October 21, 2014

Overcoming the Dangers of
DROWSY DRIVING
National Transportation Safety Board Forum

Diseases and Health Conditions that can Lead to Daytime Sleepiness

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My background

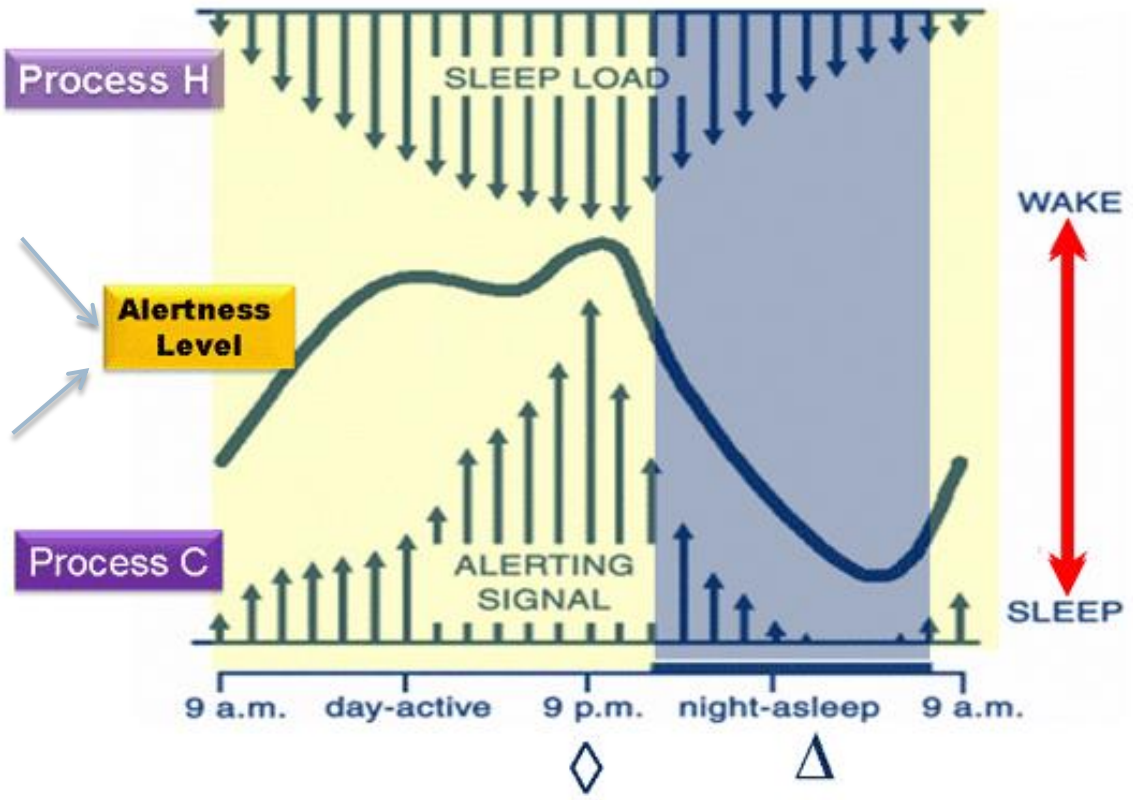
- Research in screening for sleep apnea in commercial drivers
  - FMCSA-funded study
  - NIOSH/CDC-funded study
- Penn Occupational Sleep Medicine program
- Advisor to MCSAC/MRB at FMCSA in revising guidelines on sleep apnea management in commercial drivers
- Member of American Academy of Sleep Medicine's Transportation and Safety Task Force

