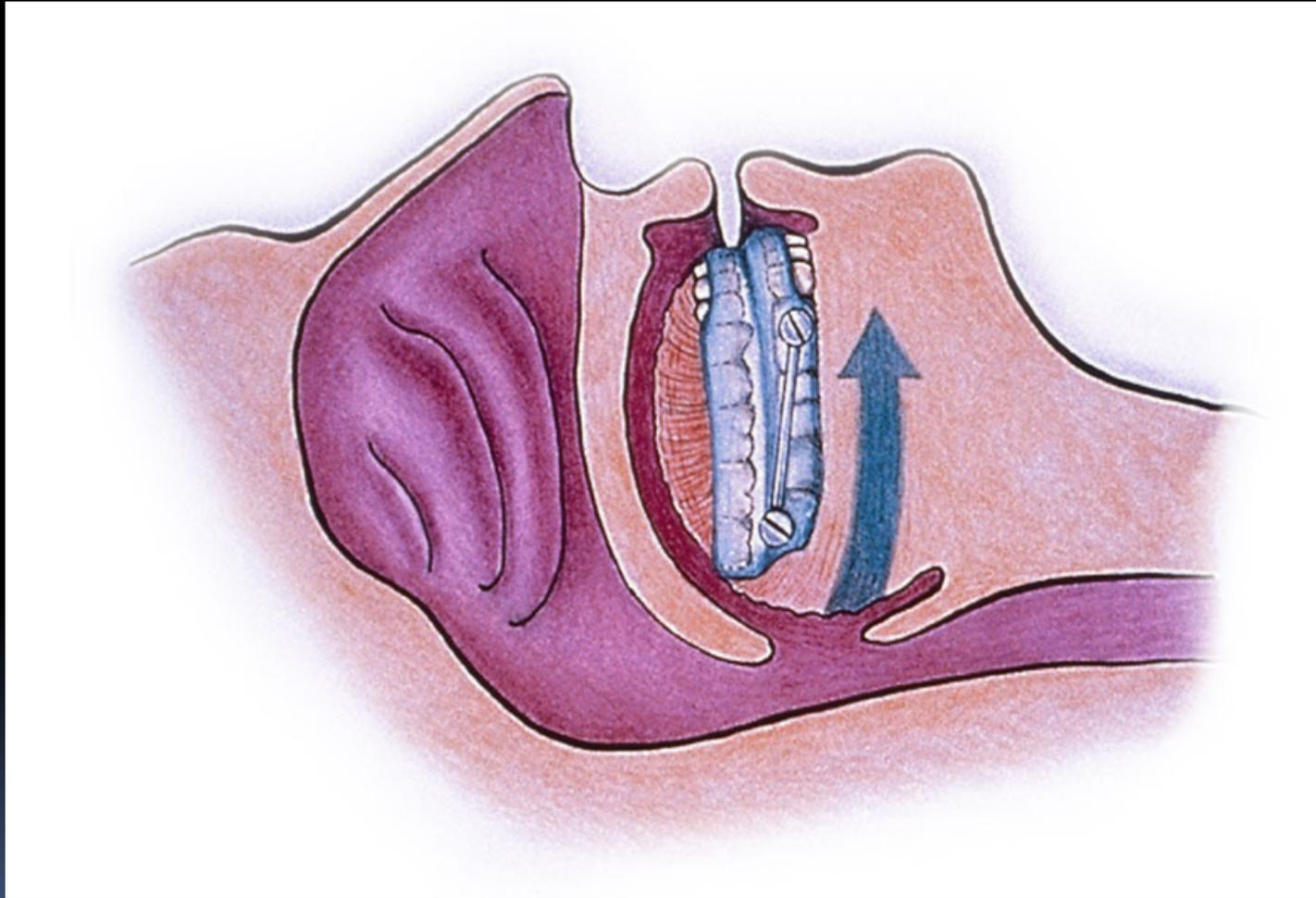
Auto CPAP Mean Pressure	9.2 cmH2O
Auto CPAP Peak Average Pressure	11.1 cmH2O
Average Device Pressure \leq 90% of Time	10.7 cmH2O
Average Time in Large Leak Per Day	29 mins. 24 secs.
Average AHI	3.9



Oral Appliances

- Indications
 - Snoring and Mild to Moderate OSA
- Efficacy
 - Variable
 - 52% of patients with $AHI < 10/hr$ on treatment
- Side effects
 - TMJ discomfort, dental misalignment, and salivation

