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Obstructive Sleep Apnea

Diagnosis and Treatment

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PARKVIEW HEALTH

Disclosures

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- No financial disclosures
- Slide set material from AASM for public lectures
- Few additional slides have been incorporated that are not part of the original AASM slide set

Definitions

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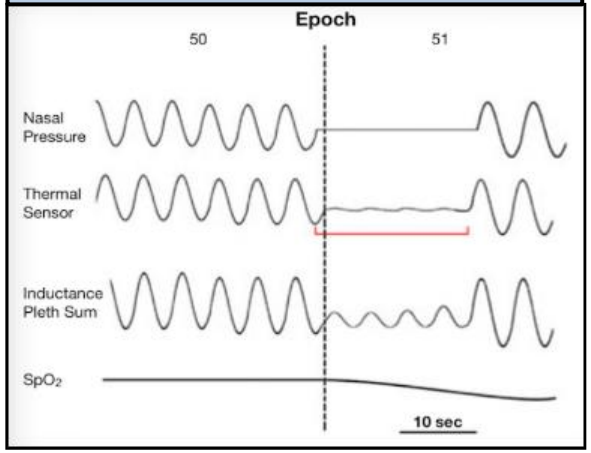
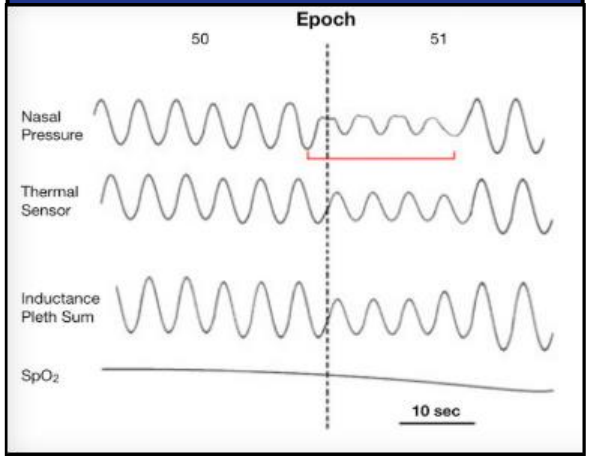
1. **Apnea**
   a. ≥ 90% drop airflow excursion from baseline lasting ≥10 seconds
2. **Hypopnea**
   a. ≥ 30% drop in airflow from baseline lasting ≥ 10 seconds and:
   b. Associated with ≥ 3% oxygen desaturation **or** arousal
3. **RERA:**
   a. ≥ 10 seconds increased respiratory effort or flattening of inspiratory waveform leading to an arousal. Does not meet criteria for apnea or hypopnea.

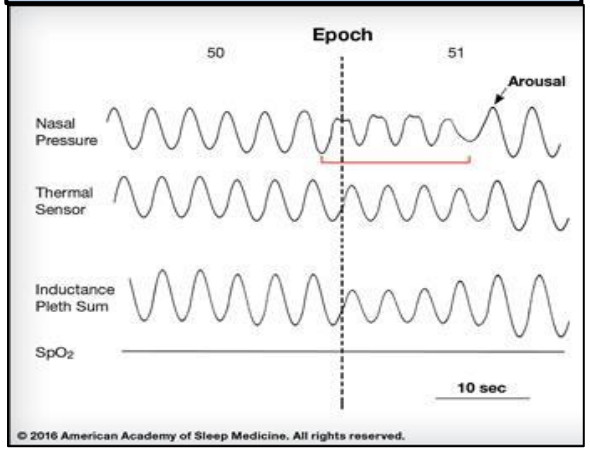
Obstructive Apnea



Obstructive Hypopnea



Respiratory Effort Related Arousal (RERA)



The AASM Manual for the Scoring of Sleep and Associated Events, Version 2.5

Measures of Sleep Apnea Frequency

- **Apnea / Hypopnea Index (AHI)**
  - # apneas + hypopneas per hour of sleep
- **Respiratory Disturbance Index (RDI)**
  - # apneas + hypopneas + RERAs per hour of sleep
- **Respiratory Event Index (REI)**
  - # respiratory events per hour of monitoring time on Home Sleep Apnea Testing (HSAT)

ICSD-3 Diagnostic Criteria for OSA

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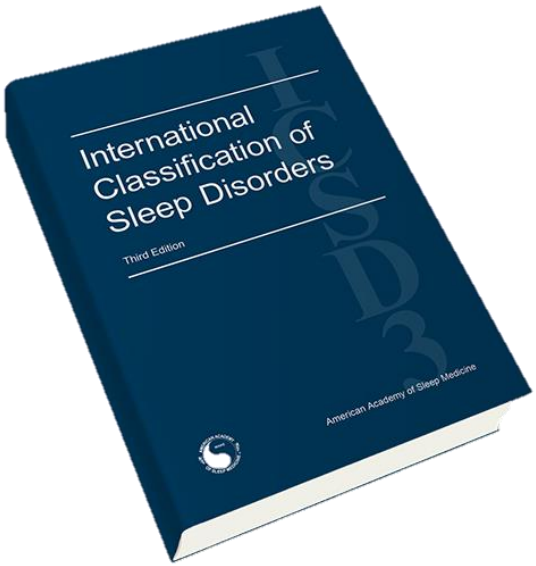

≥ 5 obstructive respiratory events/hour

and:

Snoring, witnessed apneas, fatigue, somnolence, mood/cognitive disorder, hypertension, type 2 diabetes, stroke or cardiac disease

- or -

≥ 15 obstructive respiratory events/hour

Current Prevalence of OSA in USA

Age (years)	1988-1994 Young NEJM, 1994	2007-2010 Peppard Am J Epidemiol, 2013
Men (%)		
AHI > 5/hr (30-70)	26	34
AHI > 15/hr (30-70)	9	13
Women (%)		
AHI > 5/hr (30-70)	13	17
AHI > 15/hr (30-70)	4	6

OSA Prevalence

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- Higher prevalence: male, advanced age and obesity

- Higher prevalence in subjects with CVD

The Upper Airway

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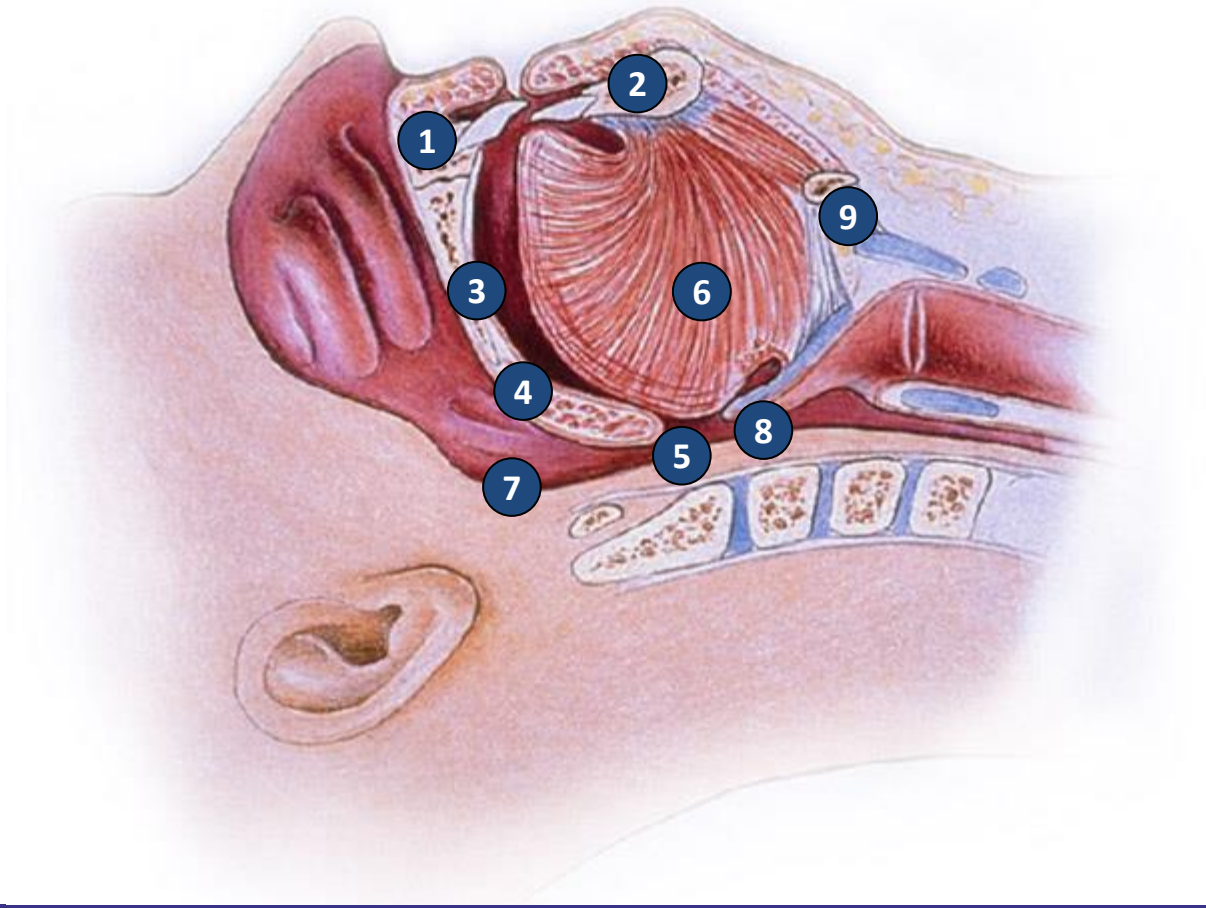

Pathophysiology of Apnea

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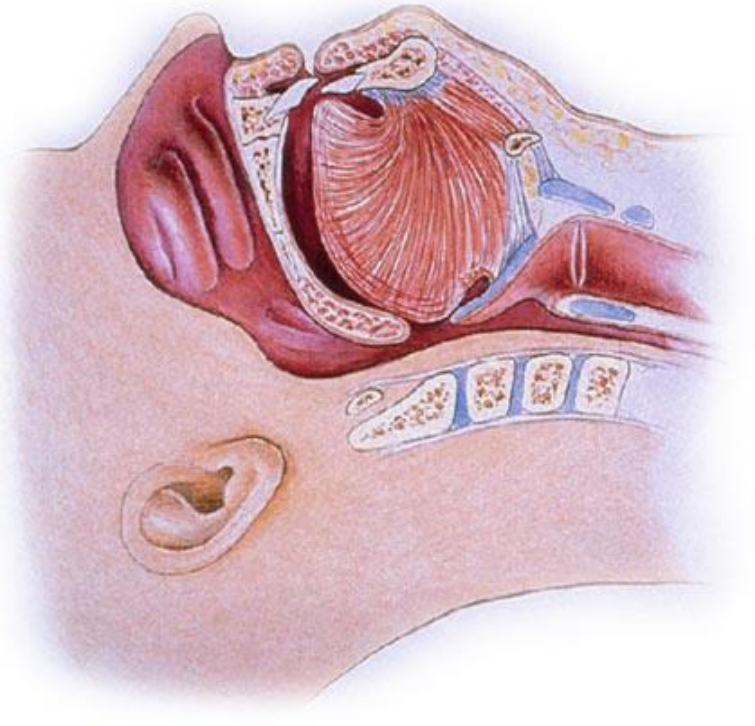
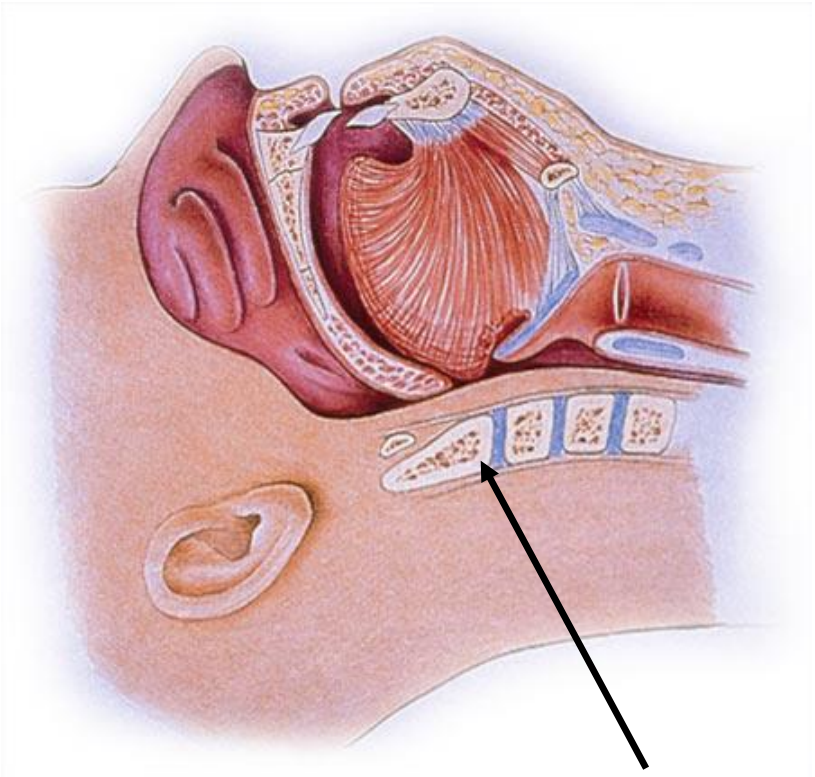


Wakefulness



Sleep

Where's the obstruction?

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- Three pharyngeal segments:
  - Retropalatal (RP) pharynx: Velo- or nasopharynx, (posterior to soft palate)
  - Retroglossal (RG) pharynx: Or pharynx, (posterior to tongue)
  - Retroepiglottic pharynx: Laryngo- or hypopharynx (posterior to epiglottis)

Control of Dilator Muscles

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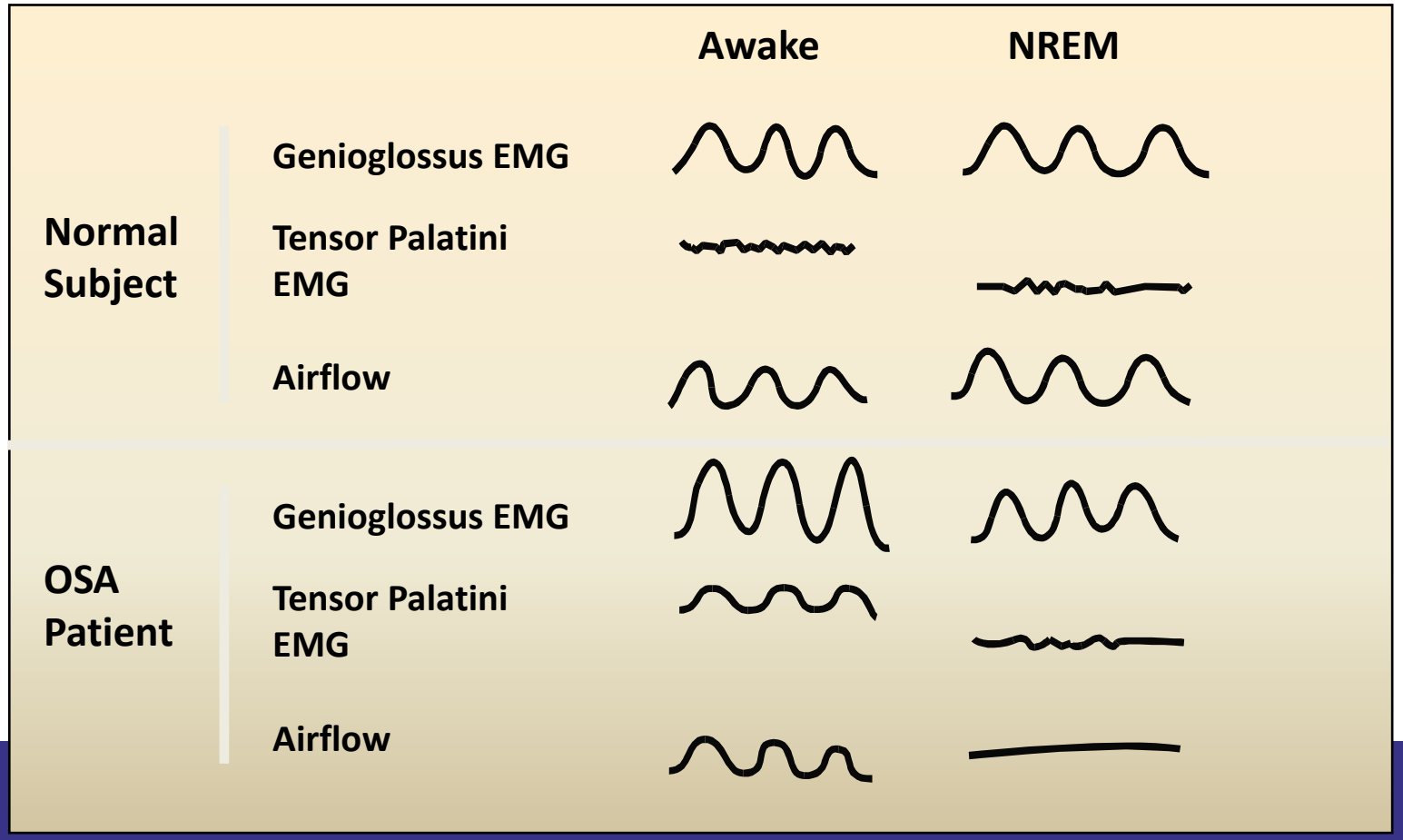
Effects On Pharyngeal Muscle Activity



