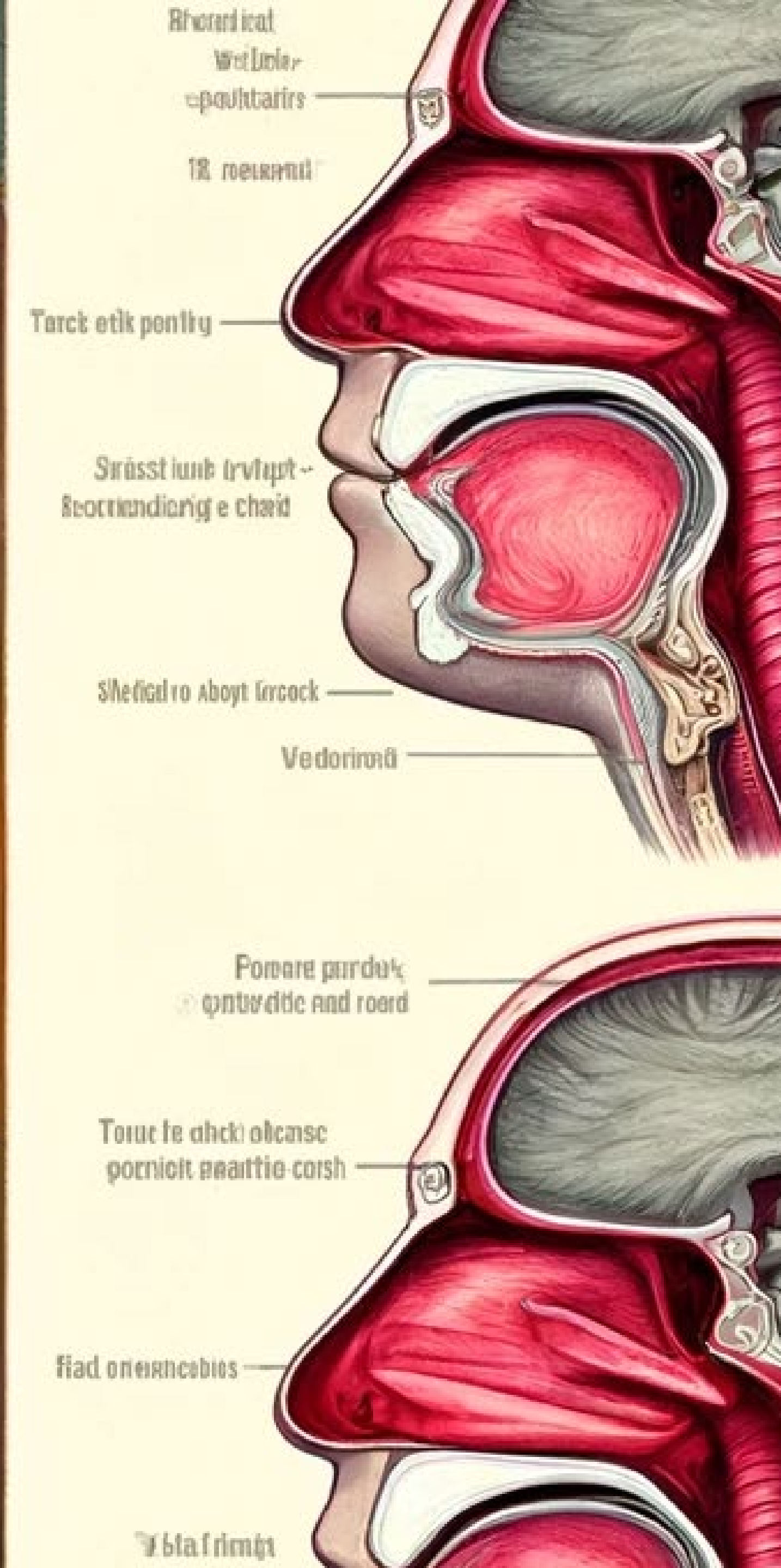


# OBSTRUCTIVE SLEEP APNEA

Juan Cuebas, MD  
Director, Erlanger Sleep



# OSA-OBJECTIVES

- Define obstructive sleep apnea
- Discuss consequences
- Discuss diagnosis and limitations
- Discuss when and how to treat
- Discuss when NOT to treat

# Why do we sleep

*“I love to sleep, my life has a tendency to fall apart when I’m awake”*

*Ernest Hemingway*

- Memory consolidation
- Prepare brain for new learning
- Blood pressure homeostasis
- Restore immune function
- Emotional restoration

# Epidemiology

- **Estimated 22 million Americans**
- **Prevalence of 9-38% in adults, more common in men**
- **Incidence of 4-5% in men and 2-3% in women in clinic settings**
- **Prevalence in U.S children: 1-5%**
- **African Americans and Hispanics >Whites**
- **African Americas 3.5 times more likely**

[Kapur VK, Auckley DH, Chowdhuri S, et al. J Clin Sleep Med. 2017 Mar 15;13\(3\):479-504.](#)

[Young T, Evans L, Finn L, Palta M. Sleep. 1997 Sep;20\(9\):705-6.](#)

[Heinzer R, Vat S, Marques-Vidal P, et al. Lancet Respir Med. 2015 Apr;3\(4\):310-8.](#)

[American Academy of Sleep Medicine. "Obstructive sleep apnea: Overview of epidemiology and clinical features." Updated 2019.](#)

# Conditions associated with OSA

- Hypertension
- Coronary artery disease
- Cardiac Arrhythmias
- CHF/PHTN
- Nocturnal sudden death
- Attention Deficit Disorder
- Obesity
- Stroke
- GERD
- Depression
- Diabetes
- MCI or Dementia

# OSA Prevalence in Cardiovascular and Cerebrovascular disease

- Atrial Fibrillation-70% (range (21-90%))
- Stroke-50-70%
- Congestive Heart Failure-20 to 60%
- Acute Coronary Syndrome-36-63%

BMC Geriatrics volume 22, Article number: 204 (2022)

Neurol Clin Pract. 2013 Jun; 3(3): 192–201

J Clin Med. 2022 Jun; 11(12): 3458

European Respiratory Journal 2023 61: 2201110



# Motor Vehicle Accidents

- Mild sleep apnea (AHI 5 to <15):  
relative risk 2.6 (1.7-2.9)\*
- Moderate sleep apnea (AHI 15 to 30):  
relative risk 1.9 (1.2-2.8)\*
- Severe sleep apnea (AHI >30):  
relative risk 2.0 (1.4-3.0)\*



\*compared with controls (AHI<5)