Oral Appliance: Mechanics

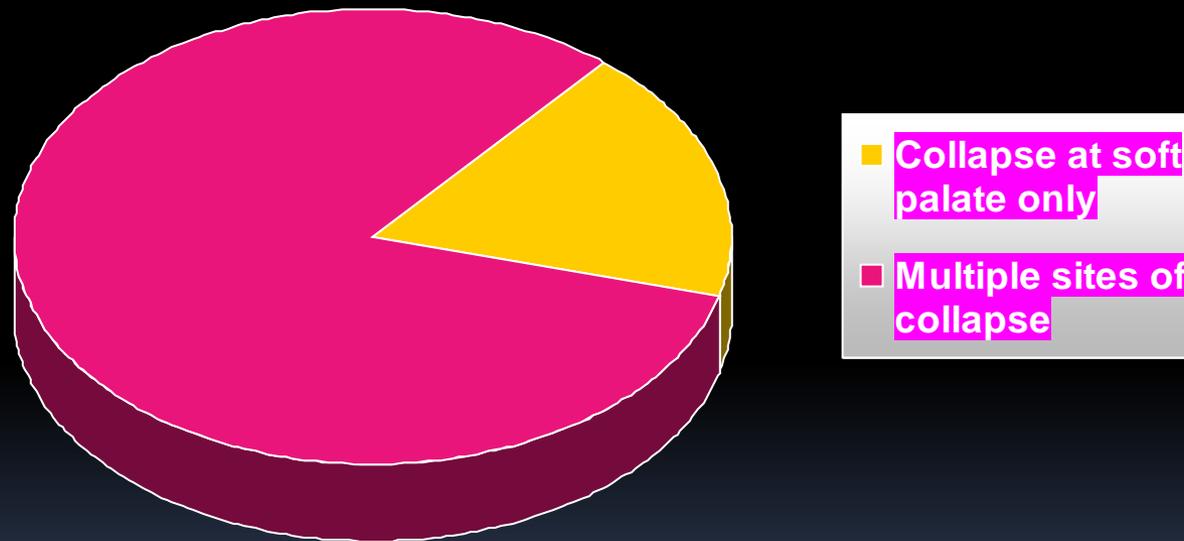




Surgical Therapies

- Reconstruct upper airway
 - Uvulopalatopharyngoplasty (UPPP)
 - Radiofrequency tissue volume reduction
 - Genioglossal advancement
 - Nasal reconstruction
 - Tonsillectomy
 - Bypass upper airway
 - Tracheostomy
 - Hypoglossal Nerve Stimulator
- 