Two-process model

Endogenous Factors
- **Stress**
- **Anxiety**
- **Urgency**
- **Motivation**

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

HOMEOSTATIC DRIVE FOR SLEEP

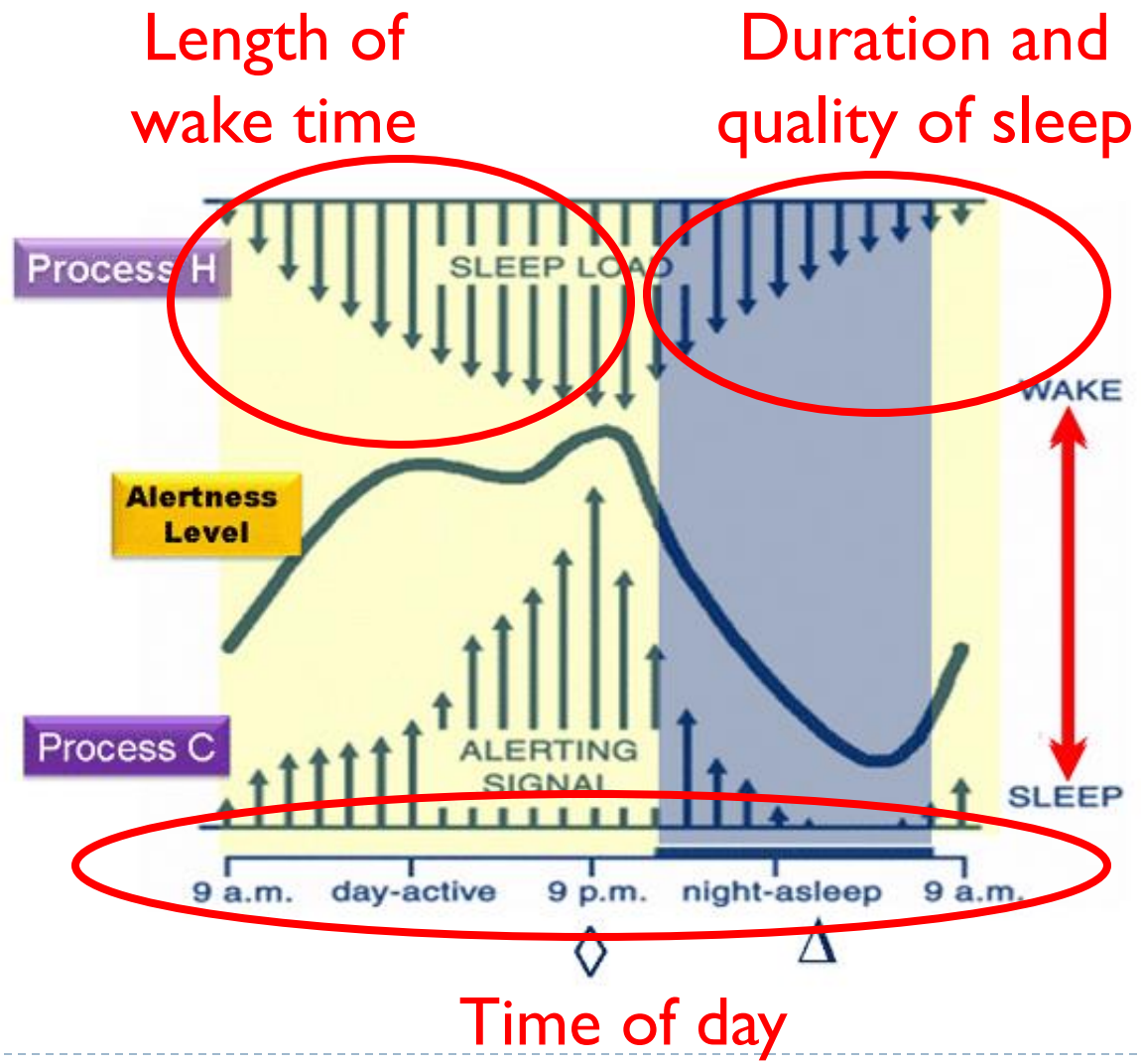


Increased behavioral capability

Reduced behavioral capability

CIRCADIAN DRIVE FOR WAKEFULNESS

Disorders that cause sleepiness



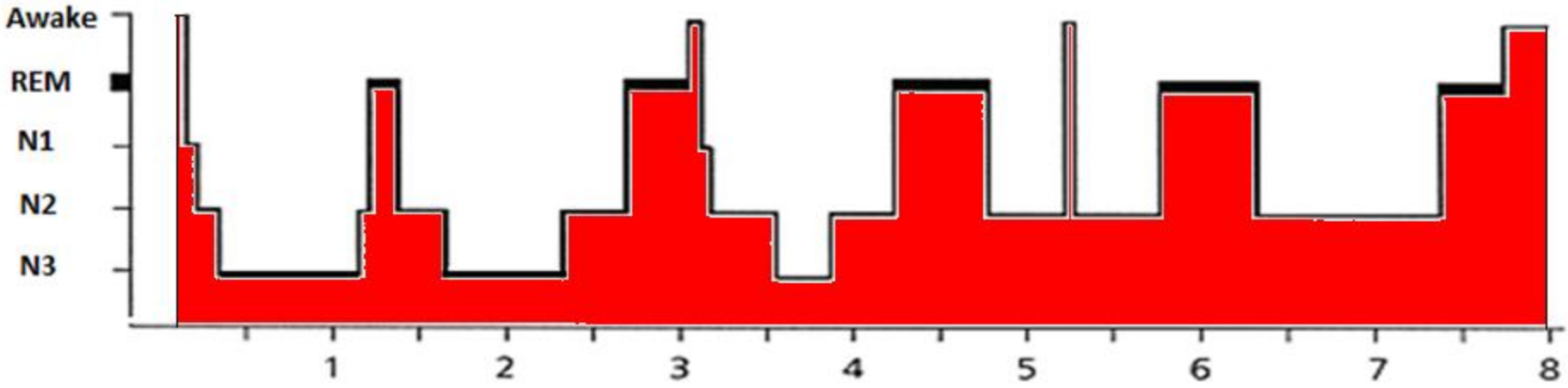
Conditions associated with daytime sleepiness

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

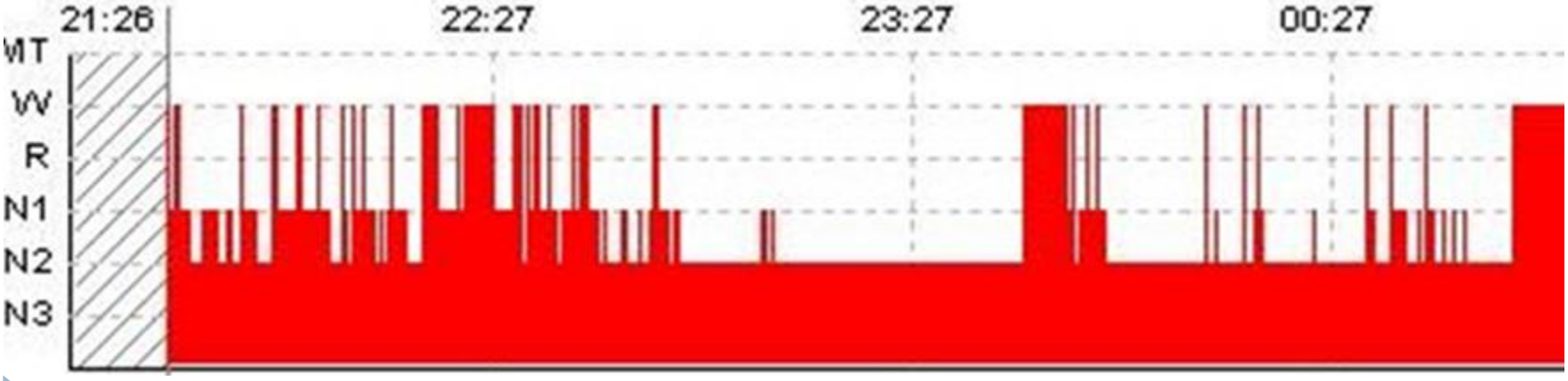
Overview – Obstructive Sleep Apnea

- 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?

