# Sleep Apnea and Cardiovascular Disease

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## Sleep Disorders – Socioeconomic Consequences

- 40 million Americans suffer from chronic disorders of sleep and wakefulness.
- 95% of these remain unidentified and undiagnosed.
- The annual direct cost of sleep-related problems is $16 billion, with an additional $50-$100 billion in indirect costs (accidents, litigation, property destruction, hospitalization, and death).

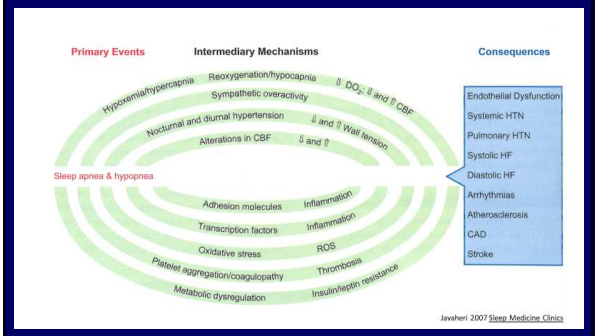
## Impact of Cardiovascular Disorders

- 900,000 deaths annually in US
- Hypertension alone affects 75 million Americans, many misdiagnosed as “essential”
- Research has discovered evidence of bidirectional relationship of sleep apnea and cardiovascular disorders
- Mechanisms: Arousals > neuro-hormonal activation > release of inflammatory mediators (cytokines) and adhesion molecules > reactive oxygen species and transcription factors due to oxidative stress

Javaheri Principles and Practice of Sleep Medicine 2004

## Possible Cardiovascular Complications of Sleep Apnea

- Endothelial dysfunction
- Hypertension
- Pulmonary hypertension
- Systolic or diastolic heart failure
- Arrhythmias
- Coronary artery disease
- TIA and stroke
- Dementia
- Death

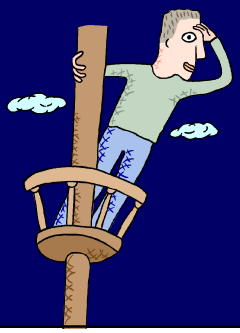



Kramer, NR et al. **The role of the primary care physician in recognizing obstructive sleep apnea.** Arch Intern Med. 1999.

- Retrospective chart review of a hospital-based sleep center
- Patients referred by general IM or FP
- 65 out of 68 patients had OSA (95%)

Kramer, NR et al. **The role of the primary care physician in recognizing obstructive sleep apnea.** Arch Intern Med. 1999.

- These patients represented 0.13% of the primary care patient panel

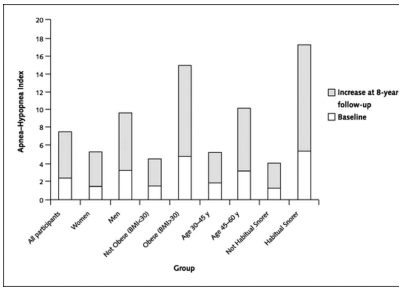


## Prevalence

- Sleep apnea (AHI>5)
  - 9% of middle-aged women
  - 25% of middle-aged men
- Sleep apnea syndrome (AHI>5 and EDS)
  - 2% of women
  - 4% of men
- Sleep apnea in elderly (>65 years old)
  - between 20% and 62%

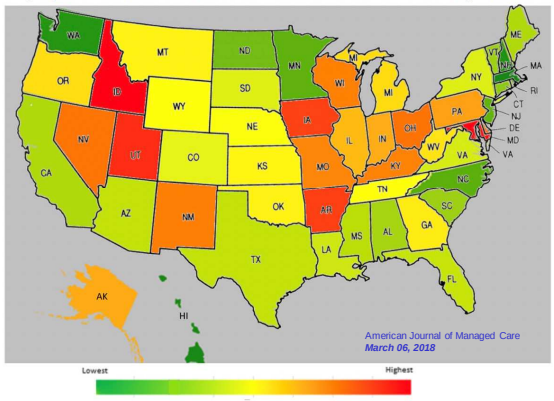
Young T, et al. The occurrence of sleep-disordered breathing among middle-aged adults. NEJM 1993

**Mean apnea-hypopnea index at baseline and the increase 8 years later in 282 participants in the Wisconsin Sleep Cohort**