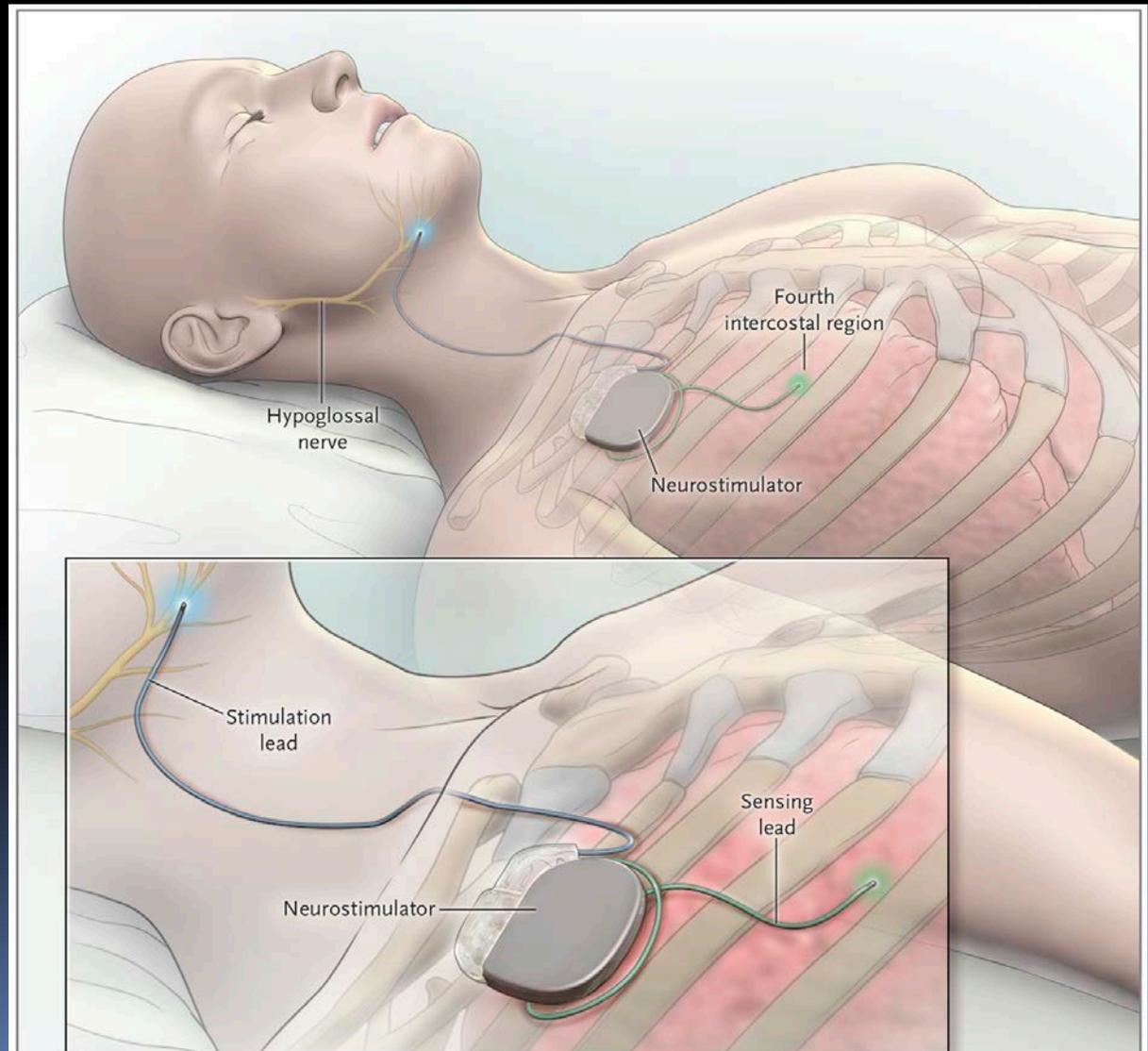
Sites of Airway Narrowing



Adapted from Morrison DL et al. Am Rev Respir Dis 1993;148

Hypoglossal Nerve Stimulator

- Activates the genioglossus muscle via unilateral stimulation of the hypoglossal nerve



Results

- 126 patients had stimulator implanted
 - 83% men, Mean BMI- 28, Mean age- 54.5 years
 - Mean AHI- 32, Mean ODI- 29
- Median AHI decreased 68% (29 → 9)
- Median ODI decreased 70% (25 → 7)
- 66% of cohort had AHI < 20 AND AHI decrease by 50%
- ESS, FOSQ significantly improved

