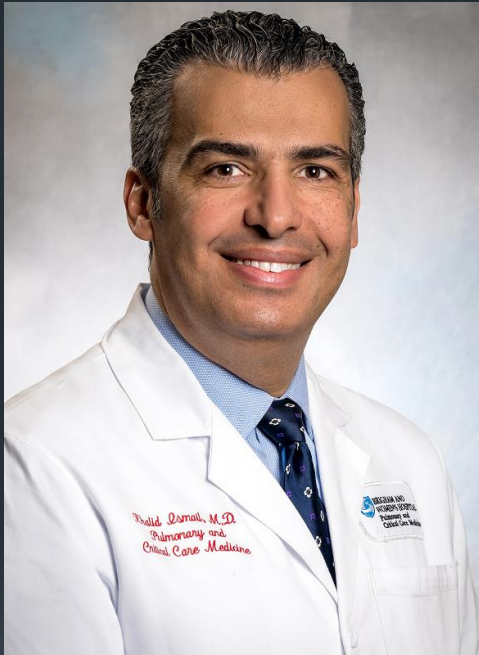


Obstructive Sleep Apnea

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Disclosures

- I have no relevant financial or nonfinancial conflicts to disclose.



Learning Objectives

- Understand the pathophysiology of Obstructive Sleep Apnea (OSA)
- Briefly discuss negative consequences of untreated disease
- Identify risk factors and screening for OSA
- Choice of available diagnostic modalities
- Discuss individualized treatment options for OSA

Case presentation

- 48-year-old man, with difficult to control hypertension, on 3 different blood pressure medications
- He has atrial fibrillation, and recently failed ablation
- He is diabetic, HgA1C is 9
- Erectile dysfunction
- Memory impairment

Case presentation

- His wife reports episodes of gasping while asleep, but only soft snoring
- He denies any trouble sleeping, or excessive daytime sleepiness but is tired throughout the day.
- On exam:
 - BMI: 42 kg/m²
 - Neck circumference: 17.5 inches



Oro-pharyngeal exam



- Large tongue, low soft palate, thick uvula
- Friedman class IV



Question # 1

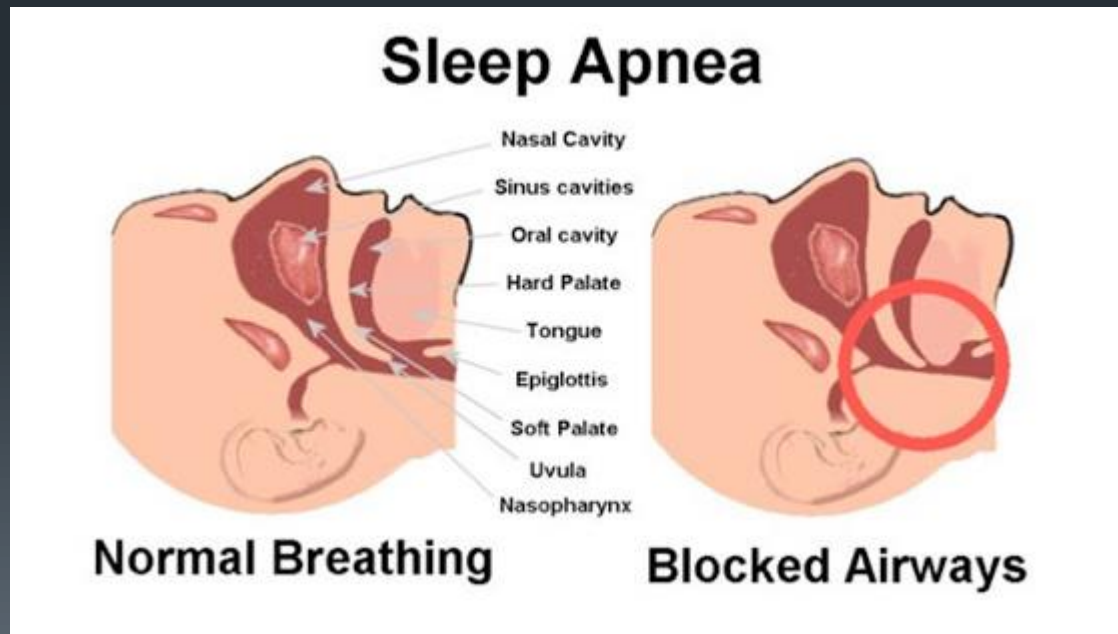
- What should be an important next step to consider in this man's evaluation?
 - a) Rule out thyroid disease
 - b) Evaluate for a secondary cause of HTN
 - c) Rule out obstructive Sleep Apnea
 - d) Evaluate for renal disease
 - e) Evaluate his diet and exercise program

Answer: c) Rule out obstructive sleep apnea

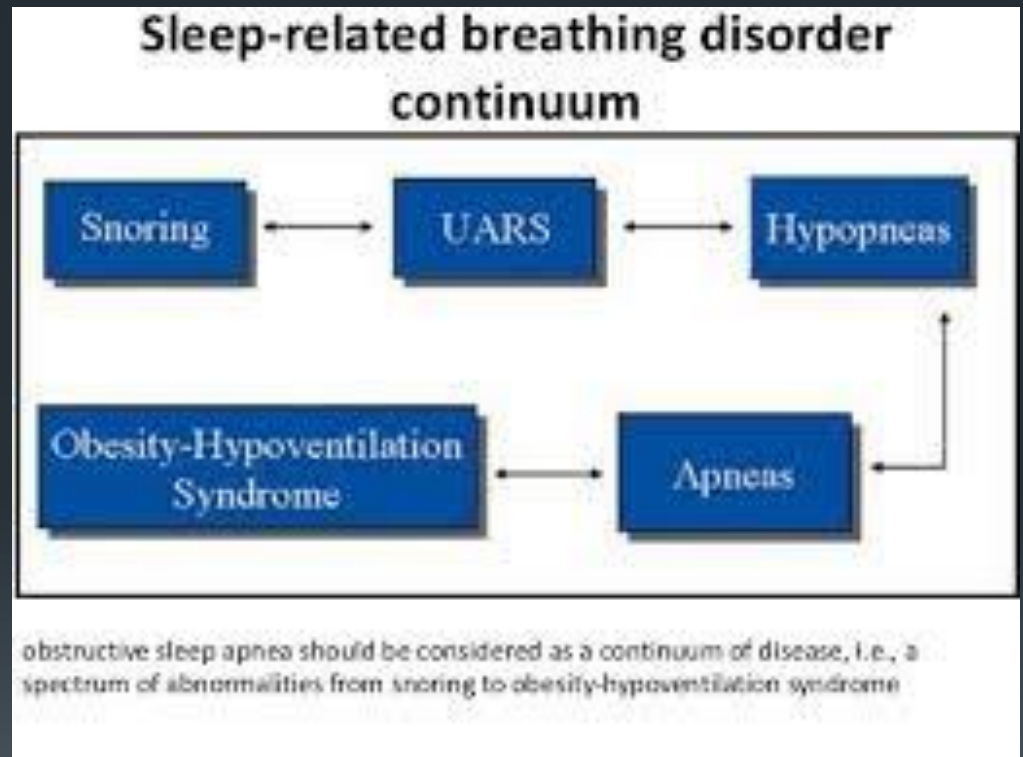
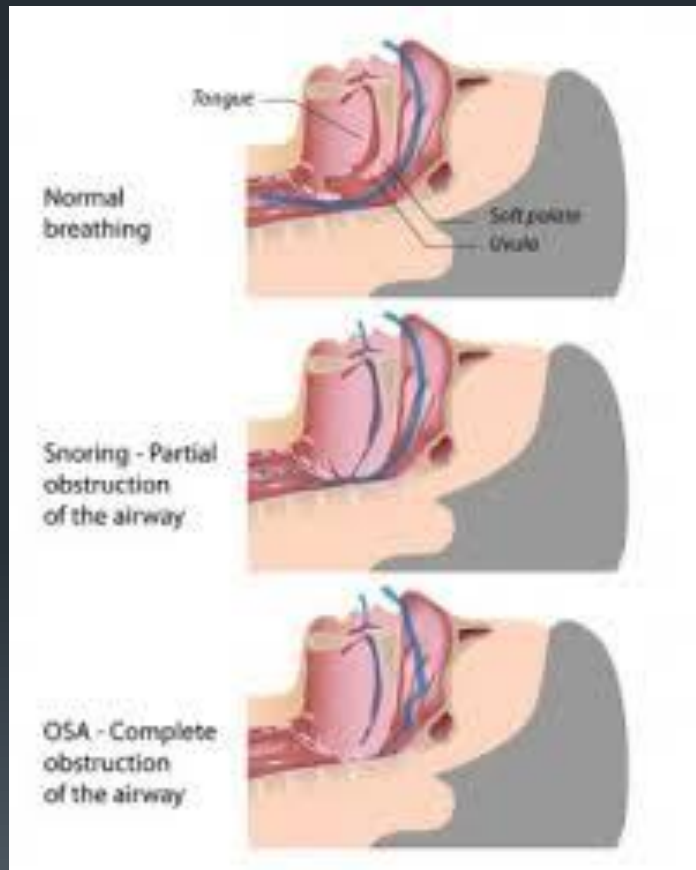
- Many Red Flags for OSA:
 - a) History: Resistant hypertension on 3 different BP medications, afib that failed ablation, erectile dysfunction and poorly controlled DM
 - b) Symptoms: witnessed apnea (most specific)
 - c) Exam: high BMI, large neck, crowded oropharynx

- Comorbidities need to be addressed, but missing a diagnosis of OSA could limit optimal management of these comorbidities

Upper Airway Obstruction During Sleep



Spectrum of Disease



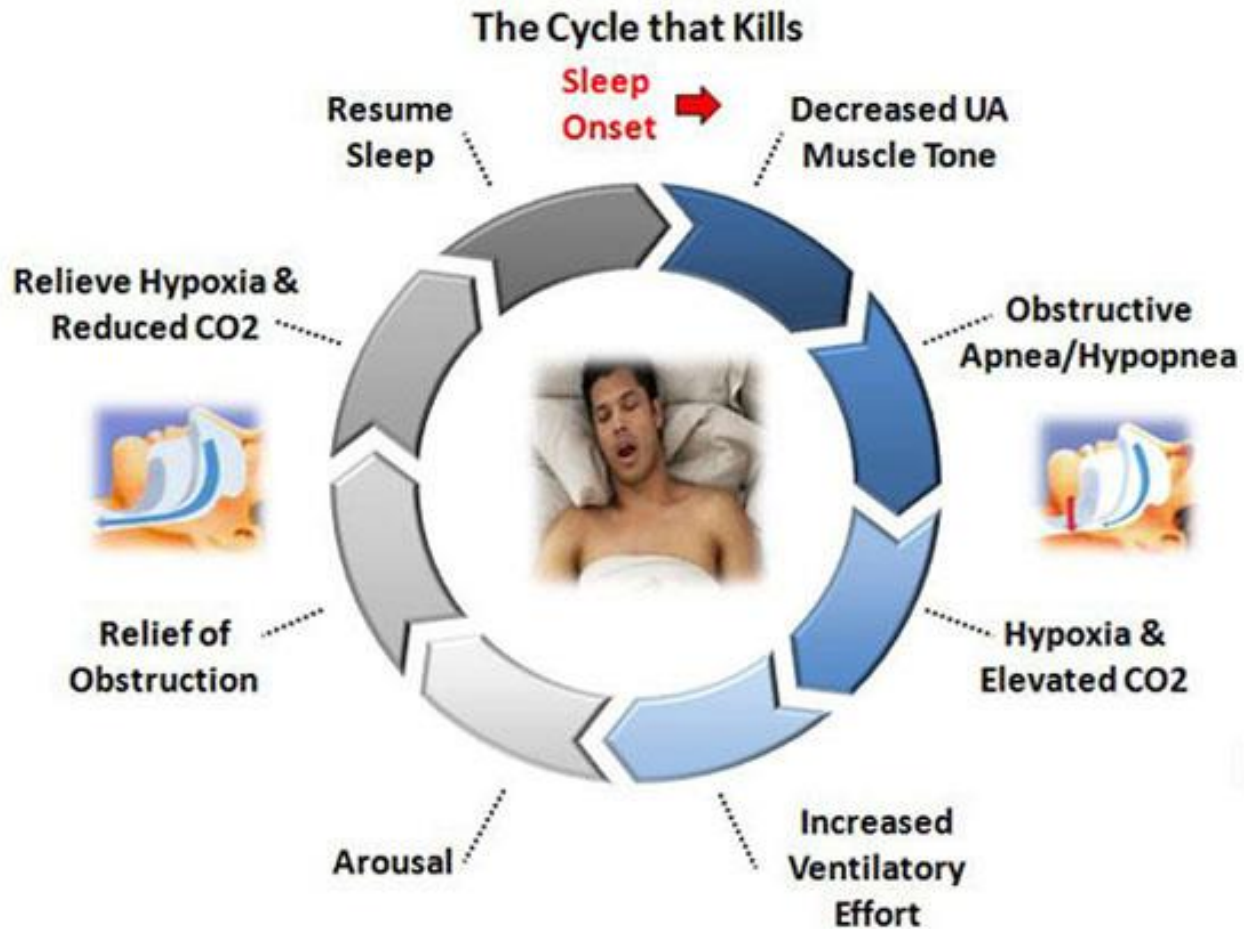
Severity = Number of events / hour of sleep
(AHI)

