Diseases and Health Conditions that can Lead to Daytime Sleepiness

Indira Gurubhagavatula, MD, MPH
Associate Professor
Director, Occupational Sleep Medicine
University of Pennsylvania, Division of Sleep Medicine
Director, Sleep Disorders Clinic, Philadelphia VAMC Sleep Center
My background

- Research in screening for sleep apnea in commercial drivers
  - FMCSA-funded study
  - NIOSH/CDC-funded study

- Penn Occupational Sleep Medicine program

- Advisor to MCSAC/MRB at FMCSA in revising guidelines on sleep apnea management in commercial drivers

- Member of American Academy of Sleep Medicine’s Transportation and Safety Task Force
Two-process model

HOMEOSTATIC DRIVE FOR SLEEP

Endogenous Factors
- Stress
- Anxiety
- Urgency
- Motivation

Exogenous Factors
- Alcohol, caffeine
- Noise
- Workload
- Physical activity

CIRCADIAN DRIVE FOR WAKEFULNESS

Increased behavioral capability

Reduced behavioral capability
Disorders that cause sleepiness

- Length of wake time
- Duration and quality of sleep
- Time of day
Conditions associated with daytime sleepiness

- Obstructive sleep apnea
- Other sleep disorders (e.g., periodic limb movements/restless legs syndrome)
- Some medical, psychiatric disorders
- Some medications
- Others
Overview – Obstructive Sleep Apnea

- What is obstructive sleep apnea?
- Who is likely to have it?
- How common is it?
- What are the usual symptoms?
- What are the health and economic consequences?
- Can we diagnose it quickly and at low cost?
- Can it be treated?
  - Does treatment help?
  - Does treatment make sense economically?
a brain on sleep, and a brain with sleep apnea

HOURS OF SLEEP
sleep architecture during sleep apnea is disrupted by drops in oxygen level
sleep apnea: what actually happens?

AWAKE

ASLEEP

http://content.revolutionhealth.com/contentimages/n5551303.jpg

http://www.thetmjcenter.com/sleep_apnea.jpg
Why are some people at risk for sleep apnea?

- OBESITY
- OBESITY
- OBESITY
- Airway crowding
  - Large tonsils
  - Large tongue
  - Small jaw
- Middle age/older
- Male gender
- After menopause in women
- Alcohol, sedatives, narcotics
- Heredity
Snoring

http://www.thesnorestopper.net/articles/tag/sleep-apnea
Apnea
Awake – open airway
Asleep – blocked airway

http://www.thetmjcenter.com/sleep_apnea.jpg
Life with sleep apnea

worse with weight gain

NIGHTTIME

APNEAS, HYPOPNEAS (observed by others)
Snoring
Choking, Gasping
Frequent urination

LOW OXYGEN

ADRENALINE

AROUSALS

DAYTIME

• Sleepiness
  • ↑ Crash risk
• ↓ mood, memory, concentration, attention
• ↑ reaction time
• Morning headache
• Impotence
• ↓ productivity
• Absenteeism

LONG-TERM

• Hypertension
• Heart disease
• Stroke
• Pre-diabetes
• Death
studies have linked OSA to crashes

Obstructive Sleep Apnea and Risk of Motor Vehicle Crash: Systematic Review and Meta-Analysis

Stephen Tregear, Ph.D.¹; James Reston, Ph.D., M.P.H.²; Karen Schoelles, M.D., S.M.²; Barbara Phillips, M.D., M.S.P.H.³

<table>
<thead>
<tr>
<th>Study sample</th>
<th>Odds of crash</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 studies in car drivers; 2 in truck drivers</td>
<td>OR=1.21 -4.89</td>
</tr>
</tbody>
</table>

Tregear et al, JCSM 2009, Dec 15 5(6); 573-581.
obesity: a growing problem

http://www.cdc.gov/nchs/data/hestat/obesity_adult_09_10/obesity_adult_09_10.htm
as obesity becomes more common, so does sleep apnea

prevalence data from 1994 was used to model current prevalence rates, based on recent age, sex, BMI data from NHANES

<table>
<thead>
<tr>
<th>Prevalence of moderate to severe apnea</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994 (Young et al) (state employees, age 30-60 years)</td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>2007-2010 (Peppard et al)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-49 years</td>
<td>10%</td>
<td>3%</td>
</tr>
<tr>
<td>50-70 years</td>
<td>17%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Peppard, Am J Epidemiol, 177 (9):1006-1014; 2013
subgroups with high rates of sleep apnea

- Hypertension\textsuperscript{1,2,3}
  - 30-40\% have sleep apnea
    (60\% of patients with sleep apnea have hypertension)