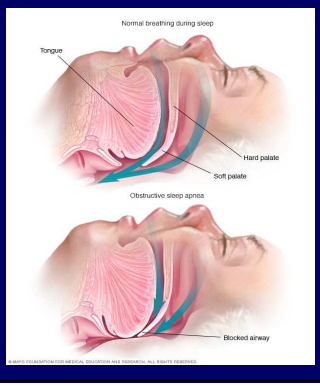


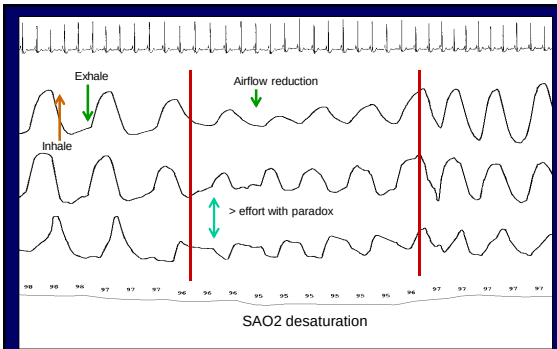

Caples, S. M. et. al. Ann Intern Med 2005;142:187-197

**Sleep Apnea Claim Lines as a Percent of All Medical Claim Lines by State, 2017**

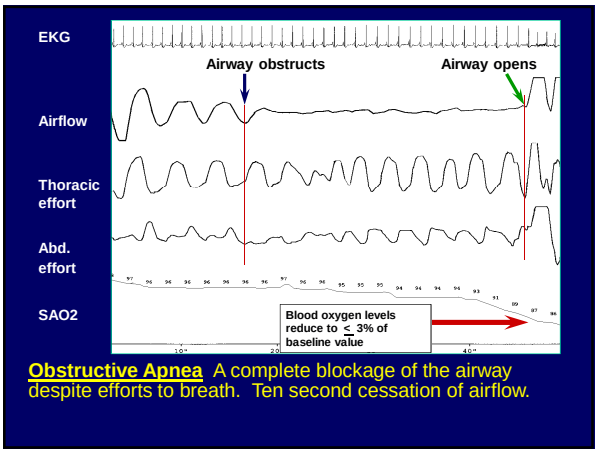



## Defining Sleep Apnea



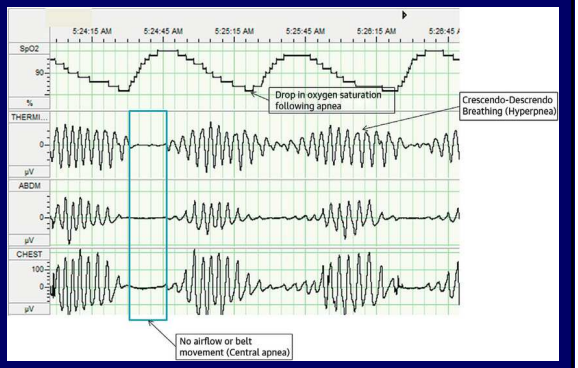




**Hypopnea** 1) 30% drop in signal excursion from baseline; 2) durations is 10 or more seconds; 3) the event is associated with an arousal and/or oxygen desaturation of at least 3% (4% for Medicare)

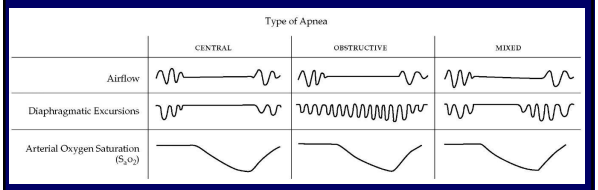



**Obstructive Apnea** A complete blockage of the airway despite efforts to breath. Ten second cessation of airflow.

## Central Apnea




## Mixed Apneas



## Apnea Severity Scale

| AHI | Rating |
|---|---|
| <5 | Normal (no Sleep Apnea) |
| 5-15 | Mild Sleep Apnea |
| 15-30 | Moderate Sleep Apnea |
| >30 | Severe Sleep Apnea |

## Clinical features of OSAS

- Habitual snoring
- Excessive daytime sleepiness
- Obesity (BMI>30)
- Age (increases in 5th decade)
- Gender (male:female = 2-3:1)
- ? Race (African-Americans, Hispanics)

## Clinical features

- Depression
- Decreased:
  - memory
  - vigilance
  - motor coordination
- Nocturnal gasping, choking
- Morning headache
- Loss of libido/secondary impotence

## Mimics of Apneas

- Nocturnal heartburn
- Chest pain, palpitations
- Coughing and choking
- Asthma attacks
- Night sweats
- Insomnia
- Jerks

## Diagnosis

- Physical findings
  - neck circumference
    - 17 inches in males
    - 16 inches in females
  - craniofacial anatomy
  - posterior oropharynx
  - body mass index (weight in kg/height in $m^2$)
    - BMI>30 with 8-12 fold increase in risk

## Enlarged Tonsils


Source: Orlando R. Hung, Michael F. Murphy: *Hung's Difficult and Failed Airway Management*, 3rd edition
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## Sleep Apnea Questionnaires

| Questionnaire | Summary of Questionnaire Contents | Diagnostic Accuracy Compared With AHI (>15 events/h)[14] |
|---|---|---|
| Berlin Questionnaire | 10 questions pertaining to the following 3 symptoms/signs:<br>• Snoring<br>• Daytime sleepiness<br>• Hypertension<br>Patients classified by score as having low risk or high risk of OSA | • *Sensitivity*: 0.77 (0.73–0.81)<br>• *Specificity*: 0.44 (0.38–0.51) |
| STOP Questionnaire | 4 questions regarding the following signs/symptoms:<br>• Snoring<br>• Sleepiness<br>• Observed apneas or choking<br>• Hypertension | • *Sensitivity*: 0.89 (0.81–0.94)<br>• *Specificity*: 0.32 (0.19–0.48) |
| STOP-BANG Questionnaire | 4 questions regarding signs/symptoms plus 4 clinical attributes:<br>• Snoring<br>• Sleepiness<br>• Observed apneas or choking<br>• Hypertension<br>• Obesity (BMI >35 kg/m$^2$)<br>• Age (>50 y)<br>• Neck size<br>• Sex<br>Patients classified as low, intermediate, or high risk for OSA | • *Sensitivity*: 0.90 (0.86–0.93)<br>• *Specificity*: 0.36 (0.29–0.44) |
| Epworth Sleepiness Scale | 8 questions asking patients to rate the likelihood of falling asleep in various daytime contexts<br>Patients classified as having normal sleep, average sleepiness, or severe and possibly pathologic sleepiness | • *Sensitivity*: 0.47 (0.35–0.59)<br>• *Specificity*: 0.62 (0.56–0.68) |

## STOP Bang QUESTIONNAIRE

| | |
|---|---|
| **S**noring - *Do you Snore Loudly (loud enough to be heard through closed doors or your bed-partner elbow you for snoring at night)?* | o Yes o No |
| **T**ired - *Do you often feel Tired, Fatigued, or Sleepy during the daytime (such as falling asleep during driving)?* | o Yes o No |
| **O**bserved - *Has anyone Observed you Stop Breathing or Choking/Gasping during your sleep?* | o Yes o No |
| **P**ressure - *Do you have or are being treated for High Blood Pressure?* | o Yes o No |
| **B**ody Mass Index - *more than 10% over ideal range.* | o Yes o No |
| **A**ge - *Older than 50?* | o Yes o No |
| **N**eck Size - *(Measure around Adams apple) Male is your shirt collar 17" or larger? Female, is your shirt collar 16" or larger?* | o Yes o No |
| **G**ender = Male? | o Yes o No |

