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.
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

Circadian Clock

Sleep Debt

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

Awake

REM

1

2

3 + 4

Hours 0 1 2 3 4 5 6 7 8
Common Sleep Disorders

- Inadequate Sleep
- "Phase" Disorder
  - Delayed – Teenager
  - Advanced – Elderly
- Sleep Walking/Talking
- Insomnia
- Sleep Apnea and Snoring
- Nocturnal Movement Disorder
  - (Restless Legs)
- Narcolepsy

Most of Us
25%
25%
50% of Kids, 5% of adults
10-15%
5-10%
5-10%
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

<table>
<thead>
<tr>
<th>Situation</th>
<th>Chance of Dozing</th>
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</thead>
<tbody>
<tr>
<td>Sitting and reading</td>
<td></td>
</tr>
<tr>
<td>Watching Television</td>
<td></td>
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<tr>
<td>Sitting inactive in a public place (i.e. theatre)</td>
<td></td>
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<tr>
<td>As a car passenger for an hour without a break</td>
<td></td>
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<tr>
<td>Lying down to rest in the afternoon</td>
<td></td>
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<tr>
<td>Sitting and talking to someone</td>
<td></td>
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<tr>
<td>Sitting quietly after lunch without alcohol</td>
<td></td>
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<tr>
<td>In a car, while stopping for a few minutes in traffic</td>
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</tbody>
</table>
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

PVT relative number of lapses

days of sleep restriction

0h TIB
4h TIB
6h TIB
8h TIB
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

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\(^1\) 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

Singh M, et al, Journal of Clinical Sleep Medicine, 2005

Prevalence of obesity (%)

Total Sleep Time Groups (Hours)

<\= 5  >5 <\= 6  > 6 <\= 7  > 7 <\= 8  >8 <\= 9  > 9

Singh M, et al, Journal of Clinical Sleep Medicine, 2005
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
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
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?

Harrison Y, Sleep 2000
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

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.

ADHD Children are Sleepy

Hyperactivity is present to Slower response time
maintain wakefulness

Golann, Sleep, 2004
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 dopaminergics 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

Oosterloo. Sleep 2005; 28: A308
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

Dinges D, Psychiatry News 2002:5-7
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.

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

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.

Gruber, R. Sleep, 2004
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!

Unknown:
- 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%
- Sleep Apnea and Snoring
  5-10%
- Nocturnal Movement Disorder
  (Restless Legs) 5-10%
- 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\(^1,2,5\)
  - 5% of all school age children
  - 10% of US adults
  - Increases with age
  - Peaks above age 50
- Age of onset varies widely\(^2,3\)
  - Common onset ≥40 years of age
- Present in both men and women, with greater prevalence in women\(^2,4\)

5. JCSM 2012
Overview of Restless Legs Syndrome (RLS)

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

References:
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
Common Sleep Disorders

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  Most of Us

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    25%
  
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- Nocturnal Movement Disorder
  
  (Restless Legs)
    
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- Narcolepsy
  
  1 in 2000
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