



# SLEEP AND ATTENTION DEFICIT DISORDER

- Philip Eichling MD, MPH,  
FAASM

# what to take away from this talk:

- ADD and sleep deprivation are very similar
- Anything that makes for sleepiness can look like ADD or make ADD worse i.e. most of the sleep disorders
- this talk reviews:
  - normal sleep
  - consequences of sleep deprivation (including ADD)
  - briefly looks at the common sleep disorders.

21%

Of the US population think  
they have sleep problems

75% have some problem

45% would ask their doctor about it

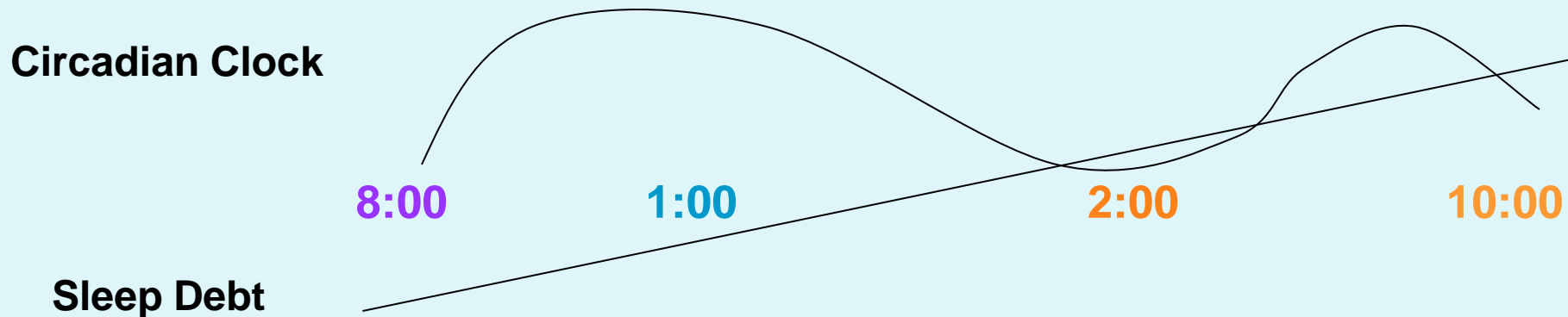
(National Sleep Foundation survey 2005)

And only

3000 board certified sleep  
specialists

# Physiology of Sleep

## 2 process Model



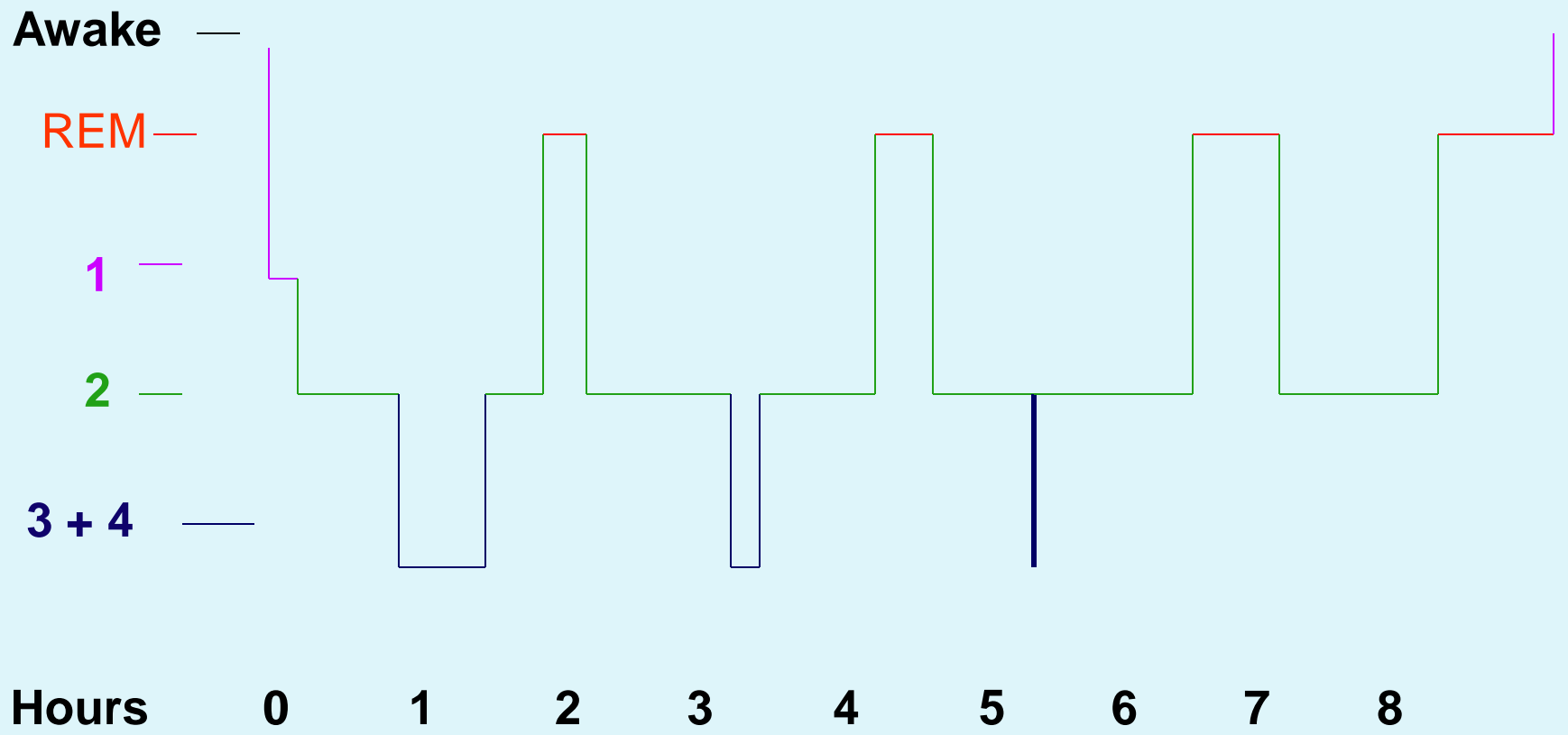
**Homeostatic process:**

**Debt Rises as the Day Goes Along: Adenosine stimulates GABA receptors suppressing dopamine**

**Circadian process:**

**SCN stimulates monoamines:- Alertness Varies Cyclically**

# Normal Sleep Cycles



# Common Sleep Disorders

- **Inadequate Sleep** Most of Us
- “Phase” Disorder
  - Delayed – Teenager 25%
  - Advanced – Elderly 25%
- Sleep Walking/Talking 50% of Kids, 5% of adults
- Insomnia 10-15%
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- Nocturnal Movement Disorder
  - (Restless Legs) 5-10%
- Narcolepsy 1 in 2000

# How Much Sleep Do We Need/ Want?

8 hours, 15 minutes on average

➤ (Stanford “Sleep Camp” Studies)

Definition of “well rested” is not being able to fall asleep in a darkened room midday

# Have We Always Been a Nation of Poor Sleepers?

- Epidemic sleep problems began about 100 years ago with the advent of electricity (Thomas Edison was an insomniac).
- Our great grandparents slept 1 1/2 hours longer than we do!