**After you have completed the STOP-BANG questionnaire, please return it to the front desk for a quick risk assessment of possible sleep apnea.**

***0-3 low risk***
***4-5 intermediate***
***6+ high risk***

## Medicare requirements for sleep study (PSG or HST)

## Sleep Apnea is Deadly

## MORTALITY FROM OSA
## Wisconsin Sleep Cohort Study

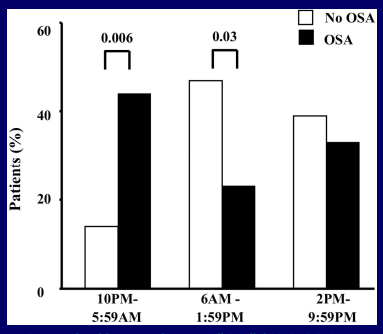
- 18 year follow up of 1522 middle aged patients ages 30-60
- All cause mortality- 2-3 times greater in those with OSA vs. no OSA
- Cardiovascular mortality- 5-6 times greater

## Day-Night Pattern of Sudden Death in OSA

Midnight to 6AM

- OSA patients 46%
- No OSA 21%
- General Population 16%
- Chance 25%

## 8-h Epochs of MI Occurrence




Sert Kuniyoshi, F. H. et al. J Am Coll Cardiol 2008;52:343-346

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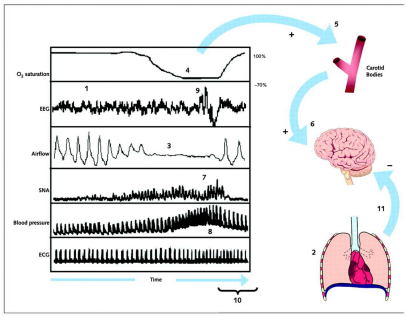
JACC

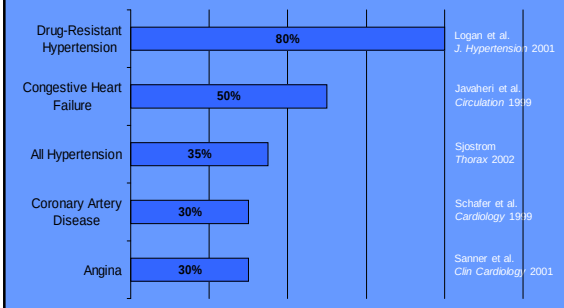
## Morbidity and Mortality

- Ischemic heart disease
- Congestive heart failure
- Cerebrovascular disease
- Pulmonary hypertension

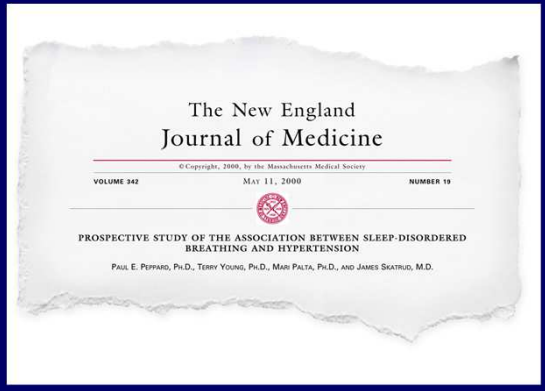
**Pathophysiologic events in obstructive sleep apnea**




Caples, S. M. et. al. Ann Intern Med 2005;142:187-197




**Prevalence of SDB in CVD Patients**



The New England
Journal of Medicine

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VOLUME 342 MAY 11, 2000 NUMBER 19

PROSPECTIVE STUDY OF THE ASSOCIATION BETWEEN SLEEP-DISORDERED BREATHING AND HYPERTENSION

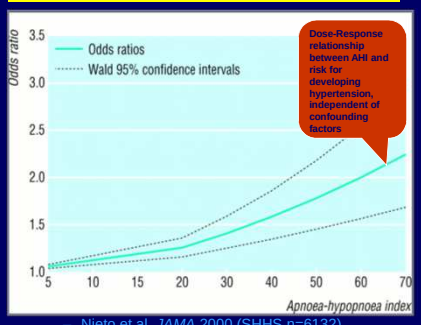
PAUL E. PEPPARD, PH.D., TERRY YOUNG, PH.D., MARI PALTA, PH.D., AND JAMES SKATRUD, M.D.

## New England Journal of Medicine, 2000 Peppard *et al*

### The Apnea-Hypopnea Index at Base Line

| Base-Line Apnea-Hypopnea Index | Odds Ratio, Adjusted for Base-Line Hypertension Status | Odds Ratio, Adjusted for Base-Line Hypertension Status, Non-modifiable Risk Factors, Habitus, and Weekly Alcohol and Cigarette Use |
|---|---|---|
| 0 events / hr | 1.0 | 1.0 |
| 0.1 – 4.9 events / hr | 1.66 (1.35 – 2.03) | 1.42 (1.13 – 1.78) |
| 5.0 – 14.9 events / hr | 2.74 (1.82 – 4.12) | 2.03 (1.29 – 3.17) |
| ≥15.0 events / hr | 4.54 (2.46 – 8.36) | 2.89 (1.46 – 5.64) |
| P for trend | < 0.001 | 0.002 |

## SDB and Hypertension




- Nieto et al. *JAMA* 2000 (SHHS n=6132)
- Lavie et al. *BMJ* 2000 (n=2677)
- Bixler et al. *Arch Intern Med* 2000 (n=1741)
- Peppard et al. *NEJM* 2000 (WSCS n=709)

## CAD and OSA

- Independent risk factor for heart disease
  - As strong a risk factor as obesity, smoking, and HTN

    Hung J, et al. Association of sleep apnoea with myocardial infarction in men. Lancet 1990.
- Evident in 30-50% of patients with CAD

  Andreas S, et al. Prevalence of obstructive sleep apnoae in patients with coronary artery disease. Coron Artery Dis. 1996
- Increased incidence of both bradyarrhythmias and tachydyrhythmias

  Guilleminault C, et al. Cardiac arrhythmia and conduction disturbances during sleep in 400 patients with sleep apnea syndrome. Am J Cardiol. 1983.