# Apnea-No flow for at least 10 seconds

- Obstructive
  - Partial or complete
- Central
  - Cessation of airflow without obstruction

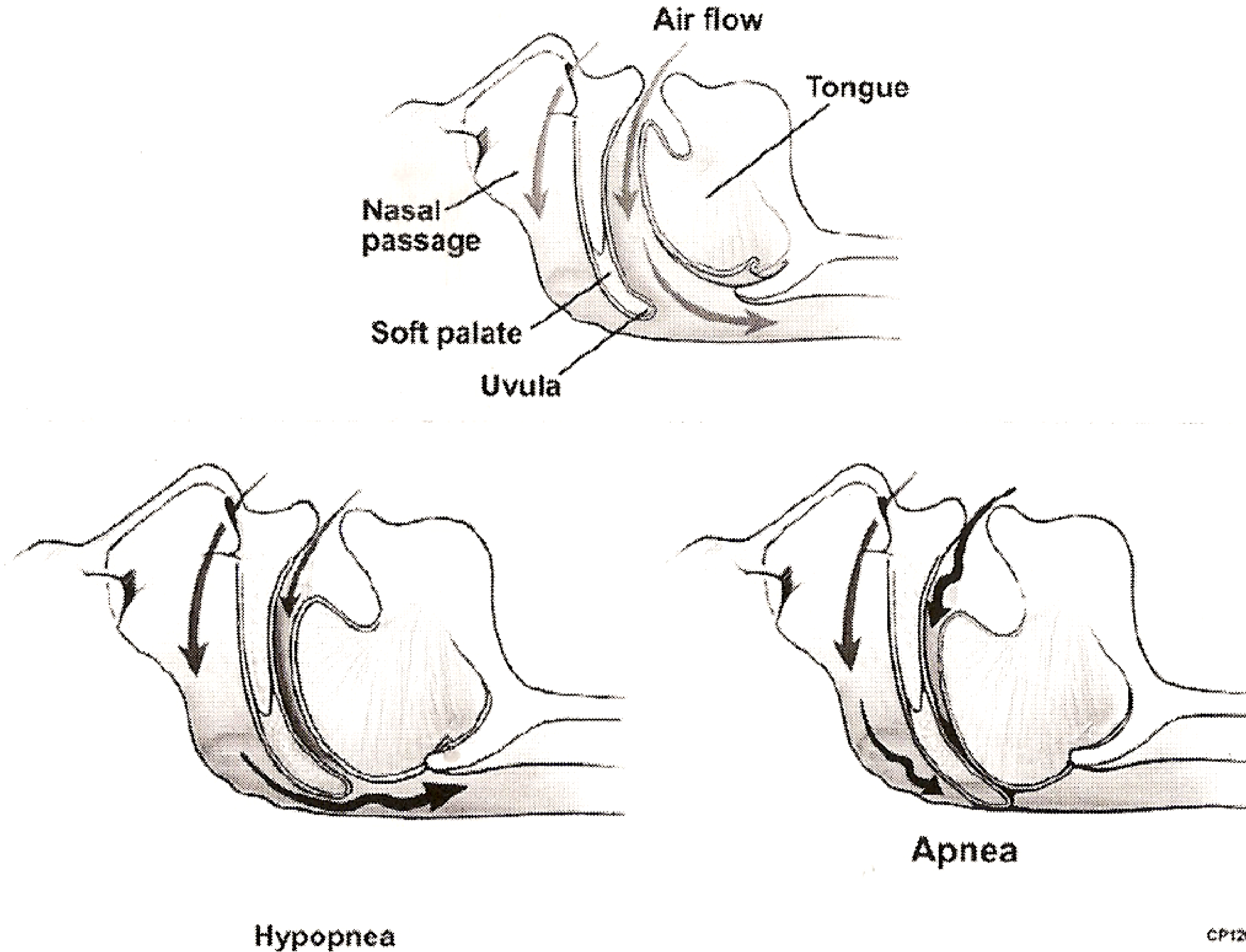


*“Sleep”, said the old gentleman, “he’s always asleep. Goes on errands fast asleep and snores as he waits at the table”*