AHI	Rating
<5	Normal
5 to 15	Mild
15 to 30	Moderate
>30	Severe

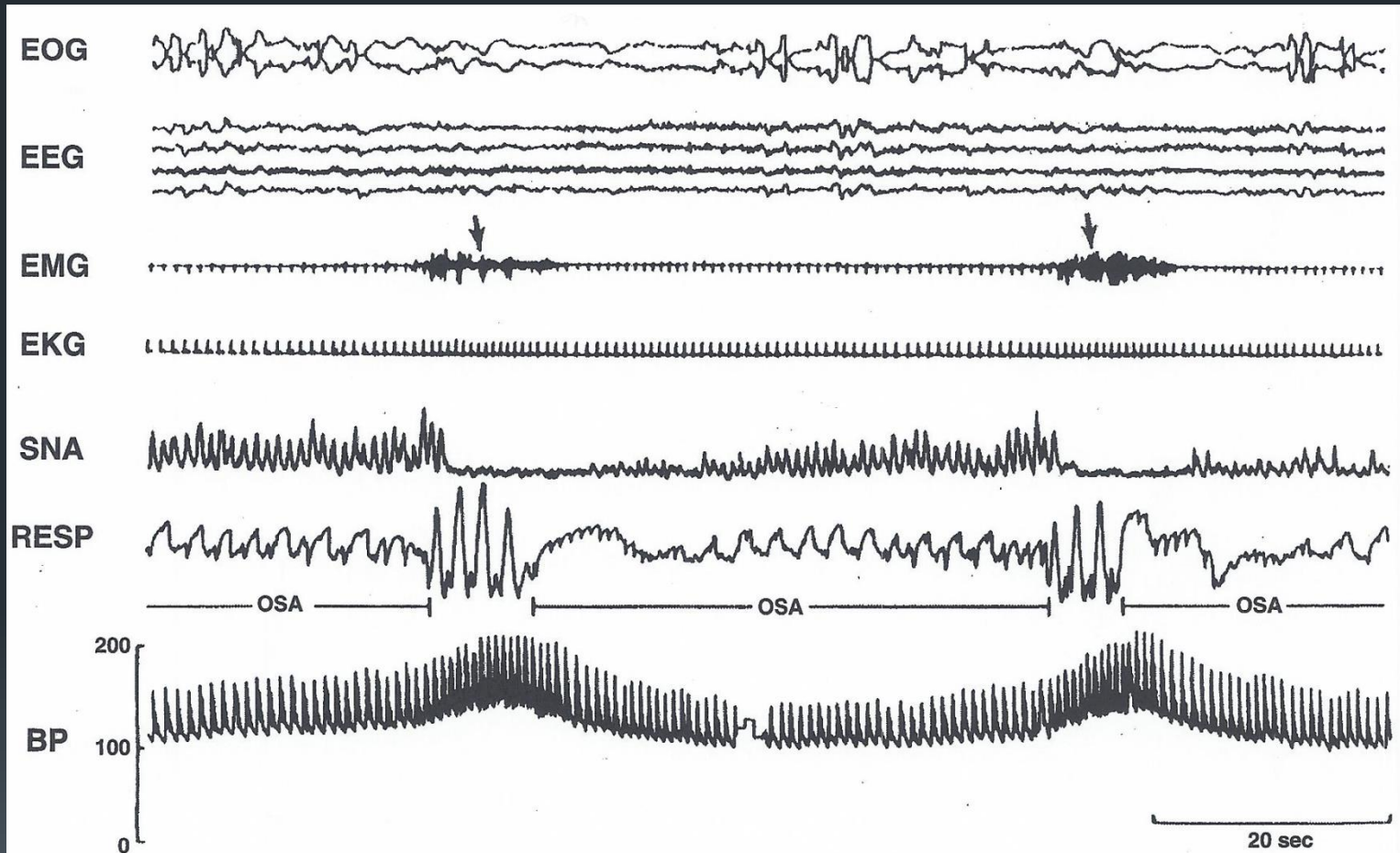


Pathophysiology

The Apneic Event

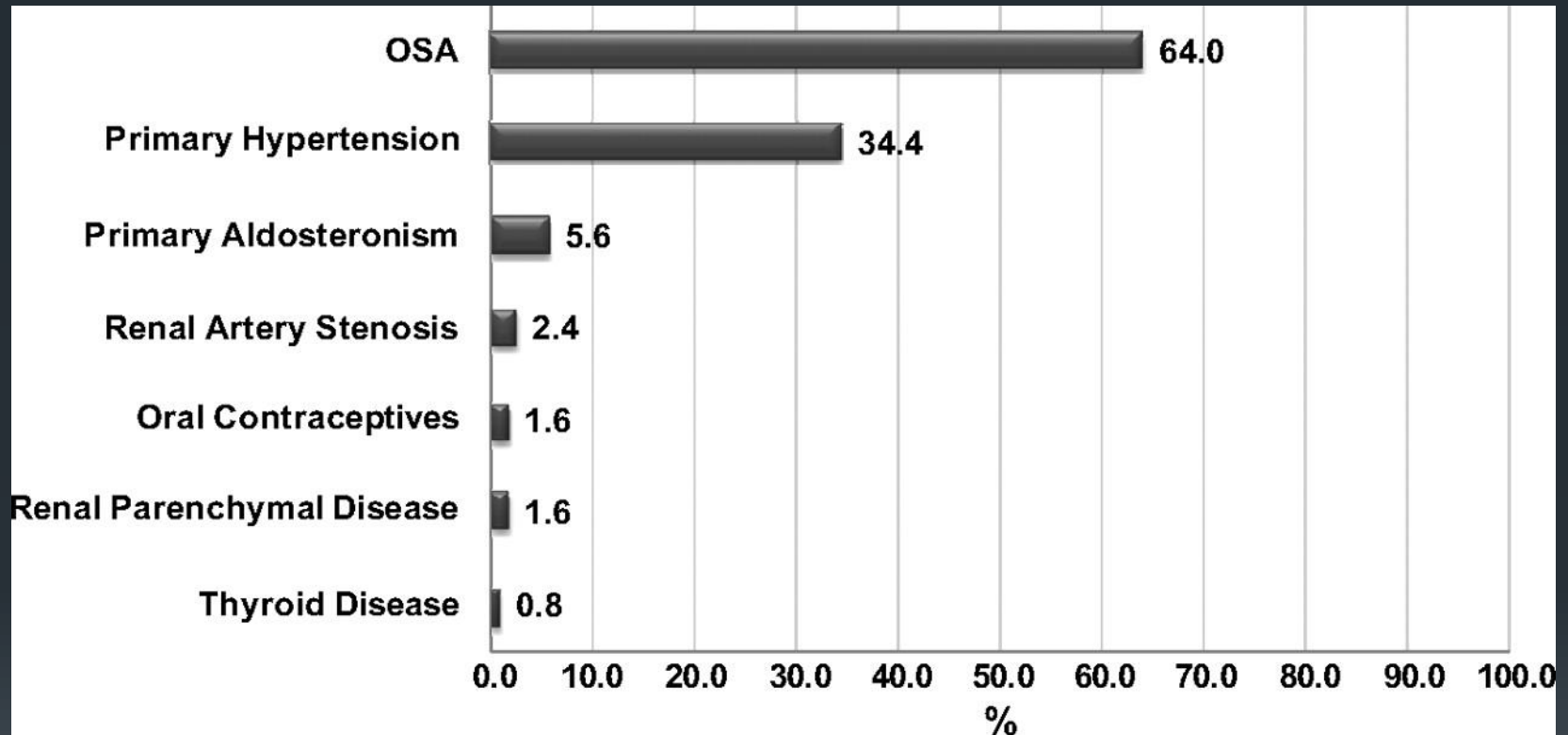


Sleep recording showing continues BP monitoring and sympathetic nerve activity in a patient with OSA



SNA: sympathetic nerve activity. Arrows represent limb activity associated with sleep arousal

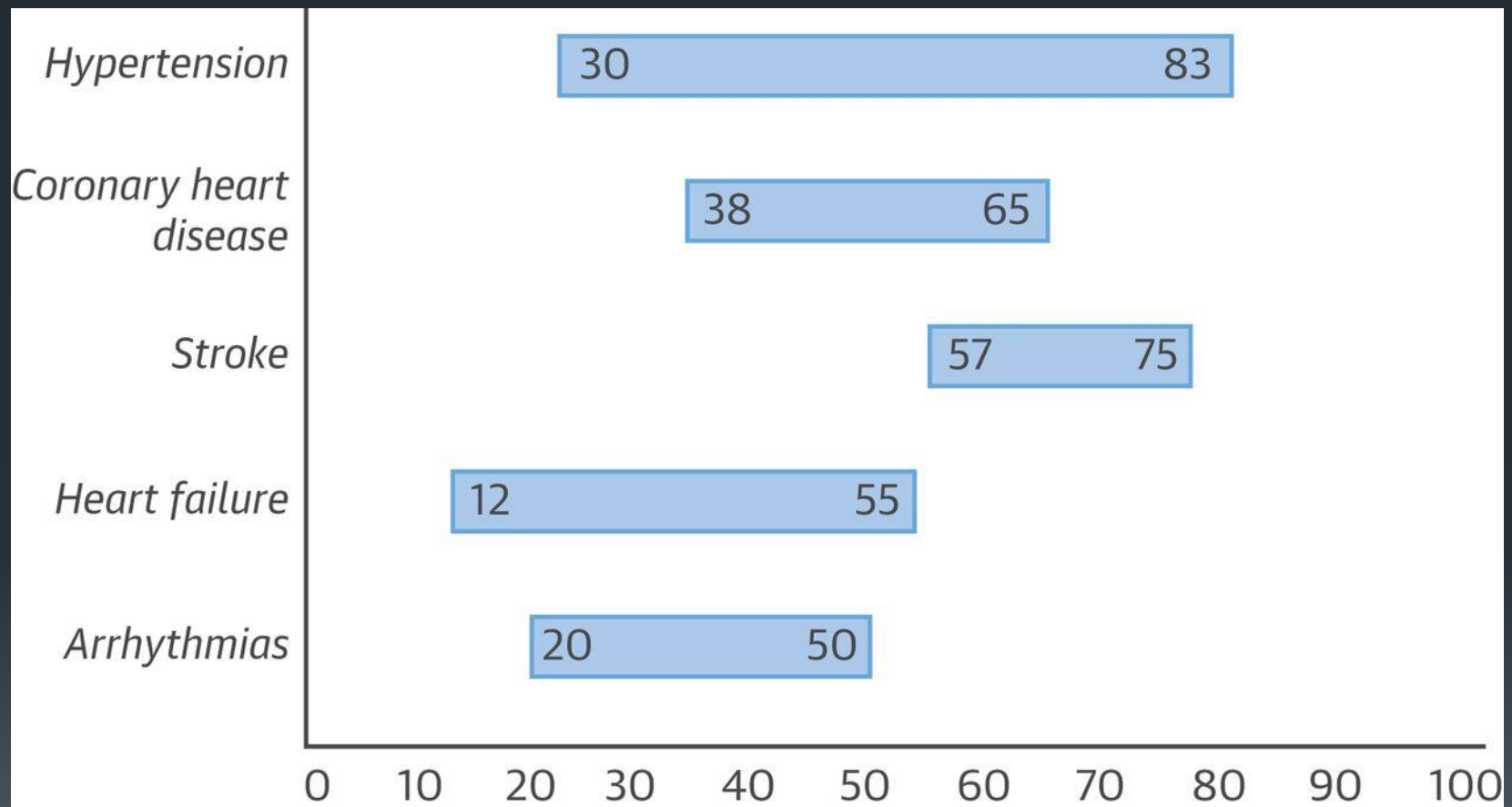
Prevalence of Secondary Causes of Hypertension Associated with Resistant Hypertension (N=125)