For each tracing, amplitude is shown on the Y axis and time on the X axis

Pathophysiology of Sleep Apnea

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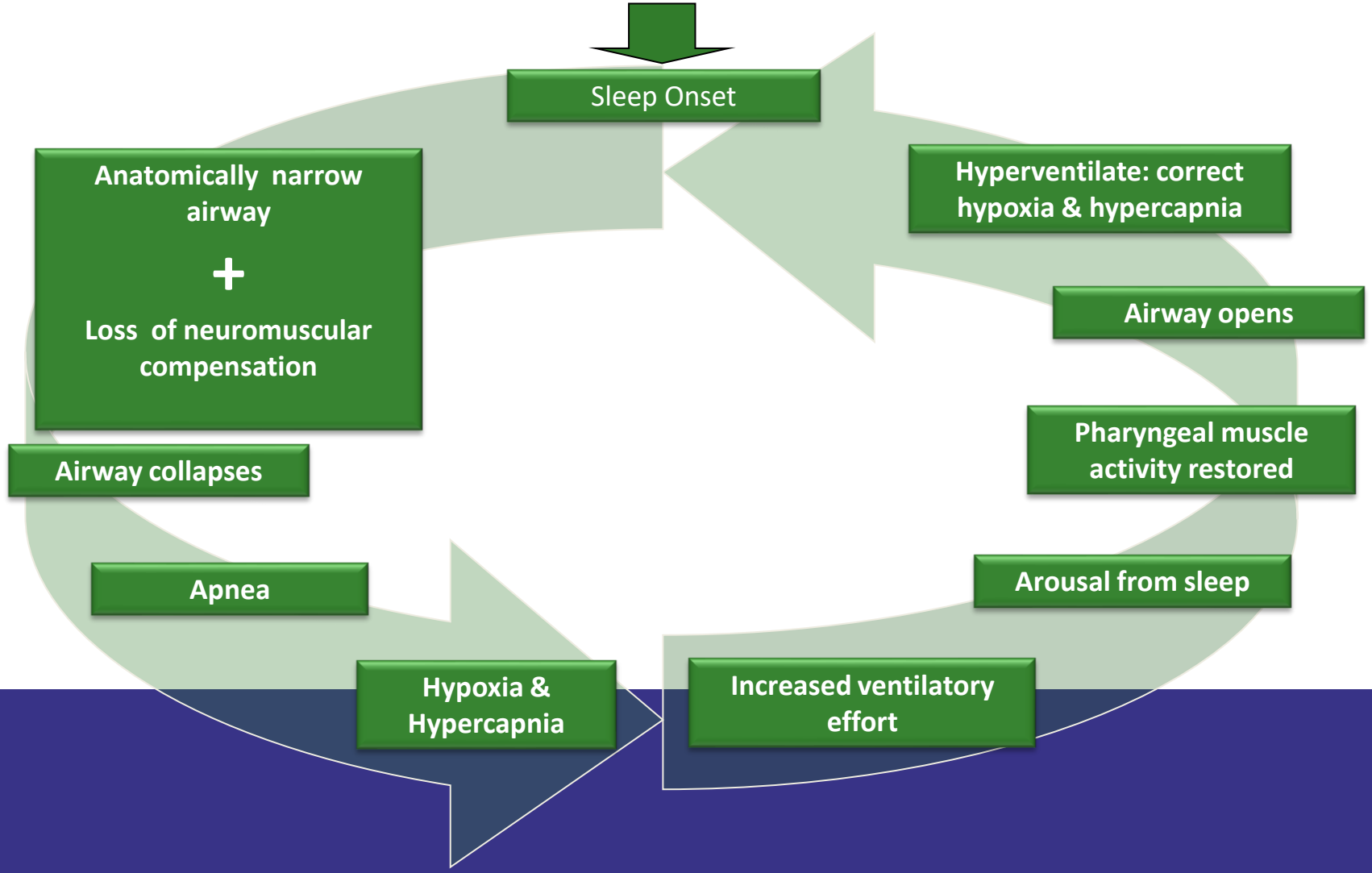
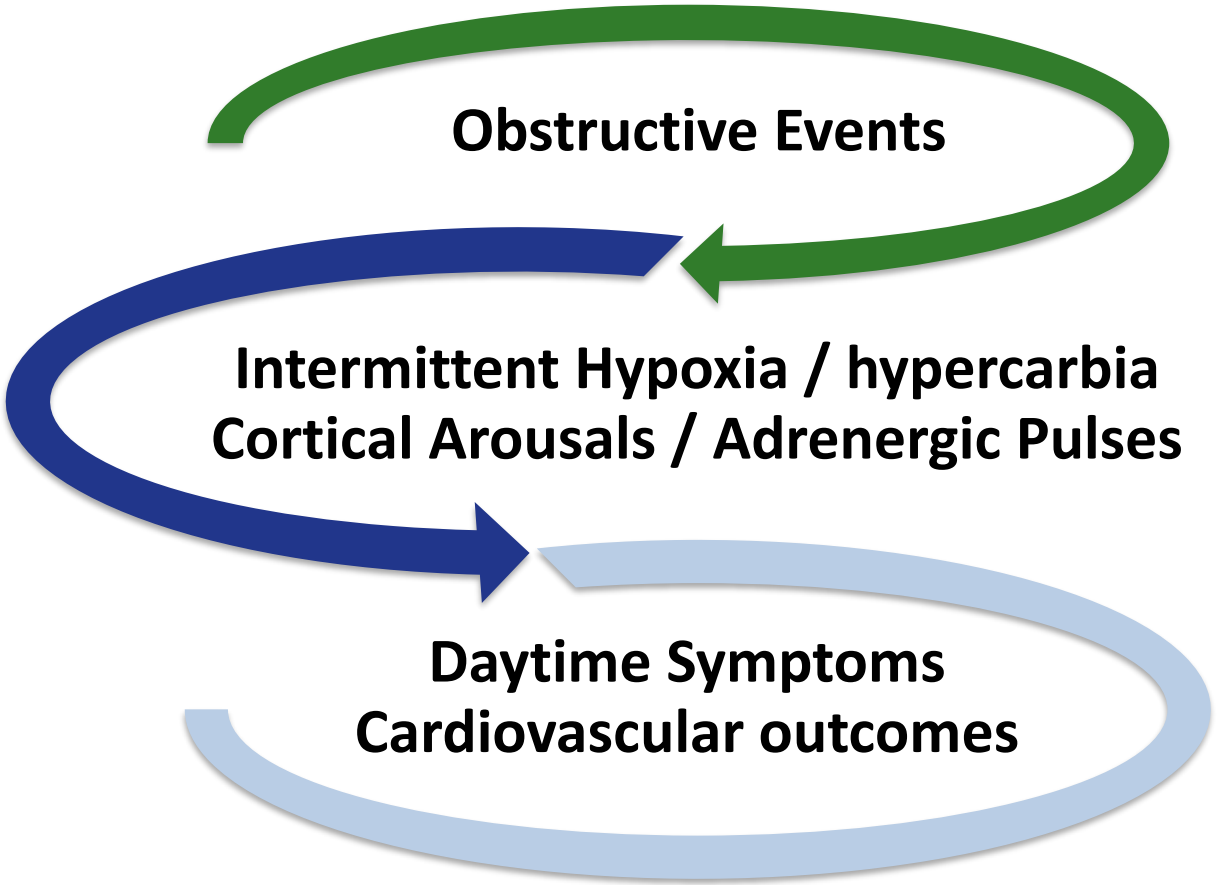
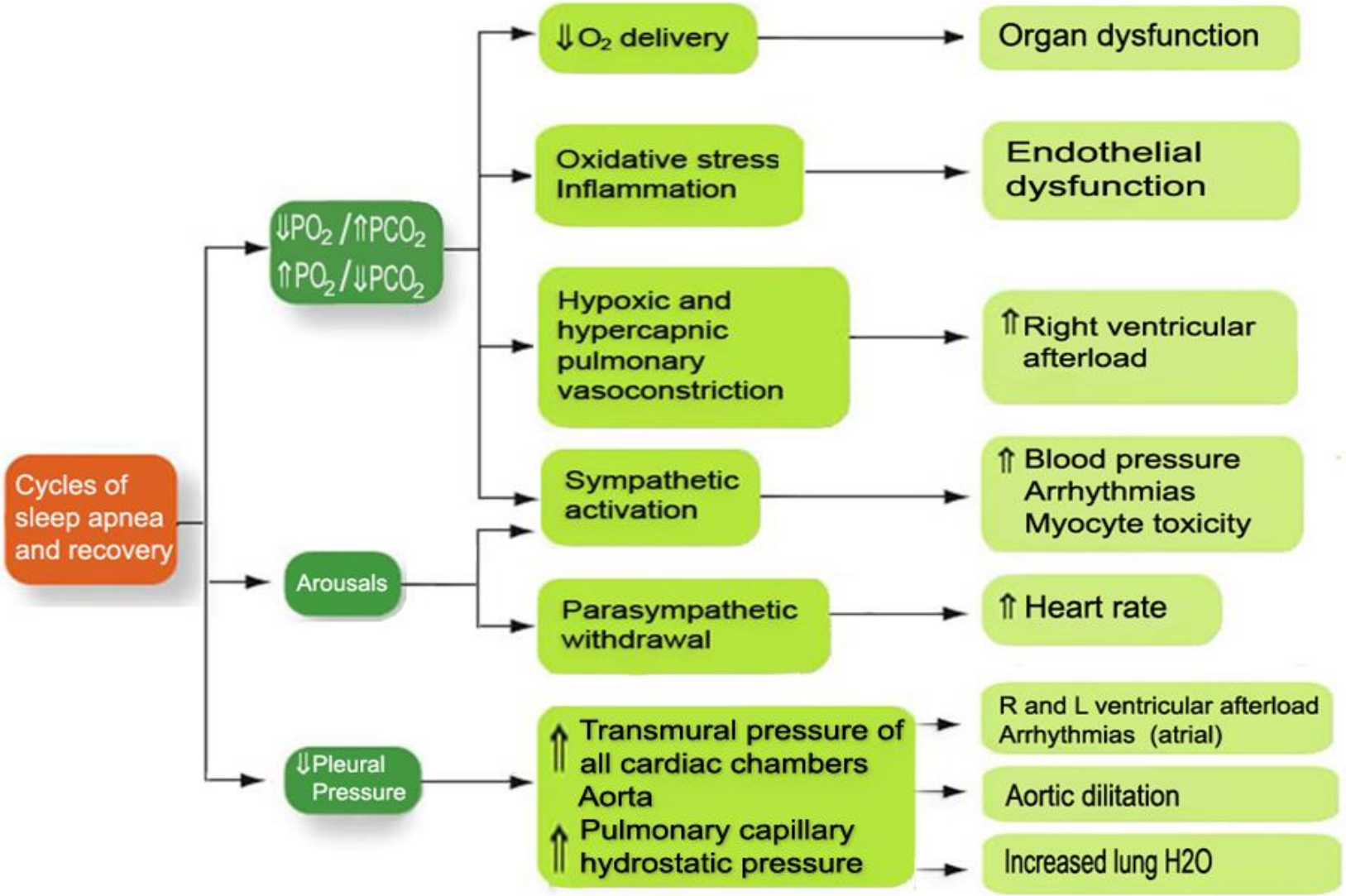
Awake: Small airway + neuromuscular compensation



Consequences of Sleep Apnea


Obstructive Events
Intermittent Hypoxia / hypercarbia
Cortical Arousals / Adrenergic Pulses
Daytime Symptoms
Cardiovascular outcomes

Biological Pathways Mediating CV Complications of OSA



Pleural pressure (Ppl) is a surrogate of the pressure surrounding the heart and other vascular structures.

Javaheri et al JACC, 2017

OSA and Mortality

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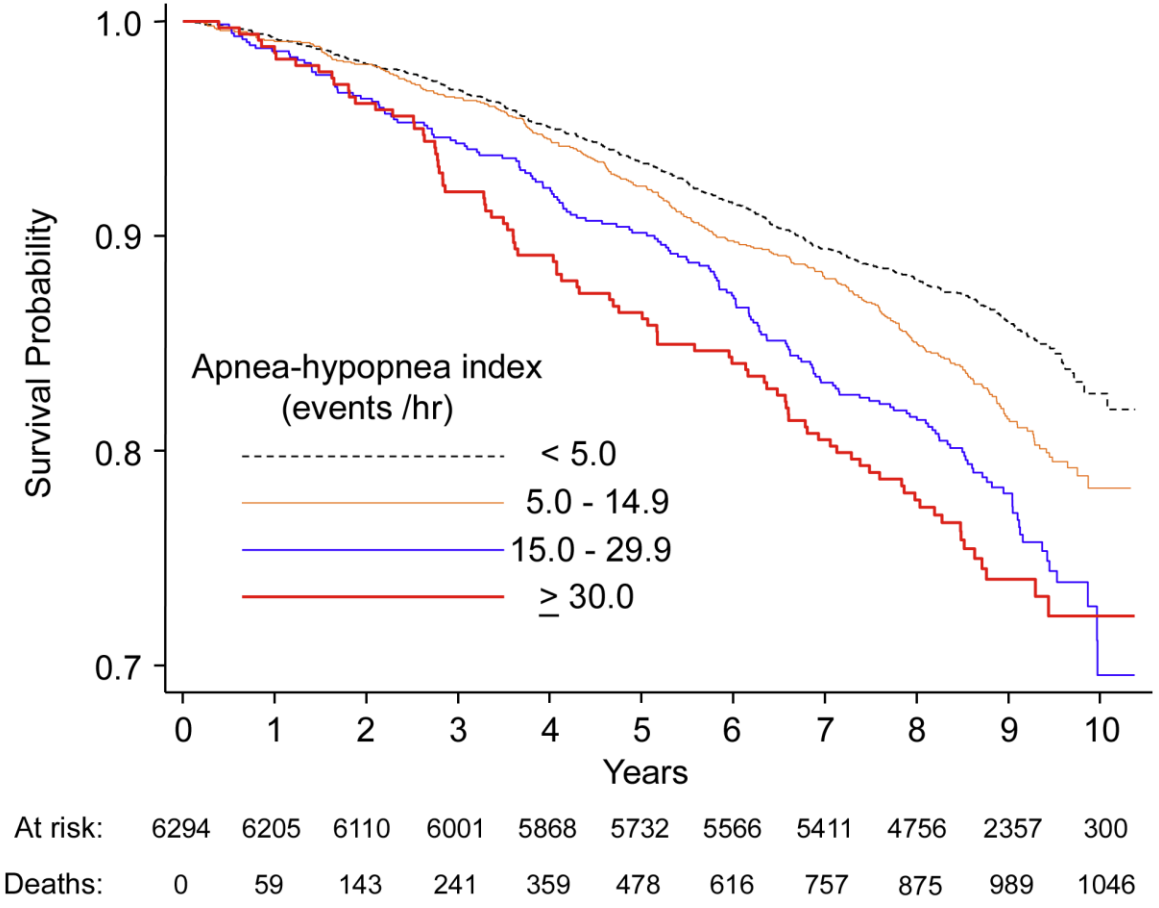

Punjabi et al, *PLoS Medicine*. 2009.

Consequences: Mortality

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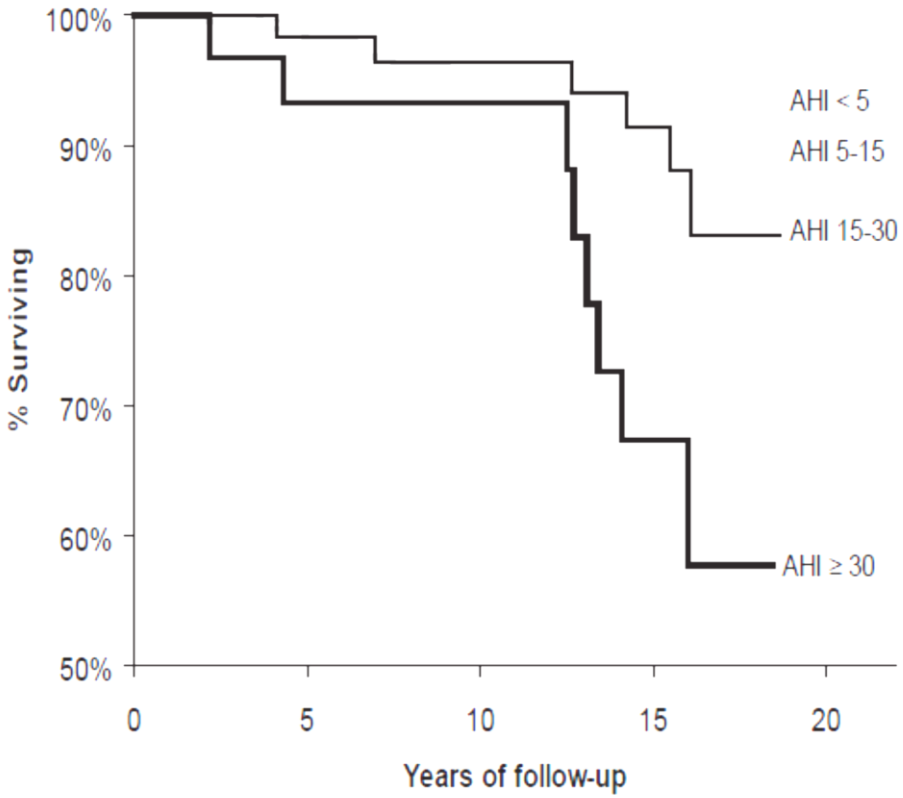
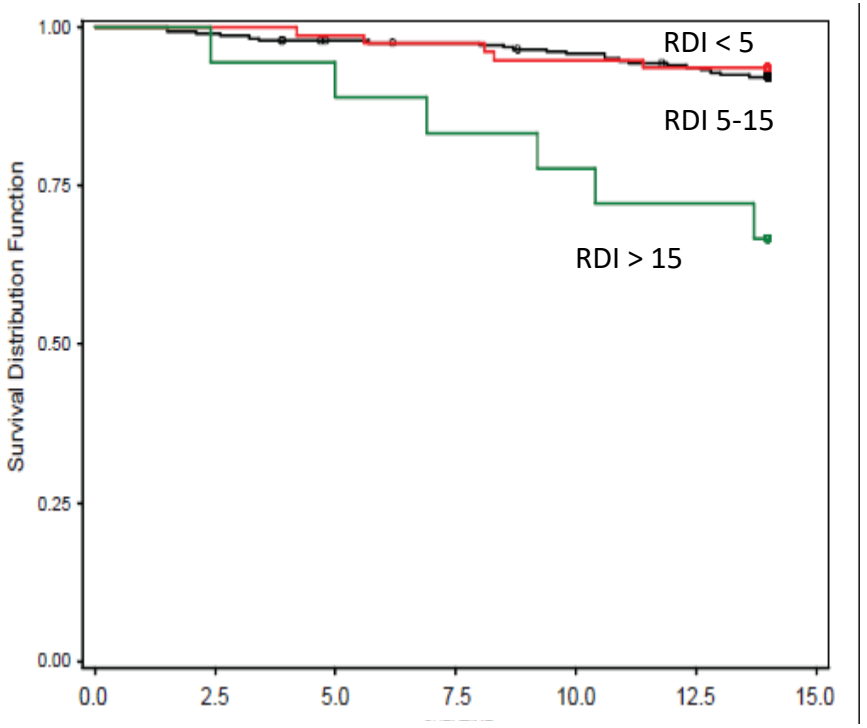
Wisconsin Cohort



