

The “Skinny” on Sleep & Heart Disease

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DEFINITIONS: SLEEP DISORDER

- A sleep disorder is a medical disorder of the sleep patterns of a person or animal.
- Some sleep disorders are serious enough to interfere with normal physical, mental and emotional functioning.
- We test for sleep disorders by performing a polysomnograph (sleep study).

DEFINITIONS: SLEEP APNEA

- Obstructive sleep apnea (OSA) is the most common category of sleep-disordered breathing.
- The muscle tone of the body ordinarily relaxes during sleep, and at the level of the throat the human airway is composed of collapsible walls of soft tissue which can obstruct breathing during sleep.
- Mild occasional sleep apnea, such as many people experience during an upper respiratory infection, may not be important, but chronic severe obstructive sleep apnea requires treatment to prevent low blood oxygen (hypoxemia), sleep deprivation, and other complications.
- The most serious complication is a severe form of congestive heart failure (*cor pulmonale*).

DEFINITIONS: NORMAL SLEEP

- Normal sleep is classified into two categories: Nonrapid Eye Movement (NREM) and Rapid Eye Movement (REM).
- In NREM sleep, parasympathetic tone increases and sympathetic tone decreases.
- The result is a reduction in HR, BP, systemic vascular resistance, and C.O with an increase in cardiac electrical stability.
- This parasympathetic dominance is cyclically interrupted during the transition from NREM to REM
- Sleep is considered a period of cardiovascular tranquility since NREM sleep accounts for about 75-85% of the sleep time in normal healthy adults.

Types of Sleep Disorders

- Obstructive Sleep Apnea (OSA)

Types of Sleep Disorders

- Obstructive Sleep Apnea

The upper airway is partially obstructed to airflow and is reduced greater than 50 % (hypopnea)

Or you have a complete reduction to airflow (apnea)

Types of Sleep Disorders

- Obstructive Sleep Apnea (OSA)
- Central Sleep Apnea (CSA)

Types of Sleep Disorders

- Central Sleep Apnea (CSA)

Decreased breathing rate or depth, particularly during sleep due to a transient reduction or withdrawal of central neural output to the diaphragm and intercostal muscles.

(Constitutes 5-10% of all apnea cases)

Types of Sleep Disorders

- Obstructive Sleep Apnea (OSA)
- Central Sleep Apnea (CSA)
- Upper Airway Resistance Syndrome (UARS)

Types of Sleep Disorders

- Upper Airway Resistance Syndrome (UARS)

Flow limitation with a switch to mouth breathing, SpO₂ is maintained to a minimum of 92%.

Chronic insomnia is more common with UARS

Younger subjects report parasomnias- most common is sleep walking with or without sleep terrors and a confusional arousal.

B/P is usually below 90mmHg

Patients complain of muscle pain, fainting, light headedness upon standing.

UARS may be misinterpreted as chronic fatigue syndrome or fibromyalgia, or occasionally prompt a referral to psychiatry.

Types of Sleep Disorders

- Obstructive Sleep Apnea (OSA)
- Central Sleep Apnea (CSA)
- Upper Airway Resistance Syndrome (UARS)
- Periodic Leg Movements of Sleep (PLMS)

Types of Sleep Disorders

- Periodic Leg Movements of Sleep (PLMS)

A burst of EMG activity in the anterior tibialis muscle for 0.5 sec & not longer than 5 seconds.

With 4 consecutive movements lasting 4 to 90 seconds.

A mean total for 5 or more PLMS per hour of sleep is considered abnormal.

Types of Sleep Disorders

- Obstructive Sleep Apnea (OSA)
- Central Sleep Apnea (CSA)
- Upper Airway Resistance Syndrome (UARS)
- Periodic Leg Movements of Sleep (PLMS)
- Restless Legs Syndrome (RLS)

Types of Sleep Disorders

- Restless Legs Syndrome (RLS)

Diagnosed only by interviewing the patient. Prevalent in women more than men.

Runs in families and probably has a genetic origin

Associated with low levels of iron, symptoms usually develop by age 30.