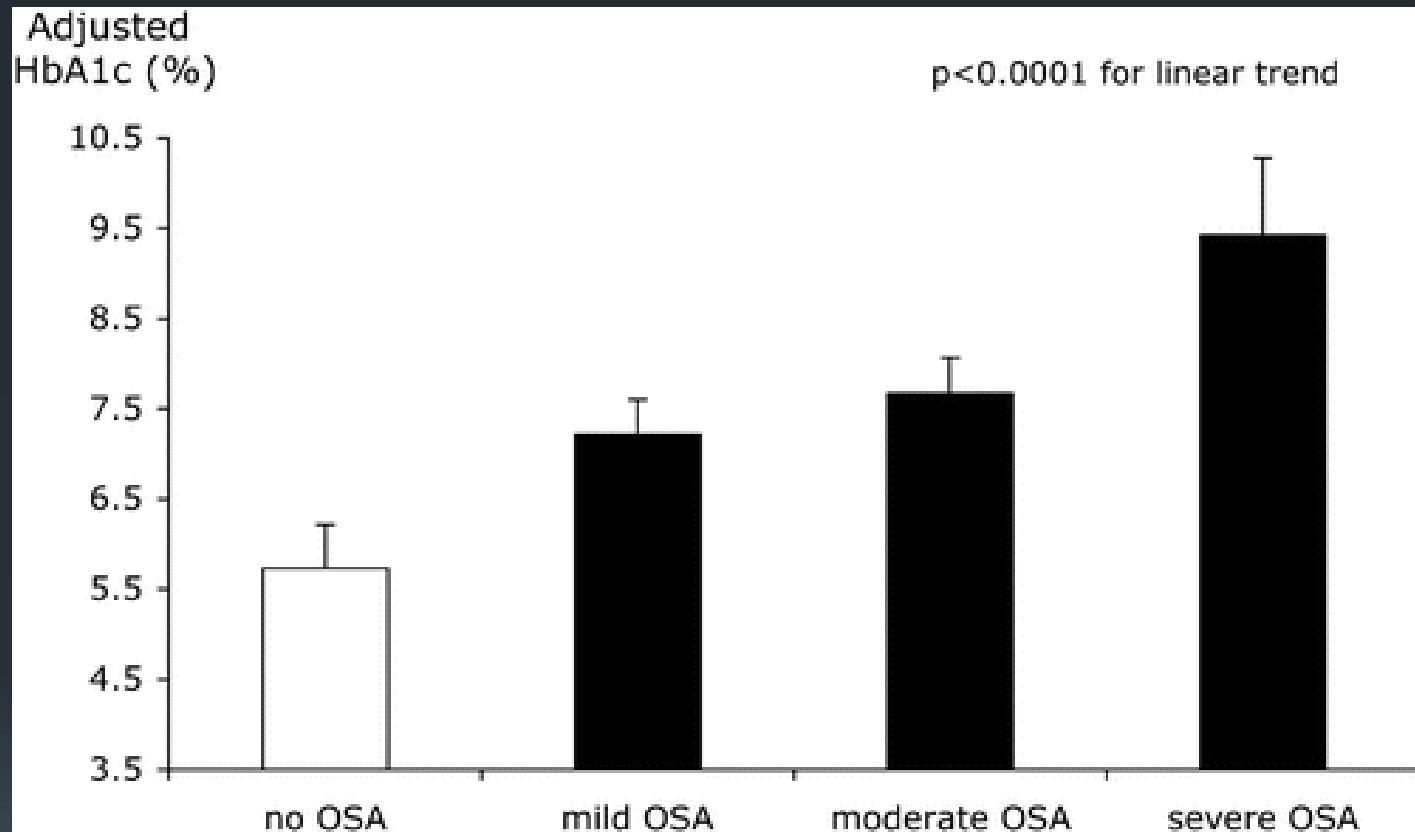
Pedrosa RP, *et al.* Obstructive sleep apnea: the most common secondary cause of hypertension associated with resistant hypertension. *Hypertension* 2011; 58: 811–817

- Logan AG, *et al.* *J Hypertens* 2001; 19: 2271–2277
- Lloberes P, *et al.* *J Sleep Res* 2010; 19: 597–602
- Muxfeldt ES, *et al.* *Am J Hypertens* 2014; 27: 1069–1078

Prevalence (%) of OSA in Cardiovascular Disease

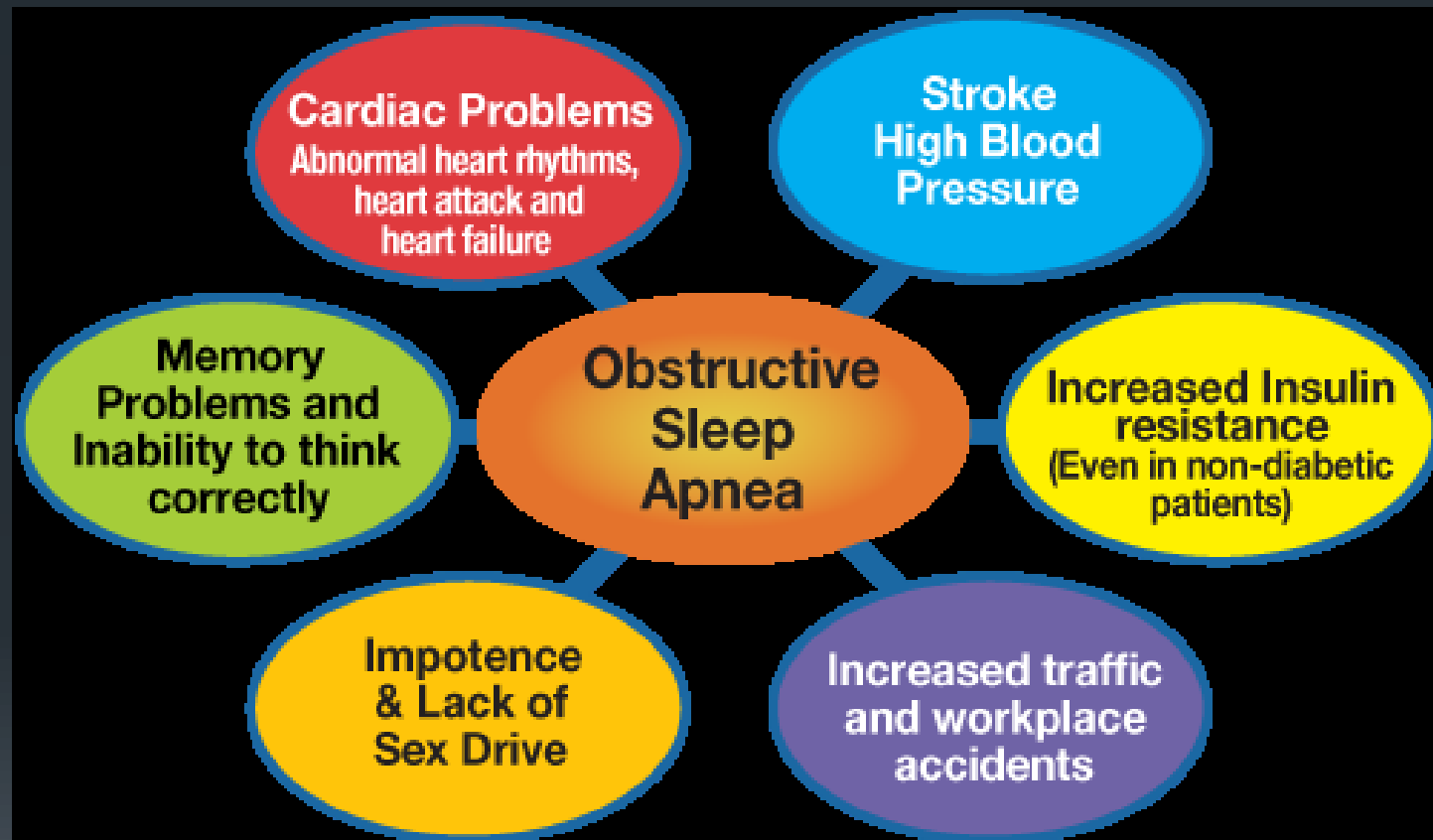


HbA1c levels and OSA



Data were adjusted for age, sex, race, body mass index, number of diabetes medications, level of exercise, years of diabetes, and total sleep time on polysomnogram

OSA is a Multisystem Disorder



All Cause and Cardiovascular Mortality

The Wisconsin Sleep Cohort – 18 year follow up (N=1522)

Baseline AHI category	All-cause mortality Hazard Ratio (95% CI)	Cardiovascular mortality Hazard Ratio (95% CI)
None: 0 - < 5	Reference	Reference
Mild: 5 - < 15	1.4 (0.7, 2.6)	1.3 (0.4, 4.1)
Moderate: 15 - < 30	1.7 (0.7, 4.1)	1.5 (0.3, 7.3)
Severe: ≥ 30	3.8 (1.6, 9.0)	5.2 (1.4, 19.2)
	P trend = 0.004	P-trend = 0.03

Mortality Risk after excluding patients on CPAP (n = 1396): Adjusted Hazard Ratios for age, sex, and body mass index



How Common is OSA...?

Epidemiology

The Wisconsin Sleep Cohort (N=1520)

AHI \geq 15/hr	Age (30-49)	Age (50-70)
Men	10%	17%
Women	3%	9%

AHI > 5, in the 30–70 years of age group:
Men: 34%
Women: 17%

Epidemiology

- Up to 85% of patients with treatable OSA remain undiagnosed.

Kapur V, et al. *Sleep Breath* 2002;6:49–54

Young T, et al. *Sleep*. 1997;20:705–706

Risk factors for OSA in Adults

- Obesity
- Airway size / Nasal Obstruction
- Age / Gender (menopausal status)
- Ethnicity / Genetics
- Conditions: Hypothyroidism, Acromegaly

Epworth Sleepiness Scale (ESS)

Modified Epworth Sleepiness Scale: Score

1. Sitting and reading	
2. Watching TV	
3. Sitting in a public place (e.g., theatre or a meeting)	
4. Sitting in a car as a passenger without a break	
5. Lying down to rest	
6. Sitting and talking to someone	
7. Sitting quietly after lunch without alcohol	
8. In a car, while stopped for a few minutes in traffic	

Scale to determine total Scores:

0= would never doze

1= A slight chance of dozing

2= Moderate chance of dozing

3= High chance of dozing

Maximum score is 24.

Score of 10 suggests presence of excessive sleepiness.

Sensitivity 59%, Specificity of 76%

Screening Questionnaires

STOP-Bang Questionnaire

Please answer the following questions by checking "yes" or "no" for each

Snoring (Do you snore loudly?)

Tiredness (Do you often feel tired, fatigued, or sleepy during the daytime?)