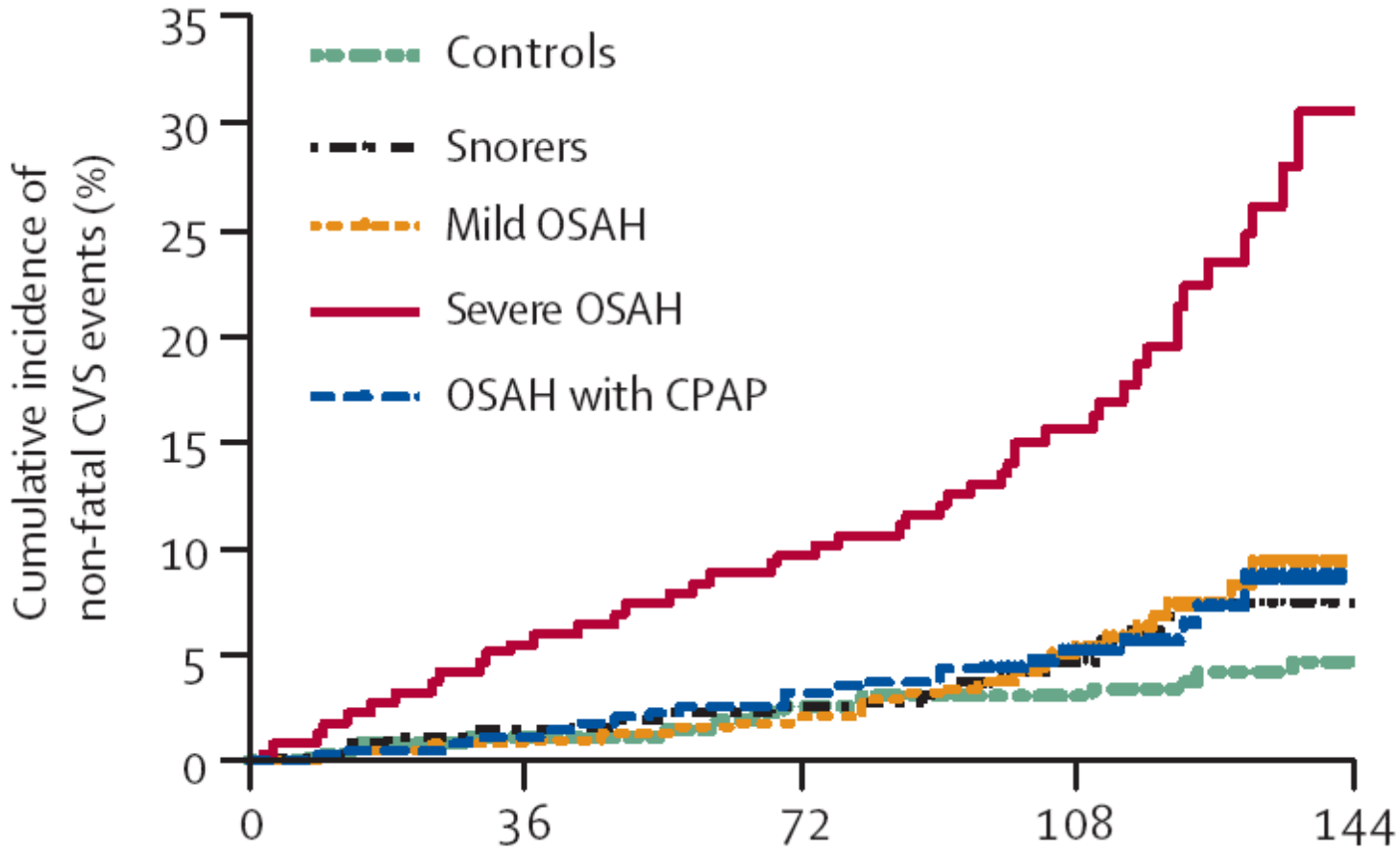
Young et al. Sleep 2008; 31:1071-1078

Busselton, Australia



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

Non-fatal Cardiovascular Events



Marin, *Lancet* 2005; 365: 1046-53

Sleep Heart Health Study: Cross-Sectional Analysis

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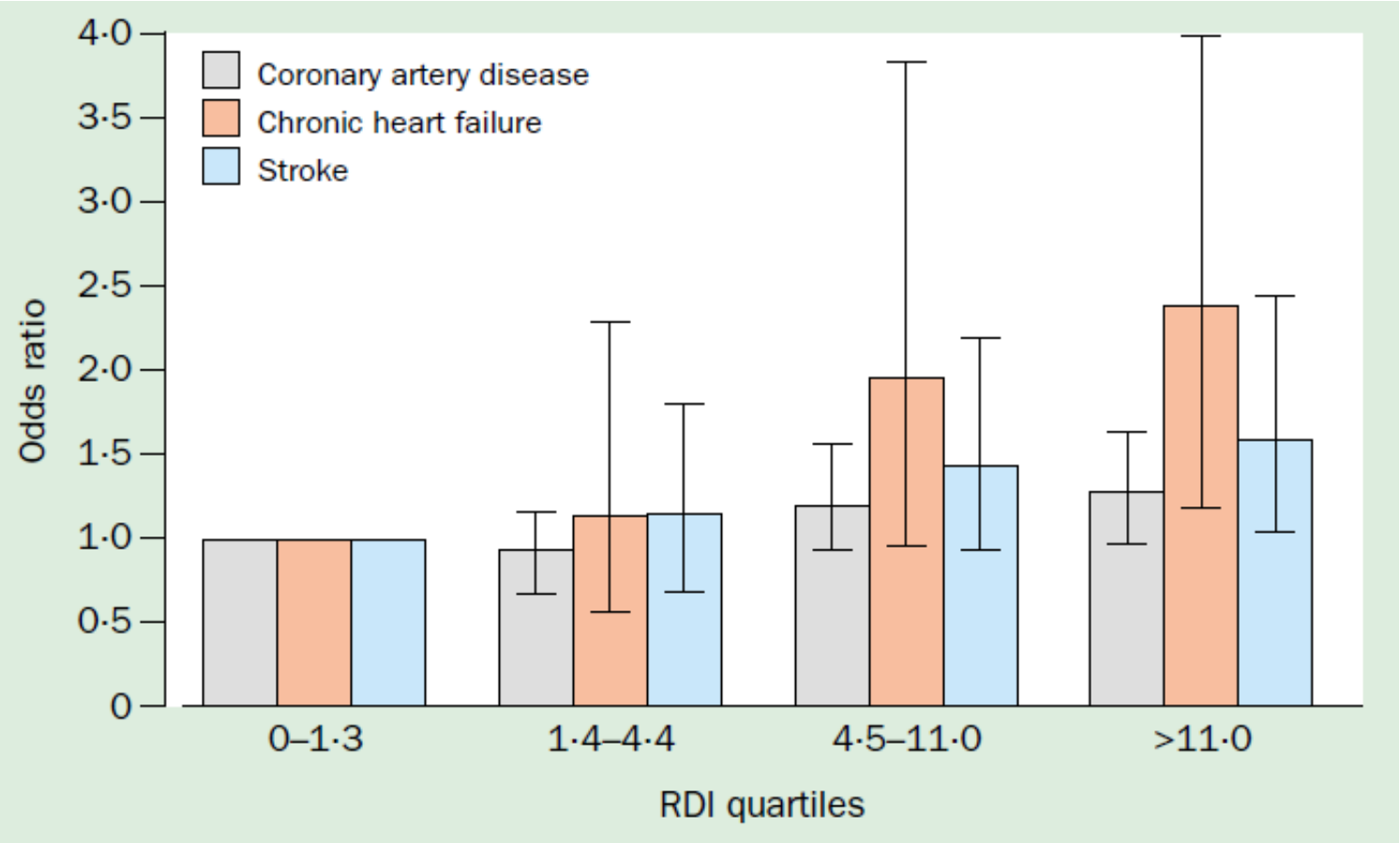

Adjusted Relative Odds of Prevalent Coronary Heart Disease, Heart Failure, or Stroke, by Quartile of SDB

Shahar E et al. *Am J Respir Crit Care Med* 2001

Hypertension and OSA by AHI

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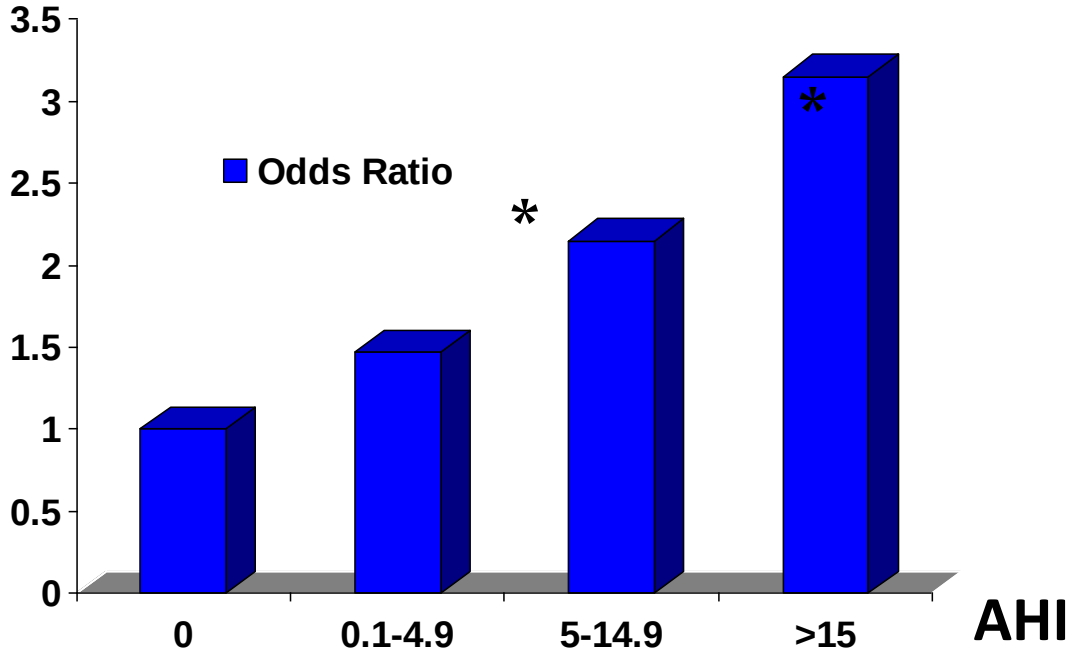

*OR adjusted for age, sex, ethnicity, BMI, neck & waist circumference, smoking and alcohol use

Wisconsin Sleep Cohort Study: Adjusted Odds Ratios for Hypertension at 4-year Follow-up Participants who were Normotensive at Baseline

Peppard PE et al. *N Eng J Med* 2000 May 11; 342(19): 1378-84

OSA and Hypertension

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Prospective Study of Sleep-disordered Breathing and Hypertension

The Sleep Heart Health Study

George T. O'Connor[1], Brian Caffo[2], Anne B. Newman[3], Stuart F. Quan[4,5], David M. Rapoport[6], Susan Redline[7], Helaine E. Resnick[8], Jonathan Samet[2], and Eyal Shahar[9]

Am J Respir Crit Care Med. 2009.

TABLE 2. ADJUSTED ODDS RATIOS* OF INCIDENT HYPERTENSION AT FOLLOW-UP IN RELATION TO BASELINE APNEA-HYPOPNEA INDEX AMONG 2,470 SLEEP HEART HEALTH STUDY SUBJECTS WITHOUT HYPERTENSION AT BASELINE

Baseline AHI	n	Model 1†	Model 2‡	Model 3§
0–4.9	1,511	—	—	—
5–14.9	629	1.13 (0.90–1.43)	0.92 (0.72–1.17)	0.94 (0.73–1.22)
15–29.9	234	1.54 (1.12–2.11)	1.12 (0.80–1.56)	1.09 (0.77–1.54)
⩾30	97	2.19 (1.39–3.44)	1.51 (0.93–2.47)	1.50 (0.91–2.46)

Definition of abbreviations: AHI = apnea-hypopnea index; BMI = body mass index.

* Estimated by generalized estimating equation models with each subject contributing one or two follow-up intervals.

Values are odds ratio (95% confidence interval) or n.

† Adjusted for age, sex, race, and time since baseline.

‡ Adjusted for factors in model 1 plus BMI.

§ Adjusted for factors in model 2 plus waist/hip ratio and neck girth.

Sleep Apnea and Stroke

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- Sleep apnea seen in 50%–80% of acute stroke and TIA patients.
  - OSA was the most common form
  - Central sleep apnea and Cheyne-stokes forms also reported
  - Sleep apnea improves in the subacute phase, primarily central and Cheyne-stokes pattern, not OSA

OSA & Incident Stroke

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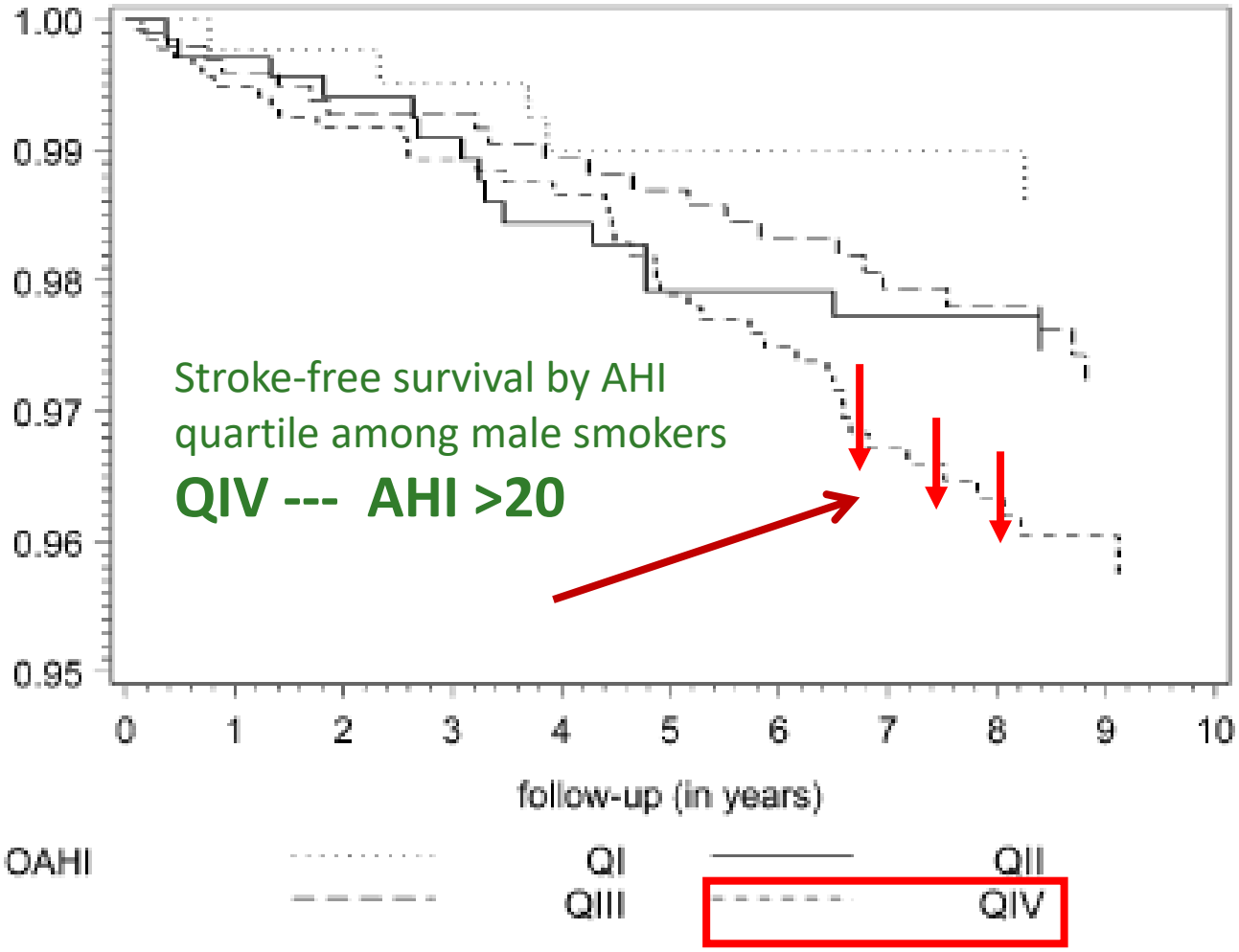

Redline, Am J Respir Crit Care Med. 2010 Jul 15;182(2):269-77.

Consequences: Arrhythmias

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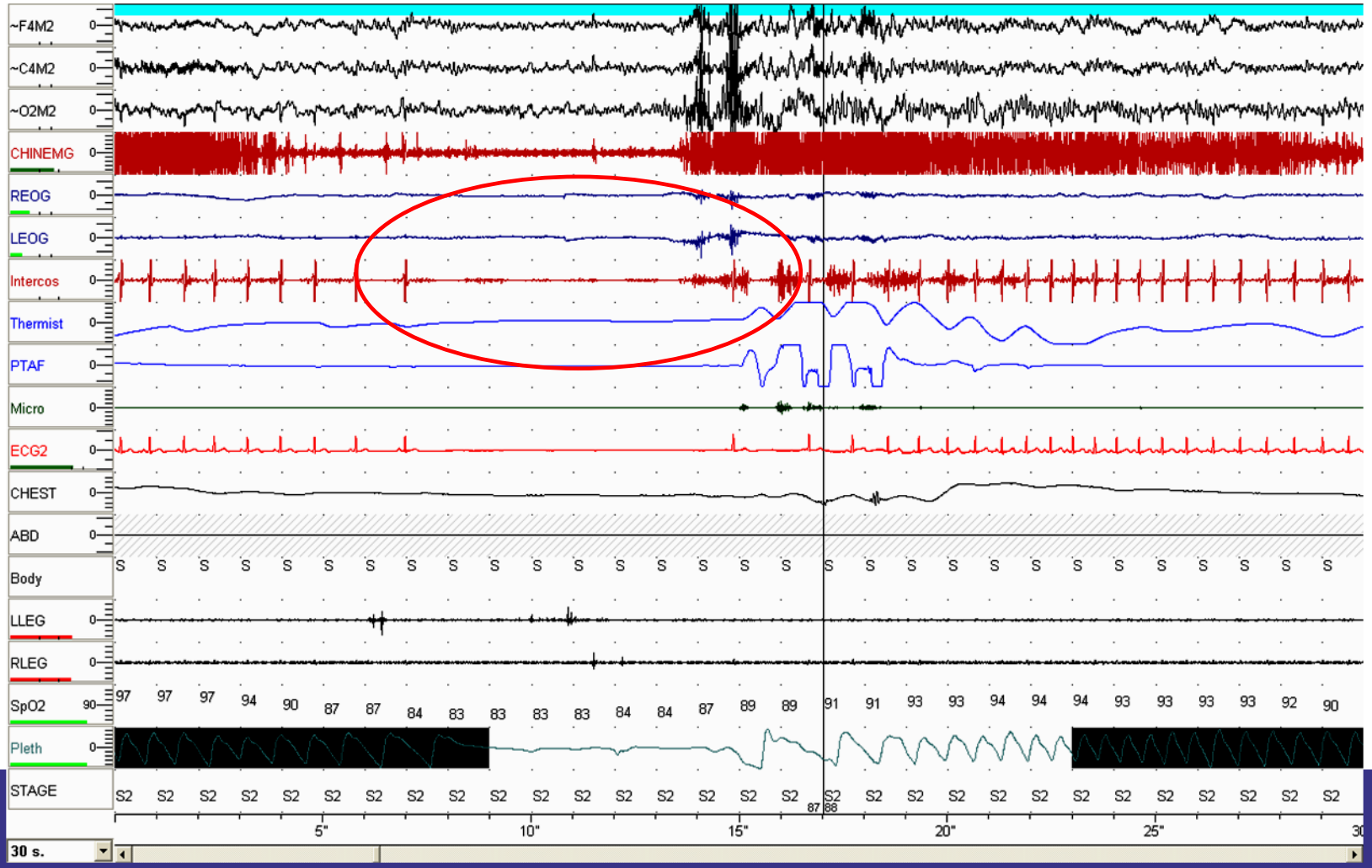

OSA and Atrial Fibrillation

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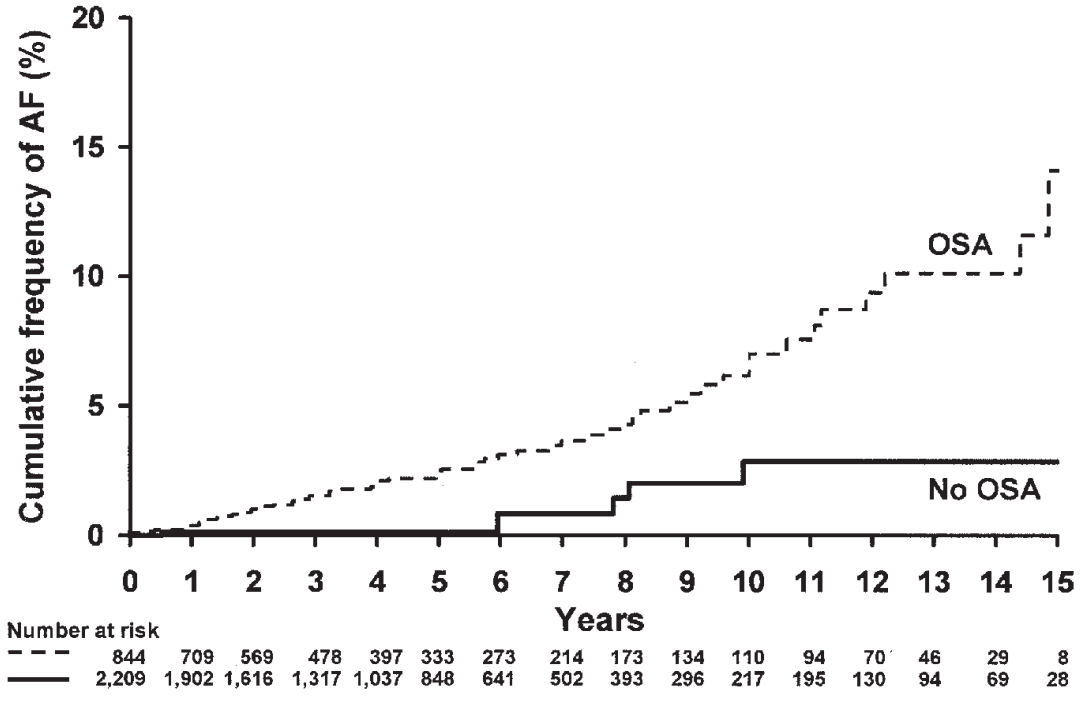
Obstructive Sleep Apnea, Obesity, and the Risk of Incident Atrial Fibrillation

Apoor S. Gami, MD,*† Dave O. Hodge, MS,‡ Regina M. Herges, BS,‡ Eric J. Olson, MD,†§
Jiri Nykodym, BS,*† Tomas Kara, MD,*† Virend K. Somers, MD, PHD, FACC*†‖
Rochester, Minnesota

J Am Coll Cardiol. 2007.