*Charles Dickens, The Pickwickian Papers*

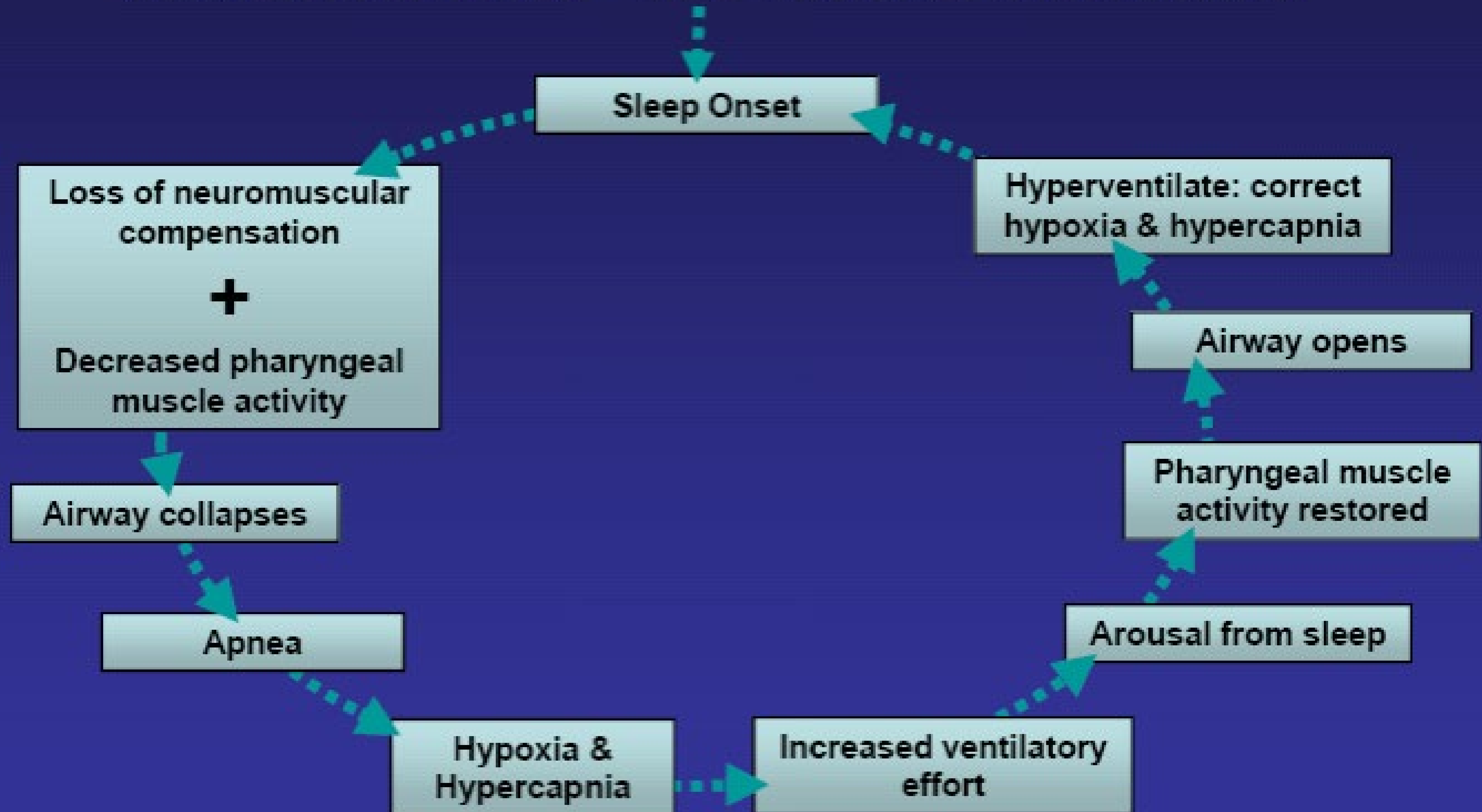


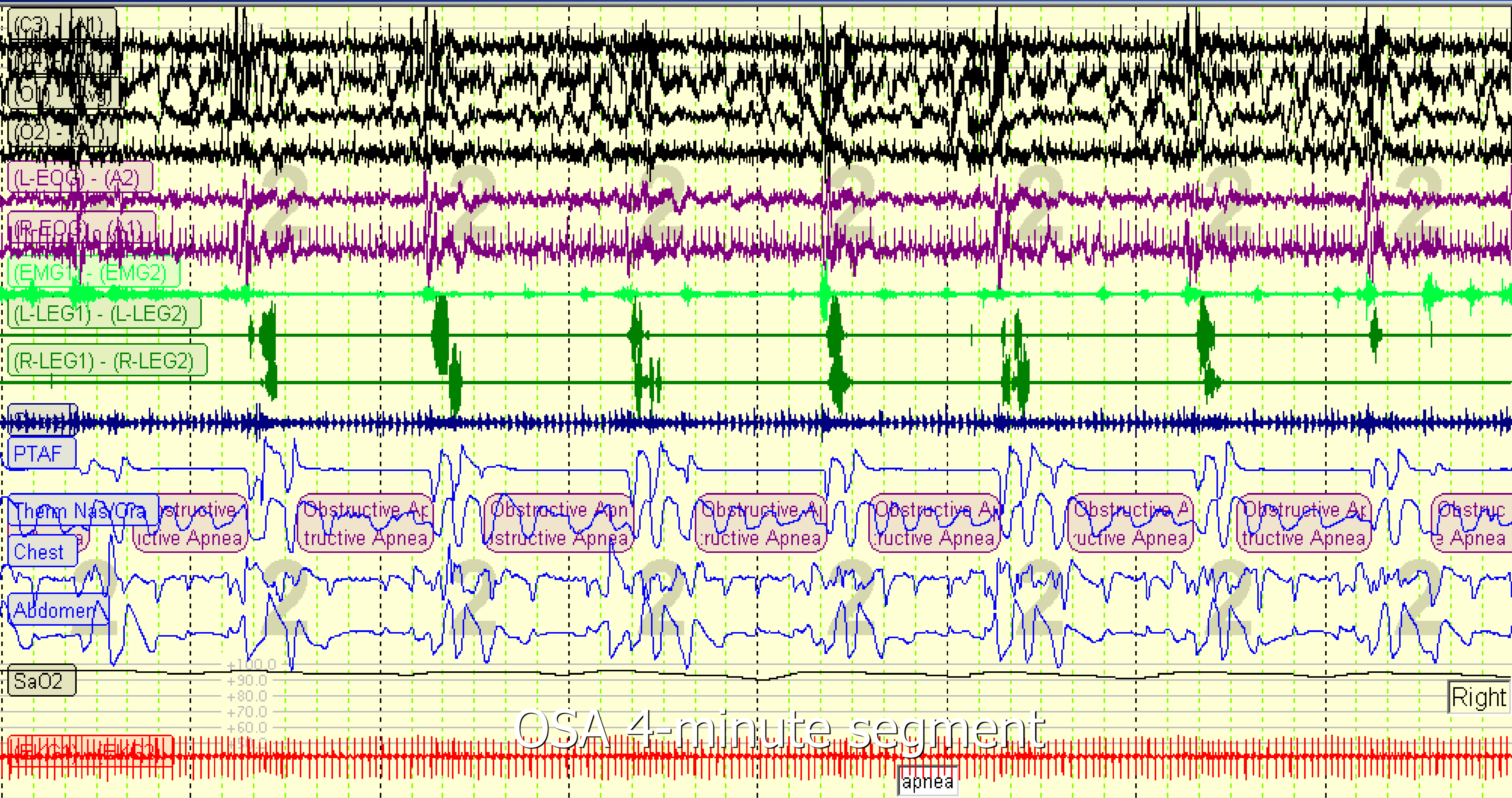
# Partial and complete airway obstruction



# Pathophysiology of OSA

Awake: Small airway + neuromuscular compensation





OSA 4-minute segment

# OSA-Severity Scale

*Apnea-Hypopnea Index (AHI)*

- Upper airway resistance Syndrome (UARS)
  - Snoring with AHI < 5
- Mild
  - 5-15
- Moderate
  - 15-30
- Severe
  - >30

# Apnea-Hypopnea Index (AHI)

## *Limitations*

- No Information on duration/depth
- Apnea=Hypopnea
- Multiple definitions of hypopnea
- 10 sec threshold arbitrary
- Hypopnea dependent on desat, not apnea
- Lacks strong correlation with symptoms, O<sub>2</sub> desats, fragmentation, QOL

# Oxygen Disturbance Index (ODI)

## *Limitations*

- Number of times/hour of sleep with O<sub>2</sub> drops by 3% or 4%
- No info on duration and depth of desat
- 3-4% thresholds arbitrary
- Includes desats associated to airflow reduction unrelated to a scorable event
- Desats due to other non-OSA cardiorespiratory conditions
- Obesity related hypoxemia

# Hypoxic Burden in Obstructive Sleep Apnea

- **Estimates total amount of oxygen desaturation over time during sleep in individuals with OSA.**
- **Strong predictor of cardiovascular morbidity and mortality in OSA patients.**
- **Higher hypoxic burden=increased risk of hypertension, stroke, arrhythmia**
- **Sum of area under desaturation curve for each apneic/hypopneic event throughout the night.**

# Hypoxic Burden in OSA

(Cont)

- Typically assessed using overnight polysomnography or home sleep apnea tests.
- Tailoring CPAP therapy based on hypoxic burden can improve cardiovascular outcomes.
- CPAP therapy shown to reduce hypoxic burden significantly.