Observed Apnea (Has anyone observed that you stop breathing, or choke or gasp during sleep?)

High Blood Pressure (Do you have or are you being treated for high blood pressure?)

BMI (Is your body mass index more than 35 kg per m²?)

Age (Are you older than 50 years?)

Neck Circumference (Is your neck circumference greater than 40 cm [15.75 inches]?)

Gender (Are you male?)

Scoring: **Sensitivity 81%, Specificity of 82%**

Scoring interpretation: 0 to 2 = low risk, 3 or 4 = intermediate risk, ≥ 5 = high risk

Berlin Questionnaire

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SLEEP EVALUATION IN PRIMARY CARE

<p>Category 1</p> <p>1. Complete the following: Height _____ Age _____ Weight _____ Male/female _____</p> <p>2. Do you snore? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know</p> <p>If you snore:</p> <p>3. Your snoring is? <input type="checkbox"/> Slightly louder than breathing <input type="checkbox"/> As loud as talking <input type="checkbox"/> Louder than talking <input type="checkbox"/> Very loud. Can be heard in adjacent rooms.</p> <p>4. How often do you snore? <input type="checkbox"/> Nearly every day <input type="checkbox"/> 3-4 times a week <input type="checkbox"/> 1-2 times a week <input type="checkbox"/> 1-2 times a month <input type="checkbox"/> Never or nearly never</p> <p>5. Has your snoring ever bothered other people? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>6. Has anyone noticed that you quit breathing during your sleep? <input type="checkbox"/> Nearly every day <input type="checkbox"/> 3-4 times a week <input type="checkbox"/> 1-2 times a week <input type="checkbox"/> 1-2 times a month <input type="checkbox"/> Never or nearly never</p>	<p>Category 2</p> <p>7. How often do you feel tired or fatigued after your sleep? <input type="checkbox"/> Nearly every day <input type="checkbox"/> 3-4 times a week <input type="checkbox"/> 1-2 times a week <input type="checkbox"/> 1-2 times a month <input type="checkbox"/> Never or nearly never</p> <p>8. During your waketime, do you feel tired, fatigued, or not up to par? <input type="checkbox"/> Nearly every day <input type="checkbox"/> 3-4 times a week <input type="checkbox"/> 1-2 times a week <input type="checkbox"/> 1-2 times a month <input type="checkbox"/> Never or nearly never</p> <p>9. Have you ever nodded off or fallen asleep while driving a vehicle? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>If yes, how often does it occur? <input type="checkbox"/> Nearly every day <input type="checkbox"/> 3-4 times a week <input type="checkbox"/> 1-2 times a week <input type="checkbox"/> 1-2 times a month <input type="checkbox"/> Never or nearly never</p> <p>10. Do you have high blood pressure? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know</p> <p>BMI = _____</p>
--	---

Scoring questions: Any answer within box outline is a positive response.

Scoring categories

Category 1 is

Category 2 is

Category 3 is

Sensitivity 86%, Specificity of 77%

Final result: 2 or more positive categories indicates a high likelihood of sleep disordered breathing.

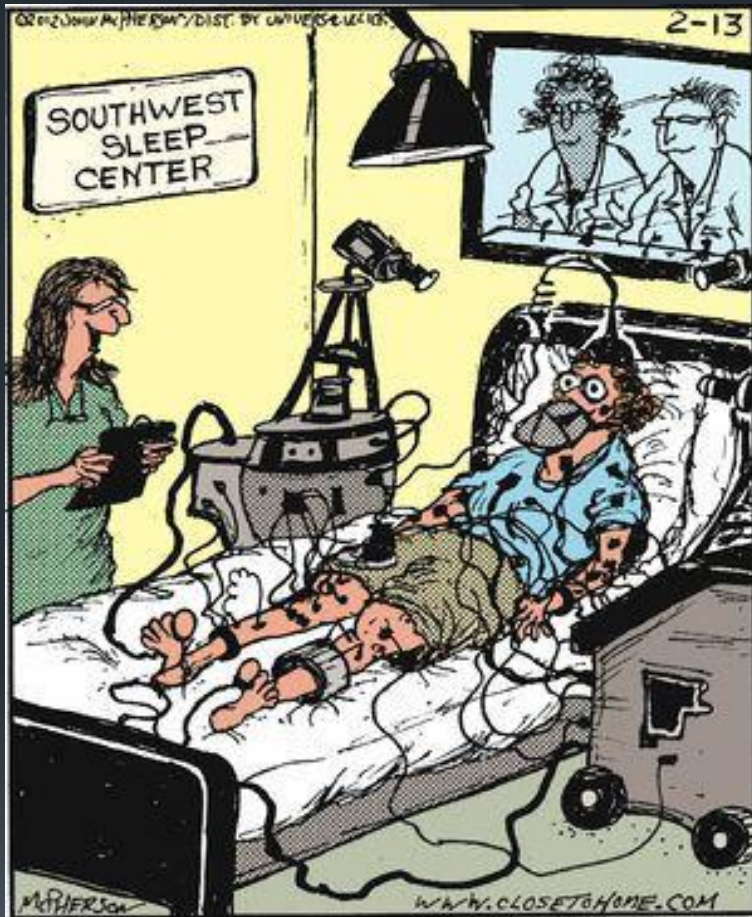
Question # 2

- In the previously discussed patient, you are considering OSA, what is the best next step?
 - a) Start empiric Continuous Positive Airway Pressure therapy (CPAP)
 - b) Order an in-lab sleep study
 - c) Order a home sleep study
 - d) Ask him to monitor his sleep quality on a smart watch
 - e) Ask him to avoid sleeping on his back

Answer: c) Order a home sleep study

- We need to establish a diagnosis and determine severity of disease in order to recommend appropriate treatment options
- Either an in-lab or home sleep study would be appropriate, but given high pre-test probability for OSA, a home sleep study is most efficient/convenient/cost-effective
- Wearable technology and other monitoring devices are in development but not fully validated for standard use
- Although a large percent of OSA is worse in the supine position, some patients have equally severe disease in the supine and non-supine sleep

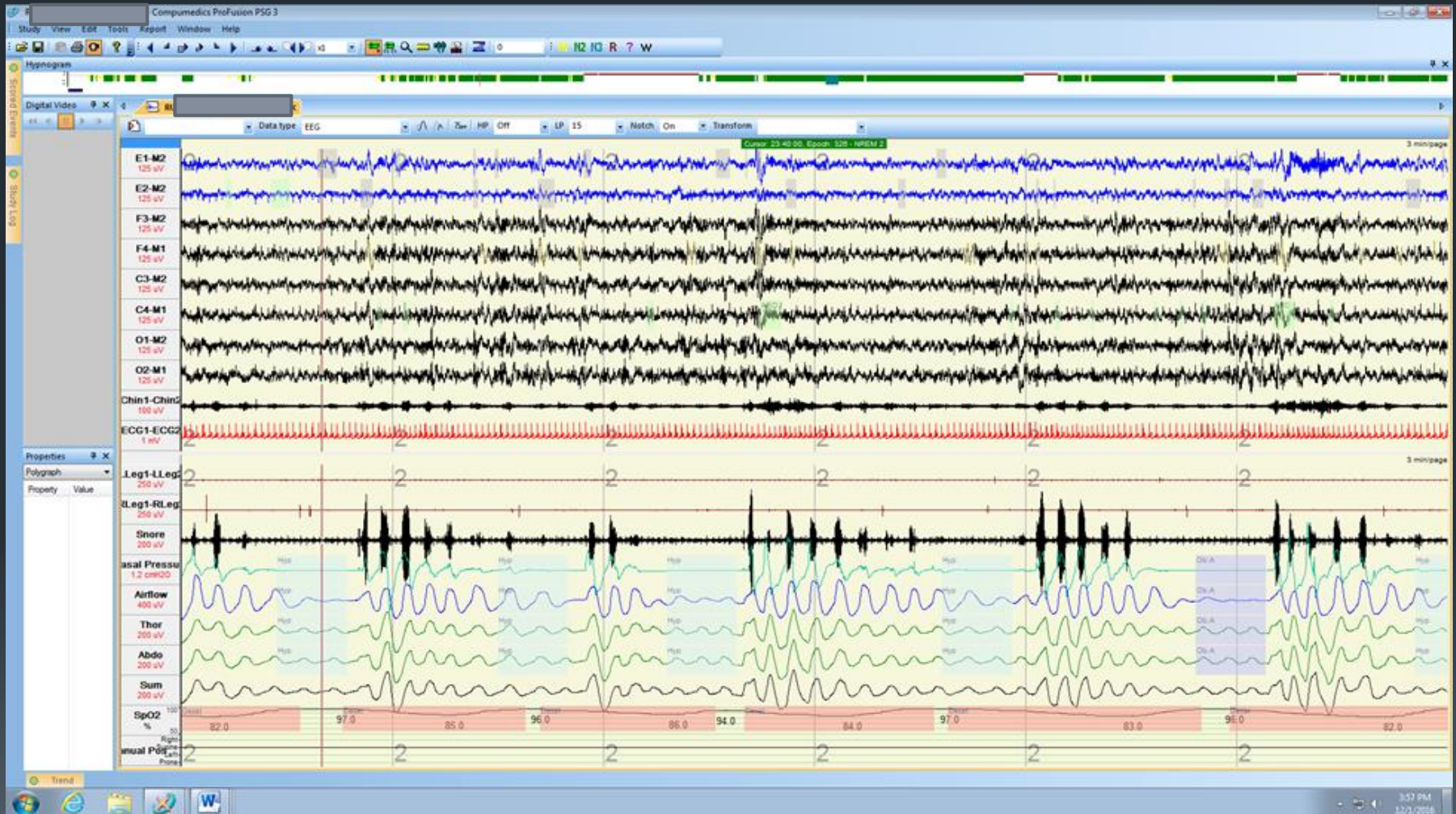
Polysomnography



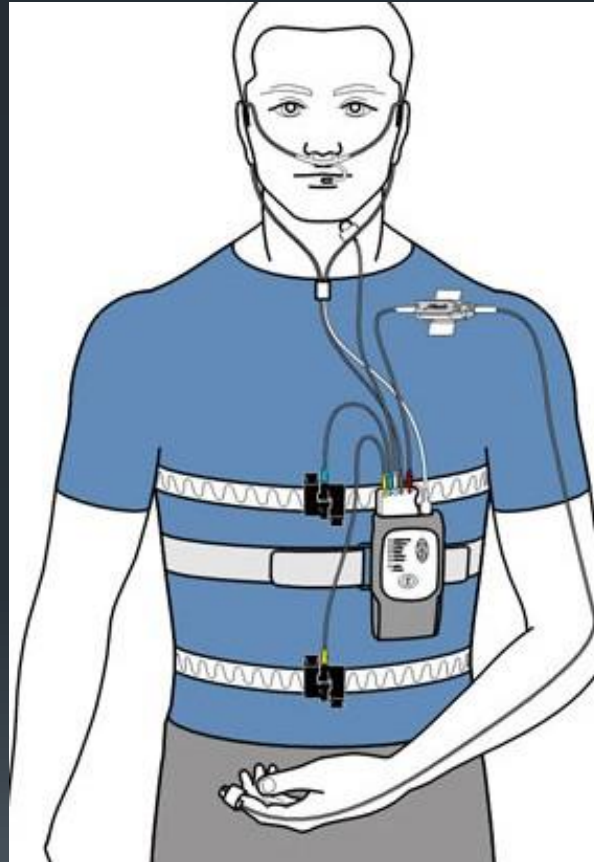
"OK, Mrs. Tully. We want you to relax, get a good night's sleep, and we'll evaluate any sleep issues that you have."