AF, n = 114

P = 0.002

AF, n = 19

OSA and Sudden Cardiac Death

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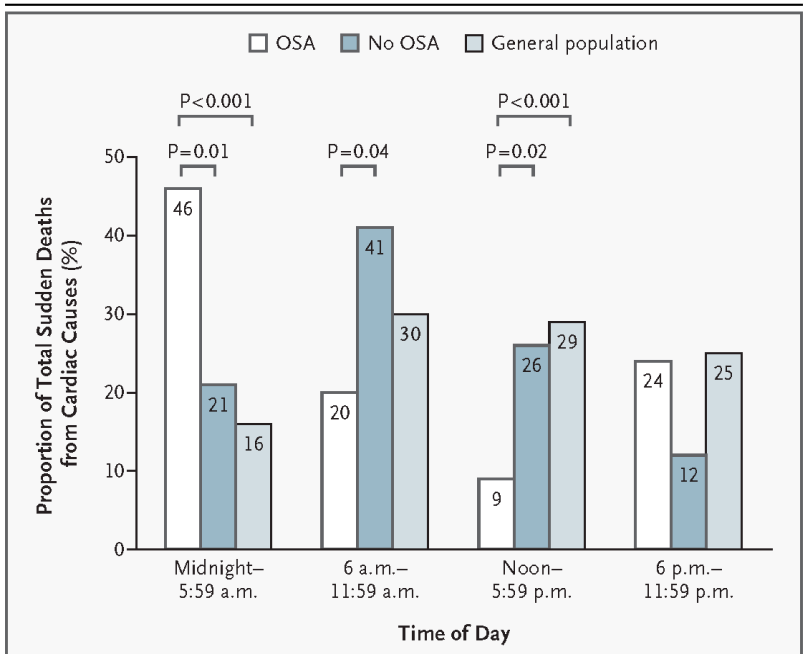
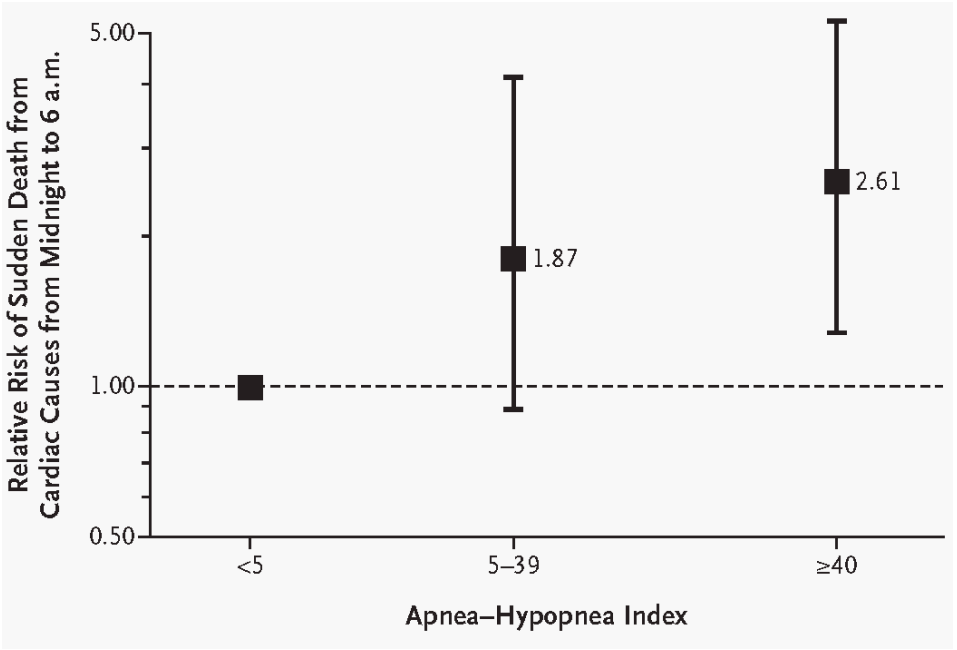


Figure 1. Day–Night Pattern of Sudden Death from Cardiac Causes in 78 Persons with and 34 Persons without Obstructive Sleep Apnea (OSA) and in the General Population.

Data for the general population were derived from Cohen et al.[1]



Sudden death during night more likely in those with OSA

Gami et al, *N Engl J Med. 2005 Mar 24;352(12):1206-14.*

Consequences: Diabetes

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- Severe OSA patients with sleepiness are at increased risk for diabetes (up to 83% of patients with type 2 diabetes have unrecognized OSA)*
- Insulin sensitivity improves after CPAP therapy
- The greatest CPAP response on glucose metabolism is in the diabetic patient with a lower BMI

*Pamidi et al, Front Neurology 2012; 3, 126

Consequences: GERD

- 54-76% of OSA patients have Gastroesophageal Reflux Disease (GERD)
  - more frequent and prolonged in OSA patients versus BMI matched controls
- Common risk factors: obesity, male sex, and alcohol use
- OSA may trigger GERD due to decreased intrathoracic pressure

Consequences: Excessive Daytime Sleepiness

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- Reduced alertness & vigilance
- Increased motor vehicle crashes
- Increased work-related accidents
- Poor job/school performance
- Difficulty concentrating & reduced productivity
- Falling asleep inappropriate social circumstances

Daytime Symptoms

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LOWER QUALITY OF LIFE

DEPRESSION

FATIGUE/MALAISE

WORSE PERCEIVED PAIN

IRRITABILITY

MORNING HEADACHES

DECREASED LIBIDO

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Diagnosing Sleep Apnea

Patient Symptoms

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Nocturnal symptoms:

Snoring

Witnessed Apneas, gasping or choking

Insomnia, frequent awakenings

Nocturia

Daytime symptoms:

Somnolence, fatigue

Poor concentration

Sleep Apnea: Is Your Patient at Risk? NIH Publication, No 95-3803.


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McPHERSON

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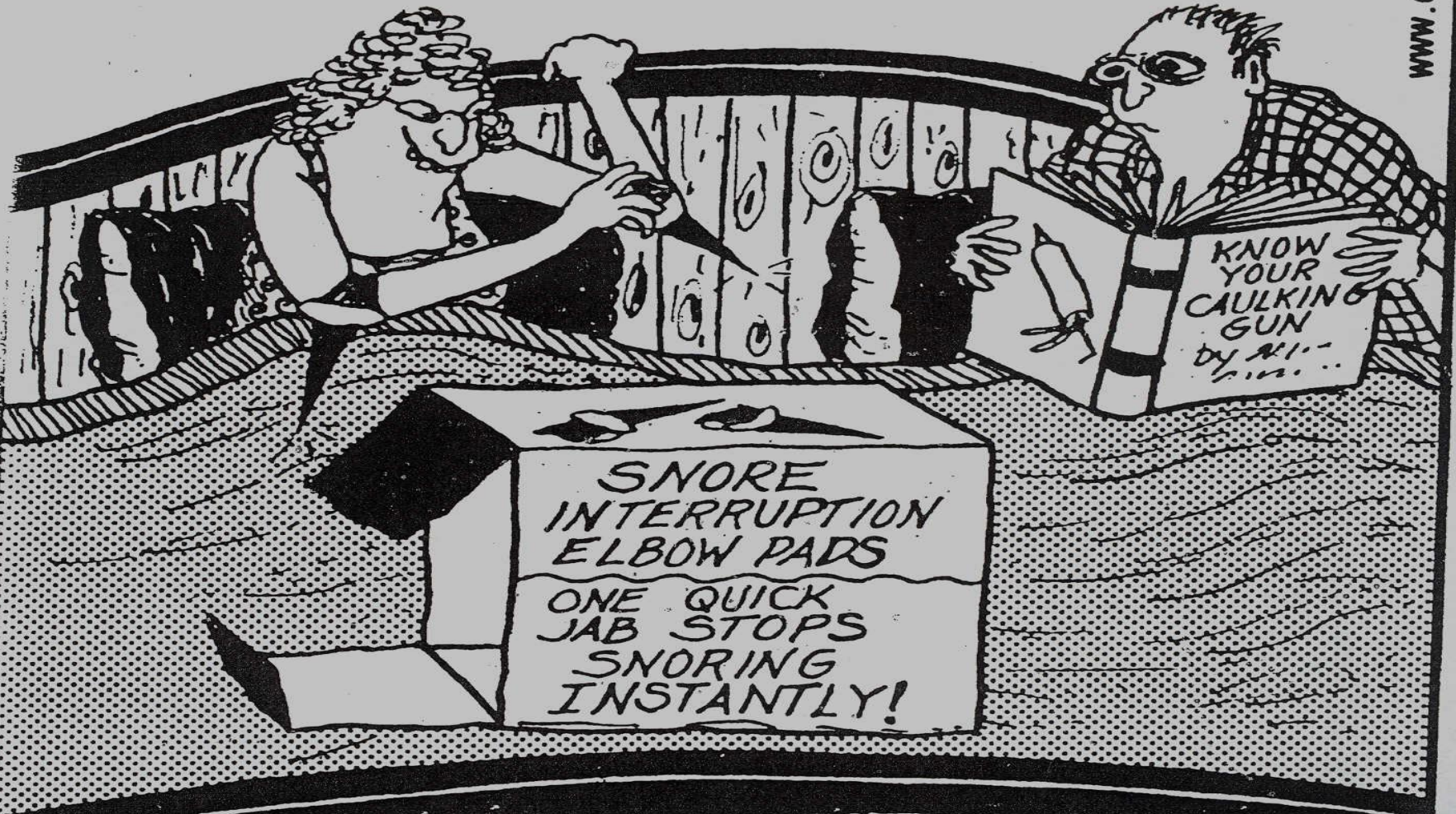
www.closetohome.com



Physical Exam Findings

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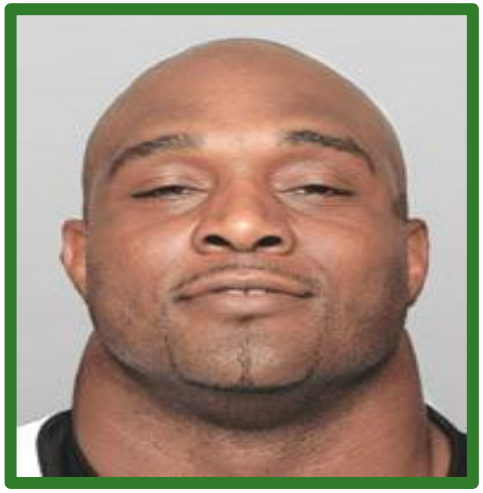
Vitals: Blood Pressure, O2 saturation, weight, BMI

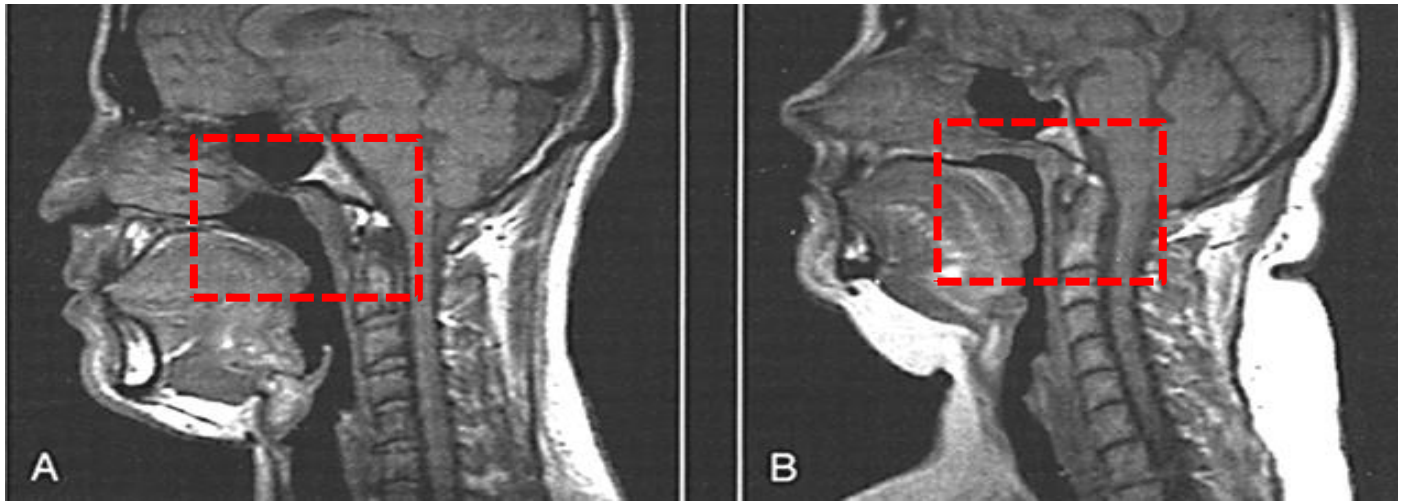
Neck circumference

- >17” men, >16” women associated with higher risk

Upper airway crowding

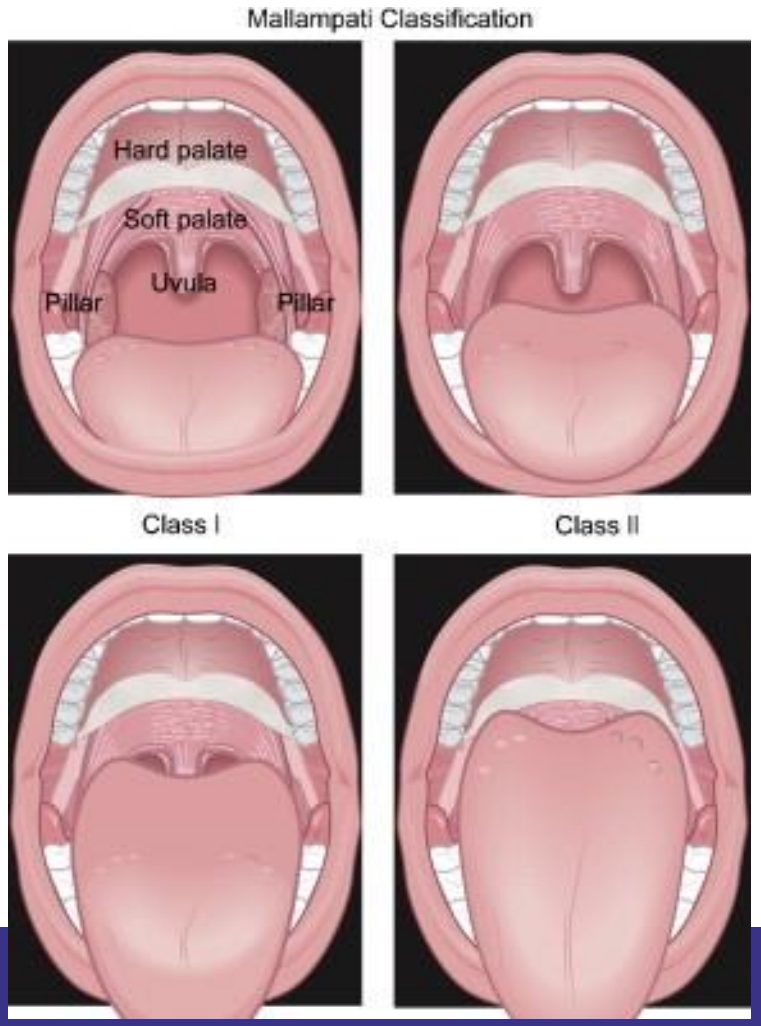
- Lateral wall narrowing
- High arched palate
- Large tongue, high based
- Large uvula and tonsils
- High Modified Mallampati score




A
B

Modified Mallampati Class

- Tongue not protruded in relaxed position
- Correlates with OSA and severity



STOP-BANG

- Validated screening tool for obstructive sleep apnea
- Score of ≥ 3 has >90% sensitivity to detect moderate to severe OSA
- High positive predictive value (85%)

Chung; Anesthesiology; 2008
Chung; Br. J Anaesth; 2012

STOP-BANG *(Give 1 point for each "Yes")*

STOP-BANG Sleep Apnea Screening Tool	
Snoring	louder than talking, heard through doors
Tired	tired, fatigued, sleepy during the day
Observed	stop breathing, choking, gasping
Pressure	hypertension
BMI	> 35
Age	> 50
Neck	> 17 in (male) or >16 in (female)
Gender	male
≥ 3 points indicates significant risk for OSA	

***There are multiple versions and scoring systems for STOP-BANG**

Diagnostic Approach

- **Clinical suspicion and evaluation**
- **Sleep testing**
  - Home sleep apnea test
  - Polysomnography

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JCSM
Journal of Clinical Sleep Medicine

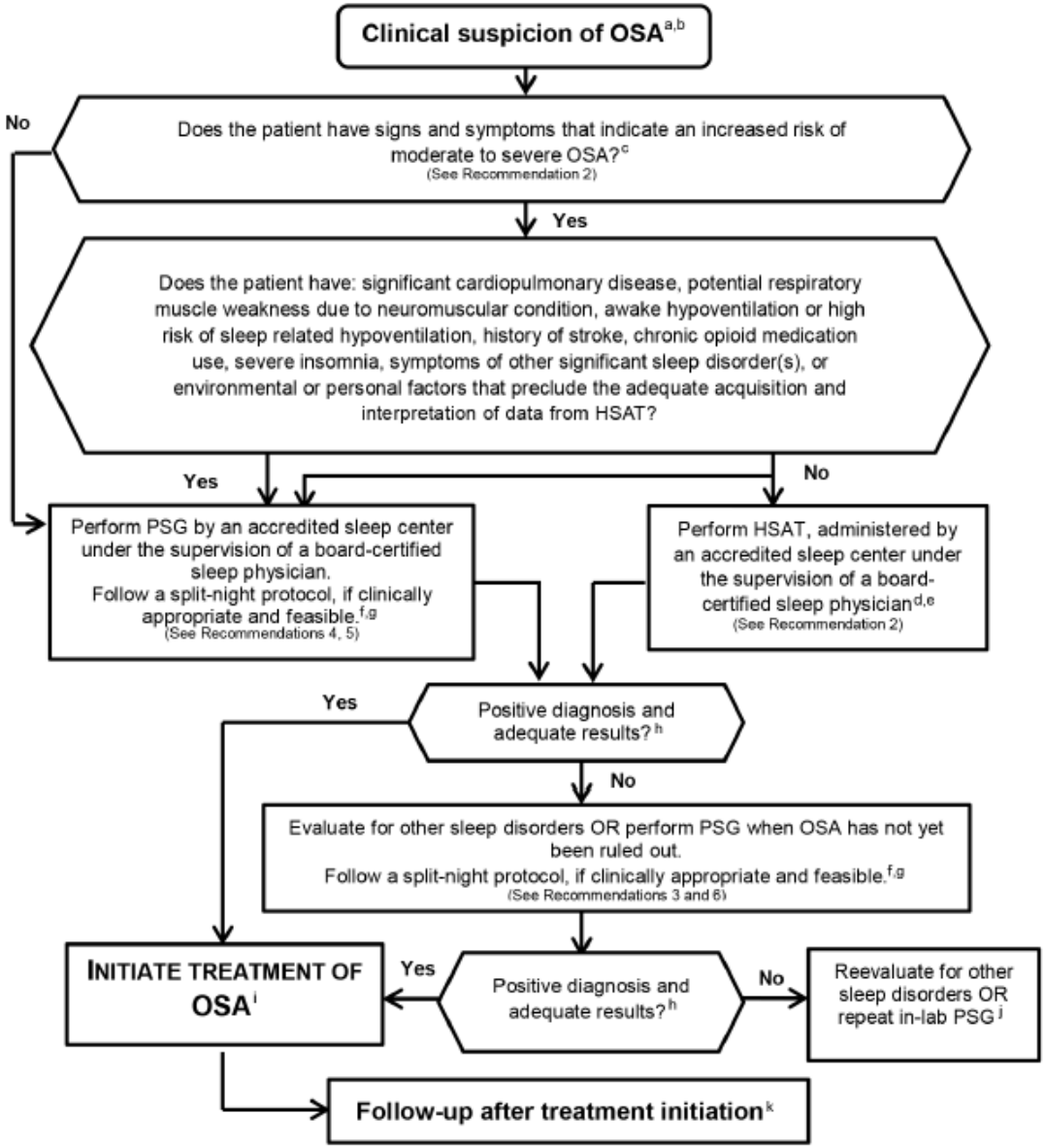
SPECIAL ARTICLES

Clinical Practice Guideline for Diagnostic Testing for Adult Obstructive Sleep Apnea: An American Academy of Sleep Medicine Clinical Practice Guideline

Vishesh K. Kapur, MD, MPH[1]; Dennis H. Auckley, MD[2]; Susmita Chowdhuri, MD[3]; David C. Kuhlmann, MD[4]; Reena Mehra, MD, MS[5]; Kannan Ramar, MBBS, MD[6]; Christopher G. Harrod, MS[7]

Kapur; JCSM/ 2017

Figure 2—Clinical algorithm for implementation of clinical practice guidelines.