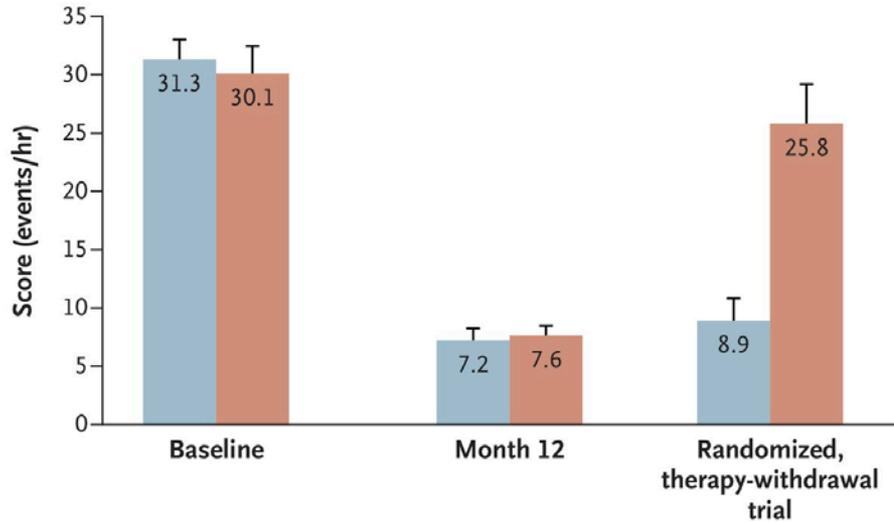
Randomized withdrawal phase

46 patient who responded to txt randomized in 1:1

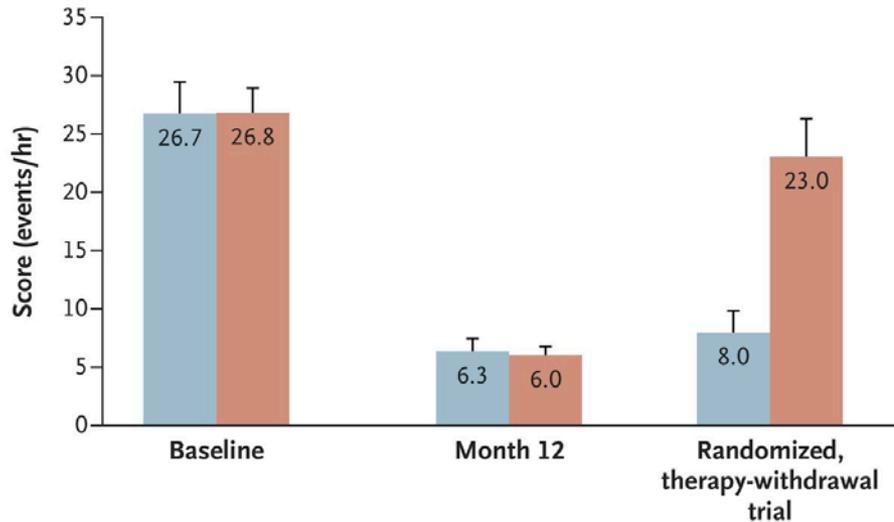
- Cessation of stimulator or therapy maintenance
- Repeat PSG after 1 week

■ Therapy-maintenance group (N=23) ■ Therapy-withdrawal group (N=23)

A Apnea-Hypopnea Index



B Oxygen Desaturation Index



Mr. Small

- AHI – 33
 - Severe sleep apnea
- Placed on an APAP
 - Range 5 → 15cm
- At Follow up
 - Feels better
 - Residual AHI 5



Medicare Considerations

This makes me want to drink!



Medicare - It is painful!

- Rules are strict
- If you are unaware of the regulations:
 - Patients may experience a delay in getting equipment
 - Patients may have to have costly, repeat testing
 - Patients may have to pay out of pocket for expensive medical equipment
 - Patients lose confidence in you

CPAP Therapy- Medicare

- Medicare pays 80%
- CPAP is rented for 13 months
 - Patients have ~\$20/month copay
- Medicare will pay for a new CPAP every 5 years
 - Face-to-face visit within 6 months
- 5 things must occur for CPAP to be covered

CPAP Therapy- Medicare

1) Pt needs face to face visit recommending PSG

- Chart note needs:
 - signs/symptoms, duration of symptoms
 - Epworth Sleepiness Scale
 - Cardiopulmonary exam, Neck circumference, BMI

2) Sleep study must show enough apnea events:

- AHI ≥ 15 (with a minimum of 30 events)
- AHI 5-14 (with a minimum of 10 events) PLUS
 - Insomnia, Daytime sleepiness, Cognitive impairment
 - Mood Disorder, HTN, Ischemic heart disease, Hx of stroke
 - AHI of 4.9 does not count

CPAP Therapy- Medicare

3) CPAP order:

- Must include:
 - Prescriber name and signature
 - Prescriber NPI #
 - Order date

4) After CPAP delivery, pt needs face-to-face visit between day 31-91 after starting CPAP

- Chart notes must state that pt is benefitting from therapy and needs to continue CPAP use

CPAP Therapy- Medicare

5) Pt has to show compliance with CPAP

- 30 day consecutive period within the 1st 90 days
- Percent of days with usage ≥ 4 hours per night is at least 70% (69.5% doesn't count)
- Clinician must document that he/she reviewed compliance data

CPAP Therapy- Medicare

- If patient fails to meet compliance criteria or does not have face to face follow-up visit, CPAP is no longer covered
 - Pt can elect to keep machine and pay out of pocket
 - Pt can give the machine back and buy a machine on their own (internet, used machine)
 - Pt can start the process over
 - Face to visit, repeat sleep study, PAP reissued
 - If starting over, patient must have in-lab test (no HST)
 - PSG may be baseline, split-night or titration

