SAFER

Sleep Alertness & Fatigue Education in Residency

Healthcare Principles in Practice
UT College of Medicine Chattanooga

Let's talk about ZZZzzzzzzzzzzzzz!!

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Disclosures

Why Sleep?

- Functions of sleep include:
  - Energy conservation.
  - Restoration of the brain and body.
  - **Memory consolidation**.

During SWS the pathways encoded during awake learning are reactivated and short-term memories are transferred from the hippocampus to neocortical sites for long-term storage (System Consolidation)

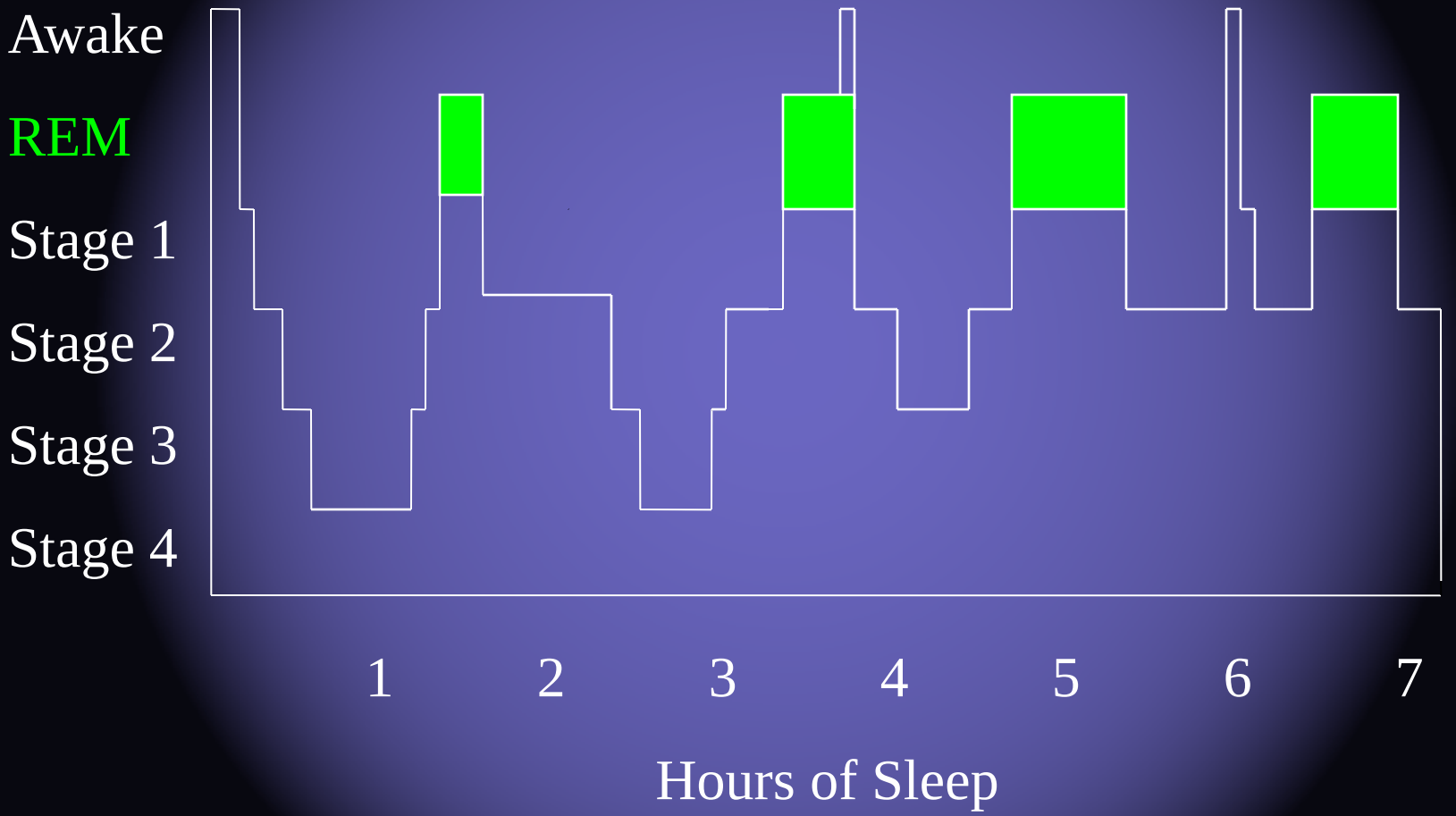
Once transfer has occurred, synapses are downscaled to prevent saturation of synaptic networks that would impede new information encoding