**Sleep-disordered Breathing and Cardiovascular Disease**

**Cross-sectional Results of the Sleep Heart Health Study**

EYAL SHAHAR, CORALYN W. WHITNEY, SUSAN REDLINE, ELISA T. LEE, ANNE B. NEWMAN, F. JAVIER NIETO, GEORGE T. O'CONNOR, LORI L. BOLAND, JOSEPH E. SCHWARTZ, and JONATHAN M. SAMET for the Sleep Heart Health Study Research Group

## Sleep Disordered Breathing and A Fib

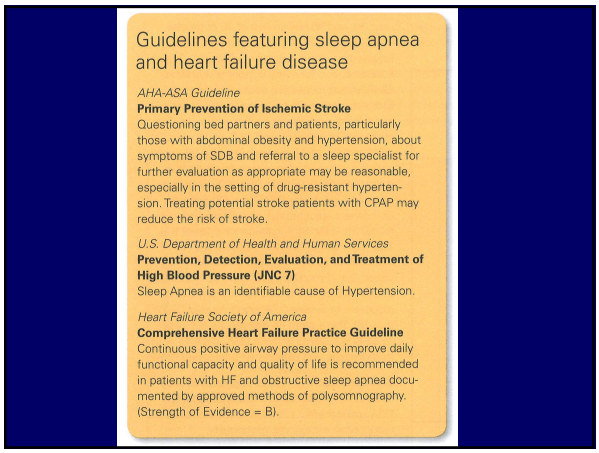
New data on mechanisms and impact:

- Upper airway collapse > hypoxia > ventilator overshoot > hypercapnia > autonomic instability and intrathoracic pressure alterations
- Increased state of thrombosis, inflammation, and oxidative stress produce a pro-arhythmogenic milieu, atrial macro-reentry, and automaticity
- OSA is a powerful predictor of ablation failure, independent of atrial enlargement, obesity, or hypertension
- A fib will affect up to 16 million patients by 2050
- A fib will cost $6.7 billion per year
- In a cardiology practice the majority of OSA patients have been referred by electrophysiologists
- Future strategies?

Mehra ACC-Cardiosource 2014

## Pulmonary Hypertension (PAH) and Sleep Apnea

- OSA recognized by WHO in 1998 as a secondary cause of PAH
- 15 – 70% of OSA patients have PAH
- COR pulmonale may occur in cases of severe OSA, especially if associated with high $PaCO_2$
- Several but not all studies show compliant, effective treatment of OSA improves PAH

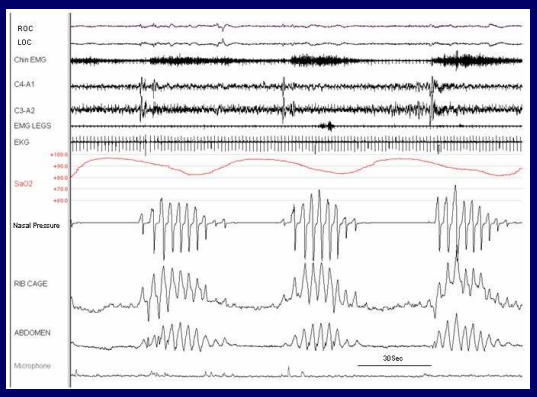



## Obstructive and Central OSA and Heart Failure $HF_REF$ $HF_PEF$

- Major public health issue
- High mortality and morbidity
- Frequent hospital admissions and readmissions
- High economic impact
- Obstructive sleep apnea is the most common, least recognized co-morbidity -- 70% of HF patients have OSA/CSA
- Similar symptoms in heart failure and OSA
- CSA associated with higher mortality
- PAP may not improve mortality in HF patients

## Obstructive and Central OSA and Heart Failure $HF_REF$ $HF_PEF$ (cont'd)

- CSA is suppressed in 50% of HF patients by CPAP
- In HF patients OSA is not associated with daytime sleepiness
- ASV is recommended for CPAP non-responders with CSA



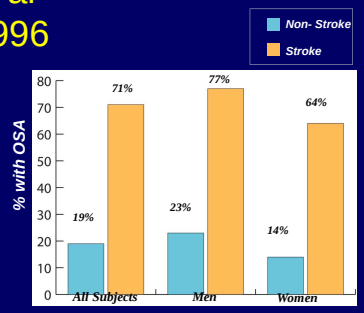

## Coronary Heart Disease and Sleep Apnea

- CAD estimated to be present in 20– 25% of OSA patients
- Prevalence is 30% in case controlled studies with an independent association
- Direct causality is not well established
- Major cardiac events are more likely in patients with severe OSA
- CPAP may significantly reduce c-v events
- AHI severity is an independent predicator of mortality in patients with CAD
- Screening for both disorders in patients with risk factors for one is suggested as well as co-management strategies
- Impaired sleep in men and disturbed sleep in women may be related to moderately higher risk of poor cardiac prognosis after first AMI
  (A. Clark SLEEP2014)

## Patent Foramen Ovale and Sleep Apnea

- Congenital cardiac defect present in approximately 25% of healthy adults and usually asymptomatic
- Patients with PFO might have left to right shunt which can lead to systemic embolization
- It is little known and poorly studied
- Severe OSA may raise the risk of complications in patients with elevated right heart pressures

## Dyken et al Stroke 1996




## OSA and Stroke

Table 3. Trend Analysis for the Relationship between Increased Severity of the Obstructive Sleep Apnea Syndrome and the Composite Outcome of Stroke or Death from Any Cause (N=1022).[a]

| Severity of Syndrome | Stroke or Death | | Mean Follow-up Period | Hazard Ratio (95% CI) |
|---|---|---|---|---|
| | No. of Events | No. of Patients | | |
| | | | yr | |
| AHI ≤3 (reference score) | 13 | 271 | 3.08 | 1.00 |
| AHI 4–12 | 21 | 258 | 3.06 | 1.75 (0.88–3.49) |
| AHI 13–36 | 20 | 243 | 3.09 | 1.74 (0.87–3.51) |
| AHI >36 | 34 | 250 | 2.78 | 3.30 (1.74–6.26) |

[a] P=0.005 by the chi-square test for linear trend. AHI denotes apnea–hypopnea index, and CI confidence interval.