Kapur; JCSM/ 2017

Table 5—Summary of recommendations.

Recommendation Statement	Strength of Recommendation	Evidence Quality	Benefits versus Harms	Patient Values and Preferences
1. We recommend that clinical tools, questionnaires or prediction algorithms not be used to diagnose OSA in adults, in the absence of PSG or HSAT.	Strong	Moderate	High certainty that harms outweigh benefits	Vast majority of well-informed patients would most likely not choose clinical tools, questionnaires or prediction algorithms for diagnosis
2. We recommend that PSG, or HSAT with a technically adequate device, be used for the diagnosis of OSA in uncomplicated adult patients presenting with signs and symptoms that indicate an increased risk of moderate to severe OSA.	Strong	Moderate	High certainty that benefits outweigh harms	Vast majority of well-informed patients would want PSG or HSAT
3. We recommend that if a single HSAT is negative, inconclusive or technically inadequate, PSG be performed for the diagnosis of OSA.	Strong	Low	High certainty that benefits outweigh harms	Vast majority of well-informed patients would want PSG performed if the initial HSAT is negative, inconclusive, or technically inadequate
4. We recommend that PSG, rather than HSAT, be used for the diagnosis of OSA in patients with significant cardiorespiratory disease, potential respiratory muscle weakness due to neuromuscular condition, awake hypoventilation or suspicion of sleep related hypoventilation, chronic opioid medication use, history of stroke or severe insomnia.	Strong	Very Low	High certainty that benefits outweigh harms	Vast majority of well-informed patients would most likely choose PSG to diagnose suspected OSA
5. We suggest that, if clinically appropriate, a split-night diagnostic protocol, rather than a full-night diagnostic protocol for PSG be used for the diagnosis of OSA.	Weak	Low	Low certainty that benefits outweigh harms	Majority of well-informed patients would most likely choose a split-night diagnostic protocol to diagnose suspected OSA
6. We suggest that when the initial PSG is negative, and there is still clinical suspicion for OSA, a second PSG be considered for the diagnosis of OSA.	Weak	Very low	Low certainty that benefits outweigh harms	Majority of well-informed patients would most likely choose a second PSG to diagnose suspected OSA when the initial PSG is negative and there is still a suspicion that OSA is present

Kapur; JCSM/ 2017

Polysomnography

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- Gold standard for obtained data
- Allows opportunity for manual PAP titration
- Multi-channel monitoring of physiological parameters during sleep
  - EEG (allows direct measurement of sleep!)
  - EOG (ocular movement)
  - EMG (muscle tone including limb movements)
  - ECG
  - SpO2
  - Video & audio monitoring (parasomnia activity)
  - Additional monitoring may include parameters such as CO2

#7485

"First we're going to run some tests to see how your insurance reacts."

Polysomnography

Home Sleep Apnea Testing

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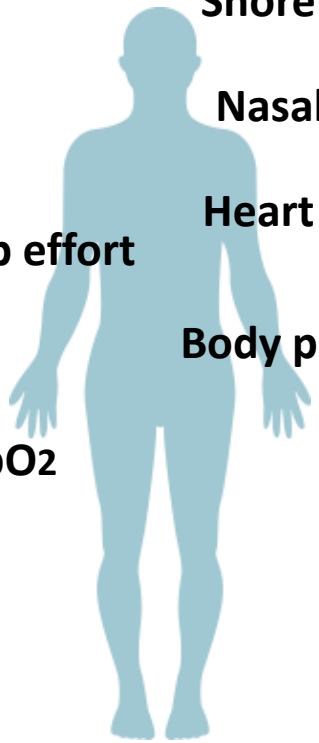
- Indicated to test for OSA in:
  - Uncomplicated patients with high pre-test probability
- Not Recommended for:
  - Significant cardiorespiratory disease
    - COPD, CHF, CVA
  - Risk for hypoventilation
    - neuromuscular, morbid obesity
  - Chronic opioid use
  - Severe insomnia

Kapur, JCSM Practice Guideline 2017

Most home testing looks like this



Snore

Nasal pressure/flow

Heart rate

Resp effort

Body position

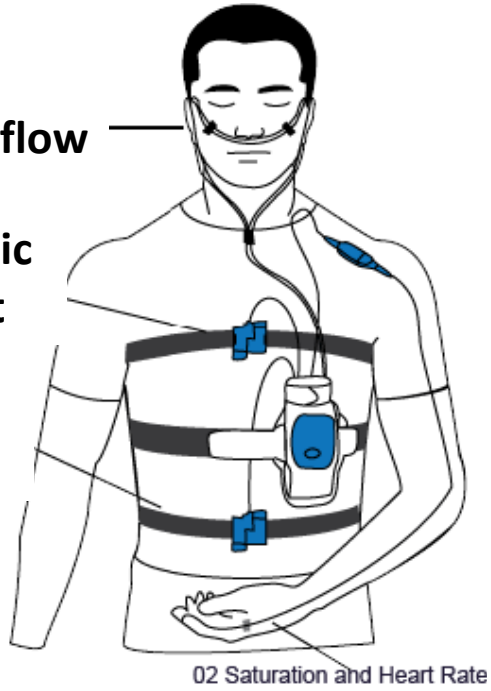
SpO2

No EEG! Sleep is not measured directly

Airflow

Thoracic effort

Abdo effort



SpO_2 & heart rate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Treatment of Obstructive Sleep Apnea

Treatment Objectives

- Reduce morbidity and mortality
  - Improve daytime somnolence and quality of life
  - Decrease cardiovascular, metabolic and other systemic consequences

Therapeutic Approach

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- Risk counseling for:
  - Motor vehicle crashes
  - Job-related hazards
  - Judgment impairment
- Apnea and co-morbidity treatment
  - Behavioral
  - Medical
  - Surgical

Behavioral Interventions

- Encourage patients to:
  - Lose weight (if overweight)
  - Exercise
  - Avoid alcohol and sedative-hypnotics
  - Avoid sleep deprivation
  - Avoid supine sleep position in susceptible patients
  - Stop smoking
  - Maintain clear nasal passages

Weight Loss and Exercise

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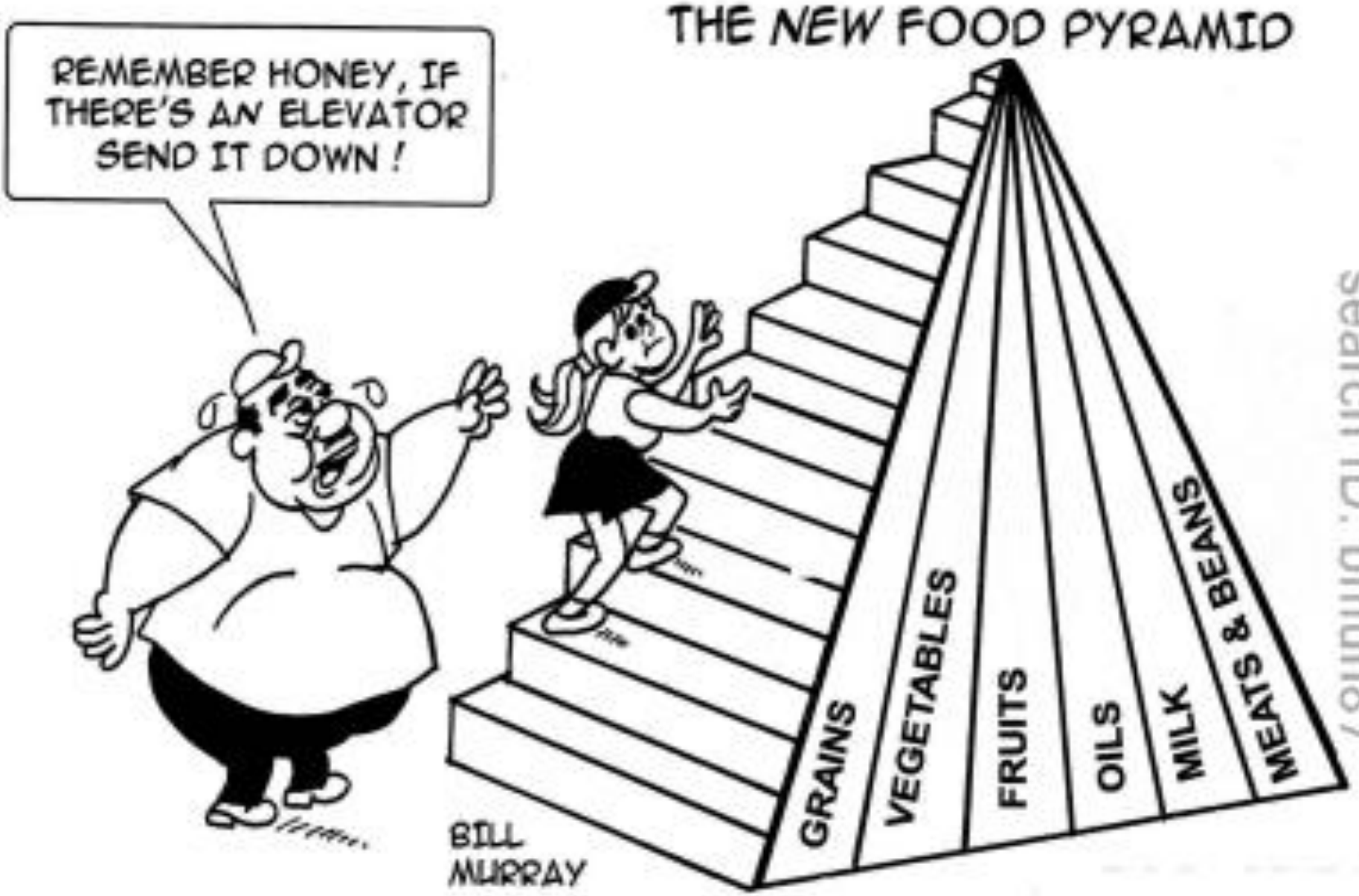
- ✗ WT loss Should be prescribed for all obese patients
- Can be curative but has low success rate
- ✓ Other treatment is required
  - Until optimal weight loss is achieved
  - And sleep apnea is proven to be resolved
- **Aerobic exercise attenuates OSA**



"The handle on your recliner does not qualify as an exercise machine."

Weight Loss and OSA

Medical Interventions

- Positive Airway Pressure (PAP)
  - Continuous Positive Airway Pressure (CPAP)
    - Fixed or auto-titrating
  - Bi-level Positive Airway Pressure
    - Multiple bi-level modalities exist. Common reasons for use in OSA include patient preference, aerophagia, pressure intolerance.
- Mandibular Repositioning Devices

Positive Airway Pressure

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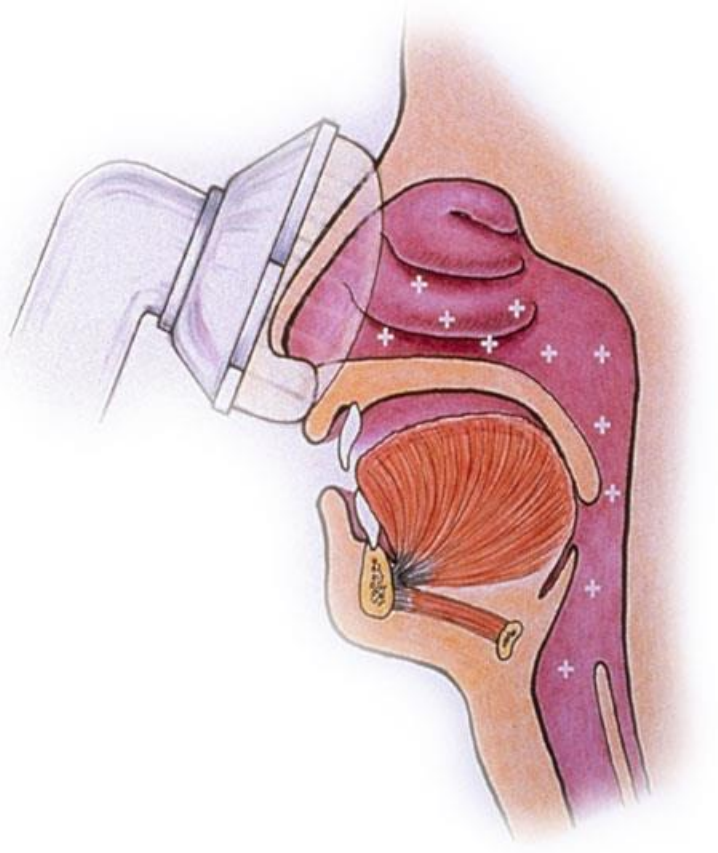

Overall Approach to SDB

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OSA	CPAP
	BiPAP
Central	Noninvasive Ventilation
	BiPAP
	ASV
Hypoventilation	BiPAP
	AVAPS

Positive Airway Pressure

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PAP Machine Basics

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PAP Interfaces

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Data Download Information

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Adherence

- **# of days used** (up to 365 nights)
  - Average and specific nights used/not used
- **# of hours used**
  - Average and for specific nights

Settings

- **Current** pressure settings
- Pressures actually **delivered**
  - Median / maximum values
- Current comfort settings

Efficacy

- Calculated **AHI** (apnea hypopnea index)
  - Overall and for specific days
- Amount of **mask leak**


Compliance Report
30 day compliance
Usage
Usage days
Usage hours
RX AutoSet
Therapy
Usage - hours
Adherence
Settings
Efficacy


Therapy Report
Usage
Leak
AHI
Nightly data

Adherence to PAP Therapy

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- Adherence to therapy in 1st several weeks is one of the greatest predictors of long-term adherence.
- Patients subjectively report: 75% use
- Objectively measured use $\geq$ 4 hrs: 17-71%
  - For comparison, compliance with asthma medications : 30%

Predictors of Poor PAP Adherence

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- Poor understanding of importance of therapy
- Concomitant use of medications or alcohol
- Lack of excessive daytime sleepiness
- Lack of perceived benefit
- Nasal obstruction
- Side effects
- Claustrophobia
- PTSD


Comfort

Strategies to Improve Adherence

- Patient Education
- Frequent and early follow-up
- Desensitization Therapy
- Equipment Optimization
  - Ensuring optimal interface, fit, absence of leak
  - Comfort settings including humidification, ramp, expiratory pressure relief

Benefits of CPAP: Sleepiness & Functional Outcomes

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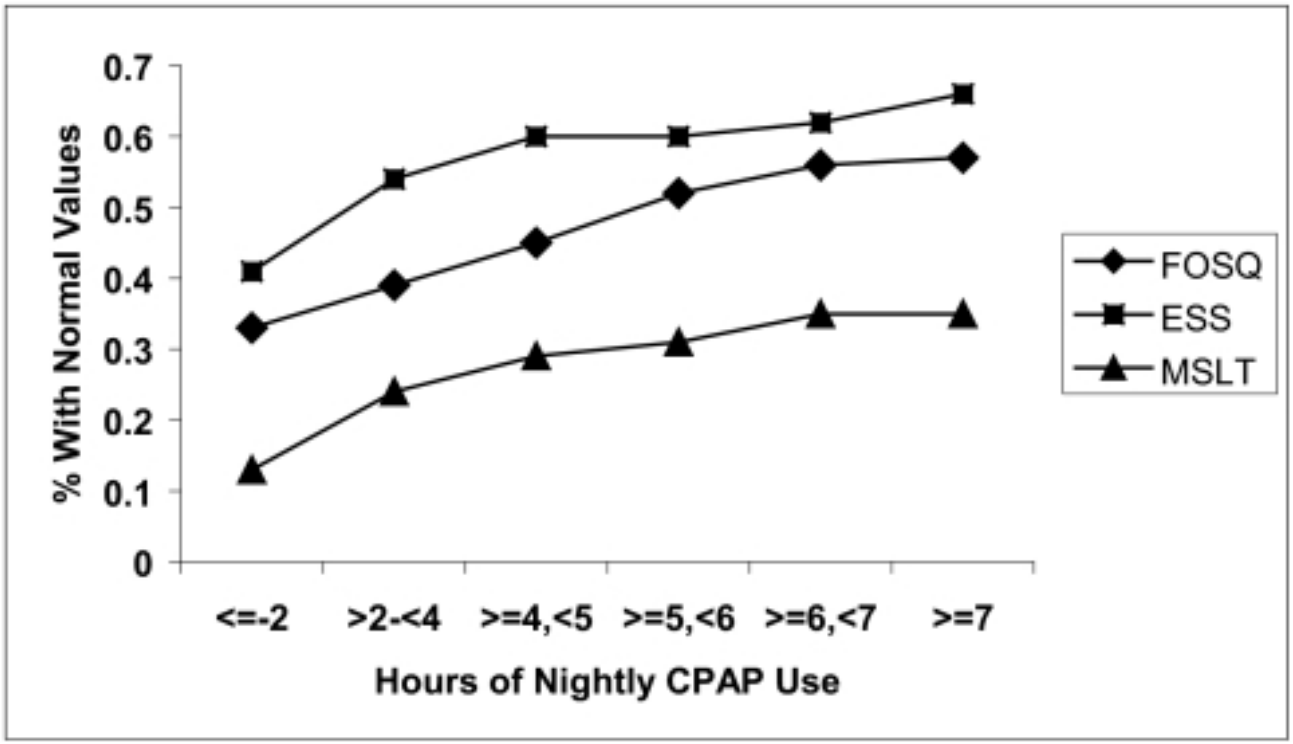


FOSQ = Functional Outcomes of Sleep Questionnaire
ESS = Epworth Sleepiness Scale
MSLT = Multiple Sleep Latency Test

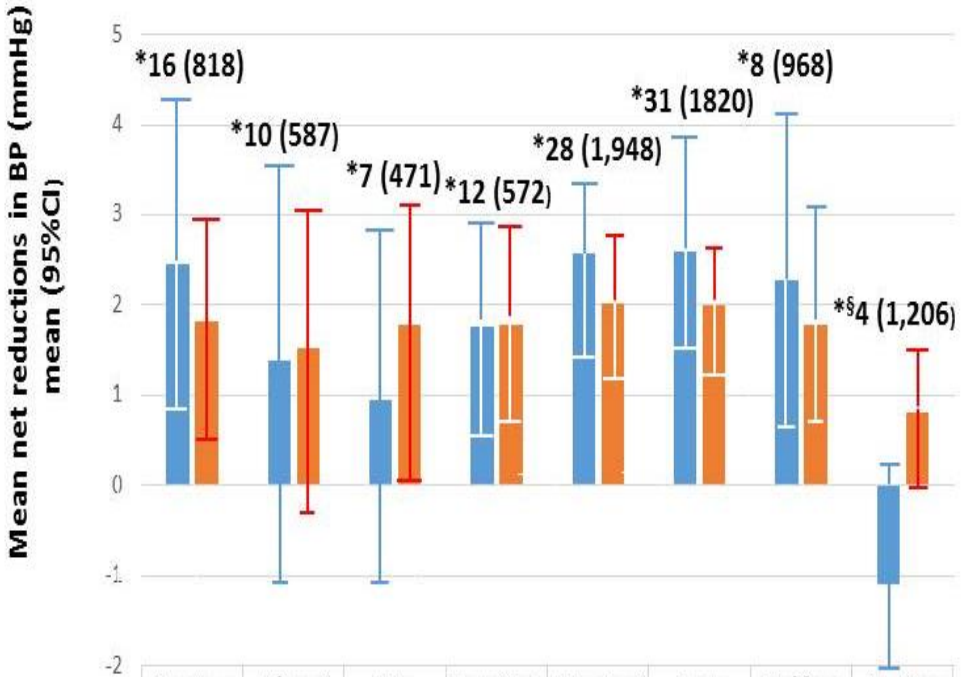
Weaver TE, et al. Sleep. 2007;30(6):715.