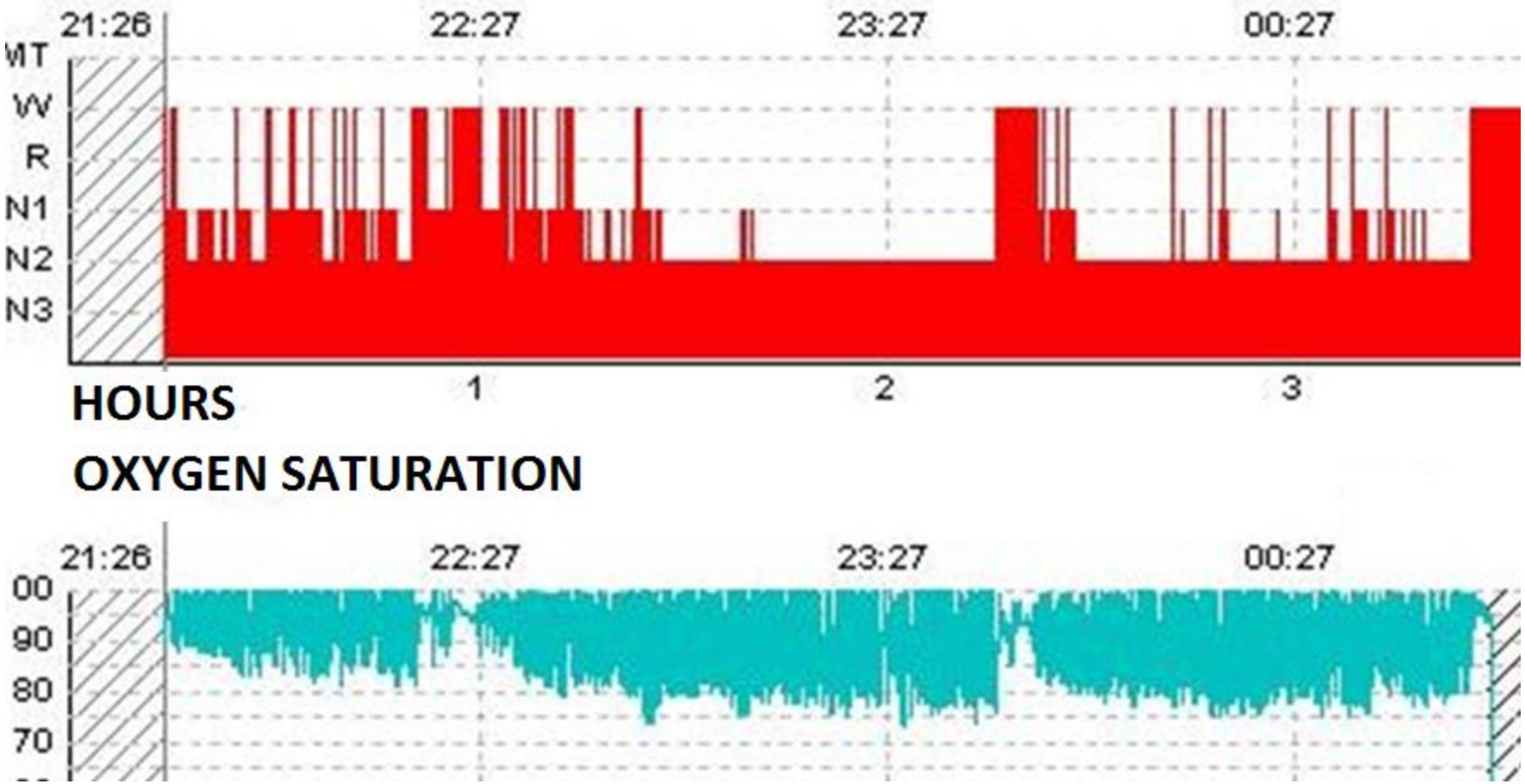
a brain on sleep, and a brain with sleep apnea



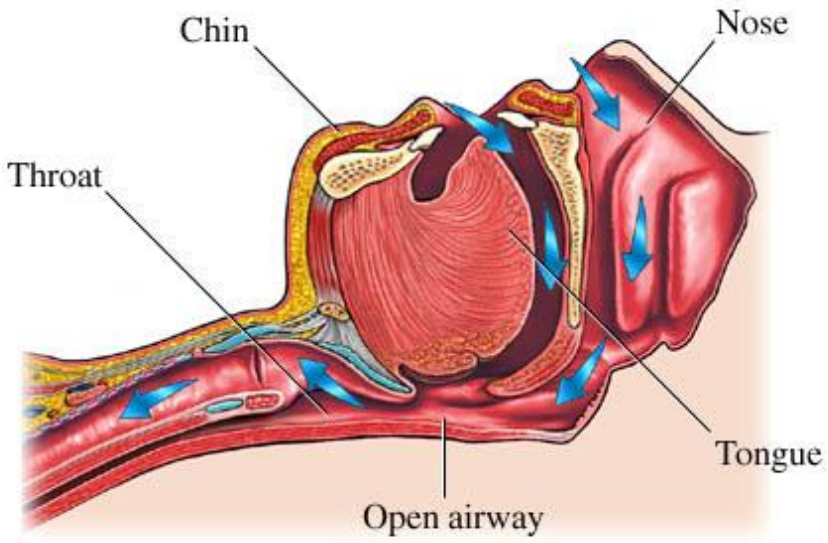
HOURS OF SLEEP



sleep architecture during sleep apnea is disrupted by drops in oxygen level

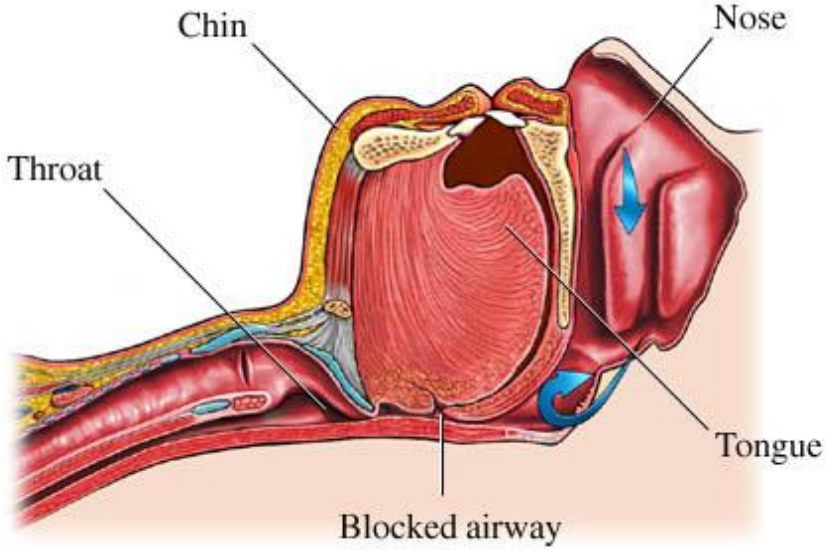


sleep apnea: what actually happens?