Characterized by 4 core clinical symptoms:

1. An urge to move the legs that is often accompanied by an uncomfortable sensation
2. The urge to move worsens when the person is at rest.
3. Upon movement, the urge is at least temporarily relieved.
4. The urge to move worsens later in the day, most commonly around bed time.

Who's at risk for OSA?

- Men 30%
- Women 10%
- Non Obese: 25%
- Obese: 45%
- Obese children: 46%
- Craniofacial abnormalities
- Increasing age- until age 65 (plateau)
- Recent estimates suggest that 60% of the Adult population is over weight (BMI \geq 25kg/m)
- At least 30% is obese (BMI \geq 30kg/m)

Orlgen et al. Prevalence of overweight and obesity in the United States. JAMA.2006

The cycle to Heart Disease

- OSA is characterized by the repetitive collapse and reopening of the upper airway during sleep.
- The repetitive collapse leads to markedly reduced (hypopnea) or absent (apnea) airflow, followed by oxyhemoglobin desaturation
- The increased work of breathing results in disruption of sleep (arousals) and activation of upper-airway muscles that reopen the airway.
- During airway collapse, the resistance to air flow results in increased respiratory effort and intrathoracic pressure swings.

The cycle to Heart Disease

- The intrathoracic pressure swings during the apneic/hypopneic events can be extreme (up to -80 cmH₂O)
- This results in an increase in cardiac afterload. (by increasing the LV transmural pressure, increasing LV wall stress/tension)
- This increase in pressure on the heart impairs LV relaxation (contributing to a decreased stroke volume and cardiac output)

Shimmi T. et al. Leftward shift of the interventricular septum and pulsus paradoxus in obstructive sleep apnea syndrome. Chest 1999;100:894

The cycle to Heart Disease

- The continuous presence of hypoxemia during the obstructive apneic events results in repetitive bursts of sympathetic neural activity, with increased activity noted even during the day, along with elevated catecholamine levels.
- The repeated arousals from OSA also lead to increases in heart rate and blood pressure.
- All these factors result in an increase in oxygen demand.

Shimmi, T. et al Leftward shift of the interventricular septum and pulsus paradoxus in obstructive sleep apnea syndrome. Chest 1999;100:894

The cycle to Heart Disease

- Obesity is considered a major risk factor for the development and progression of OSA.
- Prevalence of OSA in obese or severely obese patients is nearly twice that of normal-weight adults.
- Patients with OSA who GAIN 10% of their baseline weight are at a sixfold-increased risk for worsening OSA severity.
- An equivalent weight LOSS can result in a more than 20% improvement in OSA severity.

D. Escada, et al. Obstructive sleep apnea-hypoxemia and related clinical features in a population based sample of subjects aged 30 to 79 yr. Am J Respir Crit Care Med. 2002;165(9):1168-689.

The cycle to Heart Disease

- Snoring and Daytime sleepiness are frequently associated with OSA.
- Many of the risk factors for OSA are the same for Cardiovascular Disease.
- Vibration produced from snoring, which is common in patients with OSA, may lead to carotid vessel wall damage, perhaps resulting in the formation of atherosclerotic plaques.
- Sleep fragmentation is a consequence of OSA
- Short sleep (<6hr/NOC) has been linked to metabolic dysregulation independent of obesity.

Lee SA, et al. Heavy snoring as a cause of carotid artery atherosclerosis. Sleep 2008;31:1077

Anatomy around OSA

- Obesity worsens OSA because of fat deposition in specific areas.
- Fat deposition in the tissues surrounding the upper airway appears to result in a smaller lumen and increased collapsibility of the upper airway, predisposing to apnea.
- Fat deposits around the thorax reduce chest compliance and functional residual capacity, and may increase oxygen demand.
- Visceral obesity is common in subjects with OSA

Shelton KE, et al Pharyngeal fat in obstructive sleep apnea. Am Rev Respir Dis. 1993;148(1):410-418

Cardiac Rhythms

- The annual rate of sudden cardiac death is nearly 40 times higher than that in the matched non-obese population.
- Various kinds of cardiac arrhythmias have been reported to be related to OSA (especially for moderate and severe forms of the disease), which may contribute to cardiovascular morbidity and probably to cardiac mortality in patients with OSA.
- Systemic hypertension, congestive heart failure, arrhythmias such as AF, strokes, sudden cardiac death, and pulmonary hypertension.