# Epworth Scale

0 = Would never doze

1 = Slight chance of dozing

2 = Moderate chance of dozing

3 = High chance of dozing

## Situation

## Chance of Dozing

Sitting and reading

\_\_\_\_\_

Watching Television

\_\_\_\_\_

Sitting inactive in a public place (i.e. theatre)

\_\_\_\_\_

As a car passenger for an hour without a break

\_\_\_\_\_

Lying down to rest in the afternoon

\_\_\_\_\_

Sitting and talking to someone

\_\_\_\_\_

Sitting quietly after lunch without alcohol

\_\_\_\_\_

In a car, while stopping for a few minutes in traffic

\_\_\_\_\_

# It is not “normal” to :

- Fall asleep if reading quietly in the afternoon
- “Drift off” at afternoon meetings
- Sleep on airplanes
- Fall asleep watching TV in the early evenings
- Sleep when you are a passenger in a car
- Need caffeine and open windows to drive 2 hours
- “Drift off” while waiting at red lights

# Health Risks of Short Sleep

## 6 hours vs 7 or 8?? Mixed results

- **1978:** UCLA California general population(40,000)  
40% increased mortality:6 versus 8 hours of sleep
- **2002:** National Cancer survey: Large study  
(1,000,000) 6-7 hours lower mortality than 8-9 hours
- **2004:** Japanese study (100,000) 7 hours "better"  
than 8 hours
- **2007:** Finland study 22 yr follow-up (21,000)  
<7 26% higher mortality for men, 21% for women  
>8 24% " " " 17% " "
- **2007:** UK (10,000) < 6 24% higher mortality, reducing sleep  
from baseline by 1 hour doubles risk

**Multiple studies:** 5 hrs or less/ 9 or more= higher mortality

# Consequences of Poor Sleep:

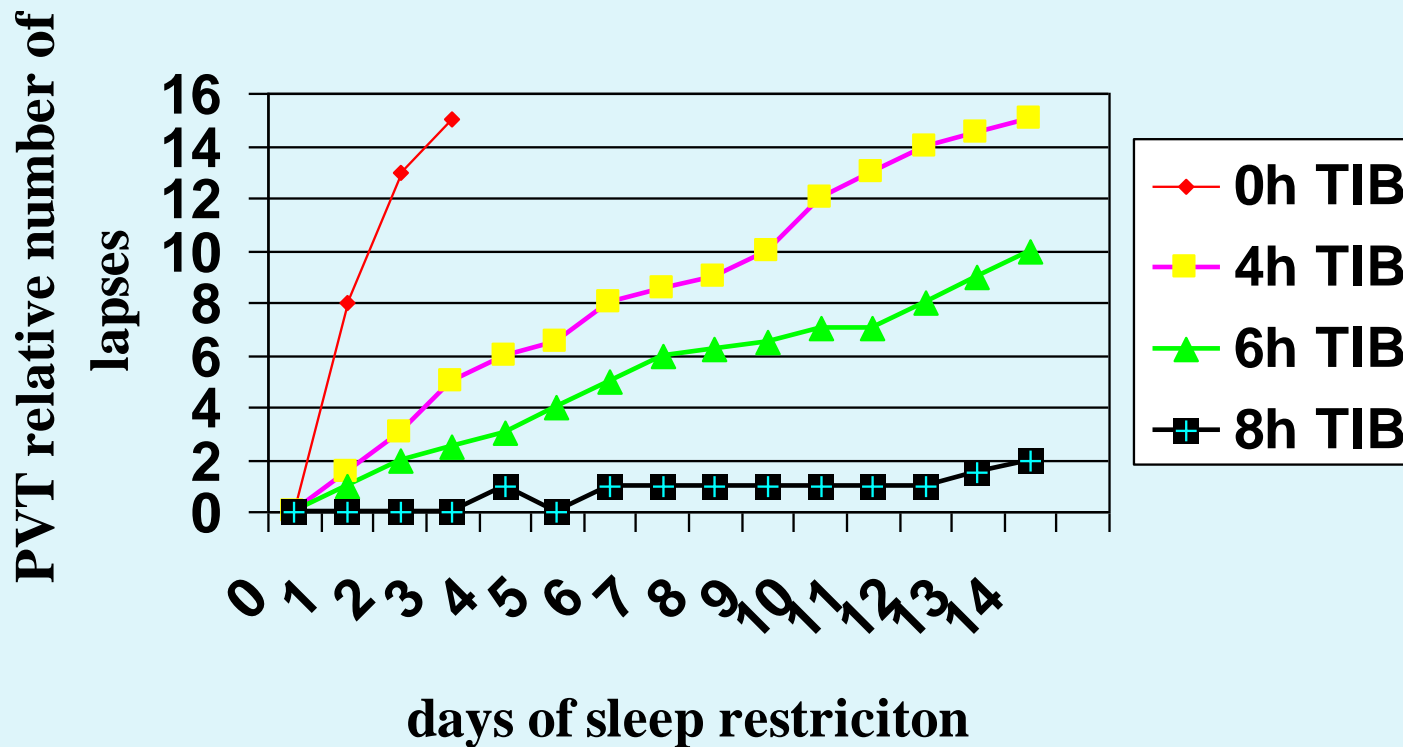
**Sleepiness!**

Sleeplessness may not kill  
you, but does create  
"Disability"