AWAKE

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



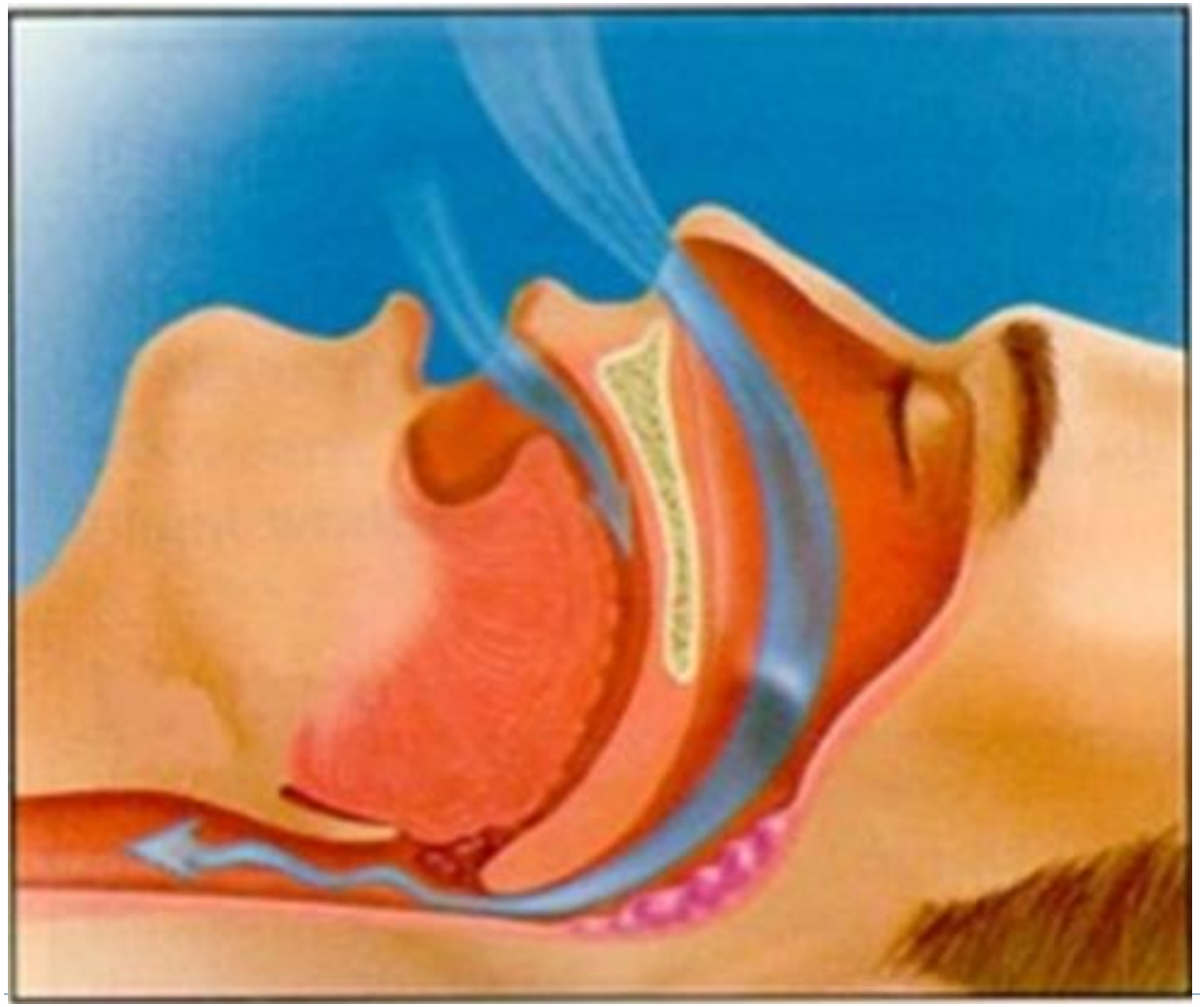
ASLEEP

http://www.thetmjcenter.com/sleep_apnea.jpg

Why are some people at risk for sleep apnea?

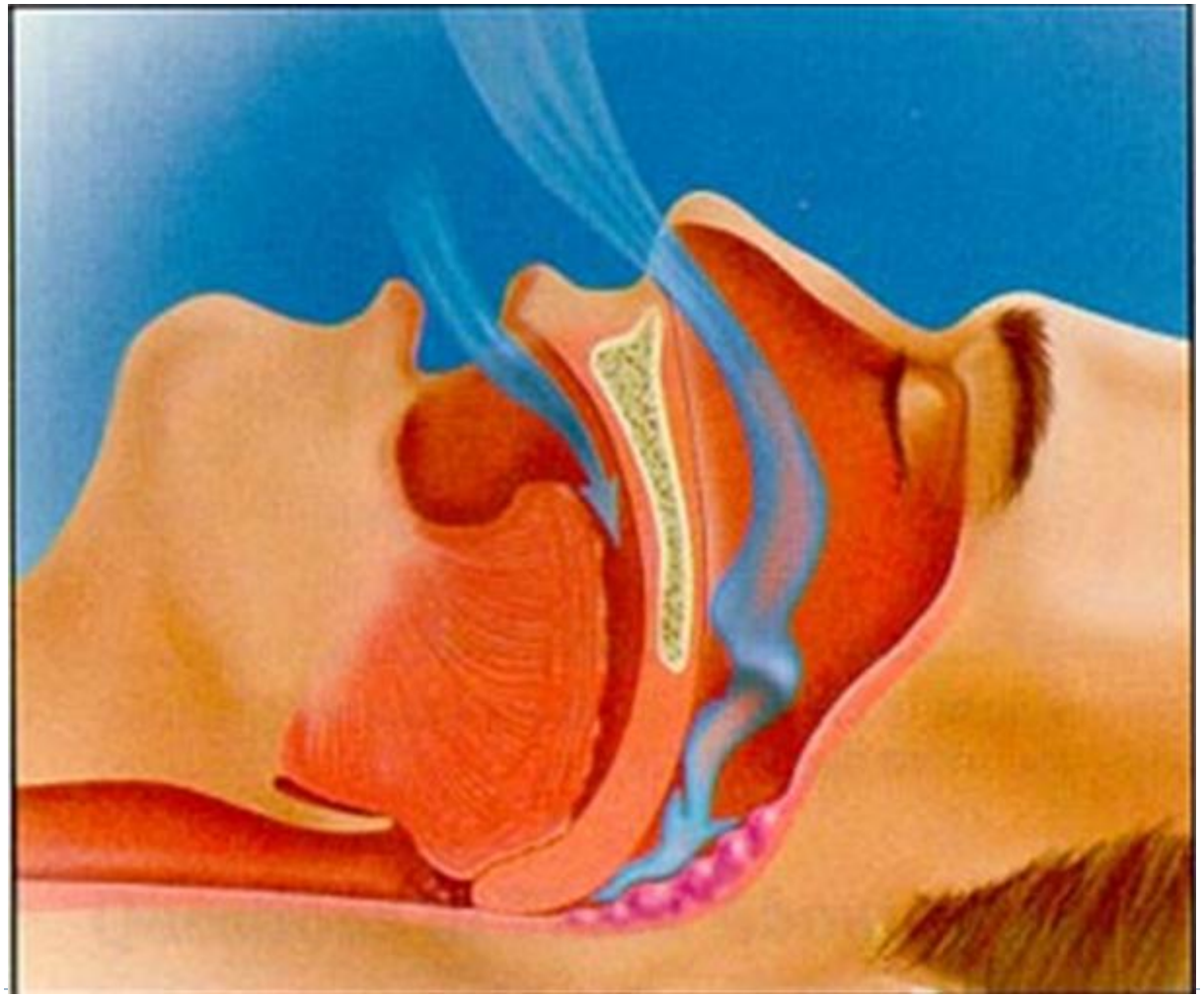
- OBESITY
- OBESITY
- OBESITY
- Airway crowding
  - Large tonsils
  - Large tongue
  - Small jaw
- Middle age/older
- Male gender
- After menopause in women
- Alcohol, sedatives, narcotics
- Heredity