Effect of CPAP therapy on blood pressure in patients with simple hypertension

Summary of meta-analyses of RCTs. Positive figures mean improvement in BP with CPAP

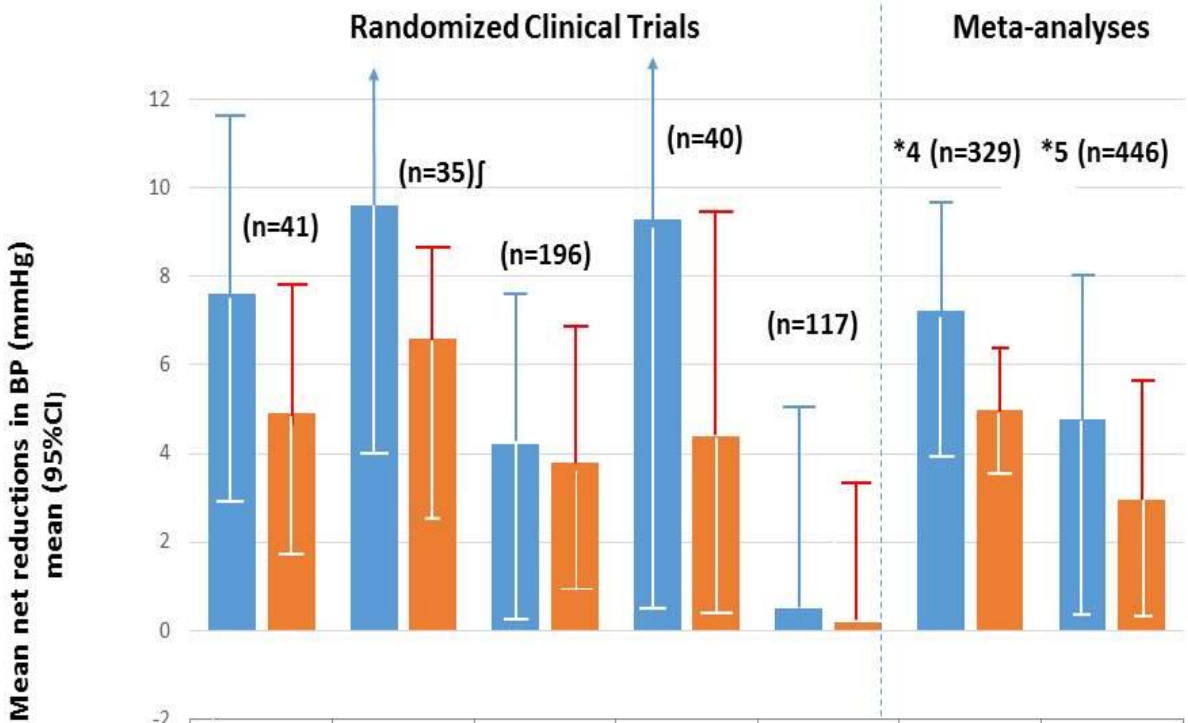
***Number of studies included; (number of patients included). Patients without EDS**

CI= confidence interval(Javaheri et al, JACC 2017)



	Bazzano (2007)	Aljami (2007)	Mo (2007)	Heantjens (2007)	Montesi (2012)	Fava (2014)	Bakker (2014)	Bratton (2014)
24h-SBP	2,46	1,38	0,95	1,77	2,58	2,6	2,27	-1,1
24h-DBP	1,83	1,52	1,78	1,79	2,01	2	1,78	0,8

Effect of CPAP therapy on blood pressure in patients with resistant hypertension in 5 randomized controlled trials and 2 meta-analyses (Javaheri et al, JACC 2017)



	Lozano (2010)	Pedrosa (2013)	Martinez-Garcia (2014)	De Oliveira (2014)	Muxfeldt (2015)	Iftikhar (2014)	Liu (2015)
24h-SBP	7,6	9,6	4,2	9,3	0,5	7,21	4,78
24h-DBP	4,9	6,6	3,8	4,4	0,2	4,99	2,95

Effects of CPAP on pulmonary hypertension

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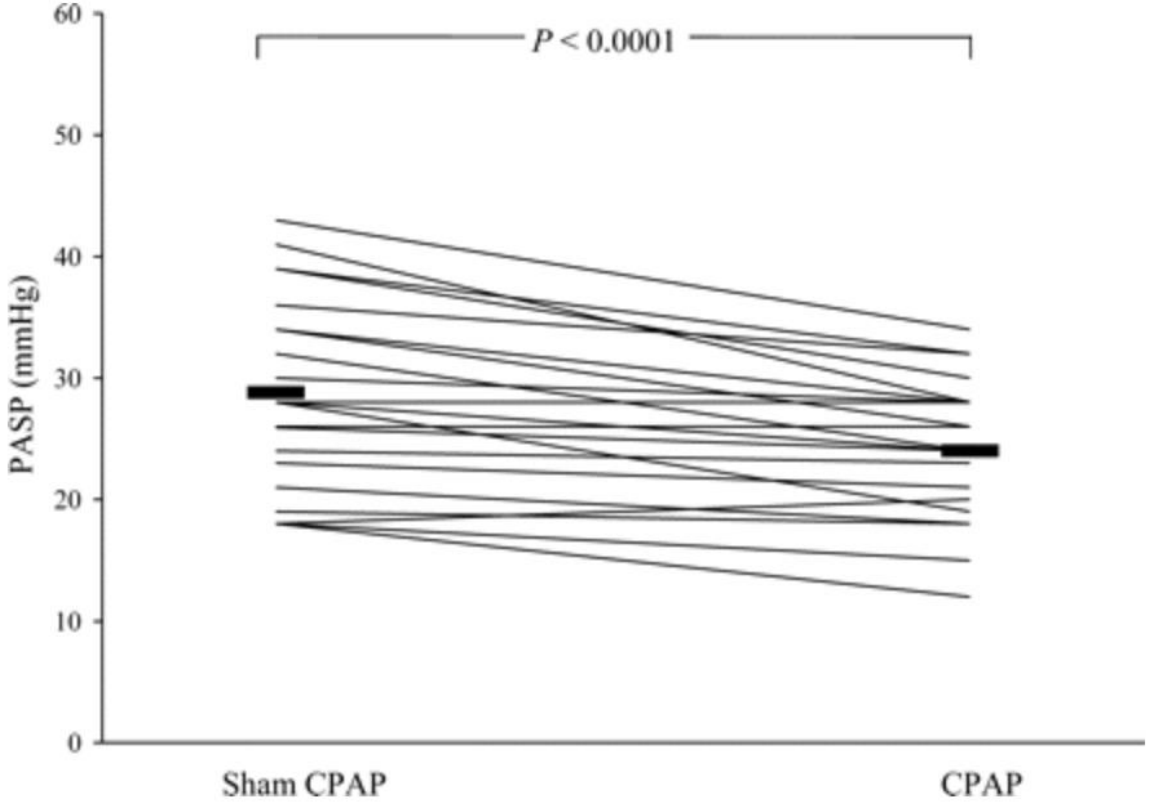

Arias, *Eur Heart J* 2006; 27: 1106-13

Effects of CPAP on Cardiac Death, MI and Stroke

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- Positive effects of CPAP in observational studies
- No significant effect in randomized controlled trials when analyzed on an intention-to-treat basis.
- When only CPAP compliant patients were analyzed, positive effects of CPAP were seen.

Barbe, JAMA 2012; 307: 2161-7
Peker, Am J Respir Crit Care Med 2016; 194:613-20
McEvoy, NEJM 2016; 375: 919-31

Effects of CPAP in Heart Failure

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- CPAP reduces vascular and myocardial sympathetic activity
- CPAP improves diastolic dysfunction
- Treatment of OSA is associated with reduced readmission rate, health cost and mortality

Usui, JACC 2005; 45: 2008-11
Hall, Circulation 2014; 130:892-901
Javaheri, Am J Respir Crit Care Med 2011; 183: 539-46

Bi-Level: Indications for Use

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- **OSA** patients with:
  - Intolerance of CPAP pressures
  - Hypoxemia despite resp. event control
  - Elevated CO2 levels despite resp. event control

- **Hypoventilation syndrome**
- **Complex or Central Sleep Apnea**

Bi-Level

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- Provides independently set pressures called IPAP and EPAP to maintain airway stability and support ventilation requirements while the patient sleeps
  - IPAP
  - EPAP

Bi-Level Terminology

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- Rise Time = the time it takes for BiPAP to change from EPAP to IPAP. You can adjust for patient comfort.

- Tidal Volume -Vt

Bi-Level S (spontaneous mode) indications outside of OSA

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- Can be used with the following patients:
  - Obesity hypoventilation
  - Neuromuscular weakness disorders
  - Restrictive thoracic disease
  - Obstructive lung disease

Bi-Level S (spontaneous mode)

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- Used with patients who are able to maintain a constant respiratory rate, but require an IPAP:EPAP pressure difference to augment tidal volume while you sleep

Bi-Level S/T (timed back up rate)

- This mode is used with patients that require:
  - Time rate from the device to support their inconsistent respiratory pattern (more common in NM disease)

Bi-Level S/T (timed back up rate)

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- Pressure support to augment their tidal volume when the device provides a breath to the patient
- Patient has the ability to spontaneously initiate breaths or tolerate timed back up breaths from the device.

Titration for Control of Apnea

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- Increase (**EPAP)** to control obstructive apnea
- Increase **(IPAP)** (maintaining 4-8 cm difference from EPAP) to control **hypopneas and snoring.**
- **Difference between the pressures is usually maintained between 4-8 cm**

Central apneas → may attempt a back up rate

Titration of Bi-Level for Persistent Hypoxemia in OSA

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- Titration Bi-Level to pressures appropriate for control of apnea, hypopnea and snoring
- If hypoxemia persists, to augment tidal volume increase IPAP in increments in an attempt to improve O2 saturation

Titration of Bi-Level for Persistent Hypoxemia in OSA

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- If such increases in pressure support does not benefit sats or increases not tolerated, add supplemental O2 as needed to maintain stats ≥ 89-90%

NOT ALL HYPOXEMIA IS OBSTRUCTIVE HYPOVENTILATION

Titration of Bi-Level for Control of Hypoventilation

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1. Transcutaneous (TCCO2) or End-Tidal CO2 (ETCO2) monitoring.
2. *Excessive **leakage must be prevented.***

3. Initiate Bi-Level at pressure **previously demonstrated as effective to control obstructive apnea.** Initiate **IPAP at (EPAP +6**cm).
4. Increase EPAP only until obstructive events are controlled.

- **Increase EPAP --increase IPAP same**
- ***Want lowest possible EPAP**

Titration of Bi-Level for control of hypoventilation (cont'd)

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5. Increase IPAP (as tolerated) until the following parameters are achieved:

    a. TcCO2 < 50 mm (**or** RR 2-4 BPM < baseline wake RR)

    b. Minimal hypopneas

    c. Improvement in O2 sat if > 89%

Mandibular Repositioning Devices

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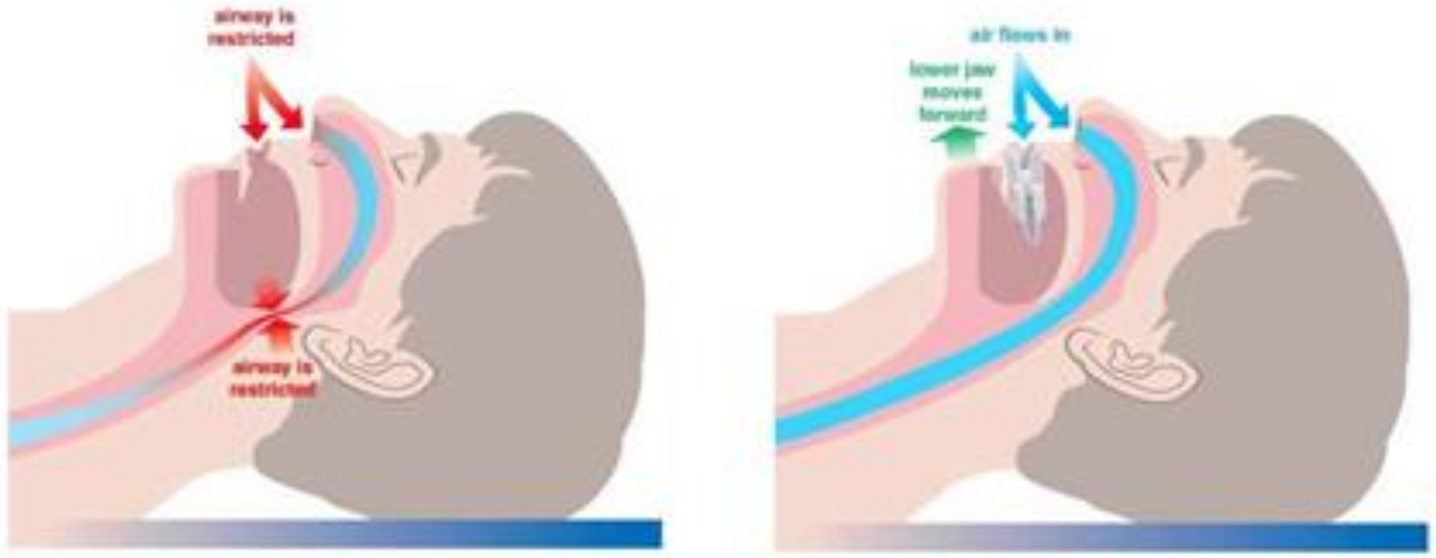
Without MRD airway is collapsed	With MRD mandible is pulled anterior and airway is open



Images from http://www.topsnoringmouthpieces.com

SPECIAL ARTICLES

JCSM
Journal of Clinical Sleep Medicine

pii: jc-00186-15
http://dx.doi.org/10.5664/jcsm.4858

Clinical Practice Guideline for the Treatment of Obstructive Sleep Apnea and Snoring with Oral Appliance Therapy: An Update for 2015

An American Academy of Sleep Medicine and American Academy of Dental Sleep Medicine Clinical Practice Guideline

Kannan Ramar, MBBS, MD[1]; Leslie C. Dort, DDS[2]; Sheri G. Katz, DDS[3]; Christopher J. Lettieri, MD[4]; Christopher G. Harrod, MS[5]; Sherene M. Thomas, PhD[5]; Ronald D. Chervin, MD[6]

Table 5—Summary of recommendation statements.

Recommendation Statement	Strength of Recommendation	Quality of Evidence	Benefits versus Harms: Burdens Assessment
The Use of Oral Appliances for Treatment of Primary Snoring in Adults			
We recommend that sleep physicians prescribe oral appliances, rather than no therapy, for adult patients who request treatment of primary snoring (without obstructive sleep apnea).	STANDARD	High	Benefits clearly outweigh harms
The Use of Oral Appliances for Treatment of Obstructive Sleep Apnea in Adults			
When oral appliance therapy is prescribed by a sleep physician for an adult patient with obstructive sleep apnea, we suggest that a qualified dentist use a custom, titratable appliance over non-custom oral devices.	GUIDELINE	Low	Benefits clearly outweigh harms
We recommend that sleep physicians consider prescription of oral appliances, rather than no treatment, for adult patients with obstructive sleep apnea who are intolerant of CPAP therapy or prefer alternate therapy.	STANDARD	Moderate	Benefits clearly outweigh harms
We suggest that qualified dentists provide oversight—rather than no follow-up—of oral appliance therapy in adult patients with obstructive sleep apnea, to survey for dental-related side effects or occlusal changes and reduce their incidence.	GUIDELINE	Low	Benefits clearly outweigh harms
We suggest that sleep physicians conduct follow-up sleep testing to improve or confirm treatment efficacy, rather than conduct follow-up without sleep testing, for patients fitted with oral appliances.	GUIDELINE	Low	Benefits clearly outweigh harms
We suggest that sleep physicians and qualified dentists instruct adult patients treated with oral appliances for obstructive sleep apnea to return for periodic office visits—as opposed to no follow-up—with a qualified dentist and a sleep physician.	GUIDELINE	Low	Benefits clearly outweigh harms

MRD Predictors of Effectiveness

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- Lower initial AHI
- Lower age
- Lower BMI
- Supine-dependent OSA
- Certain cephalometric variables such as shorter soft palate or decreased distance between the mandibular plane and the hyoid bone
- Low nasal resistance

Takaesu, JCSM; 2016
Ramar; Journal Dental Sleep Med; 2015
Eriksson; Sleep Breath; 2015
Ferguson; Sleep; 2006

MRD Contradictions

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- Insufficient number of teeth to hold device
- Untreated periodontal disease or tooth mobility
- Active TMJ disorder
- Limited maximum protrusive distance (<6 mm)
- Significant bruxism (teeth grinding)

Petit; Am J Respir Crit Care Med; 2002
Ferguson; Sleep; 2006

Oral Appliance: Mechanics

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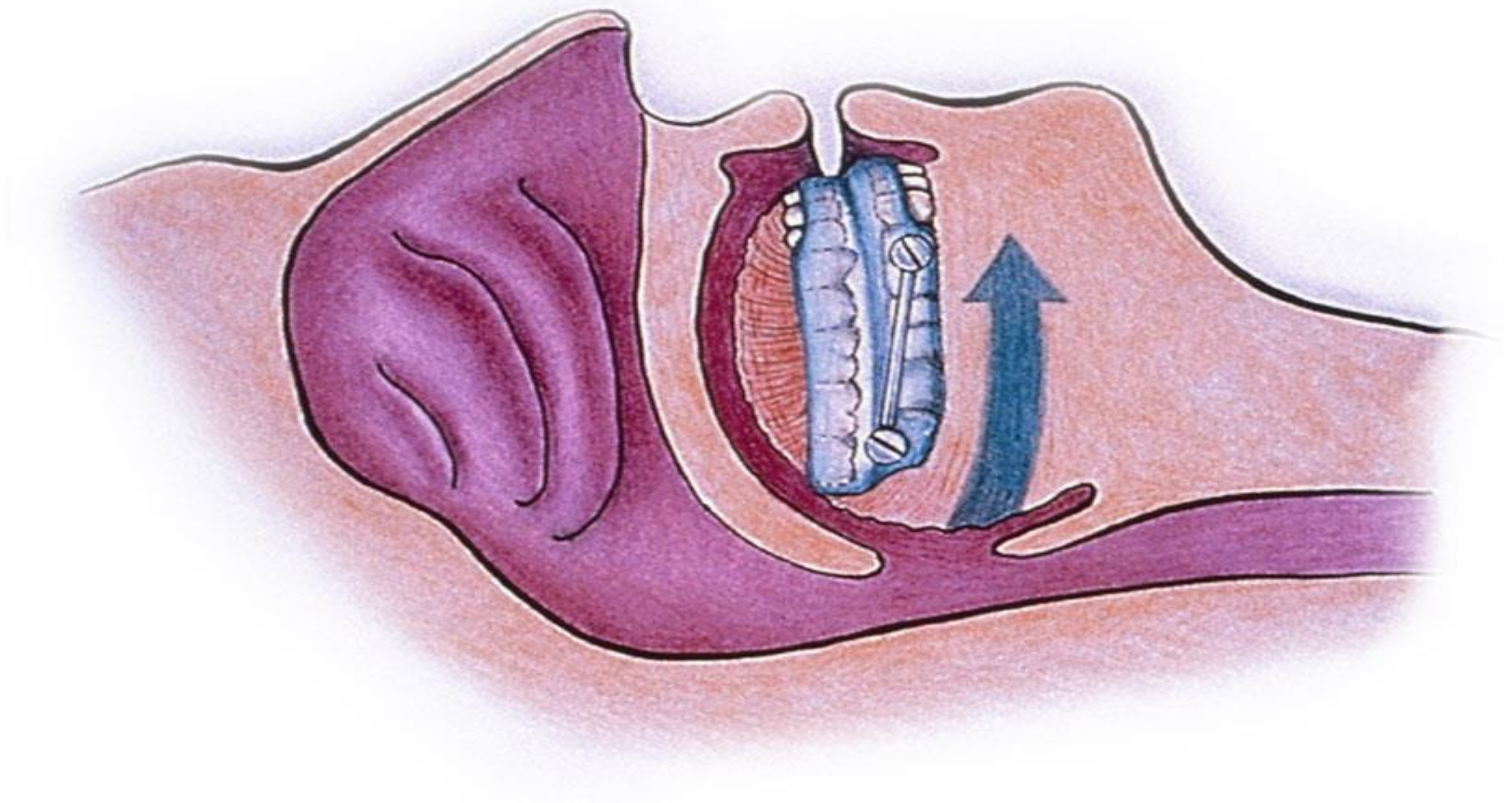