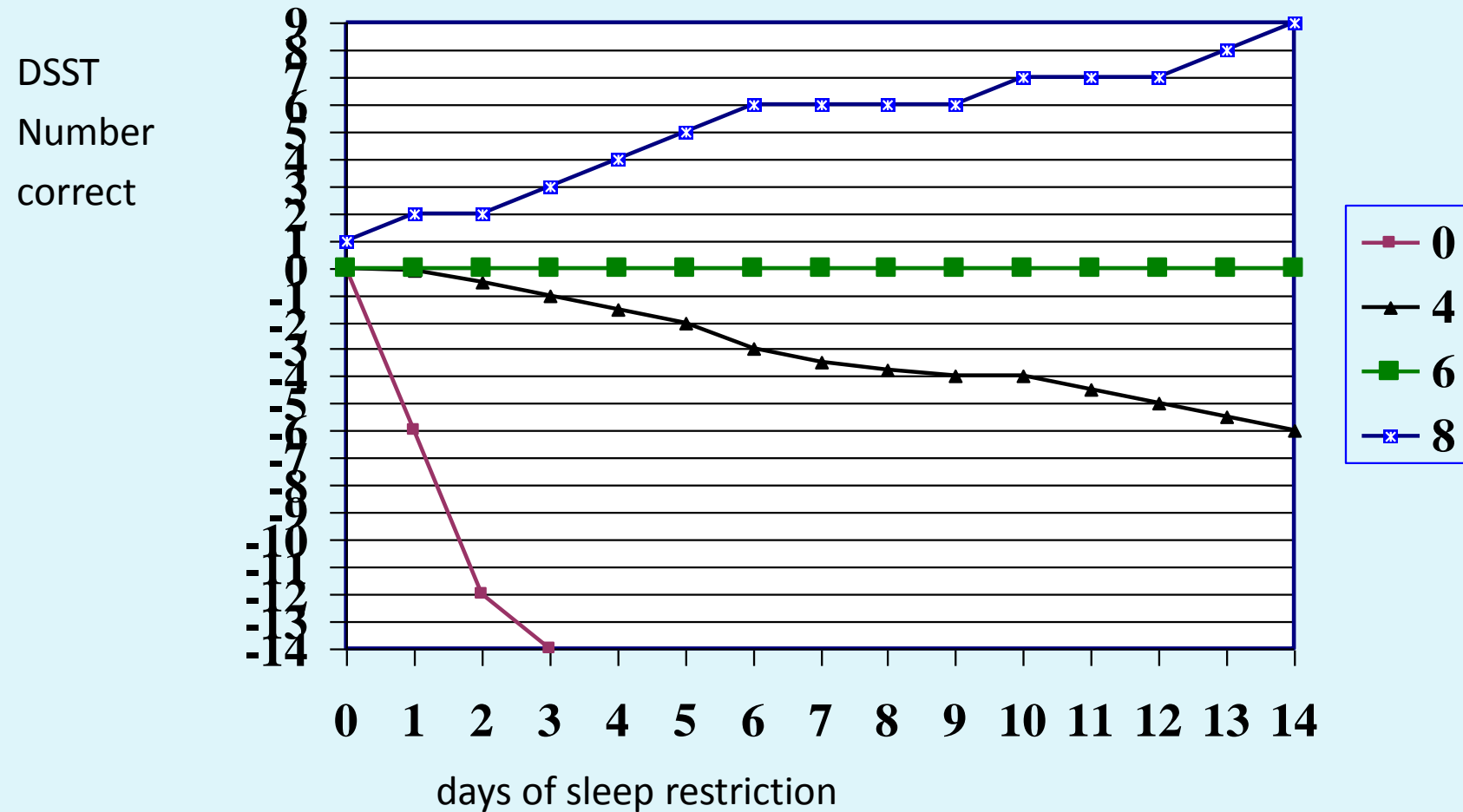
# Chronic Sleep Deprivation

Van Dongen 2006

## Vigilance during 14 days of sleep restriction



# Working memory and 14 days of Sleep Restriction

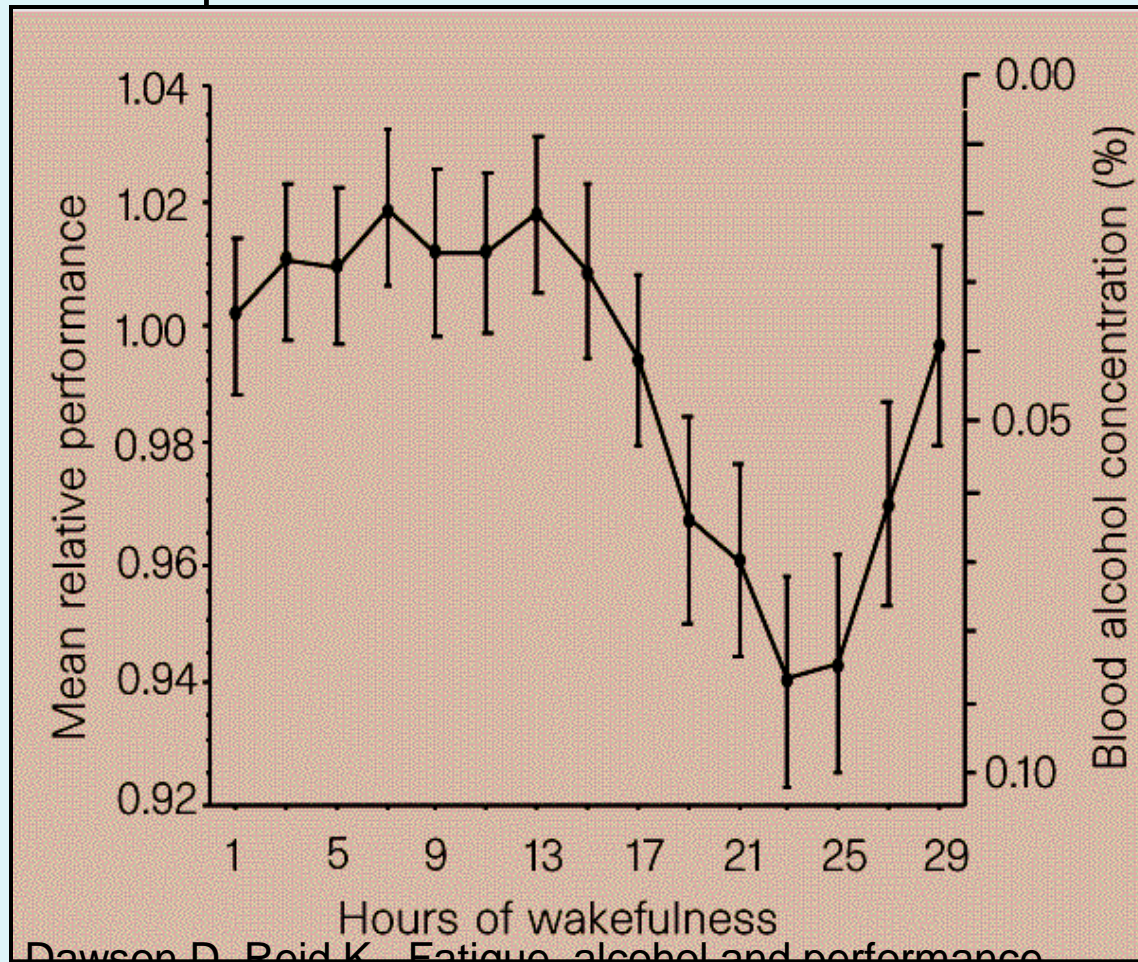


# Sleepiness Disability

Is like alcohol  
impairment



# Comparison of Deterioration in Performance: Hours of Wakefulness versus Comparable Blood Alcohol Concentration



Dawson D, Reid K. Fatigue, alcohol and performance impairment. *Nature* 1997;388:235.