Alonso-Fernandez A, et al Cardiac rhythm disturbances and ST segment depression episodes in patients with obstructive sleep apnea-hypoxemia syndrome and its mechanisms. Chest 2005;127:15-22

Cardiac Rhythms

- The prevalence of atrial fibrillation is also increased in patients with arterial hypertension; and the development of left-ventricular hypertrophy, either secondary to left-ventricular hypertrophy or due to OSA independently.
- Obesity increases total blood volume and cardiac output, resulting in increased cardiac workload.
- There is an increase in ventricular filling pressures and volumes leading to left ventricular chamber dilation and hypertrophy.

Arias MA, et al Obstructive sleep apnea syndrome affects left ventricular diastolic function: Effects of nasal continuous positive airway pressure in men. Circulation 2005;112:375-383

Acute Effects of oSA

- Systemic Hypoxemia:
- Cessation of airflow (apnea) results in systemic hypoxemia that leads to progressive chemoreflex-mediated increase in sympathetic activity.
- This response is amplified by CO₂ retention, which also activates the chemoreflexes.
- Hypoxia can depress the cardiac contractility and cardiac performance.

Chronic Effects of OSA

- Obesity appears to be a chronic inflammatory state, as evidenced by elevated levels of serum markers of systemic inflammation such as C-reactive protein (CRP), which can predispose to cardiovascular disorders.
- Sustained sympathetic hyperactivity could be a key factor for the development of a great variety of inflammatory and metabolic disturbances.
- OSA may lead to the development of both insulin resistance and to individual components of metabolic syndrome independently of obesity.

Chronic Effects of OSA

- Metabolic abnormalities and insulin resistance may conceivably lead to diabetes mellitus, a chronic effect of untreated OSA.
- Serum levels of amyloid A appear to be increased in patients with moderate to severe OSA and may be pathophysiologically linked to intermittent hypoxemia or sleep deprivation.
- An increase of markers of systemic atherosclerosis have been reported in patients with OSA including calcified carotid arteries, atheroma, and increased carotid wall thickness.

Chronic Effects of OSA

- Leptin is a hormone produced by adipose tissue
- Binds to the hypothalamus
- This binding signals the brain that the body has had enough to eat.
- Sleep deprivation in short sleep inhibits leptin production, suggesting a potential mechanism for development of obesity.
- Conversely, obese subjects have increased leptin levels it is believed there is a desensitized cellular responses to leptin.

Spiegel K et al. Leptin levels are dependent on sleep duration; relationships with sympathovagal balance, carbohydrate regulation, cortisol, and thyrotropin. J Clin Endocrinol Metab. 2004;88(11):2672-2677.

Chronic Effects of OSA

- Some studies have suggested that OSA may lead to cardiac structural changes, explained as an adaptive response to the consequent physiologic stressors
- AF, an important risk factor for heart failure, is associated with the degree of oxyhemoglobin desaturation.
- Several studies have shown an association between OSA and various nocturnal arrhythmias.
- Continuous cardiac monitoring with an atrial defibrillator showed that the onset of nearly 75% of episodes of persistent AF in OSA patients occurred between 8:00pm to 8:00am.

Mitchell RB et al. Circadian variation of arrhythmia onset patterns in patients with persistent atrial fibrillation. Am Heart J 2003;146:902.

Chronic Effects of OSA

- The risk of cardiac arrhythmias with OSA appears to be related to severity of the disease, such that the majority of OSA patients presenting significant arrhythmias have moderate or severe forms of the disease
- The most common rhythm abnormality seen is marked sinus arrhythmia. Characterized by bradycardia during the apneic phase with subsequent tachycardia on resumption of respiration.
- This arrhythmia has been proposed as a predictor of a positive diagnosis of OSA.