- Hypertension requiring $\geq 3$ drugs to treat\textsuperscript{4}
  - 83\% have sleep apnea

- Obese, type 2 diabetes\textsuperscript{5}
  - 86\% have sleep apnea

\textsuperscript{1}Kales, Lancet, 1984
\textsuperscript{2}Williams, \textit{Am J Cardiol}, 1985
\textsuperscript{3}Lavie, \textit{Am Heart J}, 1984
\textsuperscript{4}Logan et al, J Hypertens, 2001
\textsuperscript{5}Foster et al, Diabetes Care, 2009
85% of people with sleep apnea do not know they have it.
in-lab sleep study

- Brain waves
- Eye movement
- Chin, leg muscles
- Chest and abdomen effort
- Airflow, snoring
- Oxygen level

85% of cases remain undiagnosed
Port 

Sleep Study

- Chest and abdomen effort
- Airflow, snoring
- Oxygen level

http://www.fette-thimm.de/img/embletta400.jpg
# Apnea-Hypopnea Index (AHI)

## Apneas + Hypopneas

### Hours of Sleep

<table>
<thead>
<tr>
<th>Severity</th>
<th>AHI (events/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>[0-5)</td>
</tr>
<tr>
<td>Mild</td>
<td>[5-15)</td>
</tr>
<tr>
<td>Moderate</td>
<td>[15-30)</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt;=30</td>
</tr>
</tbody>
</table>

AASM Task Force, Sleep, 1999
is sleep apnea treatable?
continuous positive airway pressure (CPAP)
continuous positive airway pressure (CPAP)
CPAP restores oxygen and consolidates sleep

Without CPAP
• Sleep fragmentation
• No N3, REM
• Low oxygen saturation

With CPAP
• Sleep consolidation
• REM rebound
• Slow wave sleep achieved
• Oxygen saturation restored
In addition to lowering AHI and improving oxygen level, what are the benefits of CPAP?

- **CPAP lowers**
  - health care costs\(^1,2,3\)
  - disability claims\(^3\)
  - absenteeism\(^3\)
  - workplace turnover\(^4\)
  - crash risk\(^6\)
  - blood pressure\(^7,8\)
  - heart disease, stroke\(^9,10,11\)
  - recurrence of stroke\(^11\)
  - mortality\(^12\)
  - atrial fibrillation\(^13\)

- **CPAP improves**
  - quality of life\(^5\)
  - alertness\(^6\)
  - performance on driving simulator\(^6\)

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\(^1\) Albarrak, Sleep, 2005  
\(^2\) Ronald, Sleep Res Online, 1998  
\(^3\) Hoffman, JOEM, 2010  
\(^4\) Osterberg, Sleep Apnea Trucking Conference, 2010  
\(^5\) Sanner, Eur Respir J, 2000  
\(^6\) Tregear, Sleep, 2010  
\(^7\) Haentjens, Archives Int Med, 2007  
\(^8\) Bazzano, Hypertension, 2007  
\(^9\) Buchner, AJRCCM, 2007  
\(^10\) Marin, Lancet, 2008  
\(^11\) Yaggi, NEJM, 2005  
\(^12\) Martinez-Garcia, Chest, 2005  
\(^13\) Martinez-Garcia, AJRCCM, 2009  
\(^13\) Fein, JACC, 2013
CPAP lowers crash risk

9 studies of crash risk in OSA patients showed that after treatment with CPAP:

- Crash risk dropped
  - risk ratio = 0.278, 95% CI: 0.22 to 0.35; P < 0.001
- Daytime sleepiness improved after one night
- Simulated driving performance improved within 2-7 days

*Funded by FMCSA GS-10F-0177N/DTMC75-06-F-00039*
Tregear, Sleep, 33(10):1373, 2010
Other therapies

- Second line:
  - oral appliance, upper airway surgery, others
- Weight loss
- Limit alcohol
- Limit sedatives, narcotics
- Avoid tobacco smoke
- Keep nasal passages open (control congestion, correct deviated septum)
- Sometimes stimulant therapy is offered in addition to CPAP, to treat residual sleepiness
How do we know if patients are using CPAP?

**MONITORING SYSTEMS**
- SD cards
- Remote/wireless

**REPORTED DATA**
- Hours of use
- Pressure level
- Residual apnea
- Mask leak

*Issues can be addressed in “real” time*
CPAP monitoring: sample
Summary

SLEEP APNEA
- is common
- causes sleepiness
- is linked to major economic and health outcomes, including crashes
- can be diagnosed in the home

CPAP treatment
- is inexpensive
- is accessible
- lowers crash risk
- improves many health conditions, costs
- is trackable in real-time
Questions?