# Disability of Sleeplessness

**Simple sleepiness doesn't kill you unless:**

You are behind the wheel of a car

New Jersey Law: **Driving after being awake >20 hours is "reckless driving" felony.** Equivalent to blood alcohol level of .09

# Automobile Accidents and Emergency Medicine Residents and Physicians

## Prevalence Rates<sup>1</sup> During EM Residency for:

- Collision frequency 8% (74% post night shift)
- Near miss frequency 58% (80% post night shift)
- Correlated with:
  - numbers of night shifts worked
  - resident's self reported tolerance of shift work
  - self reported adaptation to drowsiness

1 Steele MT, The occupational risk of motor vehicle collisions for emergency medicine residents. Acad Emer Med 1999, 6:1050

# Dangers of Sleeplessness

**Auto Accidents** – Bigger than Alcohol

**Major Disasters** – Exxon Valdez

Chernobyl

Challenger

Most Airplane Crashes

**→ PILOTS ARE HAVING 'MICRO SLEEPS' → WITHIN  
MINUTES OF LANDING!**

# Consequences of Poor Sleep

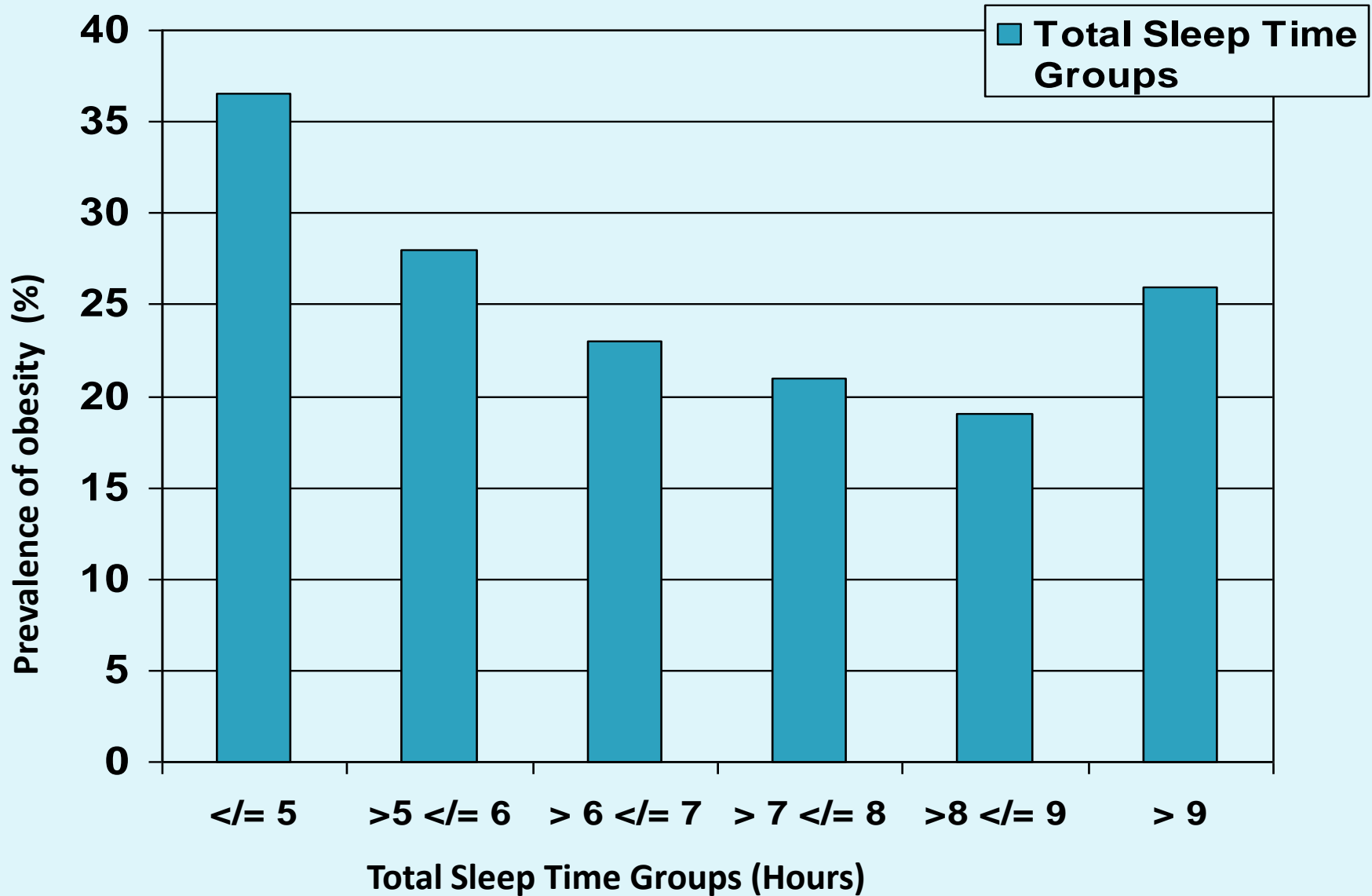
Hunger

# Sleep Loss

At least 5 different brain sleep chemicals are also hunger chemicals

- Cortisol (stress chemical)
- Neuropeptide Y (carbo. Hunger)
- Hypocretin/Orexin (Narcolepsy)
- Gallanin (fat hunger)
- Ghrelin (acute hunger chemical)