Azarbarzin, A. Et al (2019). American Journal of Respiratory and Critical Care Medicine, 200(5), 563-571. doi:10.1164/rccm.201810-1862OC.

Gottlieb, D. J., et al. Circulation, 122(4), 352-360. doi:10.1161/CIRCULATIONAHA.109.901801.



# **AWAKE/SLEEP THRESHOLD INSTABILITY IN OSA**

- Frequent transitions between wakefulness and sleep observed in OSA patients.**
- Recurrent apneic events cause repeated arousals and sleep fragmentation.**
- Increased sympathetic nervous system activity and heightened ventilatory responses contribute to instability.**
- Poor sleep quality and reduced sleep efficiency.**

# **AWAKE/SLEEP THRESHOLD INSTABILITY IN OSA**

**(Cont)**

- **Contributes to daytime sleepiness and cognitive dysfunction in OSA patients.**
- **Potentially increases the risk of developing insomnia.**
- **Effective CPAP therapy can reduce sleep transition instability and improve sleep architecture.**
- **Behavioral interventions such as cognitive-behavioral therapy for insomnia (CBT-I) may be beneficial.**

**Krakov, B. et al, New England Journal of Medicine, 353(19), 2034-2041. doi:10.1056/NEJMoa043104. Sleep, 37(3), 615-623. doi:10.5665/sleep.3492.**

**Yaggi, H. K. et al (2005). New England Journal of Medicine, 353(19), 2034-2041. doi:10.1056/NEJMoa043104.**

# HEART RATE VARIABILITY(HRV)/DYSAUTONOMIA IN OSA

- **Variation in time intervals between heartbeats reflects autonomic function.**
- **Reduced HRV common in OSA patients, indicating autonomic dysfunction.**
- **Lower HRV is associated with higher risk of cardiovascular diseases, including HTN and MI.**
- **HRV metrics can be derived from electrocardiogram (ECG) data during sleep studies.**
- **Commonly used parameters include time-domain (e.g., SDNN) and frequency-domain (e.g., LF/HF ratio)**

# Heart Rate Variability

(Cont.)

- **Intermittent hypoxia and arousals from sleep lead to sympathetic overactivity and reduced parasympathetic tone.**
- **Chronic autonomic imbalance contributes to cardiovascular morbidity in OSA patients.**
- **CPAP therapy has been shown to improve HRV, indicating better autonomic regulation.**
- **Lifestyle modifications, including weight loss and physical activity, can also enhance HRV.**

• Narkiewicz, K., Montano, N., Cogliati, C., van de Borne, P. *Journal of the American College of Cardiology*, 52(8), 686-717. doi:10.1016/j.jacc.2008.05.002  
leap apnea. *Circulation*, 98(11), 1071-1077. doi:10.1161/01.CIR.98.11.1071.

• Somers, V. K., White, D. P., Amin, R., Abraham, W. T., Costa, F., Culebras, A., ... & Russell, R. (2008). Sleep apnea and cardiovascular disease: an American Heart Association/American College of Cardiology Foundation scientific statement from the American Heart Association Council for High Blood Pressure Research Professional Education Committee, Council on Clinical Cardiology, Stroke Council, and Council on Cardiovascular Nursing. *Journal of the American College of Cardiology*, 52(8), 686-717. doi:10.1016/j.jacc.2008.05.002.

# OSA PHENOTYPES

## *Four Basic Types*

- ***Increased pharyngeal collapsibility***-reduction in the ventilatory flow rate
- ***Reduced pharyngeal dilator muscle activity*** despite rising ventilatory drive
- ***Low arousal threshold***-reduces ventilatory drive
- ***Ventilatory instability/loop gain***-excessive drive blunts ventilatory response to CO<sub>2</sub> exacerbating transient loss of stimuli needed to maintain muscle compensation in a vulnerable airway
- Future therapies may be based on phenotype
- [Wellman et al., 2011](#); [Terrill et al., 2015](#), [Younes et al., 2007](#)

# OSA with Comorbid Insomnia

(COMISA)

- **Coexistence leads to overlapping symptoms**
- **Misattribution of Symptoms**
- **Insomnia increases likelihood of CPAP intolerance and low adherence**
- **Behavioral Therapy can be less effective without concurrent tx**
- **Treatment Fatigue**
- **Increased Cardiovascular Risk higher than each alone**
- **Higher Morbidity and Mortality**
- **Higher levels of anxiety, depression**
- **Impaired Quality of Life**
- **Reduced Sleep Efficiency**

Krakow et al. (2004), Sweetman et al. (2020)

# OSA with Comorbid Insomnia

## *Treatment*

- Inform patients about the interaction between OSA and insomnia, emphasizing adherence to both treatments.
- Concurrent use of CPAP and CBT-I shown to be effective.
- Sequential Therapy: Initial treatment of insomnia with CBT-I followed by CPAP for OSA.

# OSA and Cognition

**Intermittent Hypoxia- neuronal injury and brain structural changes.**

**Sleep Fragmentation-Disrupted sleep architecture can impair cognitive function.**

**Inflammation-Systemic inflammation contributes to neurodegenerative processes.**

**Oxidative Stress: Chronic oxidative stress damages neural tissues.**

**Vascular Damage: OSA is associated with cardiovascular diseases, a risk factor for dementia.**

**1-Yaffe K et al. JAMA 2011; 306:613-19**

**2-Osorio RS, et al. (2015). "Sleep-disordered breathing advances cognitive decline in the elderly." Neurology, 84(19), 1964-1971.**

**3-Ancoli-Israel S, et al. (2008). "Cognitive effects of treating obstructive sleep apnea in Alzheimer's disease: a randomized controlled study." Journal of the American Geriatrics Society, 56(11), 2076-2081**



# OSA and Cognition

- **Epidemiological studies show increased incidence of cognitive decline**
- **Neuroimaging studies demonstrating brain changes in regions associated with memory and cognition in OSA patients**
- **CPAP therapy may improve cognitive function in OSA patients**
- **OSA is linked to increased beta-amyloid deposition (Alzheimer's)**
- **OSA exacerbates vascular risk factors contributing to vascular dementia**
- **Mild Cognitive Impairment (MCI): Higher prevalence of OSA in patients with MCI**