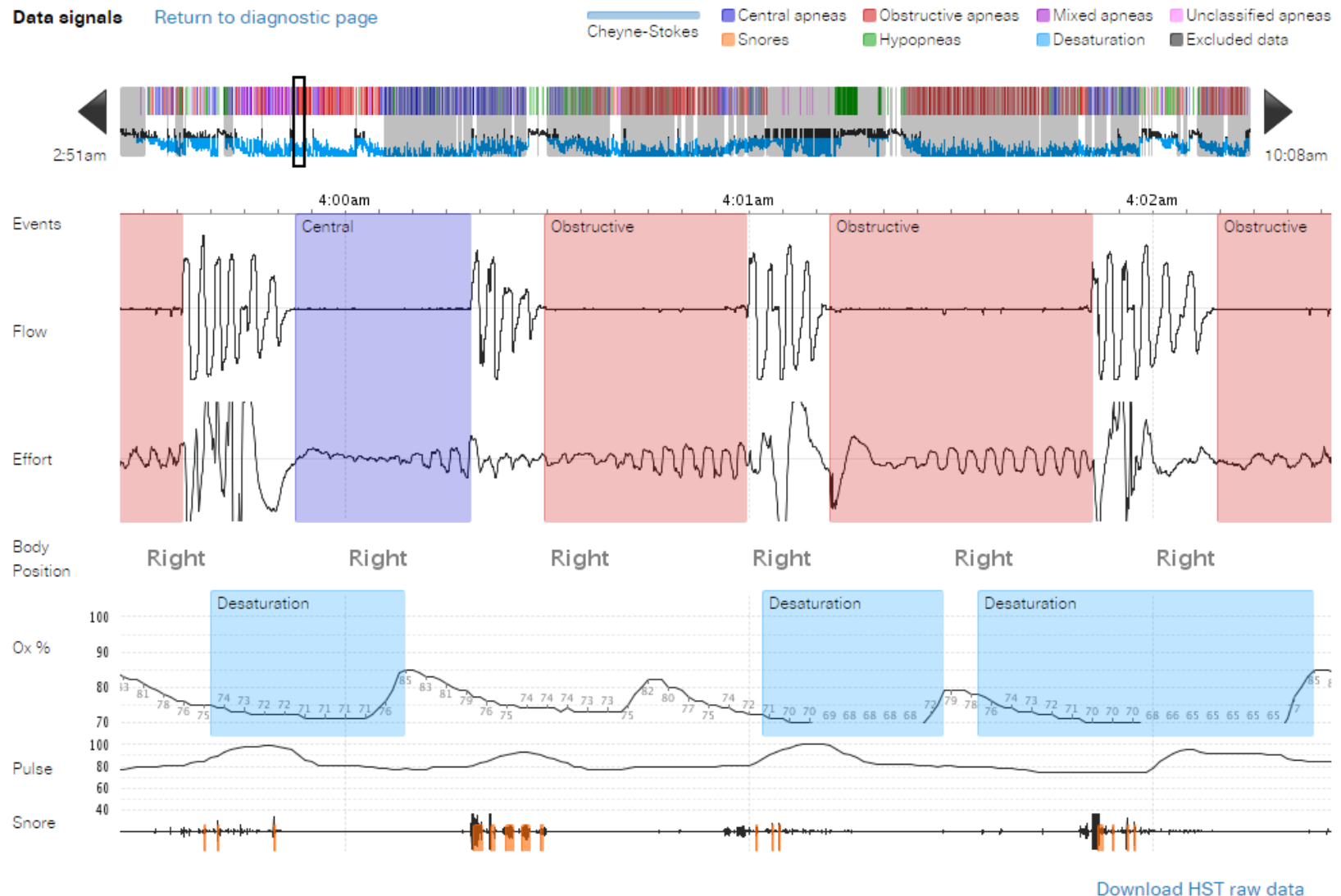
Polysomnography



Portable Home Sleep Study



Home Sleep Study – Raw Data



Proper use of Home Sleep Testing



1. High Pretest Probability for moderate to severe OSA
2. No significant cardiopulmonary or neuromuscular disease
3. No suspicion for sleep disorders other than OSA
4. May be considered when in-Lab PSG is not possible
5. May be indicated to monitor response to non-CPAP treatments for OSA

Question # 3

- Your patient had a home sleep study that confirmed the presence of OSA, with an AHI of 12/hr, with minimum oxygen desaturation of 70%. What is the best treatment option?
 - a) Start empiric Auto CPAP therapy
 - b) Refer to a dental sleep medicine provider
 - c) Recommend hypoglossal nerve stimulation surgery
 - d) Weight loss is all he needs
 - e) Recommend positional therapy for OSA

Answer: a) start empiric Auto CPAP

- Given elevated BMI, significant oxygen desaturation, and presence of cardiovascular disease, CPAP is the best option
- Dental appliances are less effective in obese patients
- Not a Hypoglossal nerve stimulation candidate, as BMI > 32, and his AHI is below cut off range (15-65/hr)
- Weight loss is certainly encouraged, but not as the only treatment, especially given significant oxygen desaturation
- No positional data to recommend positional therapy alone

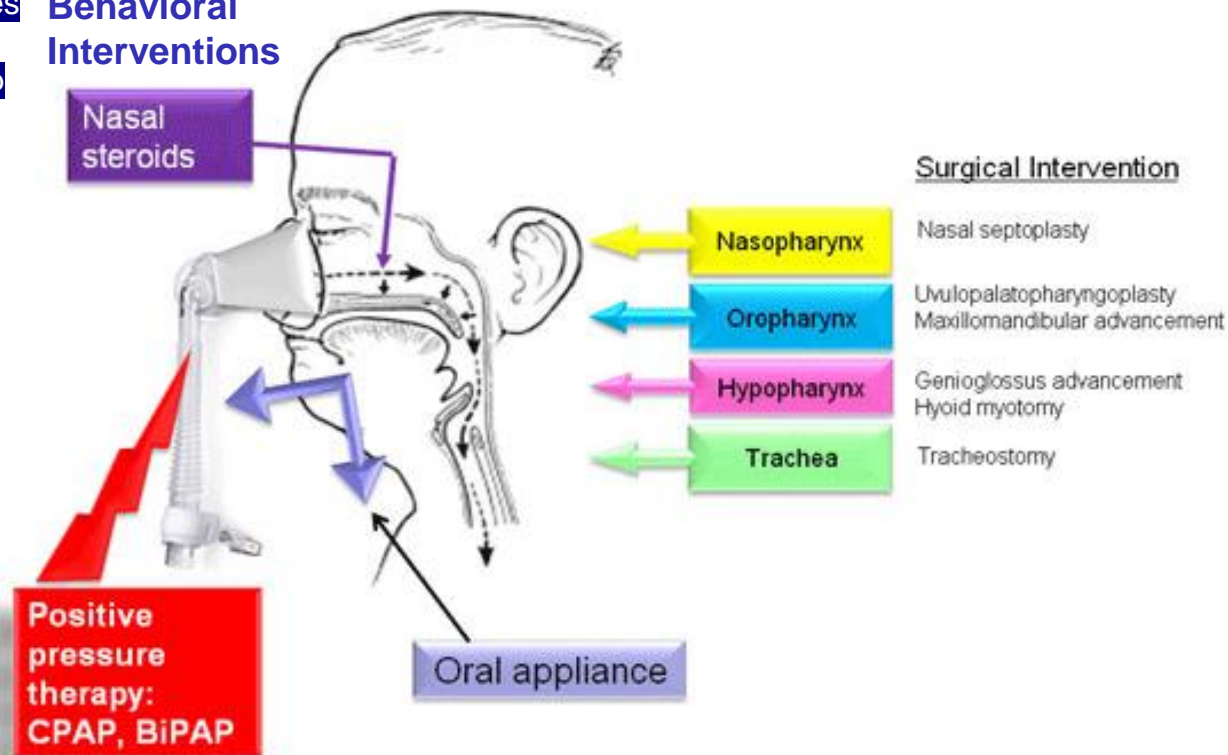
Who Should Be Treated?

- $AHI \geq 15/hr$
- $AHI 5-15/hr$, associated with:
 - Excessive daytime sleepiness and fatigue
 - Cardiovascular disease
 - Neurocognitive dysfunction

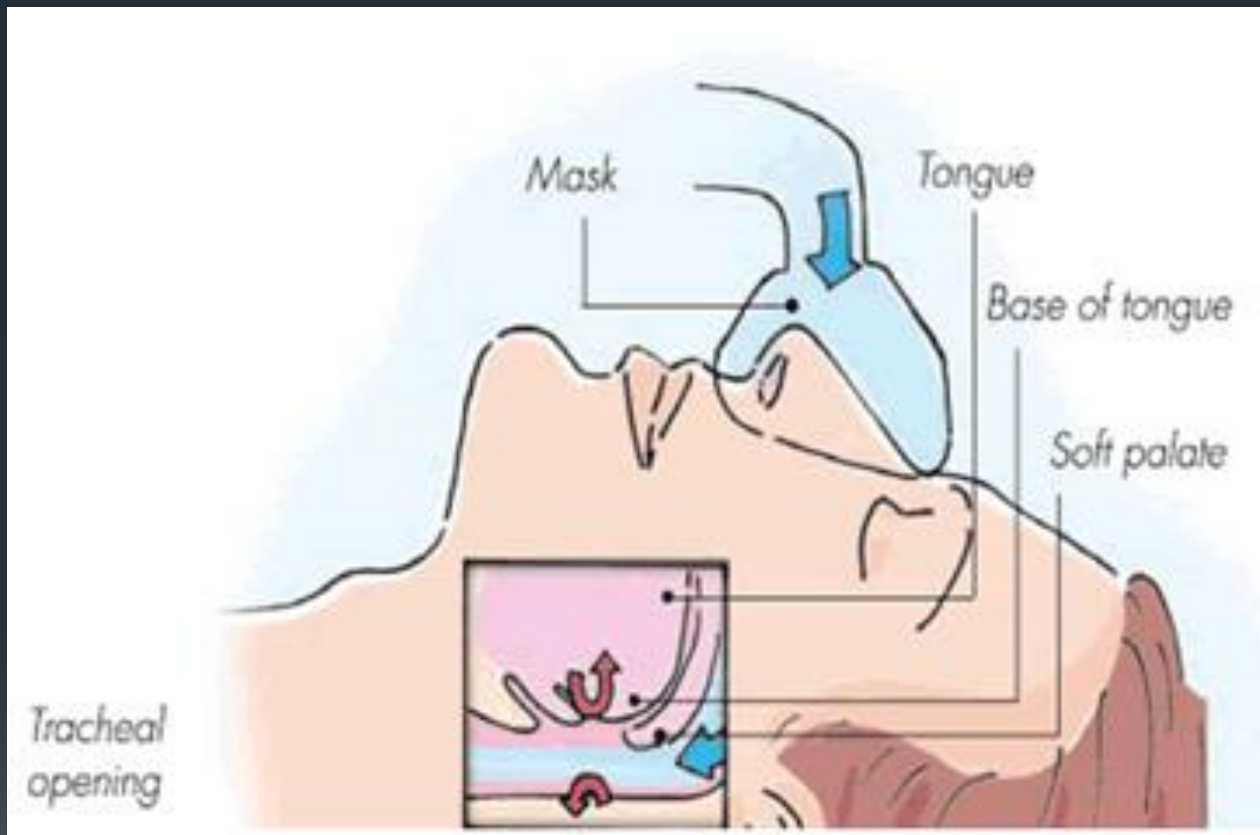
Treatment Options

- Treat Nasal Allergies
- Weight Loss
- Avoid Supine Sleep
- Avoid Alcohol and Sedatives