Thornton Adjustable Positioner (TAP)

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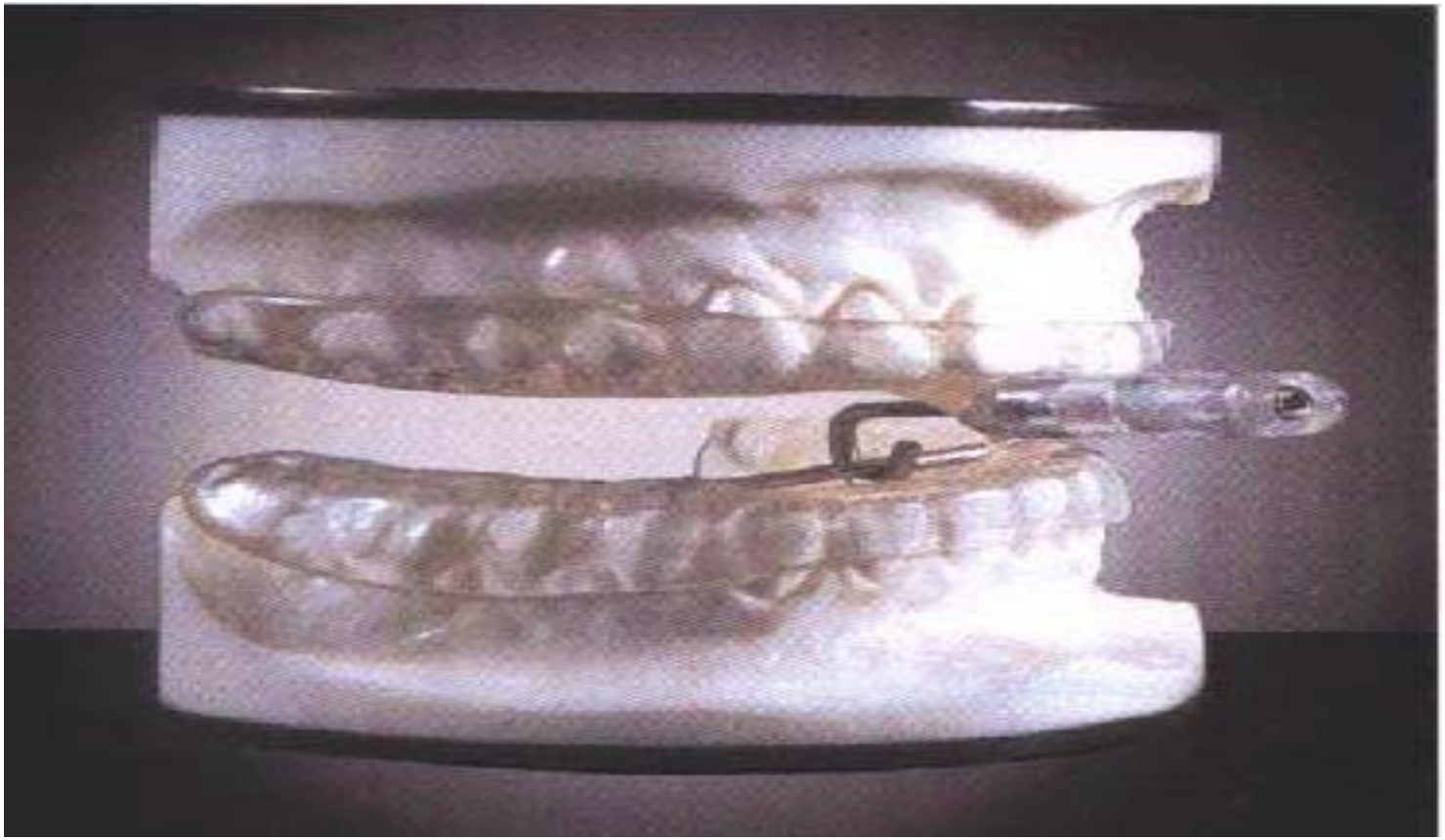

Positional Therapy

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"An effective secondary therapy or supplement to primary therapies for OSA in patients who have a lower AHI in the non-supine versus that in the supine position." (Guideline)

Morgenthaler; AASM Practice parameters; SLEEP 2006

- Patients more likely to have supine dependent OSA are typically:
  - Younger
  - Less obese
  - Have less severe OSA

Does sleeping on your back put you in a tough position?

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- Positional Obstructive Sleep Apnea (POSA) is different from other types of OSA—it is a specific condition in which the bast majority of symptoms occur when you sleep on your back. According to a recent clinical study, exclusive POSA was present in between 36% and 47% of OSA patients.

- If you have POSA, you can manage the position you sleep in which may help to decrease your POSA symptoms.

- What treatment will position you to be at your best?

Sleep-Position Training

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Positional Retraining Devices- Parker's Snore relief cushion

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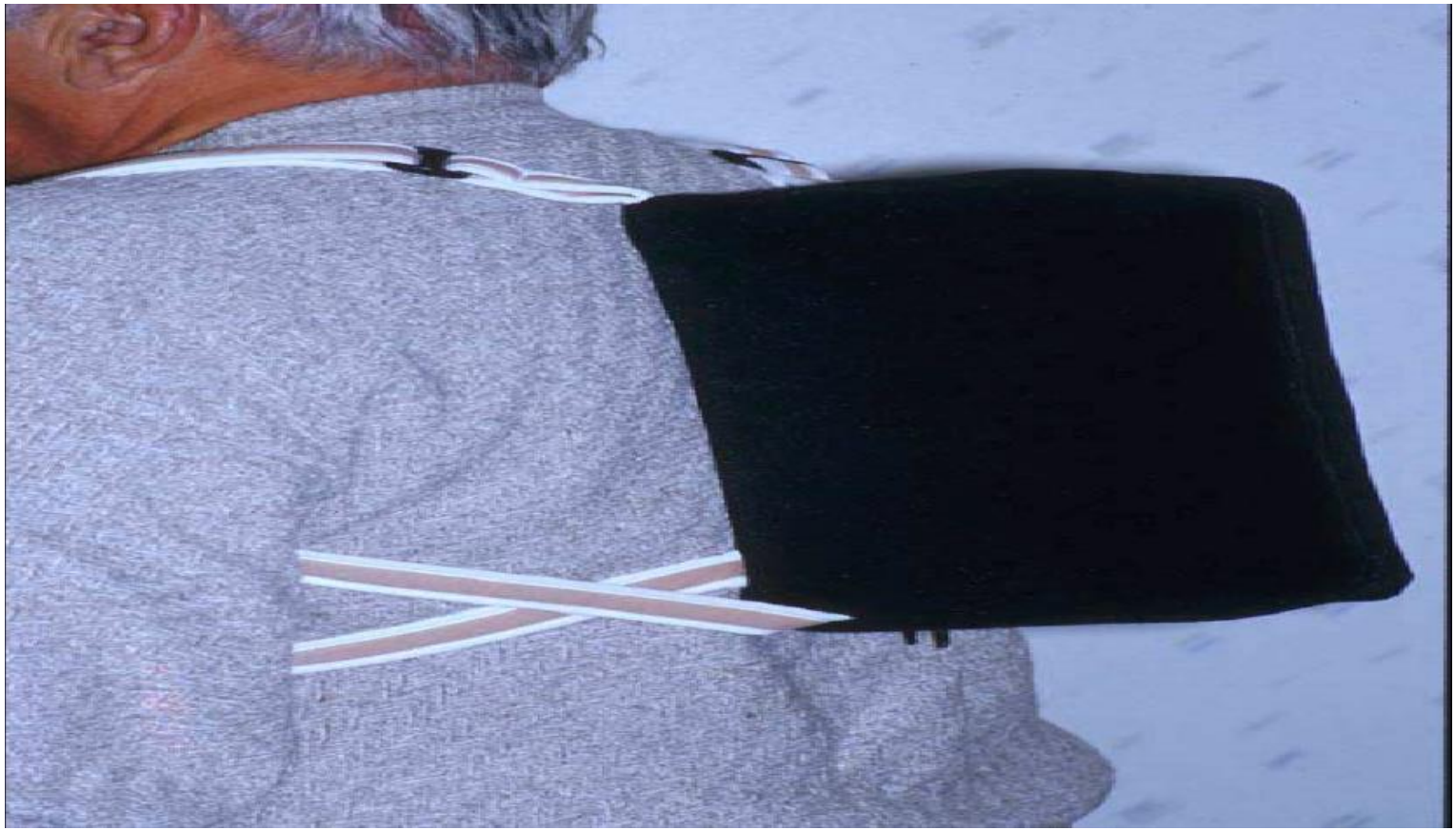

NightBalance Lunoa by Philips

A simple sleep solution for patients with positional obstructive sleep apnea.

Low vibration sleep therapy belt

Learn More

Surgical Therapy for OSA

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Surgery Type	Purpose	Examples
Adjunctive	Facilitate PAP or MRD adherence	Turbinate reduction, polypectomy, septoplasty,
Salvage	In place of PAP or MRD	Palatal/lingual radiofrequency ablation, UPPP, Lingual advancement, maxillo/mandibular advancement, tracheostomy, hypoglossal nerve stimulation

Uvulopalatopharyngoplasty (UPPP)

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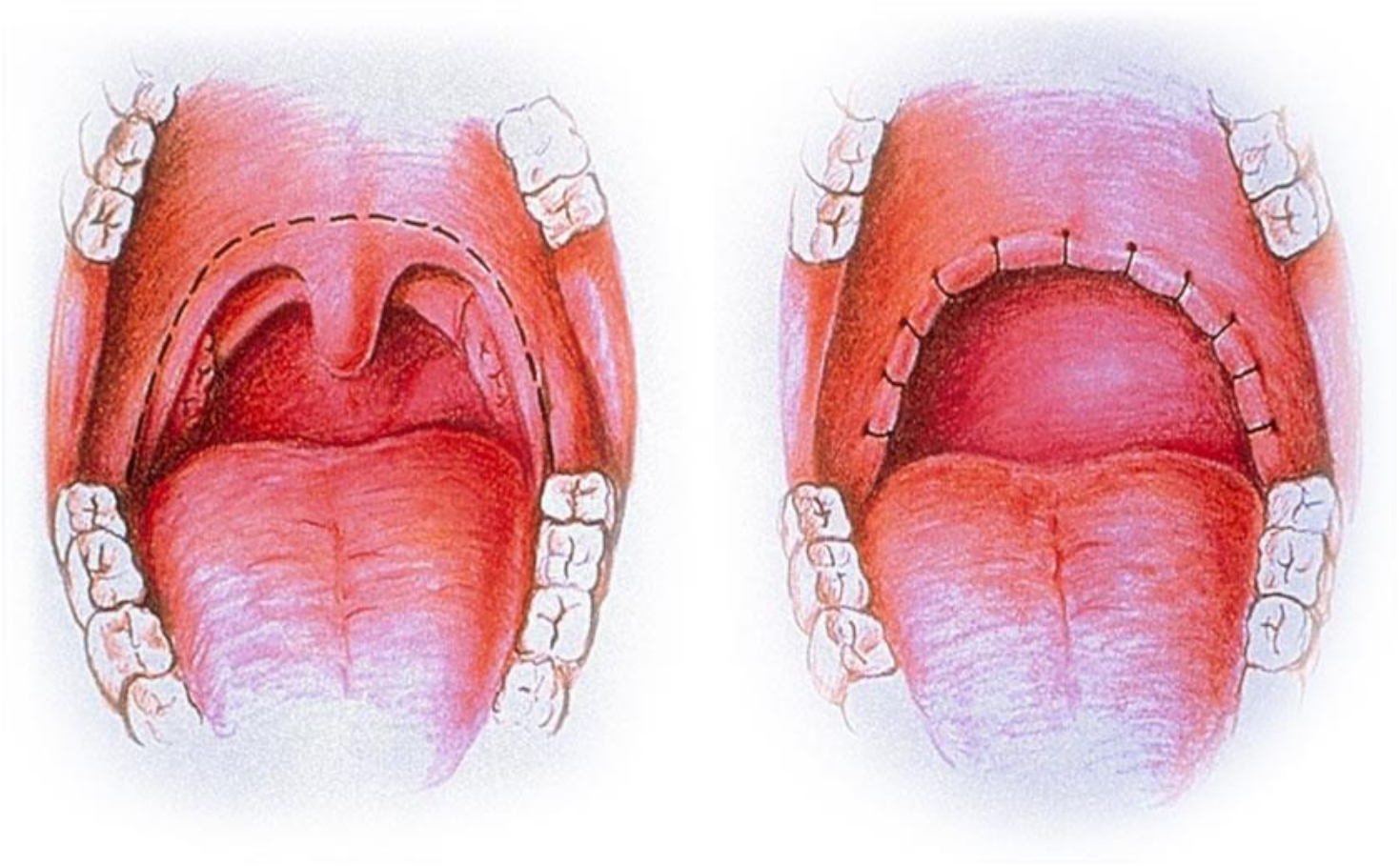

Laser-Assisted Uvulopalatopharyngoplasty (LAUP)

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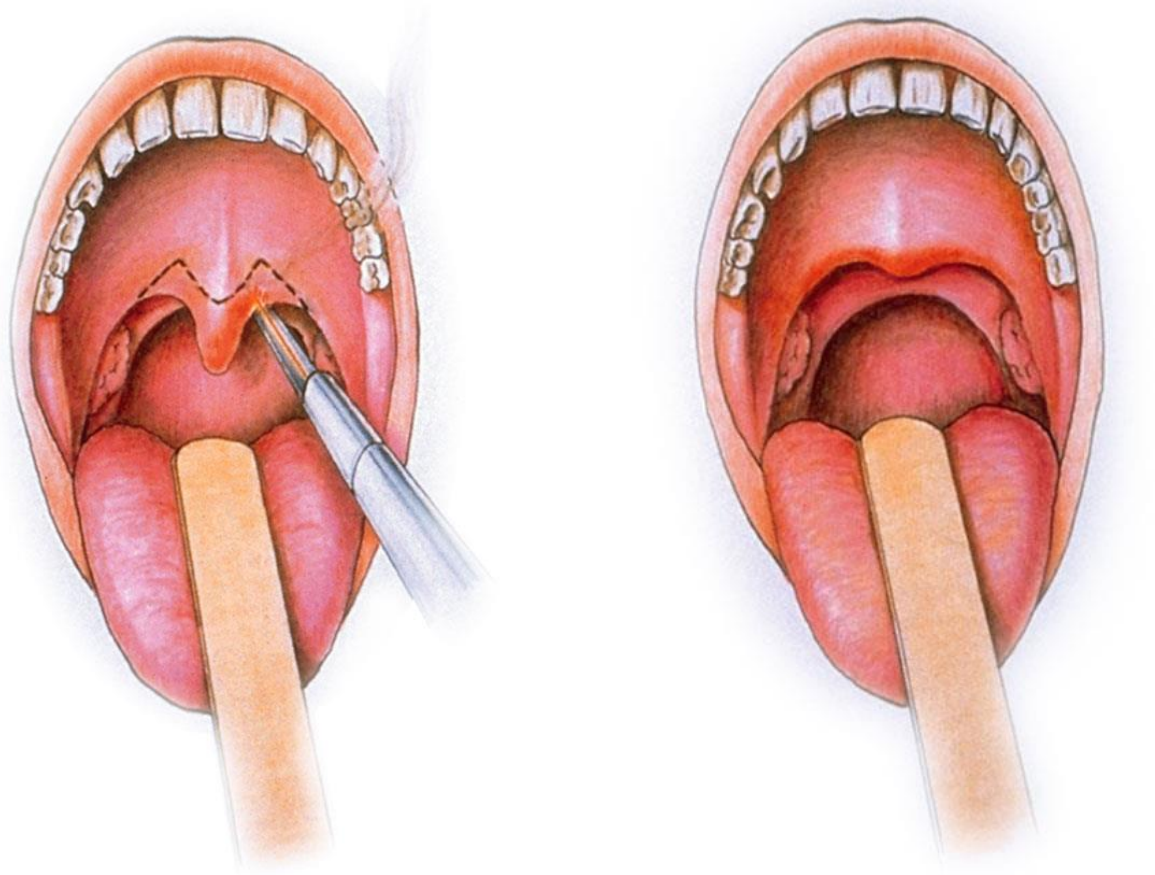

Surgical Management- MMA

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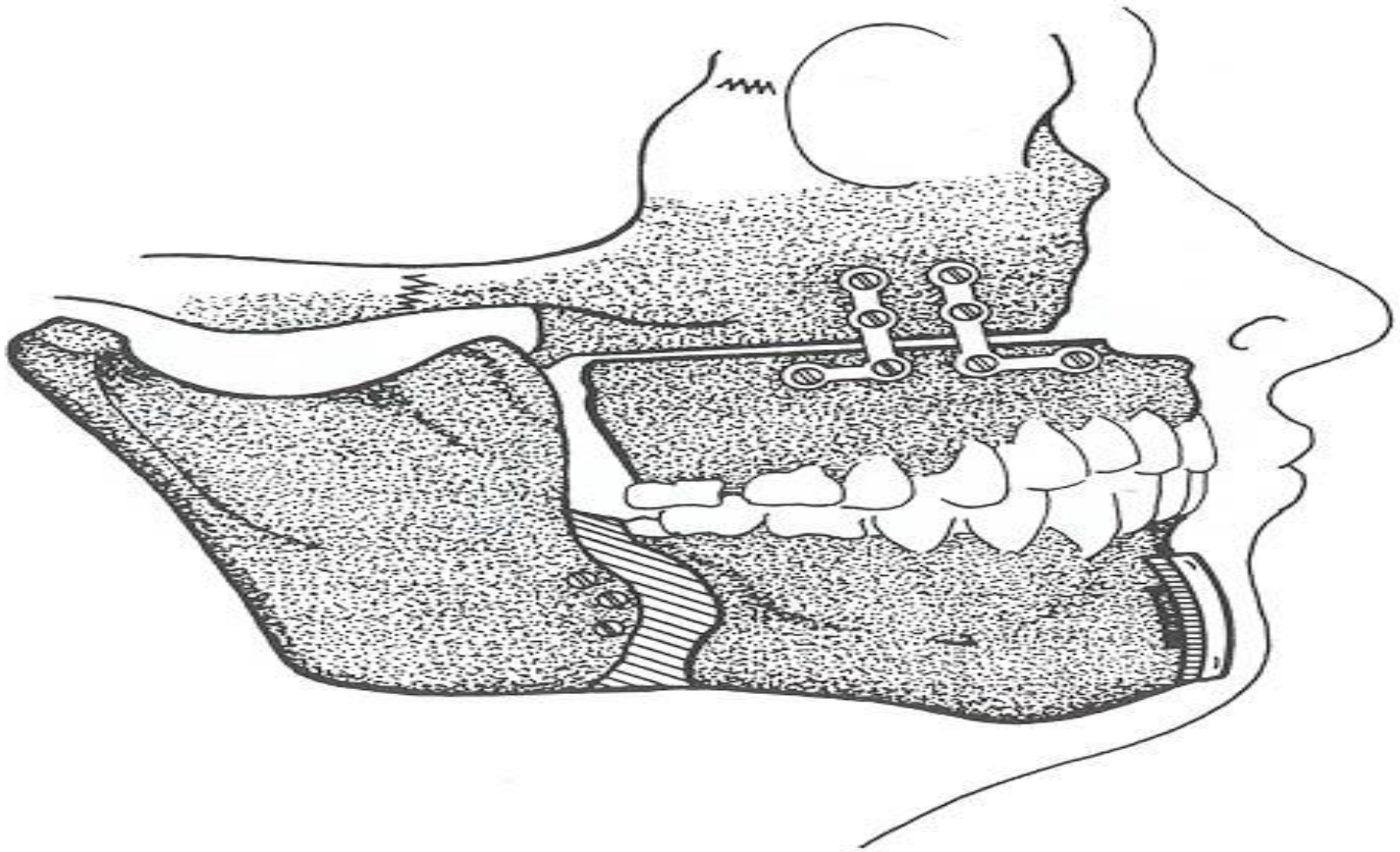

SLEEP, Vol. 33, No. 10, 2010

Practice Parameters for the Surgical Modifications of the Upper Airway for Obstructive Sleep Apnea in Adults

R. Nisha Aurora, MD[1]; Kenneth R. Casey, MD[2]; David Kristo, MD[3]; Sanford Auerbach, MD[4]; Sabin R. Bista, MD[5]; Susmita Chowdhuri, MD[6]; Anoop Karippot, MD[7]; Carin Lamm, MD[8]; Kannan Ramar, MD[9]; Rochelle Zak, MD[10]; Timothy I. Morgenthaler, MD[9]

4.3.6 Radiofrequency ablation (RFA): RFA can be considered as a treatment in patients with mild to moderate obstructive sleep apnea who cannot tolerate or who are unwilling to adhere to positive airway pressure therapy, or in whom oral appliances have been considered and found ineffective or undesirable [Review Section 3.4.1; 3.4.2; 3.4.3; 3.4.4; Figure 8, 9] (Option).