# Obesity and Sleep



# Consequences of Poor Sleep

## Increased Pain

- Fibromyalgia
- Worse arthritis
- All pain conditions are worse



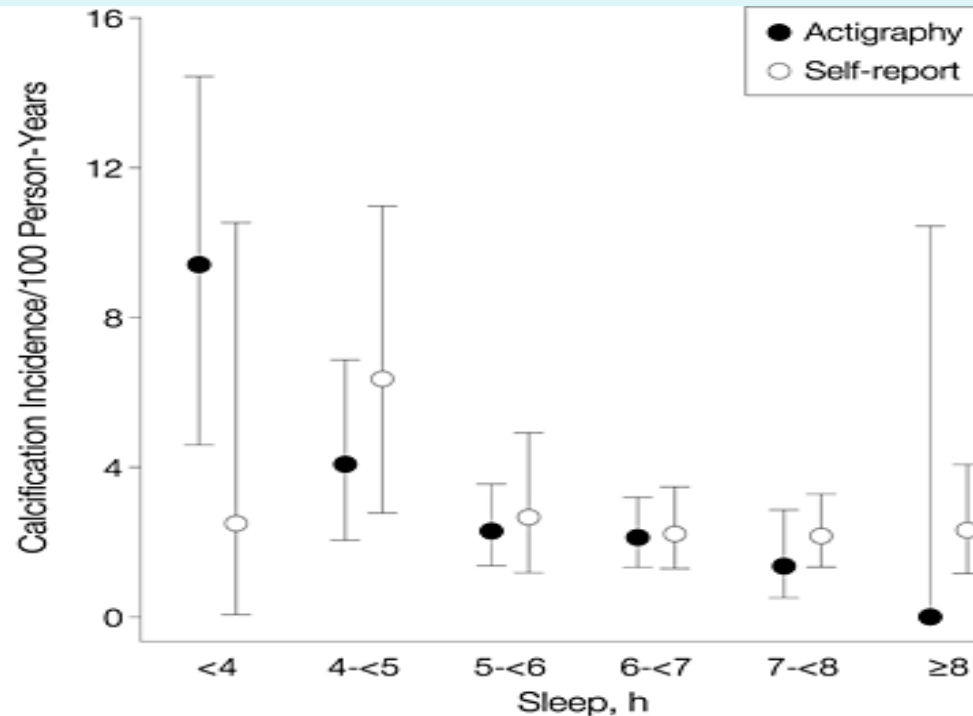
# CONSEQUENCES OF POOR SLEEP:

CARDIOVASCULAR MORTALITY

# Coronary Calcifications and Mean Sleep Duration

King, C. R. et al. JAMA 2008;300:2859-2866.

- Average age= 40. N=495
- Each hour of more sleep=33% reduction in disease, equal to 16 mm drop in BP



No. of participants

Actigraphy	17	49	148	188	88	5
Self-report	8	22	60	144	175	83

# Consequences of Poor Sleep:

## Cognitive Function

# Attention Deficit Disorder

- Poor attentiveness
- Unable to do long term planning – prioritize (integrative function of prefrontal cortex)
- Unable to deal with complicated new problems
- Overconfidence (unable to judge impairment)
- Clumsiness
- Working Memory Problems

# ADD

Executive function affected by sleepiness

Is ADD just a sleepy brain?

- Probably not, but sleepy people look very ADD like
- Sleepy young adults have same prefrontal cortex testing abnormalities as normal elderly.
- Is a normal aging brain simply a sleepy one?

# Executive Function

Prefrontal Cortex is metabolically susceptible to sleep deprivation (functional MRI studies)

Nofzinger Seminars in Neurol 2005

PFC controls goal directed behavior

- prioritization

- self organization and planning

- judgment re adequacy of outcomes

Requires attention to novel situations

- Sleep deprivation affects PFC integrative functions

# Sleep Disorders and AD/HD

## ❖ Children with AD/HD:

- Up to 39% sleep walk
- 56% have trouble going to sleep
- Have fewer sleep hours than non-AD/HD children
- Have more movement during sleep
- Have more periods of sleepiness during the day

**Barkley, R.A. (2006). Attention-Deficit/Hyperactivity Disorder, Third Edition. New York, NY: Guilford.**

# Sleep Disorders and AD/HD

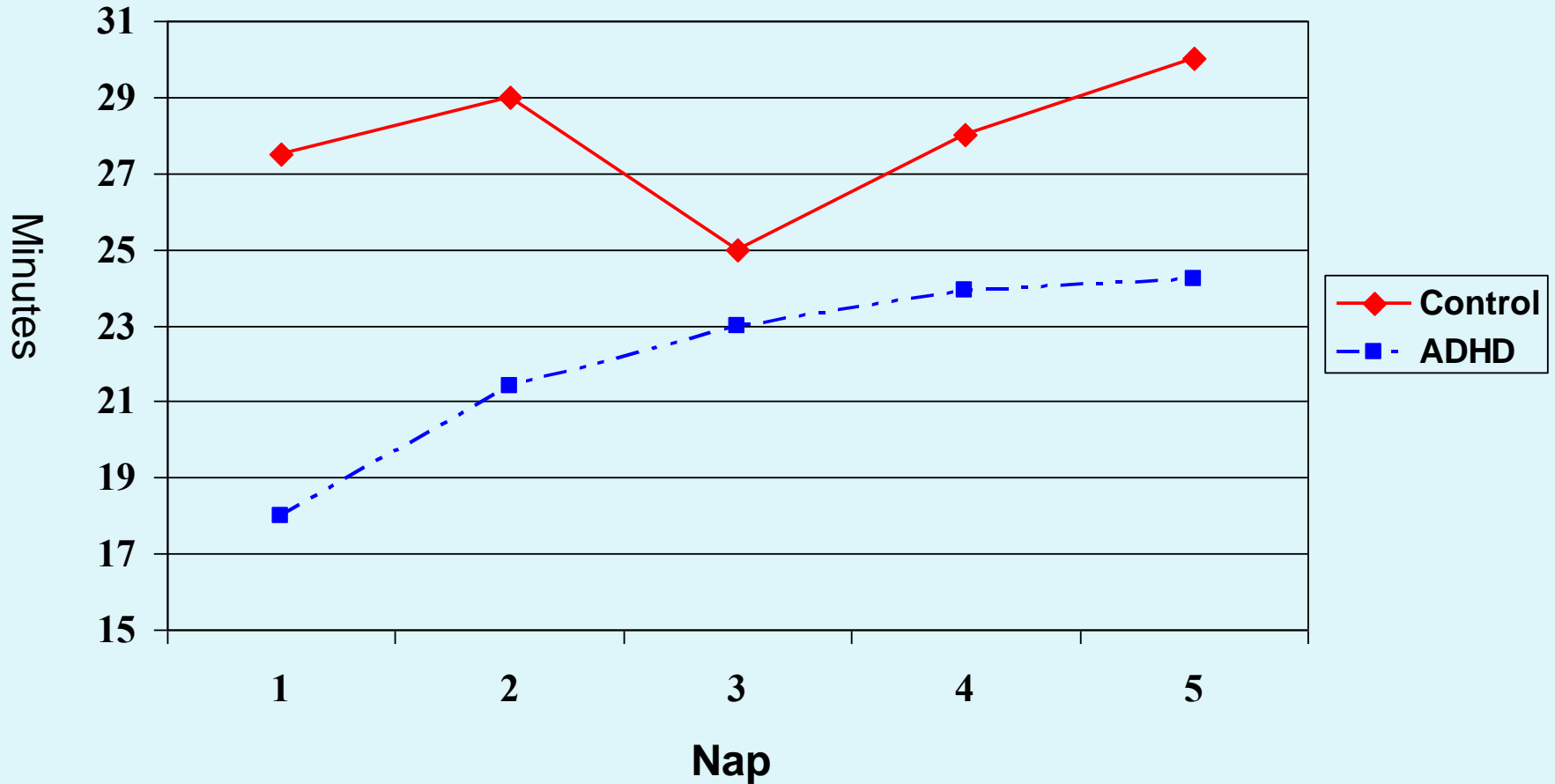
- **30 to 56% of those with AD/HD have sleep disorders**
- **Stimulant medications can lengthen sleep onset**
- **Sleep problems may exacerbate academic/work problems, but if academic/work problems not caused by Sleep problem, better sleep may not translate to fewer waking problems.**