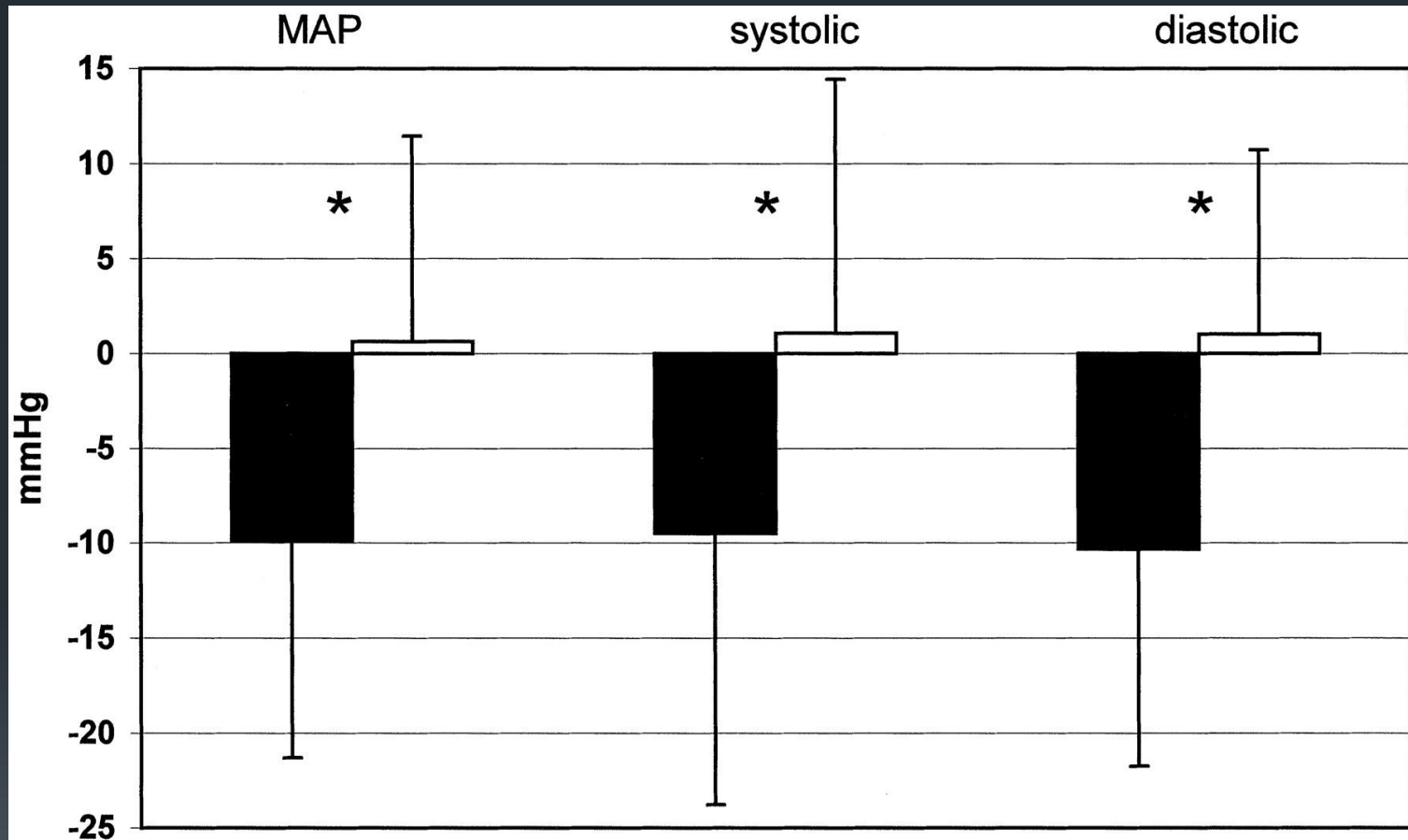
Behavioral Interventions



Positive Airway Pressure Therapy

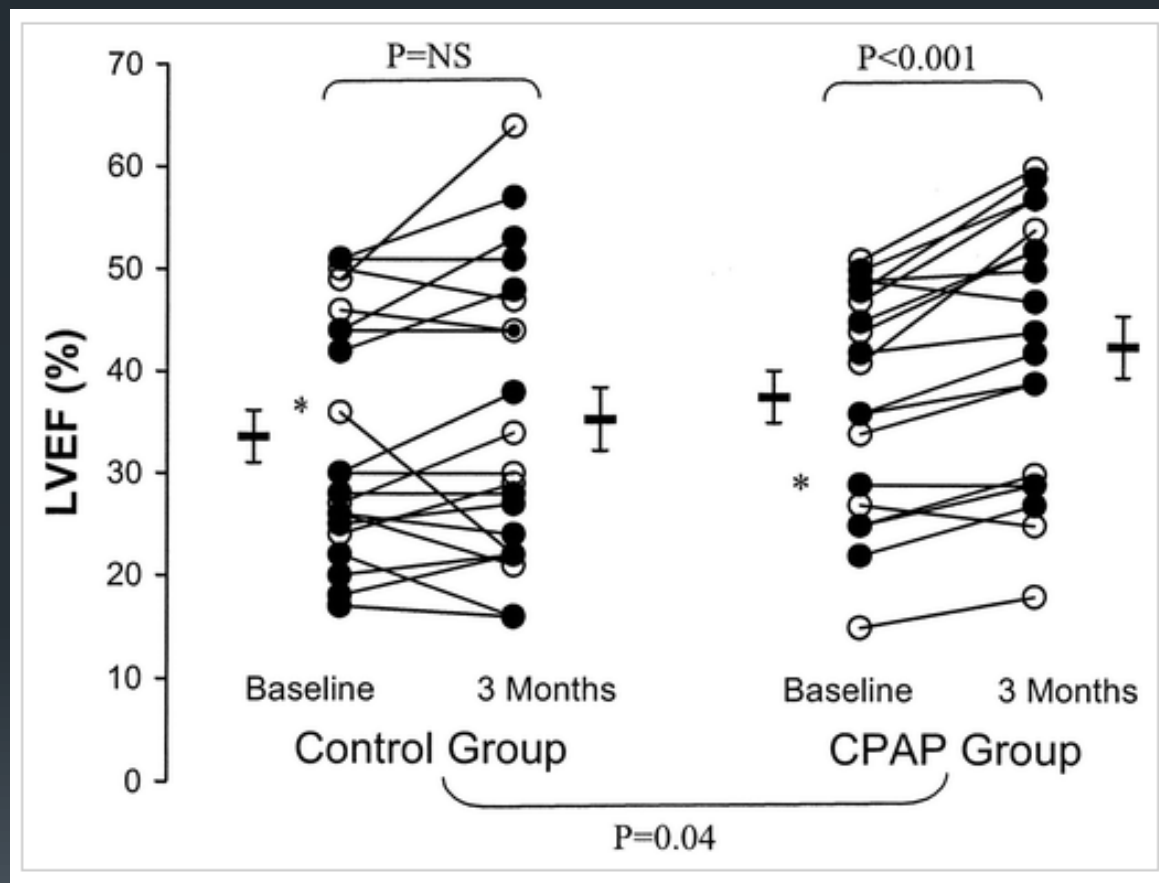


Changes in blood pressure with effective (closed bars) and sub therapeutic (open bars) nCPAP (N=60)



*p value < 0.05

Randomized Controlled Trial of CPAP in Obstructive Sleep Apnea and Heart Failure (N=55)



Open circles: idiopathic cardiomyopathies, Closed circles: ischemic cardiomyopathies.

Treatment of Obstructive Sleep Apnea Reduces the Risk of Atrial Fibrillation Recurrence After Catheter Ablation (N=426)

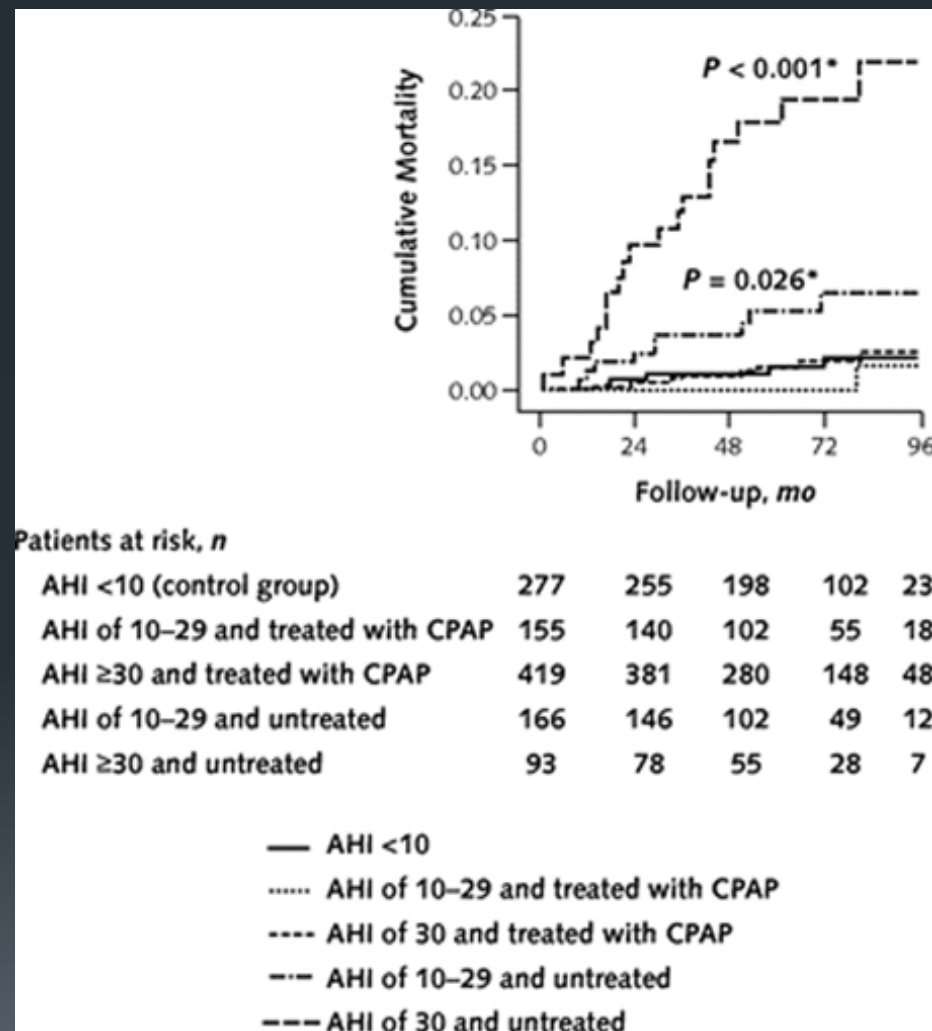
Table 3

**Multivariate Predictors of AF Recurrence
(Comparison to PVI (-) Group)**

	Hazard Ratio	95% Confidence Interval	p Value
Persistent AF	1.91	1.27-3.22	0.007
HTN	2.16	1.15-5.23	0.015
PVI (+) OSA (-)	0.53	0.25-0.96	0.048
PVI (+) OSA (+) CPAP (+)	0.48	0.22-0.91	0.03
PVI (+) OSA (+) CPAP (-)	1.12	0.71-1.92	0.65

PVI: Pulmonary vein isolation

Effect on Overall Mortality (N=1116)