**Yaggi K, et al. Obstructive Sleep Apnea as a Risk Factor for Stroke and Death. NEJM 2005;353:2034-41.**

## OSA and Diabetes

- After adjustment for body weight, higher prevalence of insulin resistance and diabetes
  - Punjabi N, et al. Sleep-disordered breathing and insulin resistance in middle-aged and overweight men. Am J Resp Crit Care Med 2002.
- Odds ratio of DM with AHI >15 versus AHI < 5 was 2.30
  - Reichmuth K, et al. Association of Sleep Apnea and Type II Diabetes. Am J Resp Crit Care Med 2005.

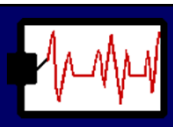
## Mortality

He J, Kryger M, et al. Mortality and apnea index in obstructive sleep apnea.Chest 1988

40% of patients with OSA (AHI>20) died during a follow-up period of 8 years

Patients with CPAP or trach had improved survival compared with patients treated with weight loss or uvulopalatopharyngeoplasty

## Studies

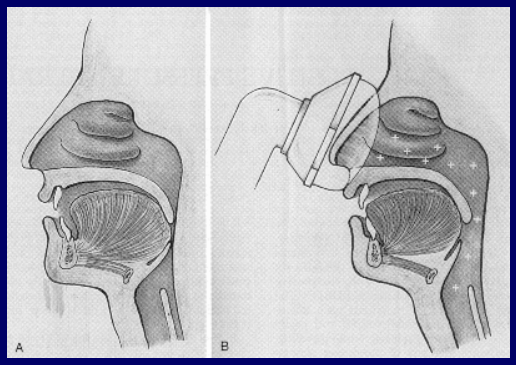


- Overnight oximetry (Profox)
- Nurse observation record
- "Poly-G" (ox, airflow, thoracic, abd)
- Home Sleep Test (HST)
- Portable
- In-lab polysomnogram

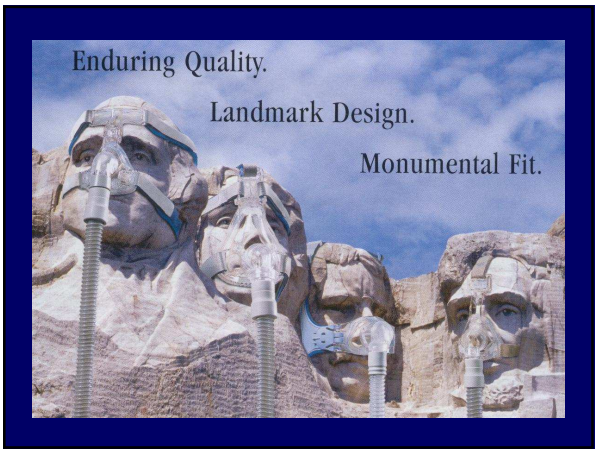
## Therapy

- Behavioral
  - Etoh
  - tobacco
  - weight reduction
  - positional sleep therapy
- PAP therapy
- Surgical interventions

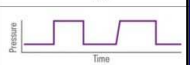
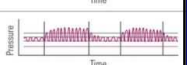
Positional Therapy: Raise HOB




## CPAP/BiPAP therapy


Enduring Quality.
Landmark Design.
Monumental Fit.

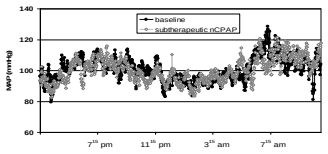
## PAP therapy

| Therapy | Aim | Features | Pressure Profile |
|---|---|---|---|
| Continuous Positive Airway Pressure (CPAP) | Maintain open upper airways | Fixed pressure |  |
| Automatic Positive Airway Pressure (APAP) | Maintain open upper airways | Continually adjusting pressure to optimize pressure level to the patient's needs |  |
| Variable Positive Airway Pressure (VPAP) | Support breathing in lung disease-related respiratory insufficiency | Fixed expiratory pressure and pressure support at inspiration, usually with fixed back-up rate |  |
| Adaptive Servo-Ventilation (ASV | Stabilise breathing and keep upper airway open | Continually adjusting inspiratory and expiratory pressure with variable, on-demand, back up rate |  |

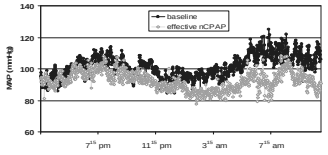
## CPAP and Hypertension

- Studies of therapeutic versus sham CPAP in normotension and mild hypertension have shown an effect in decreasing nighttime and daytime blood pressure
  - Becker H, et al. Effect of continuous positive airway pressure treatment on blood pressure in patients with obstructive sleep apnea. Circulation 2003.
- JNC VII identified OSA as first on the list of identifiable causes of hypertension
  - The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of high blood pressure: the JNC 7 report. JAMA 2003.

**Baseline Arm**




**Therapeutic Arm**

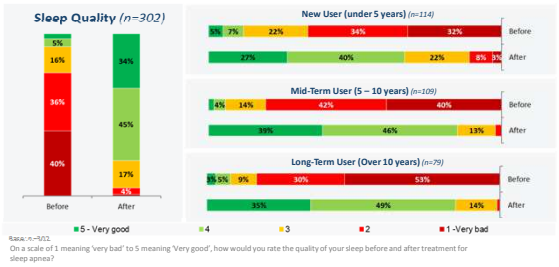



Average 10 mm Hg reduction in BP corresponds to:
- Coronary artery disease risk reduced by 37%
- Stroke risk reduced by 56%

**Effect of CPAP on Blood Pressure (Becker et al. *Circulation* 2003)**

## Sleep Quality in Patients with Hypertension

Before and after sleep apnea treatment




Base: n=302

On a scale of 1 meaning 'very bad' to 5 meaning 'Very good', how would you rate the quality of your sleep before and after treatment for sleep apnea?