Snoring



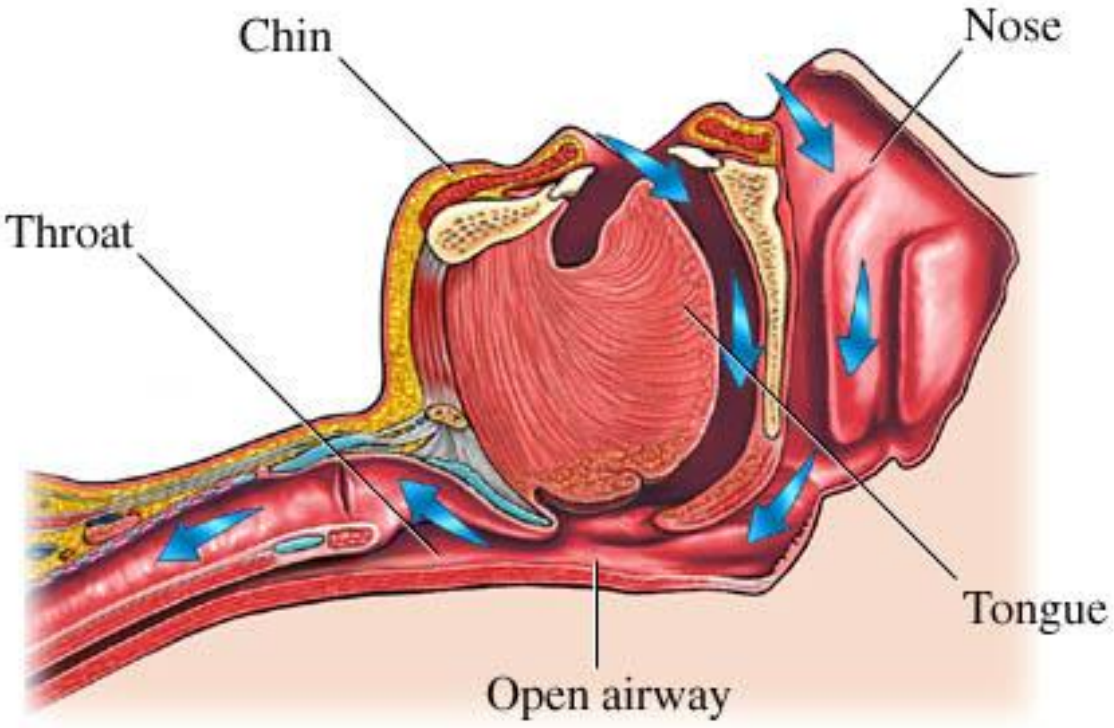
http://www.thesnorestopper.net/articles/tag/sleep-apnea

Apnea



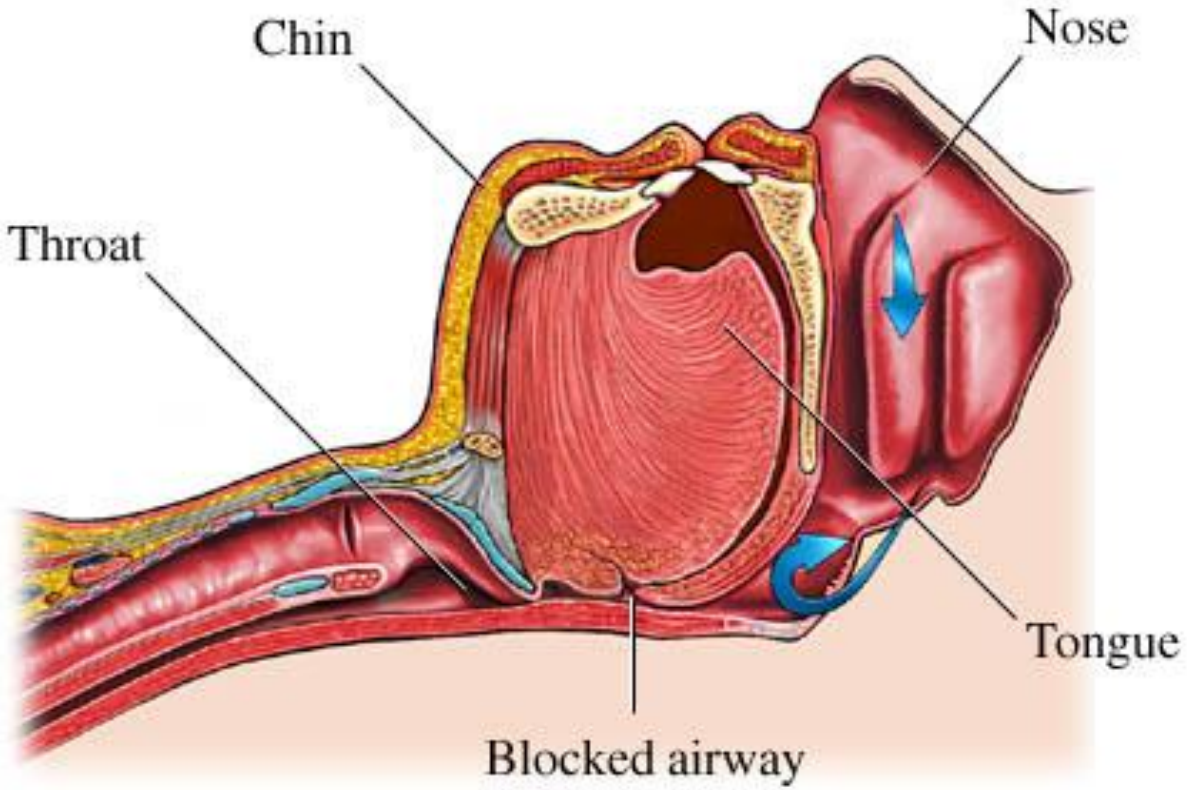
http://www.thesnorestopper.net/articles/tag/sleep-apnea