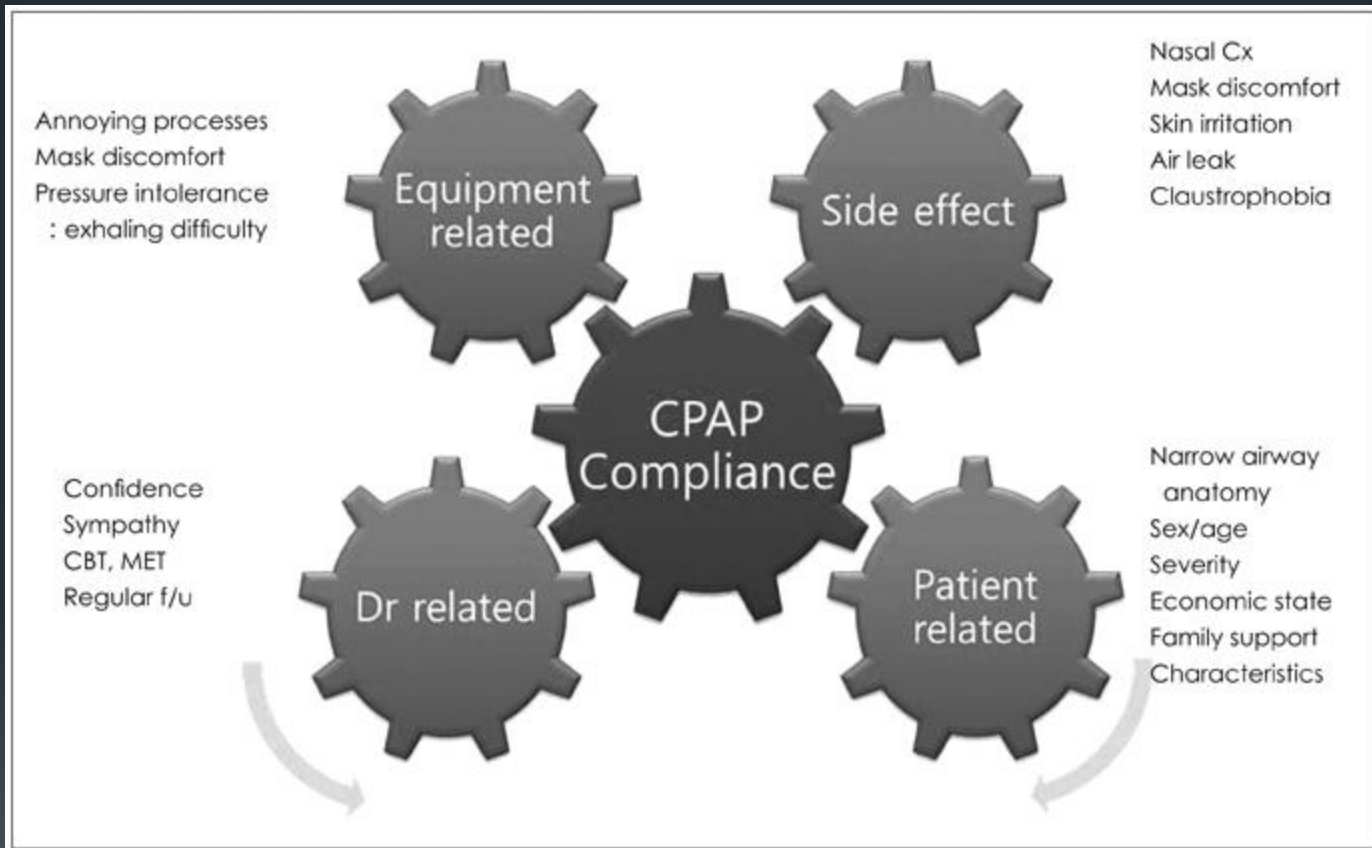


Adherence

- 29 to 83% of patients are non-adherent with CPAP (≤ 4 hours of use per night)



Troubleshooting



Mask Interface



Compliance Reports

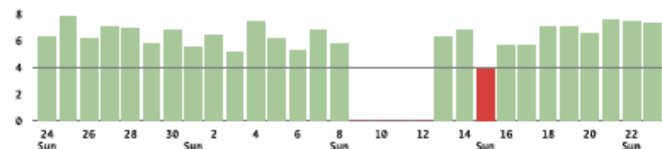
Compliance Report

Usage	06/24/2018 - 07/23/2018
Usage days	26/30 days (87%)
>= 4 hours	26 days (83%)
< 4 hours	1 days (3%)
Usage hours	166 hours 12 minutes
Average usage (total days)	5 hours 32 minutes
Average usage (days used)	6 hours 24 minutes
Median usage (days used)	6 hours 29 minutes
Total used hours (value since last reset)	2,265 hours

AirSense 10 AutoSet	
Serial number	23171133588
Mode	AutoSet
Min Pressure	8 cmH2O
Max Pressure	15 cmH2O
EPR	Fulltime
EPR level	2
Response	Standard

Therapy	
Pressure - cmH2O	Median: 9.1 95th percentile: 11.0 Maximum: 11.9
Leaks - L/min	Median: 16.8 95th percentile: 48.6 Maximum: 68.7
Events per hour	AI: 0.6 HI: 0.4 AHI: 0.9
Apnea Index	Central: 0.2 Obstructive: 0.1 Unknown: 0.2
RERA Index	0.1
Chayne-Stokes respiration (average duration per night)	0 minutes (0%)

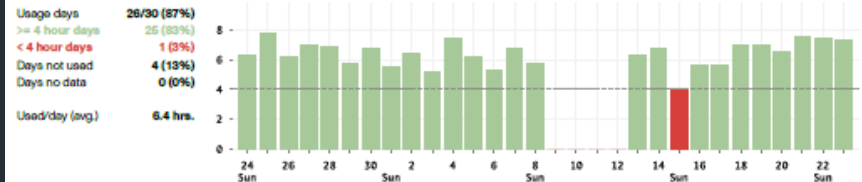
Usage - hours



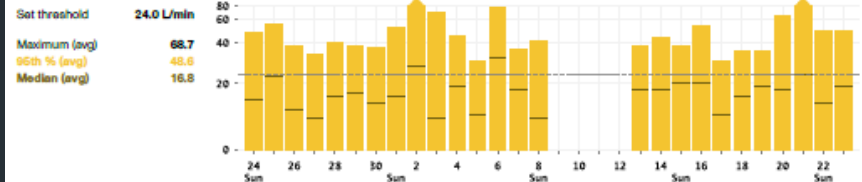
Therapy Report

AirSense 10 AutoSet	SN: 23171133588
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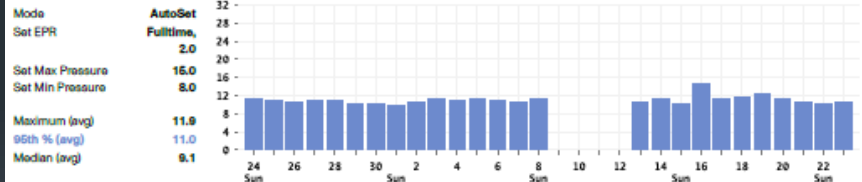
Usage (hours)



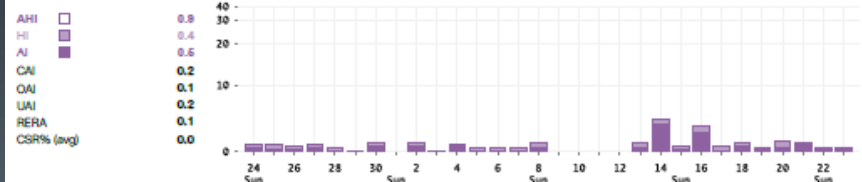
Leak (L/min)



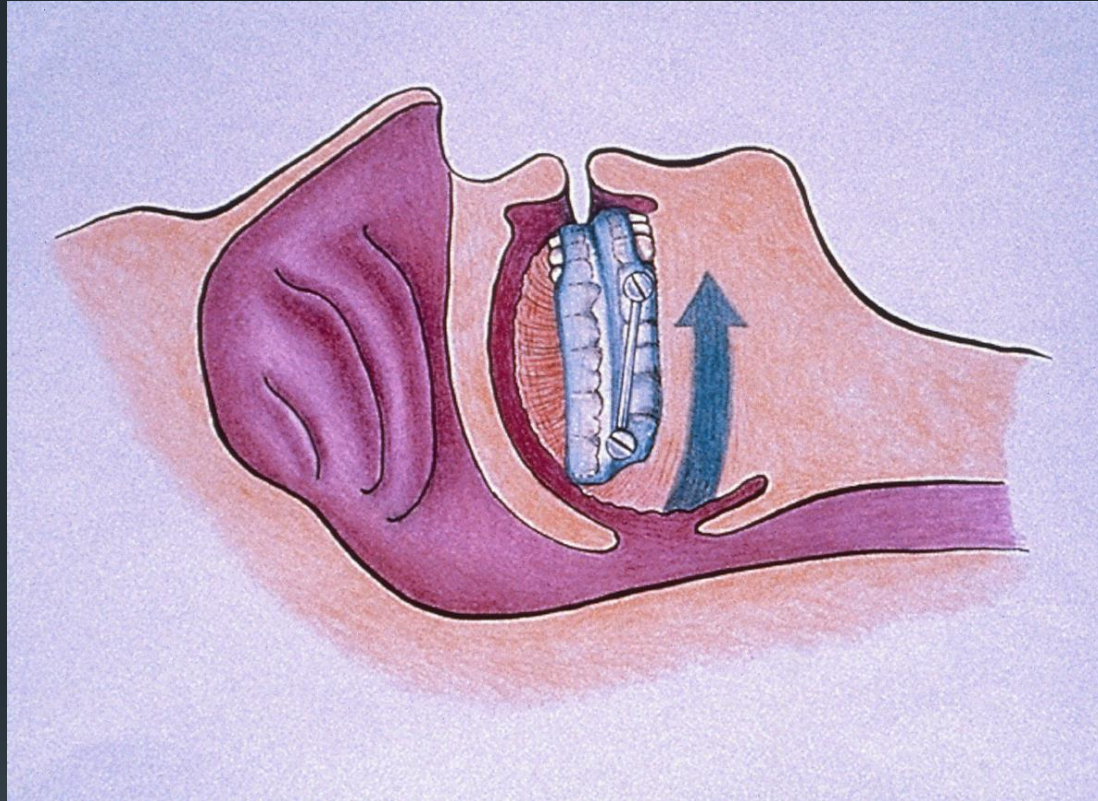
Pressure (cmH2O)



AHI (events/hour)



Mandibular Advancement Devices



Indications:

- Mild to moderate disease
- Non obese patients with small neck circumference
- Positional disease, predominant in supine position

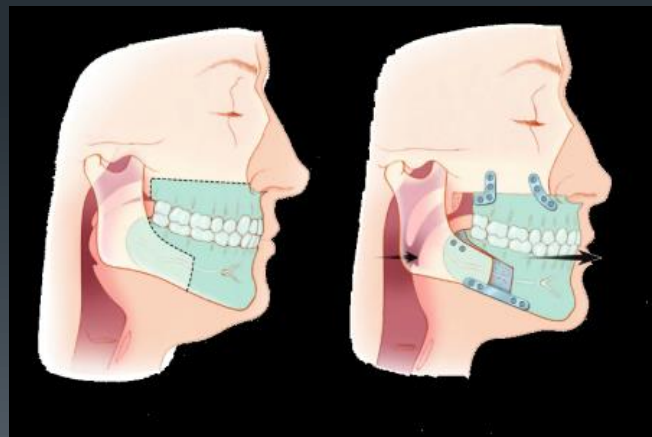
Surgical Interventions



Uvulopalatopharyngoplasty (UPPP)

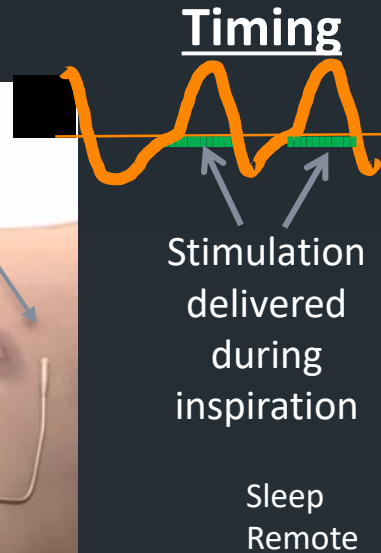
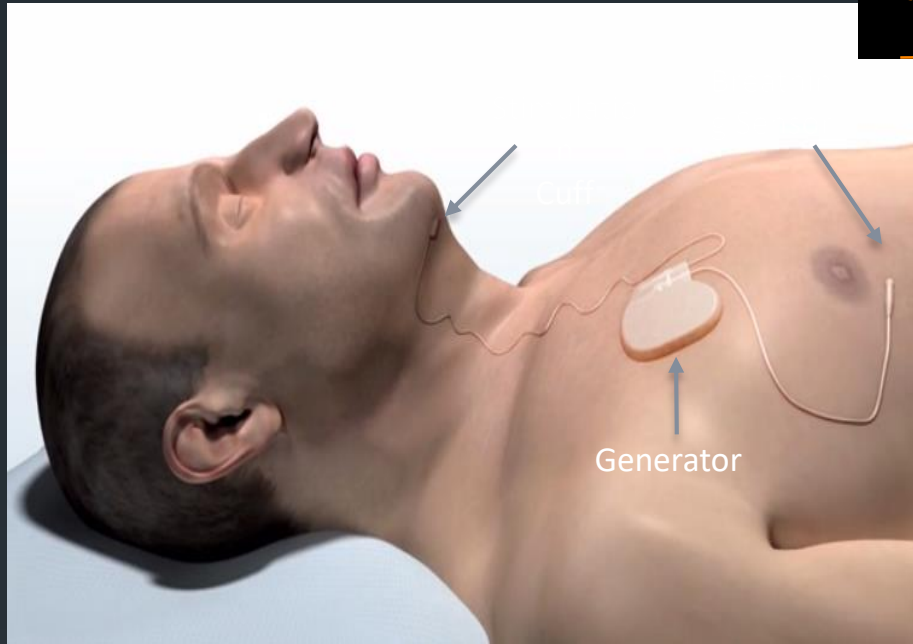