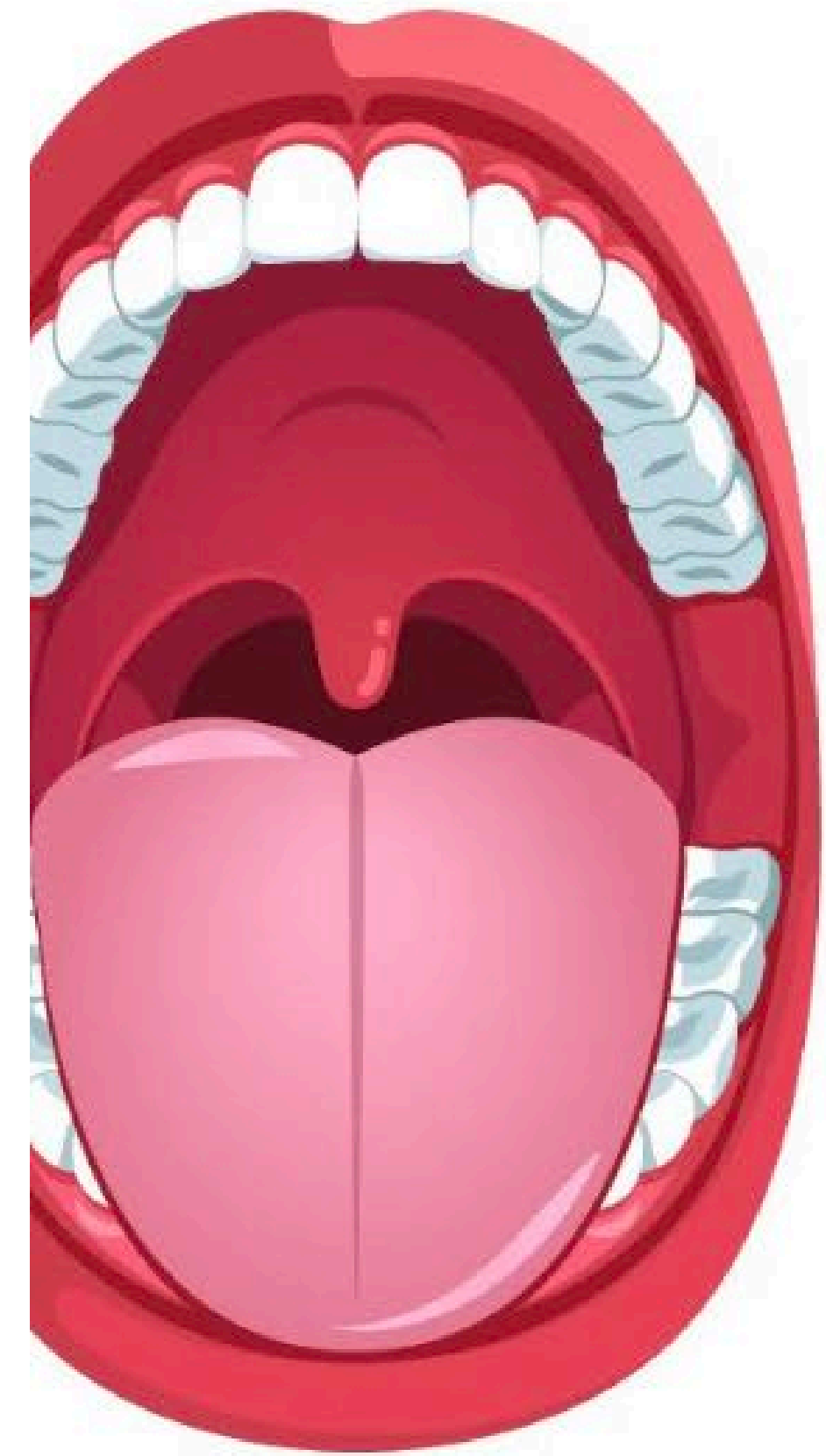
# OSA Diagnosis-Signs and Symptoms

- Snoring
- Hypersomnia
- Choking/Coughing, witnessed apneas
- Sleep fragmentation
- Cardiac arrhythmias
- Hypertension
- Impotence
- Morning Headaches
- Cognitive/Psychiatric
- Nocturia
- Glaucoma/Retinopathy