Awake – open airway



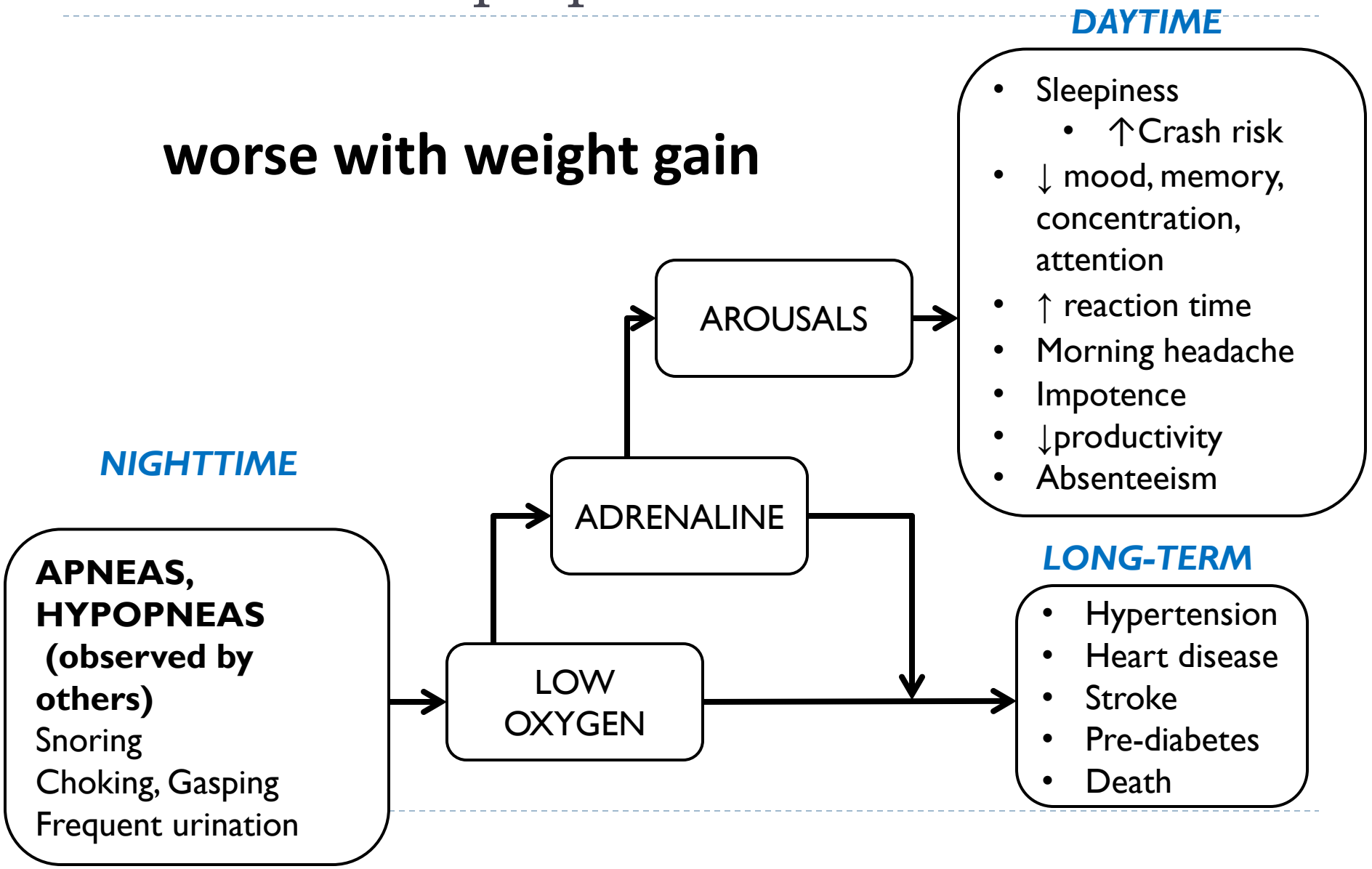
http://content.revolutionhealth.com/contentimages/n5551303.jpg

Asleep – blocked airway



http://www.thetmjcenter.com/sleep_apnea.jpg

Life with sleep apnea



studies have linked OSA to crashes

JCSM
Journal of Clinical Sleep Medicine

REVIEW ARTICLE

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

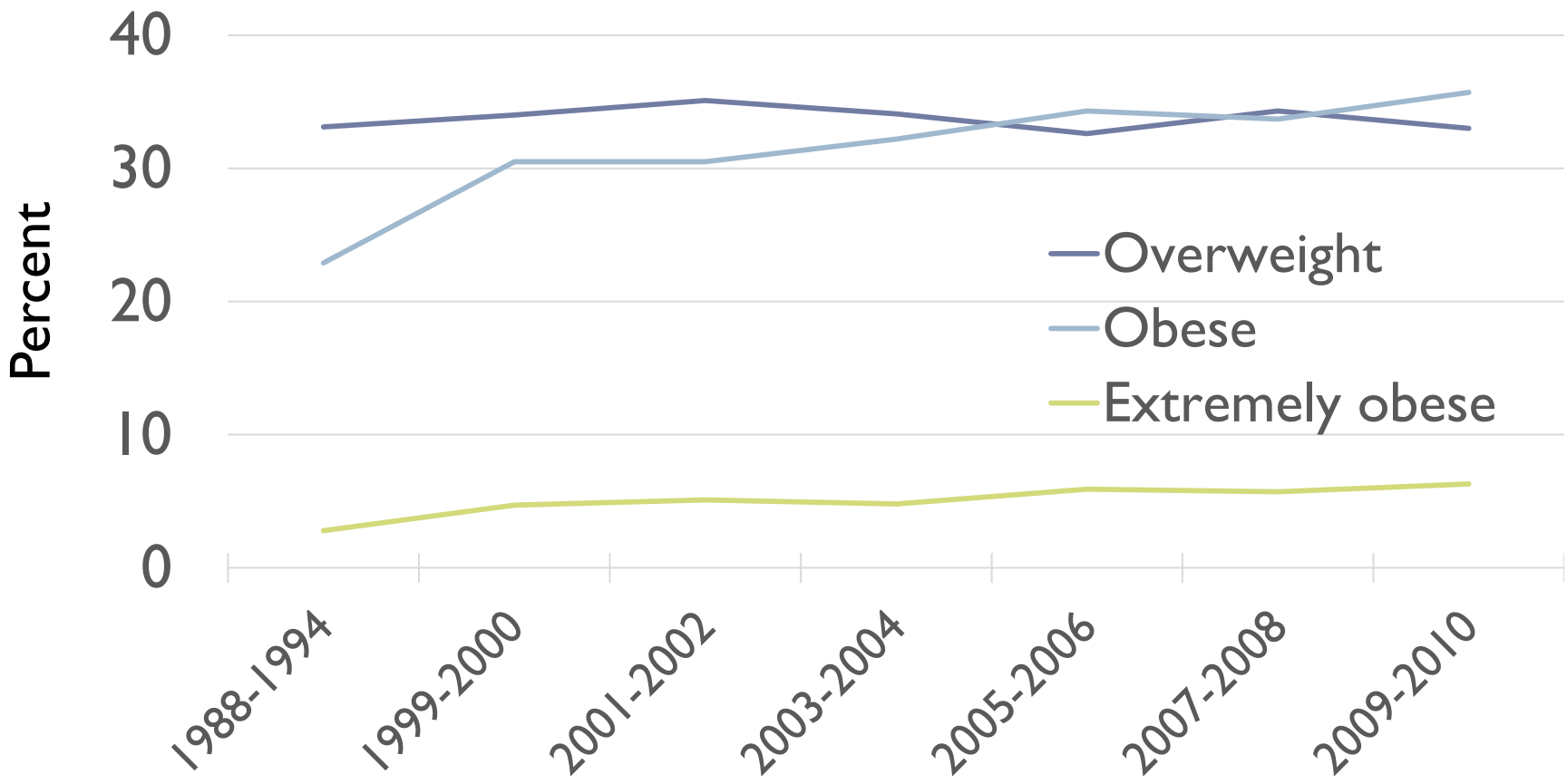
Stephen Tregear, Ph.D.[1]; James Reston, Ph.D., M.P.H.[2]; Karen Schoelles, M.D., S.M.[2]; Barbara Phillips, M.D., M.S.P.H.[3]