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4.3.3 Uvulopalatopharyngoplasty (UPPP) as a single surgical procedure: UPPP as a sole procedure, with or without tonsillectomy, does not reliably normalize the AHI when treating moderate to severe obstructive sleep apnea syndrome. Therefore, patients with severe OSA should initially be offered positive airway pressure therapy, while those with moderate OSA should initially be offered either PAP therapy or oral appliances. [Review Section 3.2.1; 3.2.2; Figure 4, 5; Table 2] (Option).

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4.3.2 Maxillo-Mandibular Advancement (MMA): MMA is indicated for surgical treatment of severe OSA in patients who cannot tolerate or who are unwilling to adhere to positive airway pressure therapy, or in whom oral appliances, which are more often appropriate in mild and moderate OSA patients, have been considered and found ineffective or undesirable [Review Section 3.1; Figure 2, 3] (Option).

SLEEP, Vol. 33, No. 10, 2010

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4.3.1 Tracheostomy: Tracheostomy has been shown to be an effective single intervention to treat obstructive sleep apnea. This operation should be considered only when other options do not exist, have failed, are refused, or when this operation is deemed necessary by clinical urgency (Option).

Upper Airway Stimulation

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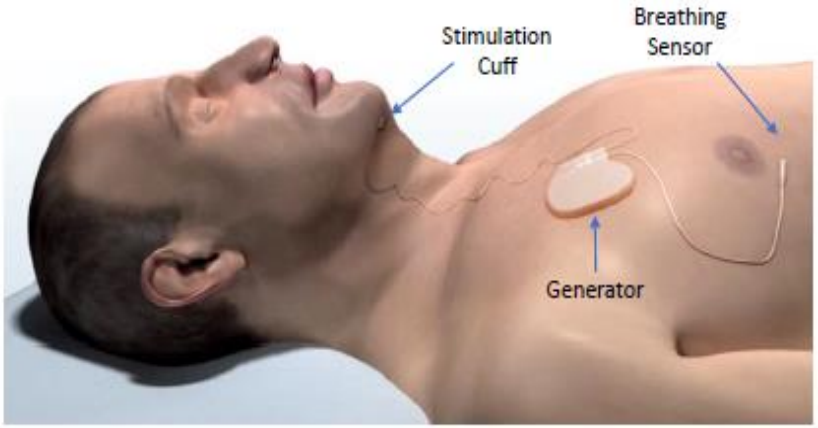
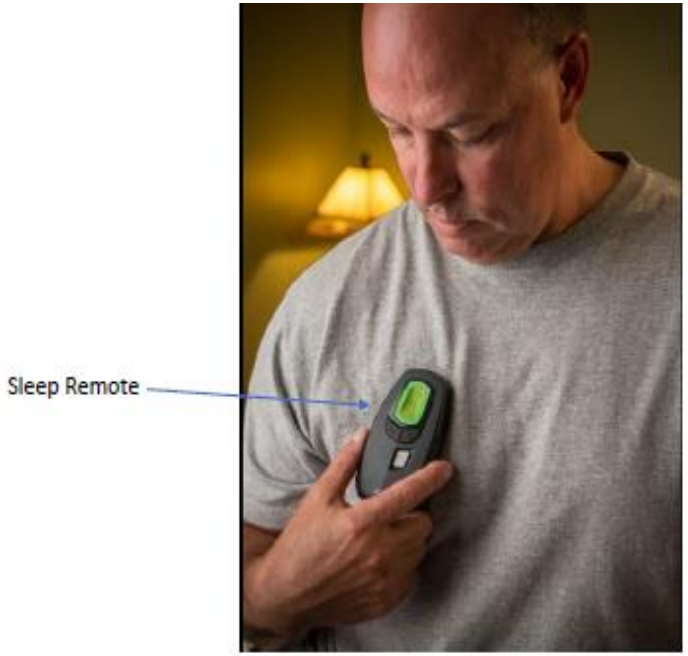


- Safe outpatient procedure – 3 skin incisions
- Fast recovery; over-the-counter pain meds typical
- MRI conditional labeling
- ~11 year battery longevity



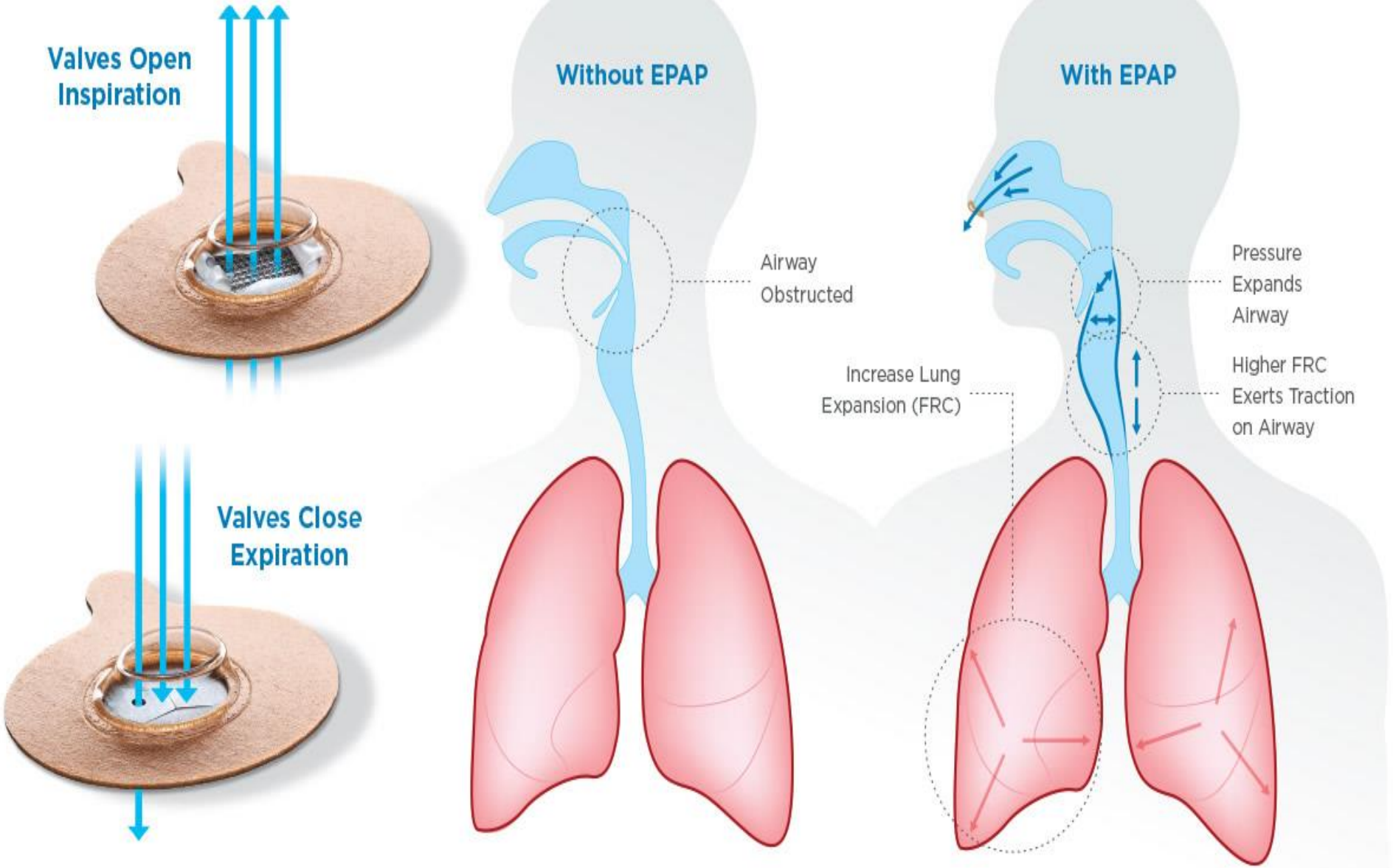
- Adjustable
- Titratable
- Daily adherence monitoring

Nasal EPAP-Long-Term Use of a Nasal Expiratory Positive Airway Pressure (EPAP) Device as a Treatment for Obstructive Sleep Apnea (OSA)

- Provent nasal strips

Single use valves are inserted into each nostril and sealed with adhesive.

- Bongo device-nasal dilators


Valves Open
Inspiration
Valves Close
Expiration
Without EPAP
Airway
Obstructed
With EPAP
Pressure
Expands
Airway
Increase Lung
Expansion (FRC)
Higher FRC
Exerts Traction
on Airway

Obstructive Sleep Apnea is:

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- Common
- Impacts long-term health
- Easily recognizable
- Treatable

Complex Sleep Apnea- TECA- Treatment emergent CSA

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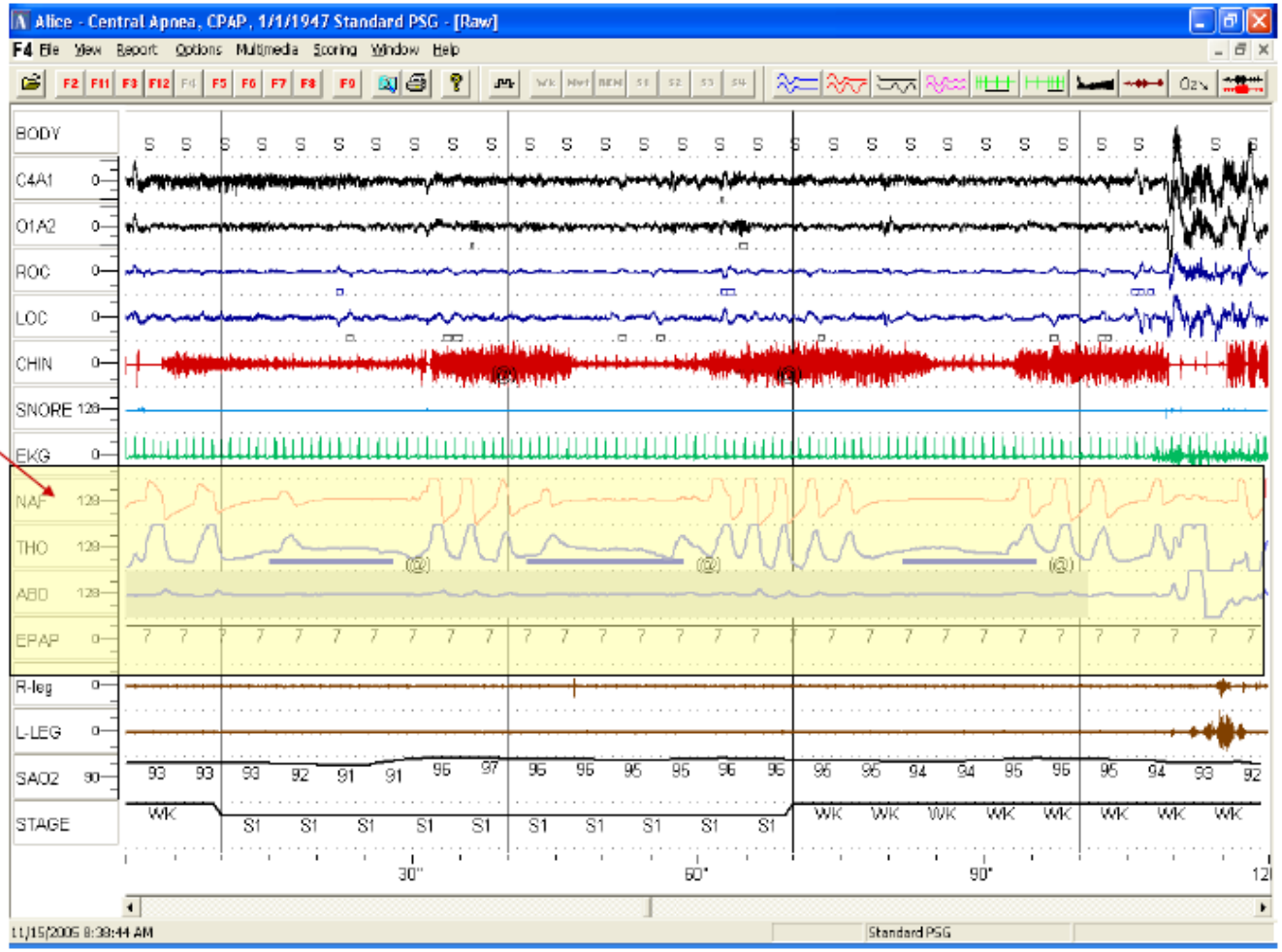
- OSA which converts to central apnea with CPAP application
  - Typically emerges during titration
  - Not obvious during diagnostic PSG
  - Often occurs at ~30 second intervals v. 60-90 second intervals with CSR
- Minimal data available
  - Estimated prevalence /7 or ~15% of the SDB population

Central apnea emerges on patient with OSA and CPAP therapy on 7 cm H_2O (seen with highlighted area)



The change of the RR changes CO2

Brain reads the change in CO2 as “hyperventilation”

Represents as central apneas during the CPAP titration

Central apnea results in rising CO2 levels and re-establishes drive to breathe

Complex Sleep Apnea- Treatment Emergent CSA

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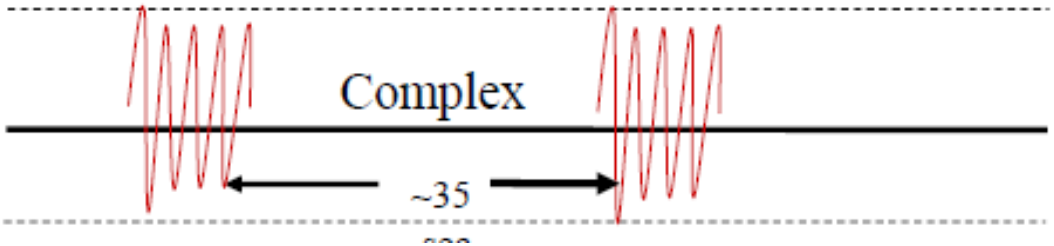
Due to a combination of upper airway resistance and abnormal 1,2

Often a temporary abnormality of ventilator control

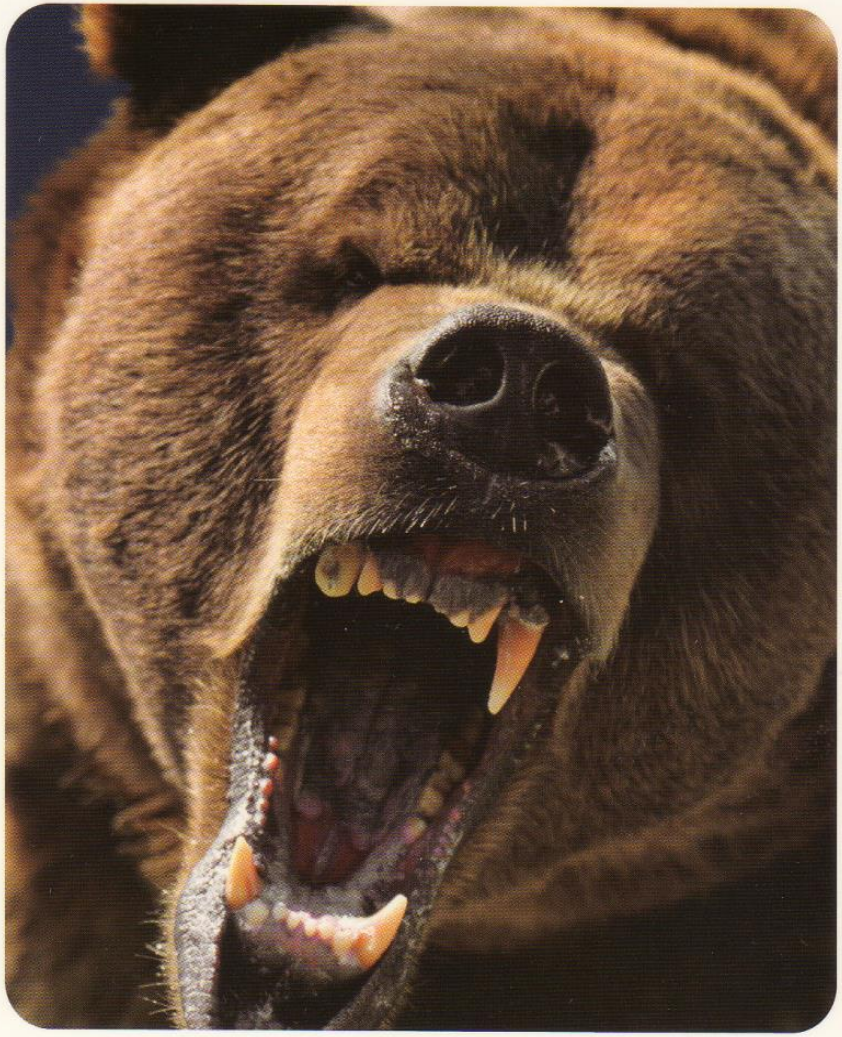


OSA eliminated with CPAP → allows for normal RR

Chemoreceptor issues are unmasked when OSA is eliminated

Life is not measured by the breaths we take but by the moments that take our breath away

Maya Angelou



4:00 am

5:42 am

An extra 1 hour and 42 minutes of sleep makes a big difference.