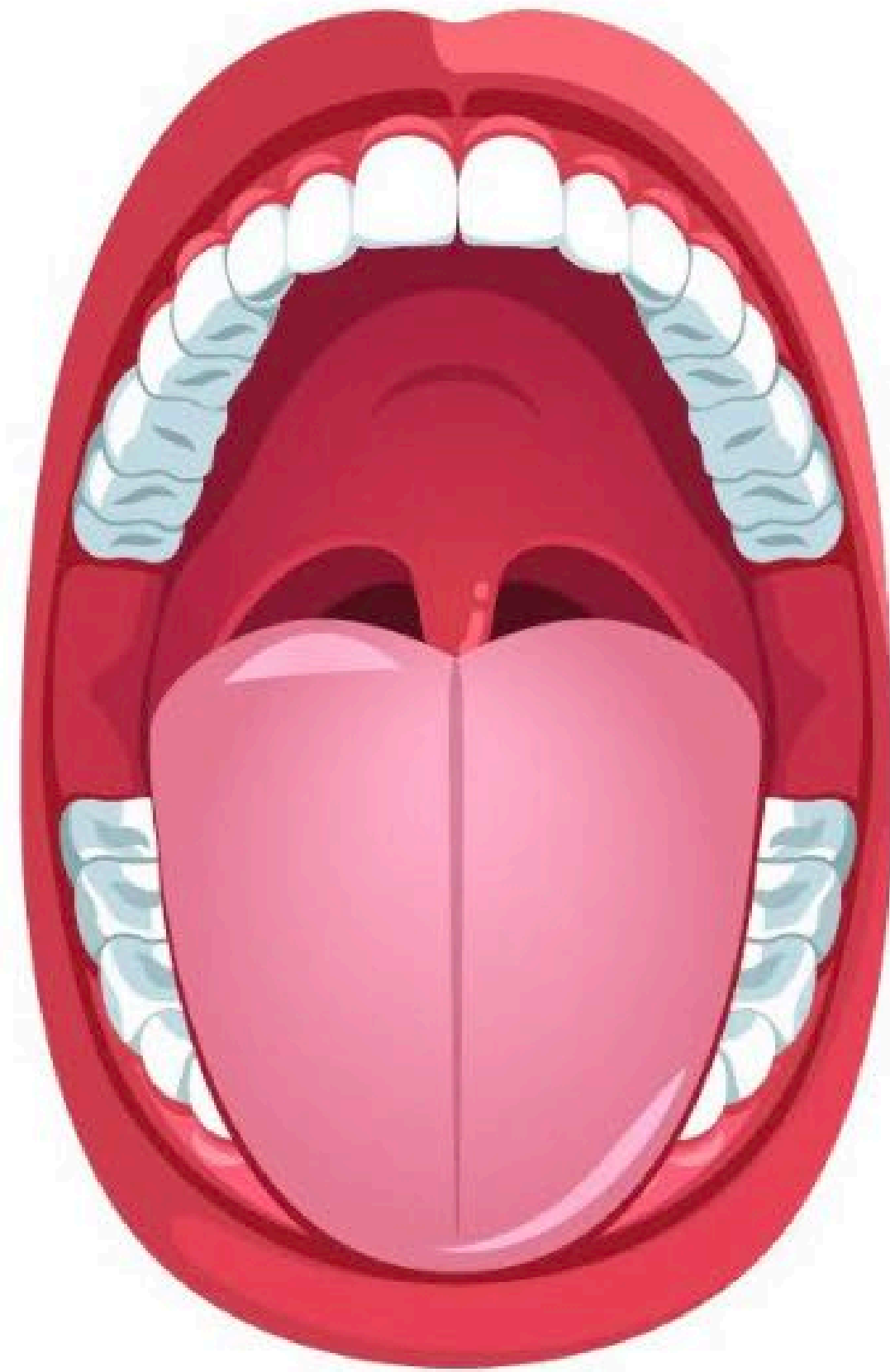
# OSA-Physical Examination

- **Narrow Airway**
- **Nasal passage obstruction**
- **Wide neck**
- **Obesity**
- **High Blood Pressure**
- **Atrial Fibrillation**
- **Heart Failure**
- **Retinal vascular proliferation**

# The Mallampati Score



**Class 1**



**Class 2**



**Class 3**



**Class 4**

# OSA Screening

- STOP-Bang

- Mild 83.6%/56.4
- Moderate 92.9%/43%
- Severe 100%/37%

- Epworth Sleepiness Scale-ESS

- Variable predictability rates

- Berlin Questionnaire

- Poor predictive value, higher with ESS

## Appendix 2: STOP-Bang Scoring Model

1. Snoring

Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?

Yes No

2. Tired

Do you often feel tired, fatigued, or sleepy during daytime?

Yes No

3. Observed

Has anyone observed you stop breathing during your sleep?

Yes No

4. Blood pressure

Do you have or are you being treated for high blood pressure?

Yes No

5. BMI

BMI more than 35 kg/m<sup>2</sup>?

Yes No

6. Age

Age over 50 yr old?

Yes No

7. Neck circumference

Neck circumference greater than 40 cm?

Yes No

8. Gender

Gender male?

Yes No

# DIAGNOSIS AND EVALUATION

- **Polysomnography-Standard**
- **Home sleep apnea testing**
- **Overnight oximetry?**
- **CBC, metabolic panel**
- **MRI Brain/Brainstem**
- **Echocardiogram**
- **EKG/Cardiac monitoring**

# Obstructive Sleep Apnea Treatments

- **Positive airway pressure (PAP)**
- **Weight loss**
- **Oral appliances**
- **Surgery**
- **Nasal strips**
- **Positional therapy**
- **NO TREATMENT??**



# Obstructive Sleep Apnea-PAP

- **Continuous Positive Airway Pressure (CPAP)**
- **Bi-Level Positive Airway Pressure (BiPAP)**

# Continuous/Bi-Level Positive Airway Pressure



CPAP devices: dependable, quiet. Heated humidity & improved interfaces have been major advances in this technology

# PAP reduces CV risk

- **Mild to moderate OSA**
- **Median follow-up 6 yrs, adjusted for other risk factors**
- **Endpoints: MI, stroke, cardiac revasc, death**
- **Event-free survival 51.8 vs 80.3%, on CPAP**
- **# needed to treat to prevent one event over 10 years: 3.5**

• Buchner et al. Am J Respir Crit Care Med 2007;176:1274-80.

# PAP improves CVD markers

- **Severe OSA randomized to CPAP vs no Rx**
- **After 4 months on CPAP:**
  - **Significant decrease in:**
    - **Carotid intima-media thickness**
    - **C-reactive protein**
    - **Catecholamines**

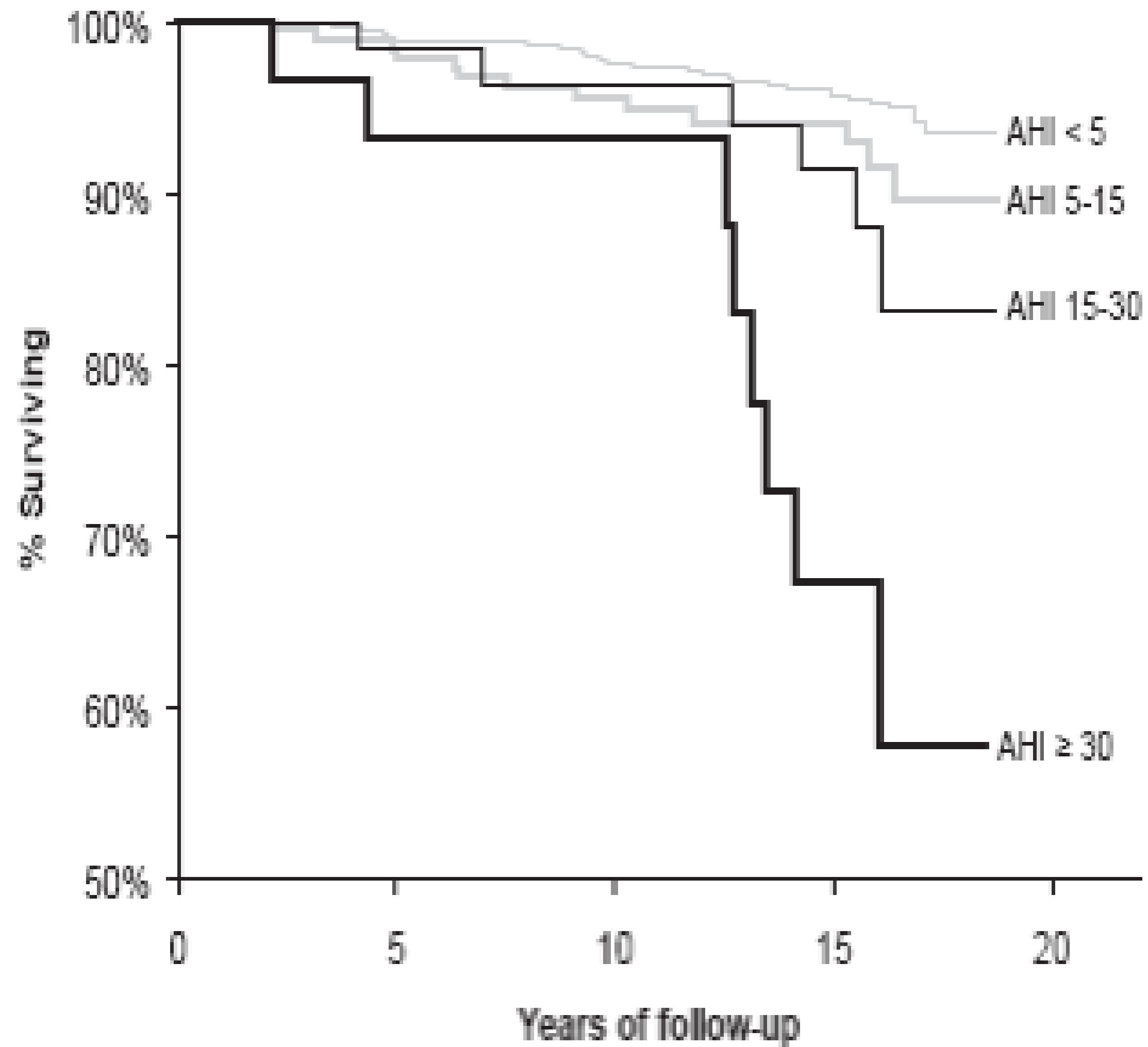
• Luciano et al. Am J Respir Crit Care Med 2007;176:706-12.