Barkley, R.A. (2012). ADHD: Cutting Edge Understanding and Management. Seminar sponsored by J&K Seminars, L.L.C., 1861 Wickersham Lane, Lancaster, PA 17603-2327, p. 28.



# ADHD Children are Sleepy

Hyperactivity is present to Slower response time  
maintain wakefulness



# ADD and Sleepiness

Up to ½ of all ADD children have **RLS**

¼ of ADD patients in one study had **sleep apnea**

» (Luen, D., Sleep 2004)

Treatment with dopminergics lowered ADD scores:  
estimate would treat 12% of all ADHD children

(Cortese Sleep 2005)

**Snoring** in children predicts ADHD development in 4 year  
prospective study OR 4.5

(Chervin, Sleep 2003)

# Hypersomnia and ADHD

Study comparing 74 hypersomnia pts (narcolepsy and idiopathic hypersomnia) to 61 ADHD pts.

Administered ADHD scales and Epworths:

18% of hypersomnia pts met ADHD criteria

16% narcoleptics and 42% IH

54% ADHD had Epworth >12

# Neurobehavioral and Cognitive Effects ADHD Like Effects: Acute Sleep Deprivation

- **Attentiveness**
  - Diminished vigilance
  - Continuous performance tasks: instability of attention increased number of errors of omission and commission
  - “fatigability” : Rapid deterioration of performance or for tasks requiring sustained attention
  - Cognitive slowing on subject-paced tasks
  - Increased cognitive errors with increased time pressure (in work-paced tasks) sacrifice speed for dexterity
  - Increased compensatory effort required to maintain behavioral effectiveness

(Dinges D, *Clin psychiatry news* 2002:5-7)

# Neurobehavioral and Cognitive Effects continued

- Poor integrative functions
  - Reduced learning (acquisition) of cognitive tasks
  - Poor prioritization skills (loss of situational awareness)
  - Increased perseveration on ineffective solutions
  - Neglect of nonessential activities
- Memory changes: decline in both short-term recall and working memory

# Neurobehavioral Function in ADHD

25 ADHD, 25 Controls:

Actigraphy testing for sleep time and quality showed no differences in the groups at baseline, i.e. **each group got same amount of sleep and the ADHD group showed poorer functioning.**

	Control (n=25) Mean +/- SD	ADHD (n=24) Mean +/- SD	F	P
SRT	421.04 +/- 59.2	507.78 +/- 97	11.86	***
Digit Span FW	4.63 +/- 0.82	5 +/- 0.9	3.73	+
Digit Span BW	3.75 +/- 1.07	3.52 +/- 0.9	.36	NS
SD-RT	3448.5 +/- 1094	3932.1 +/- 674	4	*
CPT-RT	685.29 +/- 64.73	732.17 +/- 60	4.65	*
CPT-Om Err	2.5 +/- 2.19	3.5 +/- 2.5	4.65	*
CPT-Com Err	1.38 +/- 2.87	3.33 +/- 2.8	2.2	NS

ADHD refers to attention-deficit/ hyperactivity disorder; Tapping, number of finger tapping; SRT, Simple Reaction Time, FW, Forward; BW, Backward; SD, Symbol Digit; RT, Reaction Time; CPT, Continuous Performance Test; OM Err, omission error; Com Err, commission errors.

+ marginal, \* $P < .05$ ; \*\* $P < .01$ ; \*\*\* $P < .005$ .

# Then, both groups exposed to Reduced sleep:

Reduced sleep in Control Group correlated with  
worsening in:

- Reaction time
- CPT (continuous performance tasks), omission errors.
- Digit symbol substitution test.

No change is noted in ADHD patients.

- ADHD patients do not necessarily get better with improved sleep
- Controls display ADHD-like impairment when sleep deprived that improves with sleep.

# ADD and Sleep Deprivation

## **Similarities**

Hypoarousable states

Poor attention (vigilance)

Working memory impairment.

Impaired integrative executive function

Possibly increased impulsivity and irritability

## **Differences**

ADD not characterized by microsleeps

Reaction times may be more impaired by SD

Sleep improves SD but not ADD!

Unkown:

Does SD make ADD worse?

Can exec function in SD respond to stimulation better than ADD? i.e. in critical situations



## Significance for Sleep Med/Psych:

- Adult ADD is a popular diagnosis and Sleepy people may look like ADD so always assess level of sleepiness e.g. Epworth and consider other diagnoses
- Many people treated with alerting agents when primary problem is sleep disorder – (amphetamines and Provigil don't treat sleep apnea, insomnia or restless legs)
- Sleep studies may be indicated if patient is sleepy instead of tired.