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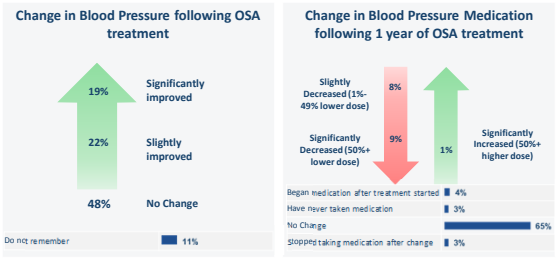
## Blood Pressure Improvement and Medication Usage

Before and after sleep apnea treatment




Base: n=288

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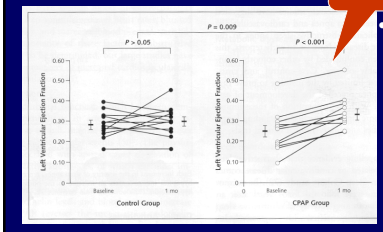
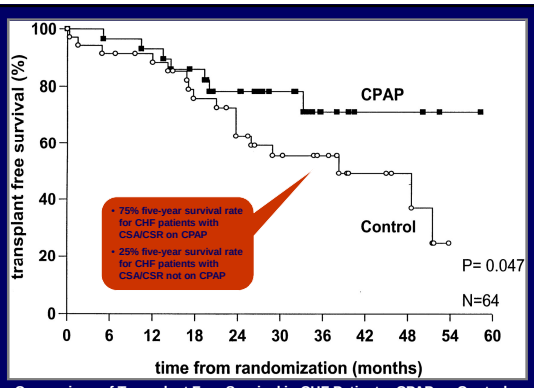
## CPAP and CHF




- Average 35% relative increase in LVEF

Keneko Y, et al. Cardiovascular effects of continuous positive airway pressure in patients with heart failure and obstructive sleep apnea. NEJM 2003.

- CPAP treatment of patients with CHF will reduce LV afterload, increase stroke volume, reduce cardiac sympathetic tone, reduce atrial naturetic peptide, and increase LVEF




Comparison of Transplant Free Survival in CHF Patients: CPAP vs Control (Sin et al. *Circulation* 2000)

## Sleep Apnea Cardiovascular Endpoints study (SAVE)

CPAP for Prevention of Cardiovascular Events in Obstructive Sleep Apnea.

*McEvoy RD, et al.*

*N Engl J Med. 2016 Sep 8; 375(10):919-31.*

## SAVE

- 2,717 adults (mostly men ages 45 to 75 years with minimal sleepiness)
- From 7 countries (though only 4 patients were from the United States) who had moderate to severe OSA and coronary or cerebrovascular disease.
- Half the patients received CPAP plus usual care or usual care alone.

## SAVE

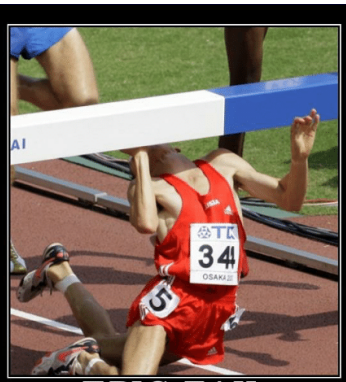
- The primary composite endpoint was death from cardiovascular causes, myocardial infarction, stroke, or hospitalization for unstable angina, heart failure, or transient ischemic attack.
- Secondary endpoints included other cardiovascular outcomes, quality of life, snoring, daytime sleepiness, and mood.

## SAVE

- After a mean follow-up of 3.7 years, no significant effect on any individual or other composite cardiovascular endpoint was observed between the CPAP group and the usual care group.

## SAVE

- The authors concluded that CPAP plus usual care, as compared with usual care alone, **did not prevent** cardiovascular events in patients with moderate to severe OSA and established cardiovascular disease.
- However, in the CPAP group there was significantly reduced snoring and daytime sleepiness, improved health-related quality of life and mood, and a suggestion that the stroke risk was lower.



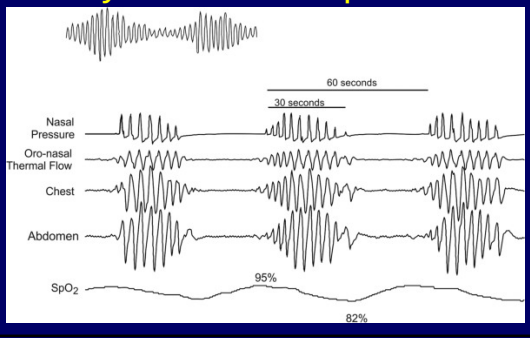

## Limitations

- Mean CPAP duration of 3.3 hours per night.
- Even the so called “rule” of 4 hours/night for at least 70% of the nights (primarily used to justify payment or occupational fitness and apparently adopted without objective basis) is not sufficient PAP adherence.
- The goal should be all night every night.

## Limitations

- Both risk factors and response to treatment for OSA, as well as frequency and types of comorbid conditions, may vary among ethnic groups.
- Patients were excluded from the study for severe daytime sleepiness, severe hypoxemia, or Cheyne–Stokes respiration.

## Central sleep apnea
## Cheyne-Stokes respirations




## Treatment of Predominant Central Sleep Apnea by Adaptive Servo Ventilation in Patients With Heart Failure (SERVE-HF) trial

Adaptive servoventilation for central sleep apnea in systolic heart failure.

Cowie MR, Woehrle H, Wegscheider K, et al.

N Engl J Med. 2015;373:1095–105

## SERVE-HF trial

1325 patients with heart failure with reduced ejection fraction (HFrEF) and co-existing central sleep apnea (CSA) treated with ASV

Primary end point: the composite of all-cause mortality, life-saving cardiovascular interventions, or unplanned hospitalizations for worsening heart failure.