Chronic Effects of OSA

- Recently a study has shown that undiagnosed OSA was present in approximately half of patients with pacemakers implanted for the management of symptomatic bradycardia, AV block, or heart failure.
- Therefore, we as clinicians must be aware and diagnose and treat patients primarily referred for pacemaker therapy for previously undiagnosed OSA, thus potentially avoiding the need for pacemaker implantation in some patients.
- In a series of 239 OSA subjects, episodes of second and third degree AV block and sinus arrest of more than 2 seconds occurred in 17 patients.

Garrigue S et al. High prevalence of sleep apnea syndrome in patients with long-term pacing. The European multicenter polysomnographic study. Circulation 2007.

Sudden Death

- Study of mortality in a pure heart failure population with OSA suggested high death rates in those who were noncompliant with CPAP compared with those who had mild or no OSA.
- In 60-80% of cases, sudden cardiac death occurs in the setting of CAD and is primarily caused by ventricular tachycardia degenerating into ventricular fibrillation.
- Sudden cardiac death occurs more commonly during sleeping hours in patients with OSA.

Gami AS et al. Day-night pattern of sudden death in obstructive sleep apnea. N Engl J Med 2005;353:1206-1214

Diabetes & Insulin Resistance

- Sleep complaints are very common in the diabetic patient.
- Patients with Type 2 diabetes have higher rates of insomnia than non-diabetic people.
- The Sleep Heart Health Study reported that diabetes is often associated with both obstructive and central sleep apnea.

Gottlieb DJ et al. Prospective study of obstructive sleep apnea and incident coronary heart disease and heart failure: the Sleep Heart Health Study. Circulation 2008

Diabetes & Insulin Resistance

- Multiple studies have related sleep time to the development and/or worsening of diabetes, metabolic syndrome, and hypertension.
- Individuals who get less than 6 hours or more than 8 hours per night develop these conditions much more often than those that sleep 7-7.5 hours per night.
- Sleep disordered breathing increases sympathetic nerve activity and catecholamine release, which may promote hyperinsulinemia.
- This association between OSA and insulin resistance was seen in both obese and non-obese patients.

Diabetes & Insulin Resistance

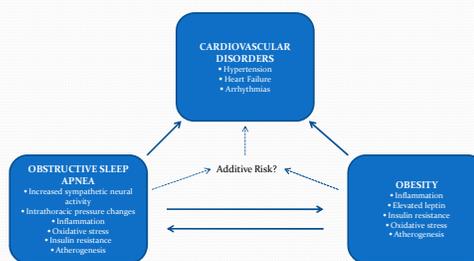
- The American Diabetes Association recommends that all diabetic patients be screened of OSA.
- Shift workers, who are typically short sleepers, have been found to have more diseases than non-shift workers.



Fun Facts

- Officials estimate 10 million Americans have the condition but have not been diagnosed.
- Sleep apnea affects up to 18 million Americans.
- Sleep apnea in children has been linked to Attention Deficit/Hyperactivity Disorder (ADHD) Some studies suggest sleep apnea runs in families.
- People with sleep apnea are 3 times more likely to be involved in motor vehicle accidents.
- Smoking and alcohol use increase the risk of sleep apnea.
- African-Americans, Pacific Islanders, and Mexican-Americans may be at increased risk for sleep apnea.
- Often a spouse or other family member is the first to notice signs of sleep apnea- not the person with the condition.

Summary



Testing for OSA

- Have a Polysomnography (sleep study)
- Sometimes referred to as a Polysomnogram (PSG)
- Performed by a RPSGT, certified by the American Association of Sleep Technicians (AASST)
- Performed by a RRT, certified by the National Board for Respiratory Care



Epworth Sleepiness Scale

SITUATION	CHANCE OF DOZING
Sitting & Reading	
Watching TV	
Sitting inactive in a public place	
As a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after lunch without alcohol	
In a car, while stopped for a few minutes in traffic	

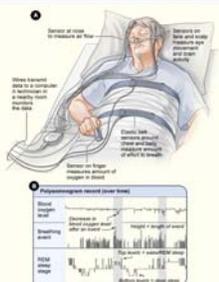
- 0 = no chance of dozing
- 1 = slight chance of dozing
- 2 = moderate chance of dozing
- 3 = high chance of dozing

Epworth Sleepiness Scale

SCORE RESULTS	
1 - 6	Within Normal Limits
4 - 8	Moderately Sleepy
9 & Over	Excessively Sleepy (seek physician)



Hook Me Up!