# Common Sleep Disorders

- Inadequate Sleep Most of Us
- “Phase” Disorder
  - Delayed – Teenager 25%
  - Advanced – Elderly 25%
- Sleep Walking/Talking 50% of Kids, 5% of adults
- Insomnia 10-15%
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- Nocturnal Movement Disorder
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- Narcolepsy 1 in 2000

# Restless Legs Syndrome (RLS) Defined

A neurological movement disorder characterized by

1. an irresistible **urge to move** the legs usually accompanied by uncomfortable sensations
2. that occur most prominently in the **evening**
3. or when at **rest**
4. **Relieved** transiently with **movement**

**What it is not:** muscle cramps, referred back pain, other neuropathy pain, other movement disorders and akathesias

# Epidemiology of Restless Legs Syndrome

- Prevalence<sup>1,2,5</sup>
  - 5% of all school age children
  - 10% of US adults
  - Increases with age
  - Peaks above age 50
- Age of onset varies widely<sup>2,3</sup>
  - Common onset  $\geq 40$  years of age
- Present in both men and women, with greater prevalence in women<sup>2,4</sup>

1. Phillips et al. *Arch Intern Med.* 2000;160:2137-2141.

2. Hening et al. *Sleep Med.* 2004;5:237-246.

3. Walters et al. *Neurology.* 1996;46:92-95.

4. Nichols et al. *Arch Intern Med.* 2003;163:2323-2329.

5. JCSM 2012

# Overview of Restless Legs Syndrome (RLS)

- Sleep disturbance is often the primary reason patients seek medical attention<sup>3</sup>
- Most common sleep presentations:
  - Sleep Onset Insomnia
  - Phase Delay sleep Pattern
  - Sometimes, multiple arousals
- Believed to be associated with dopaminergic dysfunction<sup>4,5</sup>
- May limit the ability to sit for extended periods  
Of time<sup>4,6</sup>

1. Phillips et al. *Arch Intern Med.* 2000;160:2137-2141.

2. Hening et al. *Sleep Med.* 2004;5:237-246.

3. Allen et al. *Sleep Med.* 2003;4:101-119.

4. Allen & Earley. *J Clin Neurophysiol.* 2001;18:128-147.

5. Turjanski et al. *Neurology.* 1999;52:932-937.

6. Earley. *N Engl J Med.* 2003;348:2103-2109.

# RLS and Depression

## Big Overlap – Complicated Relationship

### **RLS patients**

- Harvard Study – 18% had a 12 month rate of onset of major depression
- 37% had lifetime onset of major depression
- Other studies – 33 to 71% of patients with RLS have mood disorders

### **Depressed patients (psych clinic)**

- 26% had met RLS criteria
- Population Studies –
  - OR 1.64 for RLS in depressed patients

» (Picchetti, D., Sleep, 2005)

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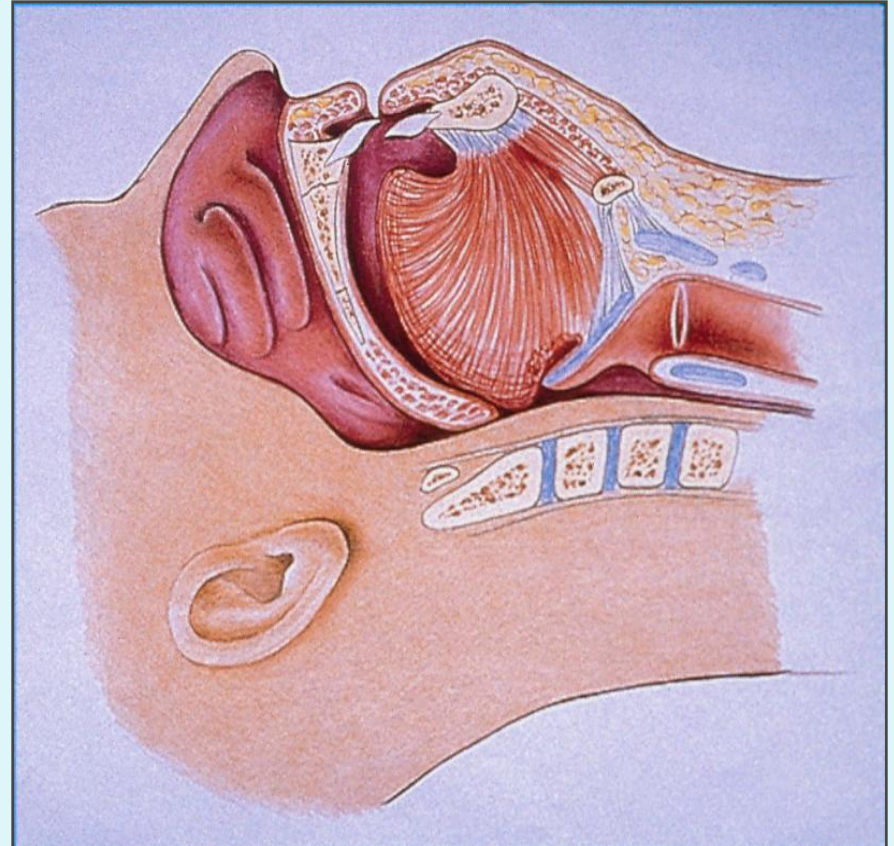
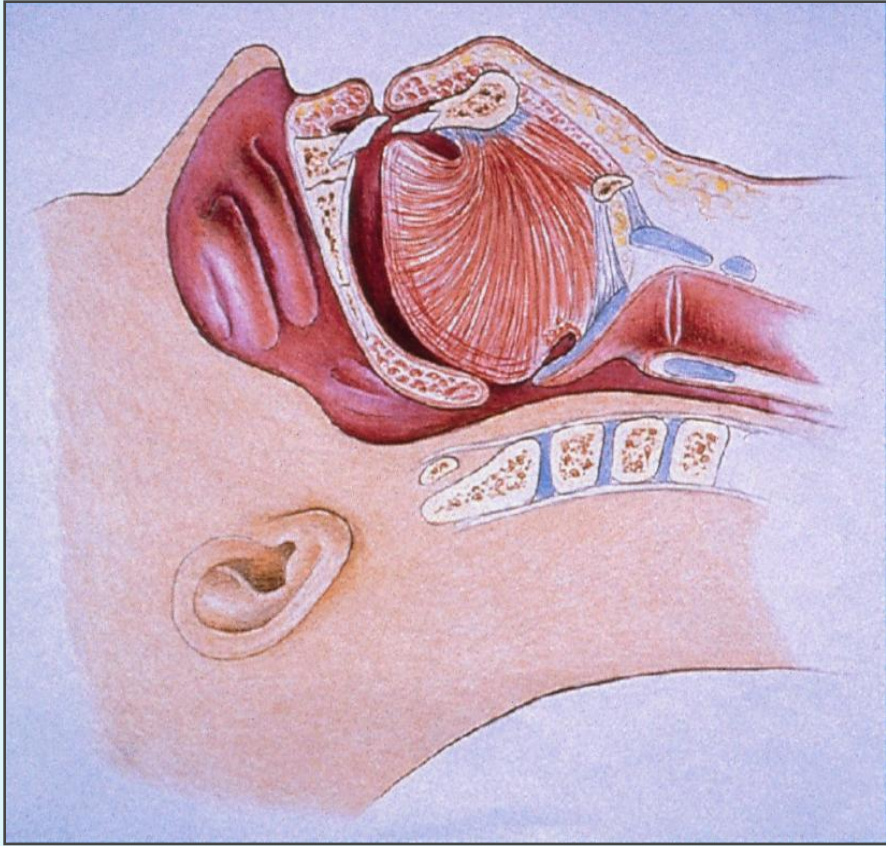
Sleepiness doesn't kill but