## SERVE-HF trial

- The intention-to-treat analysis showed no significant difference between individuals randomly assigned to ASV and those randomly assigned to control for the primary end point (P=0.10). However, the ASV group experienced significantly **higher all-cause and cardiovascular mortality** than the control group (HR 1.28 [P=0.01], and HR 1.34 [P=0.006], respectively), and no improvement in quality of life.
- The authors concluded that the ASV device used (Auto CS, ResMed, USA) increased mortality without improving quality of life and, therefore, should not be used in HFrEF patients with CSA (in patients with LVEF<45%).

## Limitations

- Substantial nonadherence to the study protocol: 29% of patients either discontinued or never used ASV, while 16% of patients randomly assigned to control crossed-over to positive airway pressure therapy.
- ASV compliance was low, averaging only **3.4 h** per night one year postrandomization. This low adherence suggests that subjects remained exposed to CSA during a substantial length of time when ASV was not worn

## Limitations

- ASV device used has relatively high default pressures as part of its ventilation algorithm (minimum end-expiratory pressure of 5 $cmH_2O$ and minimum inspiratory pressure support of 3 $cmH_2O$), making it more likely to induce hyperventilation and to lower cardiac output in those with normal or low left ventricular filling pressures than a device with lower default pressures

## Treating sleep apnea is cheap:
cost per quality-adjusted life-year (QALY)

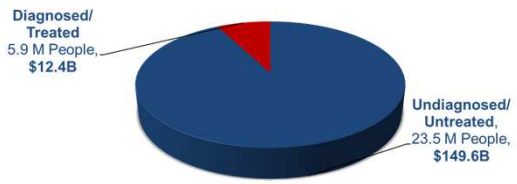
- Med management of ischemic heart disease ➢ $8,300
- Intensive lifestyle intervention for preDM ➢ $8800
- Drug treatment of hypertension ➢ $4,800-$50,000
- Implantation of AICD in pt with low EF ➢ $47,000
- Diagnosis and treatment of OSA ➢ $9,200-$13,400

Cost justification for diagnosis and treatment of obstructive sleep apnea: position statement of the American Academy of Sleep Medicine. Sleep. 2000;23:1017-1018.

## Costs Associated with OSA in United States in 2015

**$162.0 B**

*Annual per patient diagnosis and treatment costs are 67% less than leaving patients undiagnosed.*




Source: [1]Primary research with experts, secondary clinical research, U.S. Census (2014), Peppard "Increased Prevalence of Sleep-disordered Breathing in Adults." American Journal of Epidemiology (2013), Frost & Sullivan Patient Survey

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# Cost Burden of OSA in the Undiagnosed vs. Diagnosis & Treatment Costs

| Undiagnosed | | Diagnosed | |
|---|---|---|---|
| # People with OSA | 23,500,000 | | 5,900,000 |
| | Cost of Undiagnosed OSA ($US Bil) | | Cost of Diagnosed OSA ($US Bil) |
| Comorbidities & Mental Health | $30.0 | Diagnosis, Testing and Follow Up | $0.8 |
| Motor Vehicle Accidents | $26.2 | Non-surgical Treatment | $6.2 |
| Workplace Accidents | $6.5 | Surgical Treatment | $5.4 |
| Lost Productivity | $86.9 | | |
| **Total Costs ($US Bil)** | **$149.6** | | **$12.4** |
| Cost per Person | $6,336 | | $2,105 |

Source: [1]Primary research with experts, secondary clinical research, U.S. Census (2014), Peppard "Increased Prevalence of Sleep-disordered Breathing in Adults." American Journal of Epidemiology (2013), Frost & Sullivan Patient Survey,

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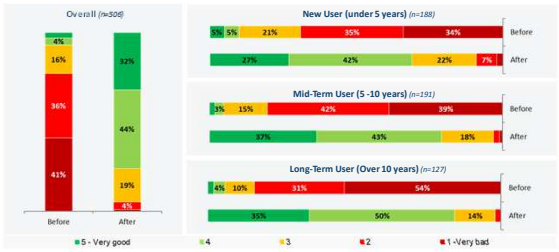
# Quality of Sleep - Overall

## Before and after sleep apnea treatment

**76% reported the quality of their sleep as 'good'/'very good' after treatment (vs. 7% before treatment). While all user groups indicate improvement, long-term users have the most positive impact after treatment (85%).**




On a scale of 1 meaning 'very bad' to 5 meaning 'Very good', how would you rate the quality of your sleep before and after treatment for sleep apnea? (Percentages under 3% not shown for transparency).

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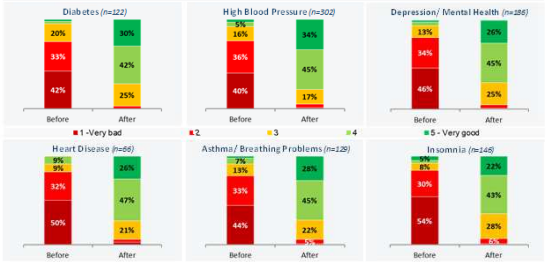
# Quality of Sleep Across Comorbidities

## Before and after sleep apnea treatment

**A high proportion of respondents with comorbidities declare their sleep quality as 'good'/'very good' after treatment. The biggest difference is among High Blood Pressure patients (79% vs 8% before treatment.) and the smallest among Insomnia patients (65% vs. 8% before treatment.)**

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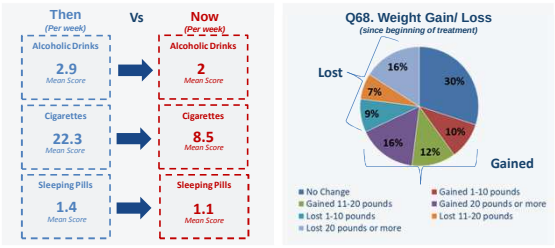
## Substance Abuse and Weight

Before and after sleep apnea treatment







Q62-Q67. Before treatment how many cigarettes/ alcoholic drinks/ sleeping pills did you smoke/ drink/ take on average per week? And how many since treatment?