Oxygen Use with CPAP

- If patient has diagnosis of sleep apnea:
 - Must have in-lab PAP titration study showing that they still desat despite adequate treatment of sleep apnea
 - Home nocturnal oximetry no longer accepted
 - At least 2 hour titration
 - During sleep study, must show at least 5 minutes $\leq 88\%$ while on PAP therapy
 - AHI must be <10
 - If starting AHI 5-10, AHI must be improved on PAP
 - Document possible need for O₂ in chart notes referring patient for sleep study



*“Some people talk in
their sleep. Lecturers
talk while other people
sleep.”*

Camus

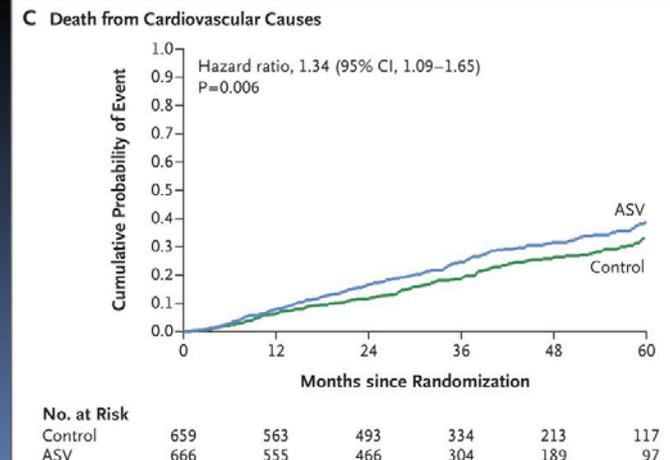
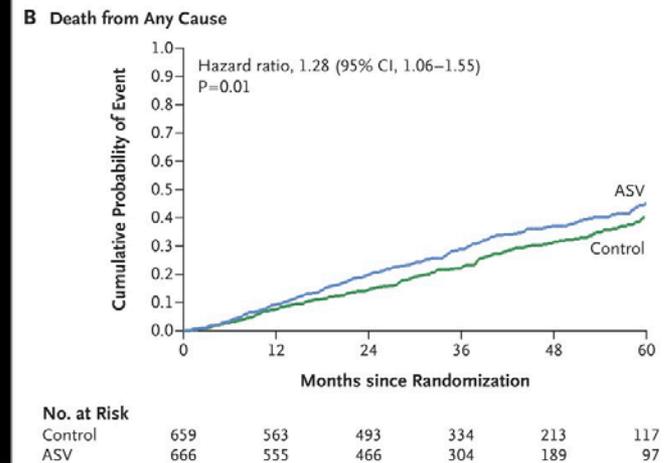
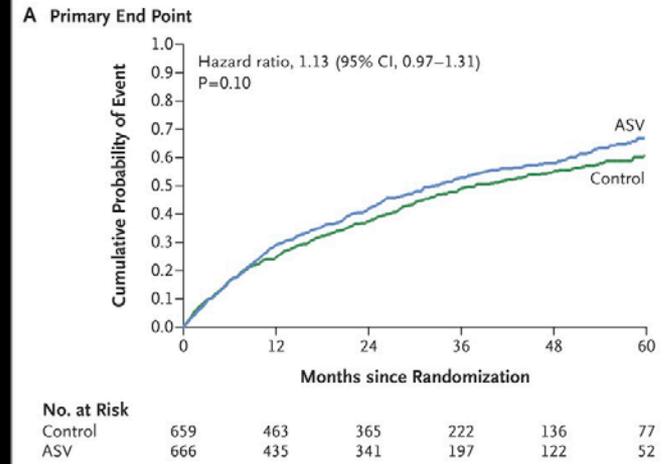
A vertical bar on the left side of the slide, consisting of several colored segments: a small black segment at the top, followed by a grey segment, a yellow segment, and a long pink segment at the bottom.

Questions?

CHF and Central Sleep Apnea

- With ASV
 - Increased death from any Cause
 - 34.8 vs 29.3 event rate
 - HR 1.28
 - Increased death from Cardiovascular Cause
 - 29.9 vs 24 event rate
 - HR 1.34

Martin, N Engl J Med 2015; 373:1095-1105 [September 17, 2015](#)



- 
- Adaptive servo-ventilation had no significant effect on the primary end point in patients who had heart failure with reduced ejection fraction and predominantly central sleep apnea, but **all-cause and cardiovascular mortality were both increased with this therapy.**

- 
- Hypothesis
 - CSA is good for people with CHF
 - Positive airway pressure is bad for patients with CHF