Sleep Apnea

does



# Pathophysiology of Apnea



# Sleep Apnea

- Very high mortality, about same risk as smoking
- Most conservative estimate = 50% increase in cardiovascular events
- Up to 23 times more likely to have a heart attack

# Who Gets Apnea?

- Large neck (>17"men, >16" women)
- Small chin
- Family History
- Men more than women before menopause
- Women after menopause
- Stuffy and narrow nose
- Alcohol/sedation

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**INSOMNIA**

# Falling Asleep Troubles:

## Insomnia

True for both:

- sleep onset insomnia
- sleep maintenance insomnia

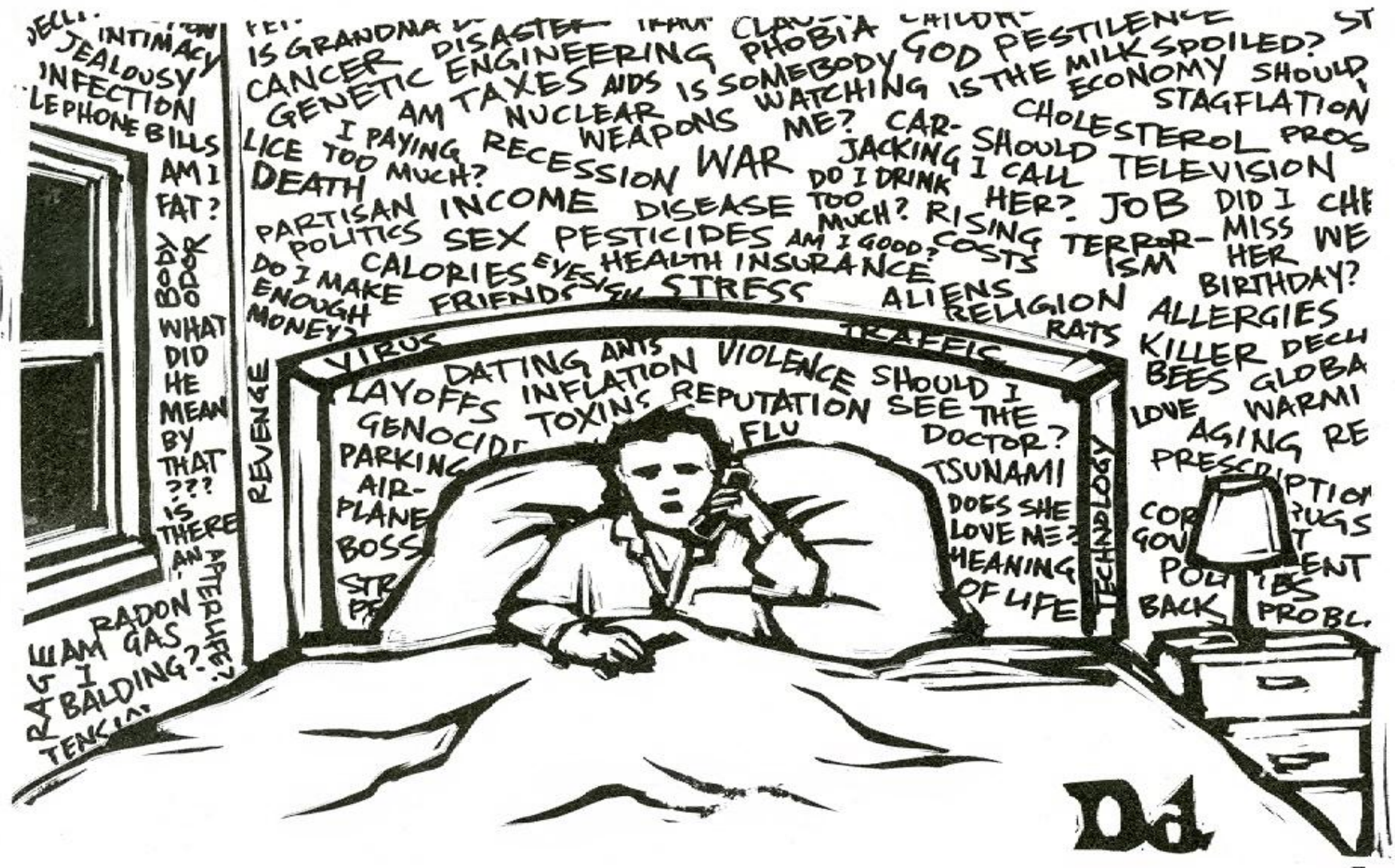
1. Initiating event

2. Performance anxiety perpetuating  
insomnia

# Sleepiness and insomnia

- Usually insomnia patients are **not sleepy** but they may say that they are tired or non refreshed.. Therefore there is not an association with ADD necessarily unless sleepiness results from long hours awake at night..
- **Insomnia brains are metabolically active** and therefore hyper alert rather than sleepy.
- If someone has insomnia and is sleepy, think they may have another disorder e.g. RLS or apnea





“When I can’t sleep, I find that it sometimes helps  
 to get up and jot down my anxieties.”



# Trouble Falling Asleep

VS

## Trouble with Multiple Awakenings

- Falling asleep usually needs behavioral evaluation and treatment
- Multiple awakenings often need medical evaluations

# Common Causes of Awakening

- Sleep apnea/Snoring
- Depression/Anxiety
- Drug/Alcohol/Caffeine effects
- Physical Discomfort
- Menopause
- Twitching (periodic movements/ RLS)
- Tooth Grinding
- Room Environment issues (light, noise, etc.)
- Bladder problems (often this is perceived as reason, but isn't)



**THE END**