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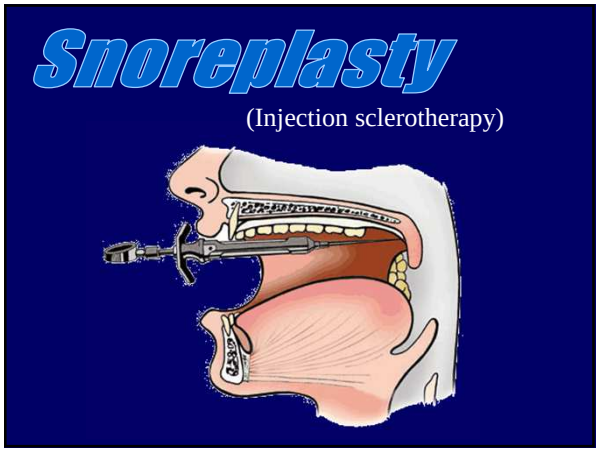
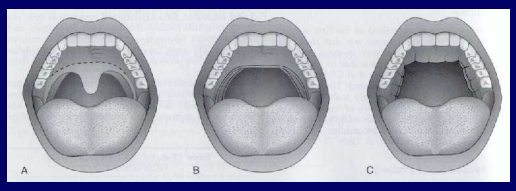
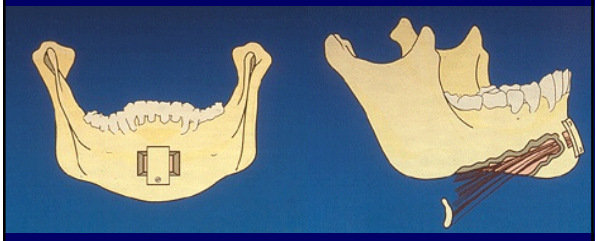
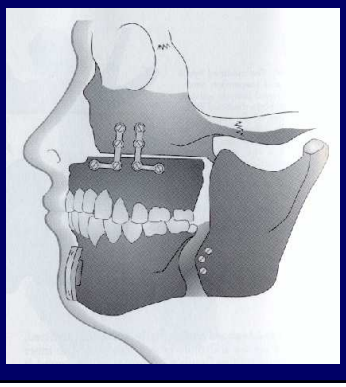




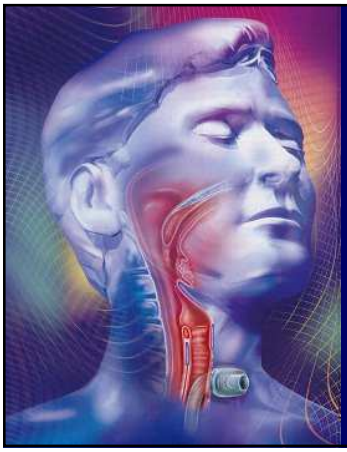

## Mandibular Osteotomy with Genioglossus advancement



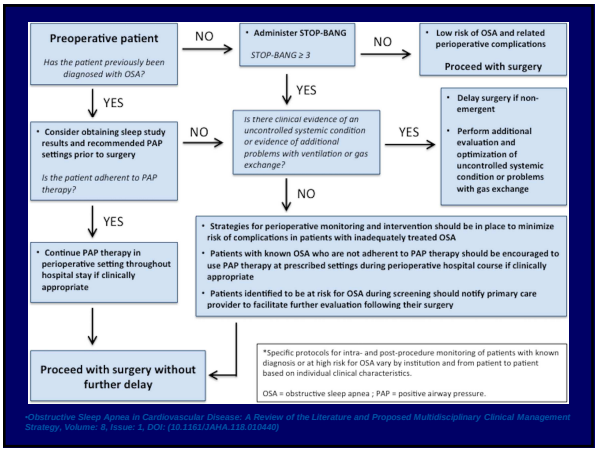
## Maxillomandibular advancement osteotomy



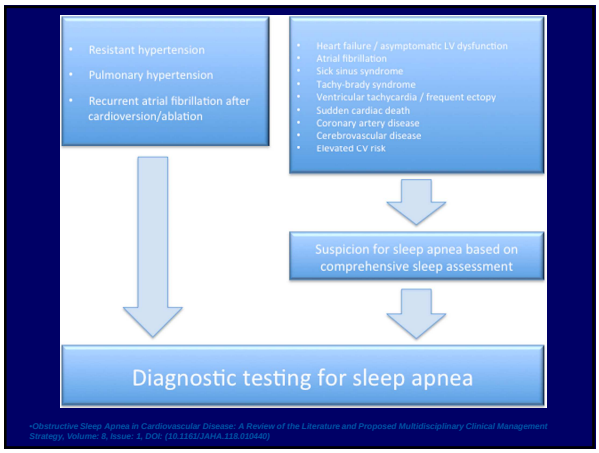
## Tracheostomy



- ✓Morbid obesity
- ✓Severe facial deformity
- ✓Significant cardiac arrhythmias
- ✓CPAP/BiPAP intolerance




•Obstructive Sleep Apnea in Cardiovascular Disease: A Review of the Literature and Proposed Multidisciplinary Clinical Management Strategy, Volume: 8, Issue: 1, DOI: (10.1161/JAHA.118.010440)


Resistant hypertension
Pulmonary hypertension
Recurrent atrial fibrillation after cardioversion/ablation
Heart failure / asymptomatic LV dysfunction
Atrial fibrillation
Sick sinus syndrome
Tachy-brady syndrome
Ventricular tachycardia / frequent ectopy
Sudden cardiac death
Coronary artery disease
Cerebrovascular disease
Elevated CV risk
Suspicion for sleep apnea based on comprehensive sleep assessment
Diagnostic testing for sleep apnea
•Obstructive Sleep Apnea in Cardiovascular Disease: A Review of the Literature and Proposed Multidisciplinary Clinical Management Strategy, Volume: 8, Issue: 1, DOI: (10.1161/JAHA.118.010440)