Hyoid bone suspension



Maxillomandibular advancement (MMA)

Hypoglossal Nerve Stimulation

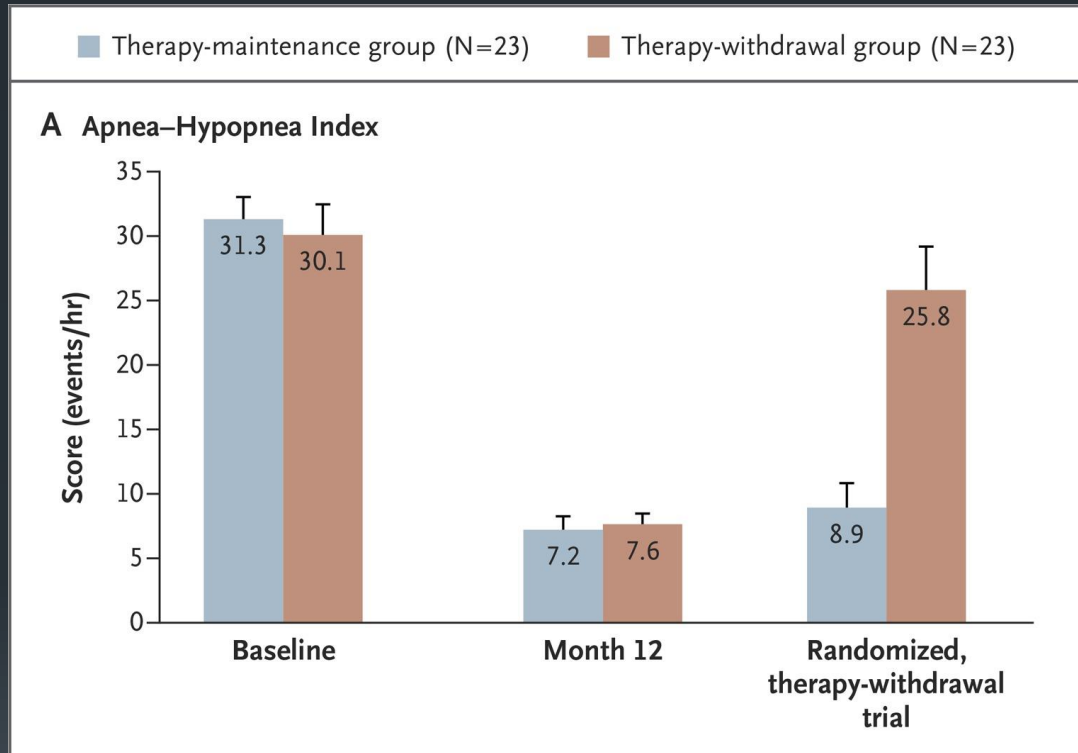


- Well-established technology
- Safe, outpatient procedure
- Three small incisions in neck and chest

- Adjustable
- Titratable
- Daily adherence monitoring

Upper Airway Stimulation for OSA

The STAR Trial



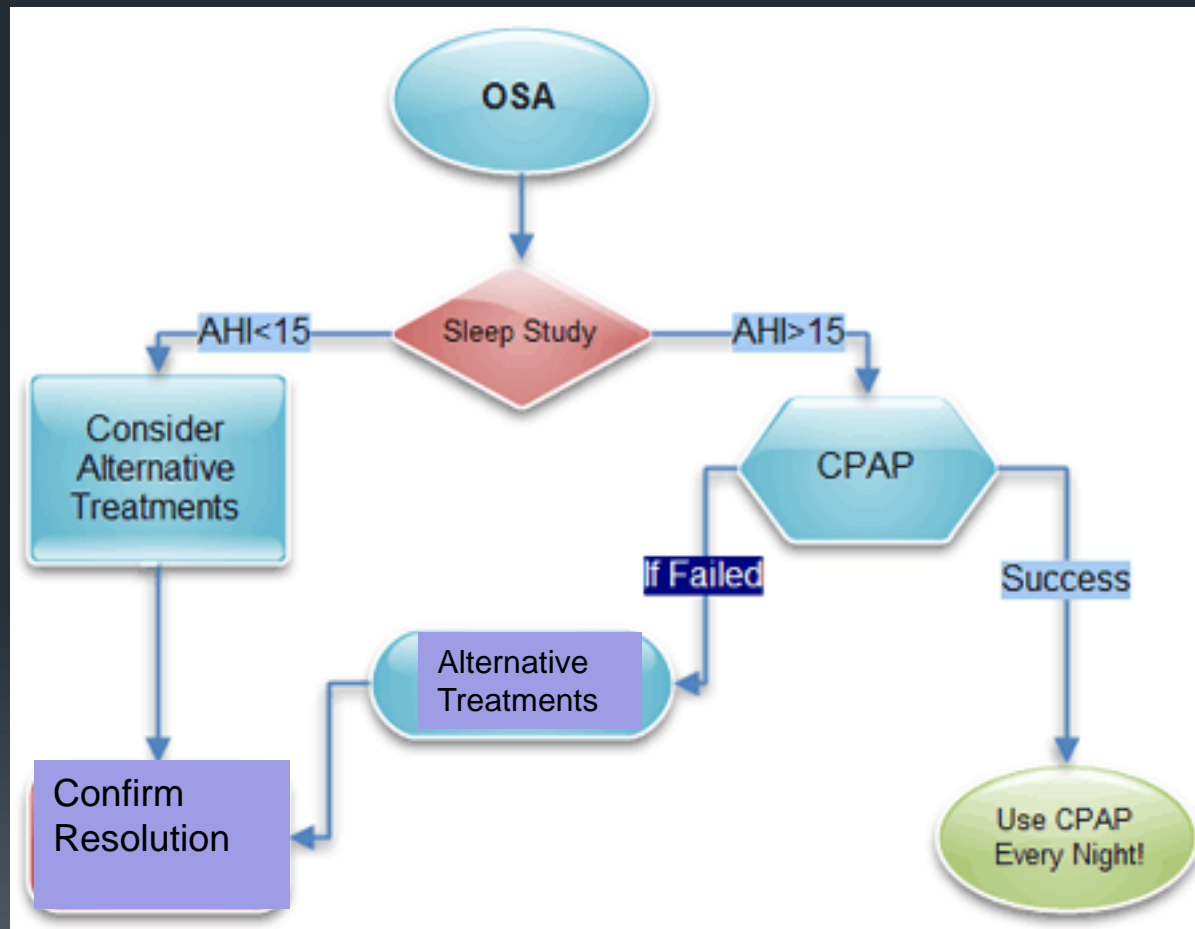
Primary Outcomes at 12 Months after Implantation and during the Randomized, Therapy-Withdrawal Trial.

Indications

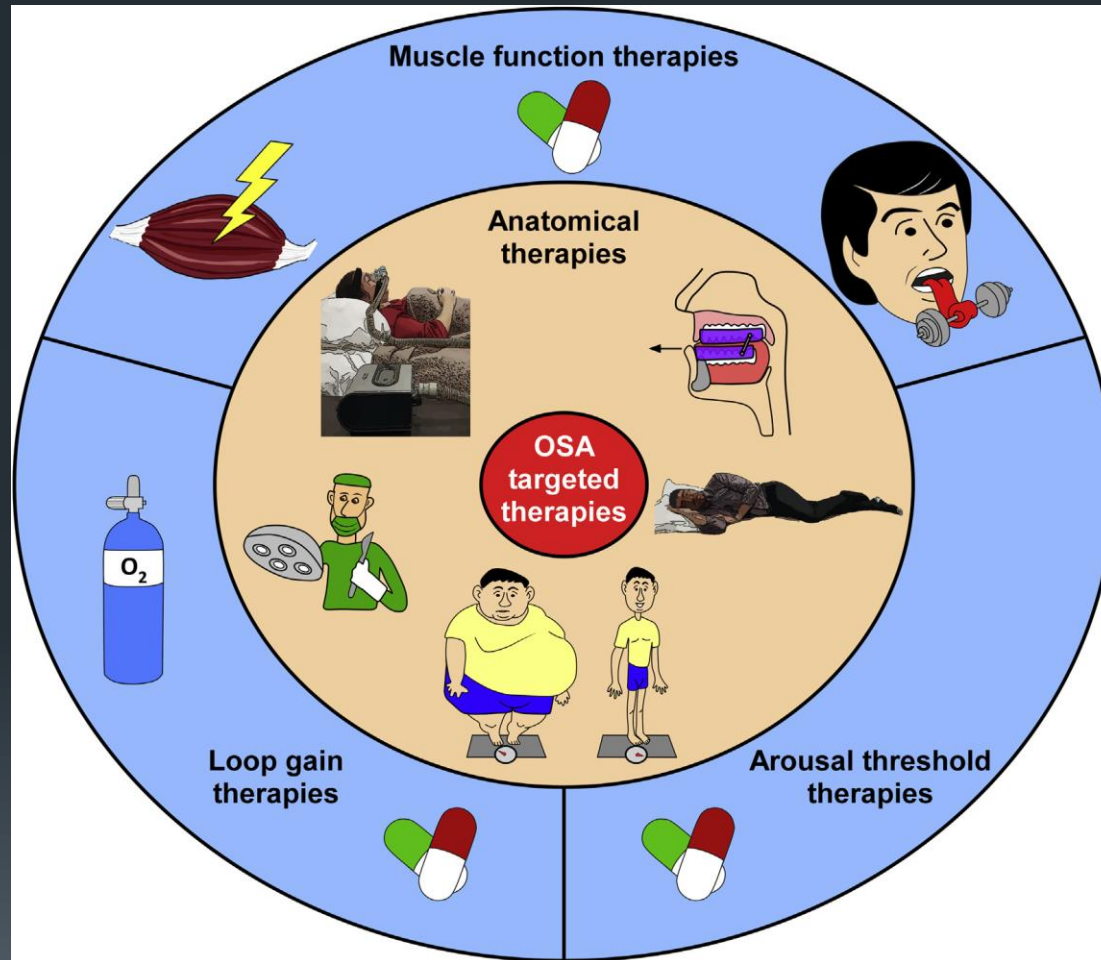
- Adults 22 years of age and older
- BMI ≤ 32
- Diagnosed OSA with an AHI range of 15-65 per hour
- CPAP failure or inability to tolerate CPAP treatment
- Appropriate airway anatomy (Drug-Induced Sleep Endoscopy, DISE exam)



Treatment; How I Do it



Personalized Management Approach



Take Home Points

- OSA is common, yet remains largely underdiagnosed in the general population
- Untreated OSA is associated with multiple negative cardiovascular, neurocognitive and metabolic consequences, in addition to daytime functional impairment
- In-lab Polysomnography is very comprehensive and used to evaluate multiple sleep disorders, other than OSA
- Home sleep testing is convenient, cheap, and fast, but is only indicated if OSA is the only sleep disorder likely to be present
- PAP therapy remains the mainstay of treatment for moderate to severe OSA, but adherence remains an obstacle
- Personalized approach to each individual patient should be the standard of care

References

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CHEST Feb 01, 2020. VOL 157, 2, P403-420,