Study sample	Odds of crash
18 studies in car drivers; 2 in truck drivers	OR=**1.21 -4.89**

http://www.fmcsa.dot.gov/facts-research/research-technology/report/FMCSA-RT-04-008.pdf

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

Prevalence of moderate to severe apnea		
	Men	Women
1994 (Young *et al*) (state employees, age 30-60 years)	9%	4%
2007-2010 (Peppard *et al*)		
30-49 years	10%	3%
50-70 years	17%	9%

Peppard, *Am J Epidemiol*, 177 (9):1006-1014; 2013

subgroups with high rates of sleep apnea

- Hypertension[1, 2, 3]
  - 30-40% have sleep apnea

    (60% of patients with sleep apnea have hypertension)

- Hypertension requiring ≥ 3 drugs to treat[4]
  - 83% have sleep apnea

- Obese, type 2 diabetes[5]
  - 86% have sleep apnea

[1]Kales, Lancet, 1984
[2]Williams, *Am J Cardiol*, 1985
[3]Lavie, *Am Heart J*, 1984
[4]Logan *et al*, J Hypertens, 2001
[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

portable sleep study

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

http://www.fette-thimm.de/img/embletta400.jpg

apnea-hypopnea index (AHI)

$$\frac{\text{APNEAS + HYPOPNEAS}}{\text{HOURS OF SLEEP}}$$

Severity	AHI (events/hour)
None	[0-5)
Mild	[5-15)
Moderate	[15-30)
Severe	>=30

AASM Task Force, Sleep, 1999

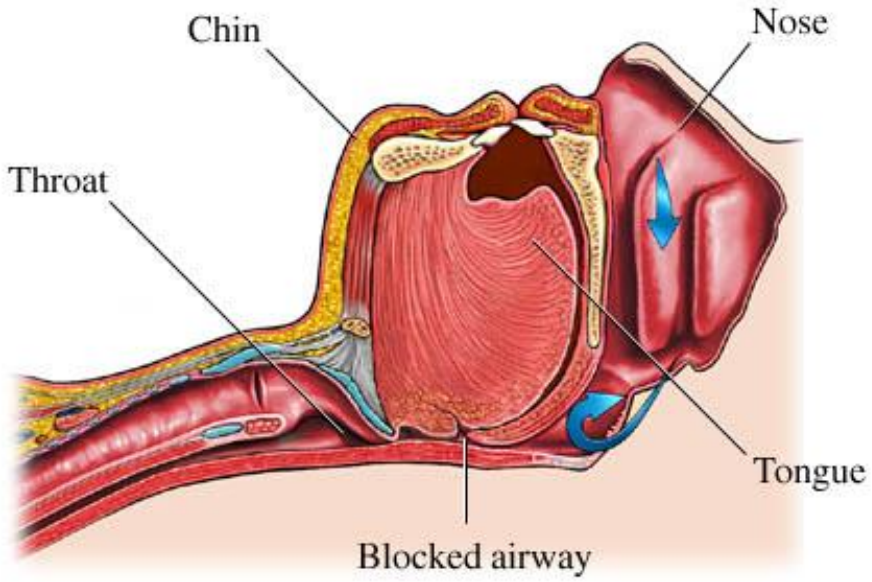
is sleep apnea treatable?

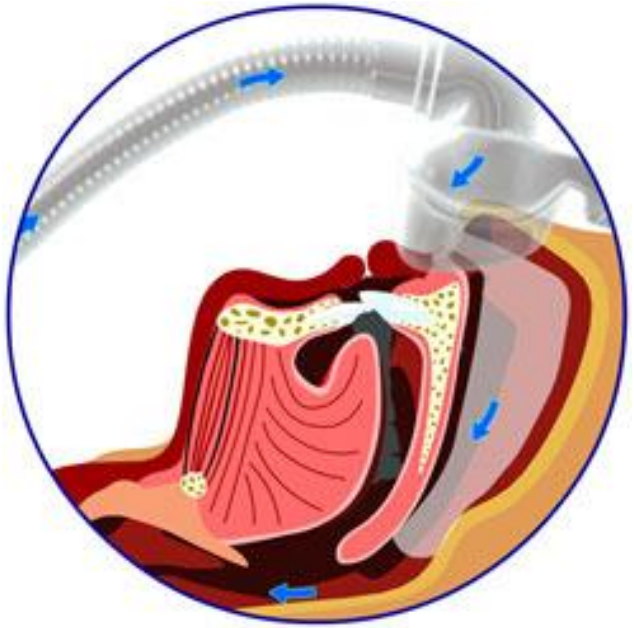
http://amysorrells.files.wordpress.com/2012/06/flat_bicycle_tire.jpg

continuous positive airway pressure (CPAP)

http://www.everettclinic.com/crs/aha/cpap.jpg

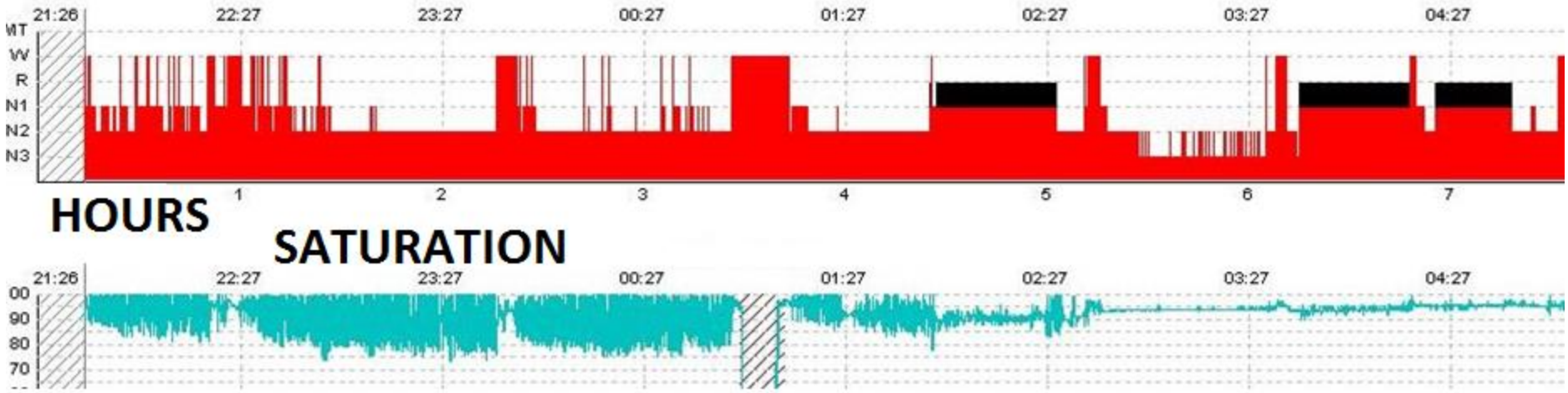
continuous positive airway pressure (CPAP)





http://www.sleepwise.com.au/images/D912193040.gif
http://www.resmed.com/uk/images/cpap_treatment.jpg