Hook Me Up!



Reading AHI

- AHI = Apnea to Hypopnea Score
- Classify Apnea: lack of airflow for ≥ 10 seconds
- What's Hypopnea? Excessive shallow breathing or abnormally Low RR. Reduction of airflow $> 50\%$
- AHI Index is used to classify the severity of OSA's in objective measures.
- AHI Score:
 - Mild ≥ 5 Events
 - Moderate ≥ 15 Events
 - Severe ≥ 30 Events

Treatment

- Most common treatment and most effective is Continuous Positive Airway Pressure (CPAP).
- It has shown benefits in dozens of randomized controlled trials.
- Benefits include reducing daytime sleepiness, improving quality of life, and lowering blood pressure.
- CPAP use in OSA has shown to decrease visceral fat accumulation in OSA patients, without an overall decrease in BMI.

Treatment

- CPAP has been shown to reduce the higher sympathetic nervous system activity.
- CRP levels, and Amyloid A (inflammation) levels may also be reduced with the application of CPAP.
- Weight loss may produce beneficial changes in cholesterol, insulin resistance, leptin, inflammatory markers and endothelial function.
- All associated with OSA and obesity.

Treatment

- Data to support an improvement in systolic and diastolic ventricular function observed in OSA patients correctly treated with CPAP.
- Supraventricular tachycardias have been reported in several studies that CPAP treatment markedly reduced the occurrence of these events in OSA subjects.
- One study recorded a complete elimination of nocturnal bradyarrhythmias (No history of cardiac disease) after 8 months of CPAP.
- 47% had bradyarrhythmias prior to the study.

Treatment

- OSA patients with Type 2 diabetes, CPAP has been linked to better glycemic control and improved insulin sensitivity.
- Diabetic patients who used CPAP for at least 4 hours had significant decreases in fasting and after meal sugar levels.
- Use of CPAP for more than 4 hours resulted in better control of sugar levels and fewer days with elevated levels.
- CPAP is thought to reverse the impairment in glucose homeostasis caused by OSA.

Weight Loss

- We have seen a link that bariatric surgery provides better survival and fewer cardiovascular events at mid- and long-term follow-up.
- However, there are risks and complications that can be linked as well.
- The 30-day mortality has been reported to be as high as 2.0 - 4.6% at 1 year.
- A lifestyle change in diet habits and exercise is still most recommended.

Surgical Options

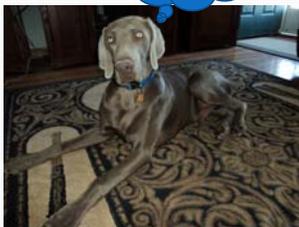
- Nasal Reconstruction: Deviated septum, nasal valve collapse and turbinate enlargement.
- Uvulopalatopharyngoplasty (UPPP) : removes uvula, tonsillar pillars, and lower part of the soft palate. (55% success)
- Genioglossus Advancement (GA): makes a hole I the mandible and pulling the base of the tongue forward.(Greater success % than UPPP)
- Maxillomandibular Advancement (MMA): cutting of the jaw bones and enlarging the posterior airway space up to 12mm (95% success)
- Tracheostomy: Last choice

Summary

- The prevalence of untreated OSA is much higher than expected.
- OSA and Cardiovascular disease are almost parallel to each other.
- OSA is also linked to insulin resistance that can lead to Diabetes.
- Treatment is easy with CPAP to reverse many of the comorbid conditions when patients are compliant.
- Weight loss with a change in eating habits and exercise are still recommended in addition to CPAP therapy.

Thank You!

I have questions, Mom!



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