# PAP Treatment effect on Cognition

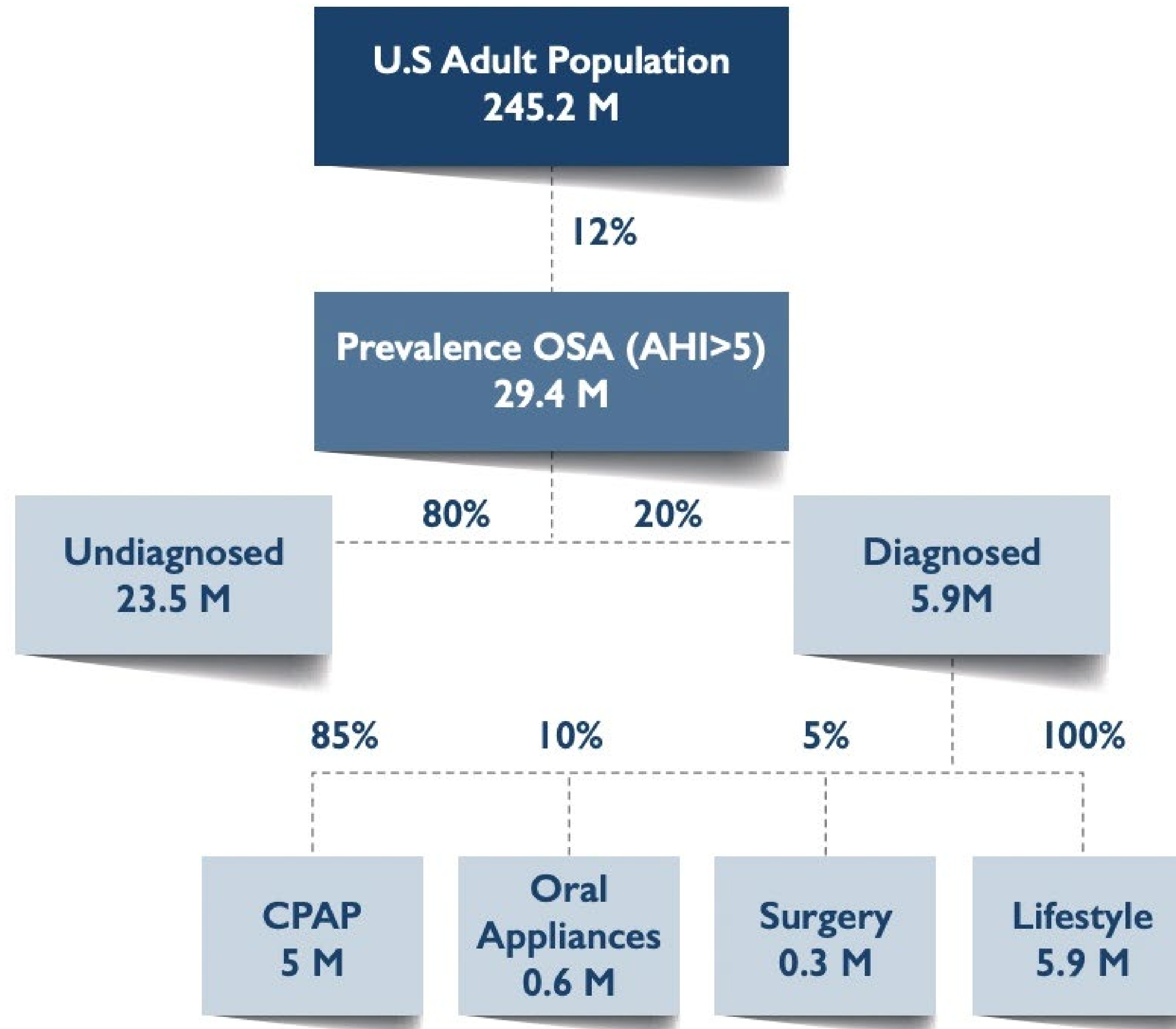
- **110 patients with mild-moderate OSA tested before and after CPAP 3 months and compared to controls**
- **Verbal fluency and psychomotor function normalized with CPAP**
- **Mood improved**
- **Vigilance and working memory did not return to controls**

# OSA Mortality

B.