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

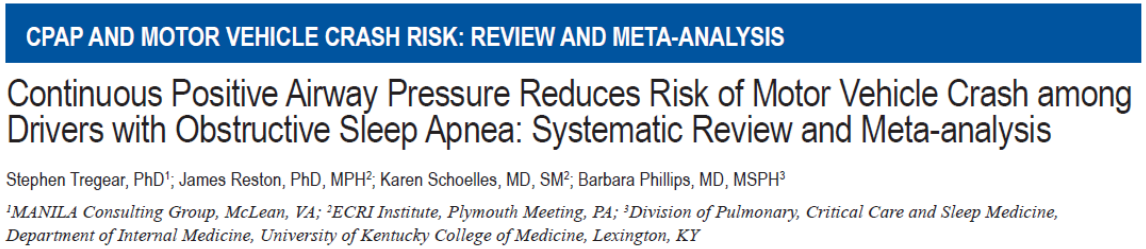
In addition to lowering AHI and improving oxygen level, what are the benefits of CPAP?

- 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]

[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
[9]Martinez-Garcia, *Chest*, 2005
[10]Martinez-Garcia, *AJRCCM*, 2009
[13]*Fein, JACC*, 2013

CPAP lowers crash risk



CPAP AND MOTOR VEHICLE CRASH RISK: REVIEW AND META-ANALYSIS

Continuous Positive Airway Pressure Reduces Risk of Motor Vehicle Crash among Drivers with Obstructive Sleep Apnea: Systematic Review and Meta-analysis

Stephen Tregear, PhD[1]; James Reston, PhD, MPH[2]; Karen Schoelles, MD, SM[2]; Barbara Phillips, MD, MSPH[3]

[1]MANILA Consulting Group, McLean, VA; [2]ECRI Institute, Plymouth Meeting, PA; [3]Division of Pulmonary, Critical Care and Sleep Medicine, Department of Internal Medicine, University of Kentucky College of Medicine, Lexington, KY

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

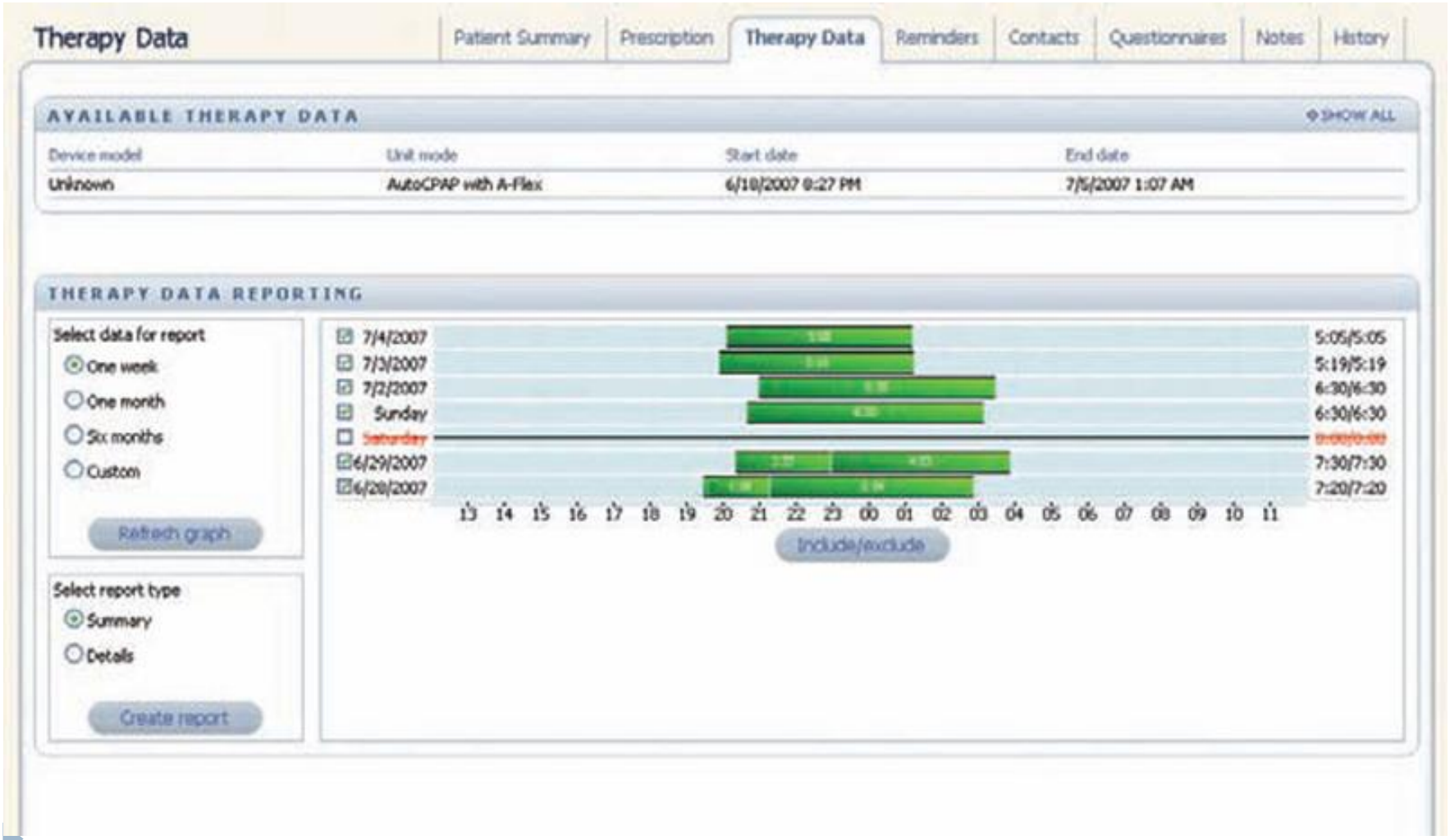
- SD cards
- Remote/wireless

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?