**Figure 1 -Prevalence, Diagnosis and Treatment of OSA in the United States**



*Hidden Health Crisis  
Costing America  
Billions  
Underdiagnosing and  
Undertreating  
Obstructive Sleep  
Apnea Draining  
Healthcare System*

*Frost and Sullivan,  
<https://aasm.org/wp-content/uploads/2017/10/sleep-apnea-economic-crisis.pdf>*

# Health care utilization and OSA

- **In 10 years prior to dx of OSA:**
  - **\$3972/patient vs. \$1969/patient**
  - **6.2 hosp days/patient vs. 3.7 hosp day/patient**
- **In 2 years after dx & rx of OSA:**
  - **33% mean reduction in physician claims**
  - **Decrease hosp days: 1.27 to 0.54/pt/yr**



# Treatment adherence rates

- **Antidepressants ~65%\***
- **Antihypertensives ~50%\*\***
- **Insulin ~63%\*\*\***
- **CPAP ~70%**

\*Cramer et al. Psych Svcs. 1998;49(2):196-201

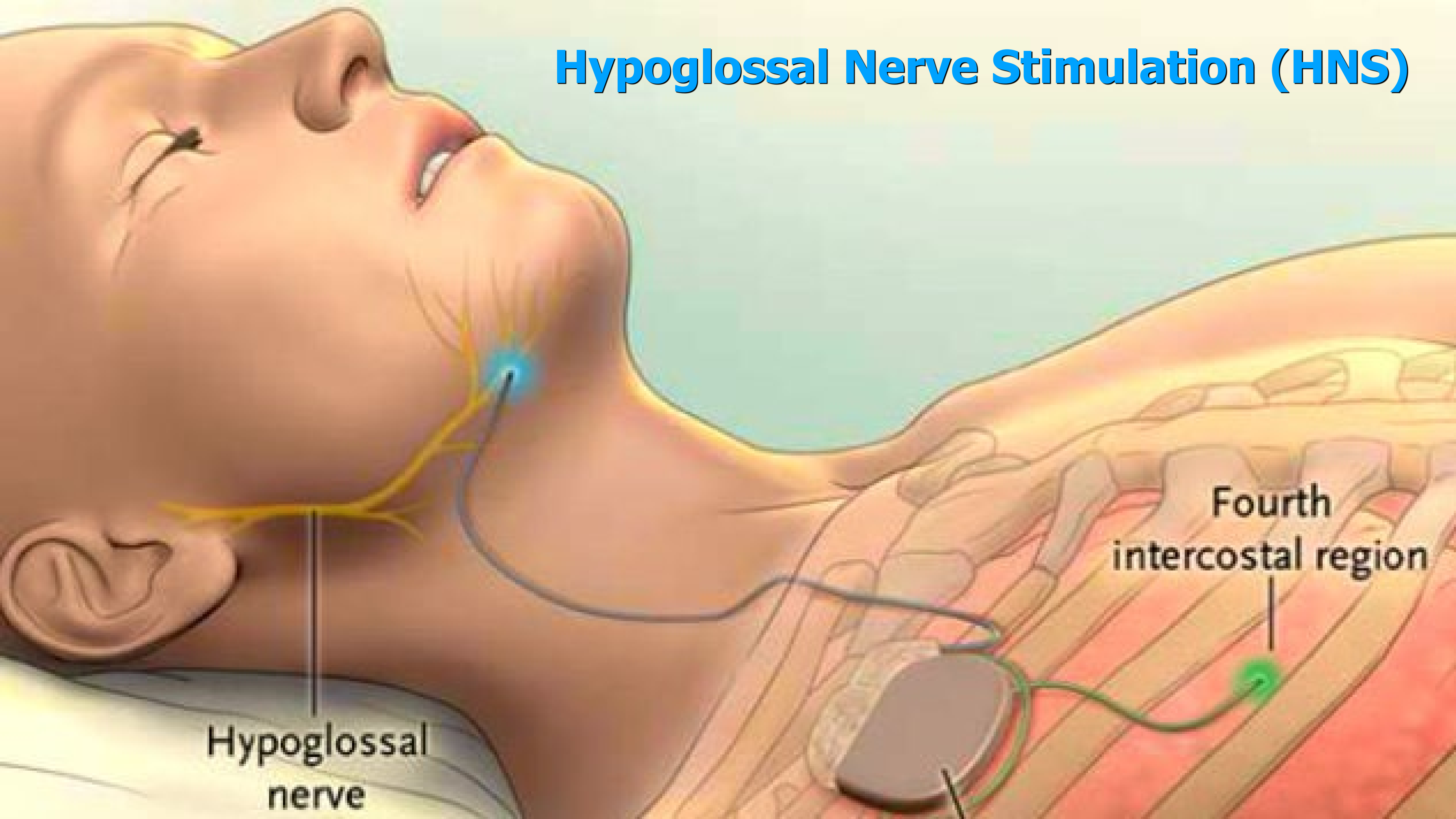
\*\*Vrijens et al. BMJ 2008;336:1114

\*\*\*Cramer Diabetes Care 2004;27(5):1218-1224

# OSA Treatment-Surgical

- **UPPP**
- **Mandibular Advancement (MAP)**
- **Glossiectomy**
- **Adenotonsillectomy**
- **Hypoglossal nerve stimulation (INSPIRE)**

# Hypoglossal Nerve Stimulation (HNS)



Hypoglossal  
nerve

Fourth  
intercostal region

**OSA**  
**Oral Appliance**  
**Therapy**



# OSA-Pharmacology

- **Avoidance of CNS depressants**
- **Protriptyline**
- **Fluoxetine**
- **Theophylline**
- **Clonidine**
- **Medroxyprogesterone**

# OSA-WHEN NOT TO TREAT

- Large randomized controlled trial in non-sleepy patients with moderate-to-severe OSA-no significant reduction in cardiovascular events
- Another trial on minimally symptomatic OSA patients-no significant improvement in quality of life or reduction in cardiovascular risk with CPAP
- Asymptomatic patients have lower motivation to adhere
- CPAP can cause discomfort, nasal congestion, and other side effects
- AASM-CPAP for moderate-to-severe OSA, asymptomatic benefit uncertain.

# OSA-WHEN NOT TO TREAT

(Cont.)

- **CPAP costs**
- **Individualized decision-making**
- **Biomarkers and imaging techniques to better stratify risk and guide treatment**
- **Personalized medicine to identify which asymptomatic patients might benefit**
- **Further research is needed to clarify long-term impact of treating asymptomatic OSA on cardiovascular and metabolic outcomes.**

# Conclusions

*“Enjoy the honey-heavy dew of slumber. Thou hast no figures nor no fantasies, Which busy care draws in the brains of men; Therefore thou sleep'st so sound.*

*William Shakespeare, Julius Caesar*

- **OSA is a relatively common, treatable condition**
- **There is substantial evidence for OSA having a causal role in HTN & CAD**
- **OSA is a risk factor for stroke, cognitive impairment, obesity, type II diabetes, depression, motor vehicle accidents, and death**
- **Treatment can reduce these risks in the right patients Further research on better metrics and endotyping is the future**



***“Sleep Thou  
Sancho” returned  
Don Quixote, “for  
thou wast born to  
sleep as I was born  
to watch”***

***Don Quijote  
Miguel de Cervantes***