During ensuing REM sleep the permanent synaptic build-up is consolidated (Synaptic Consolidation)

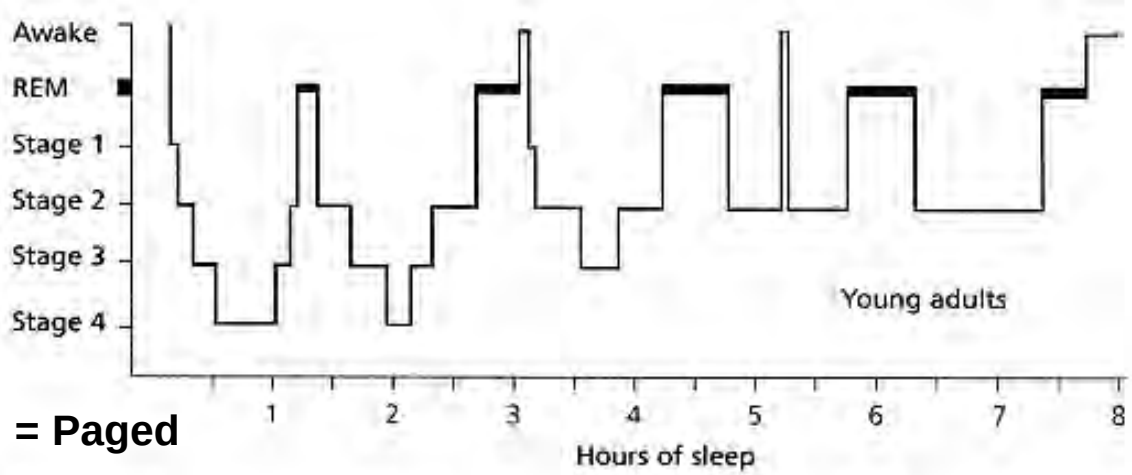
Why Sleep?

- Deeper sleep occurs in the area of the brain activated by a newly learned task.
  - This deeper sleep also correlates with improvement in activity seen the following day.
  - Performance on a newly learned task is often better the next day if adequate sleep is achieved during the night.

Normal Sleep Cycle in Young Adults

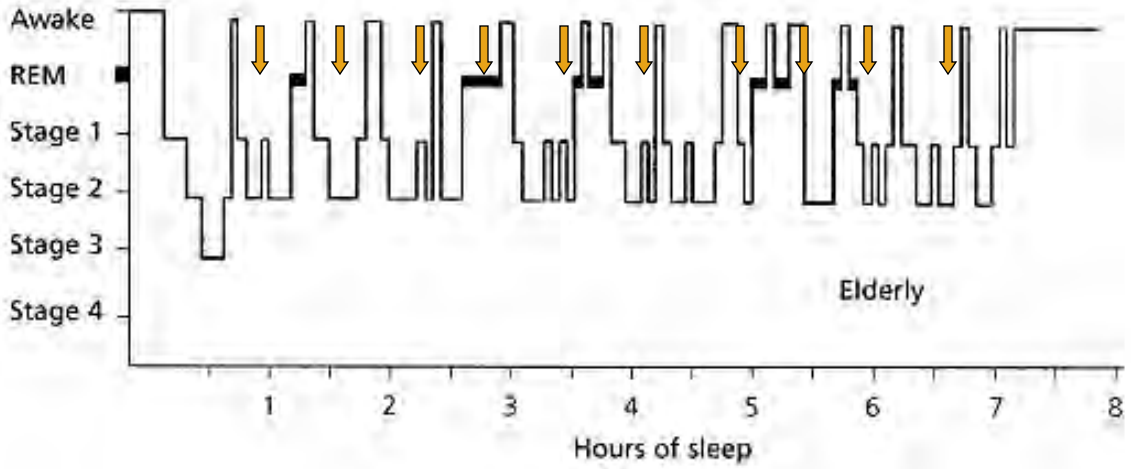


Sleep Fragmentation Affects Sleep Quality



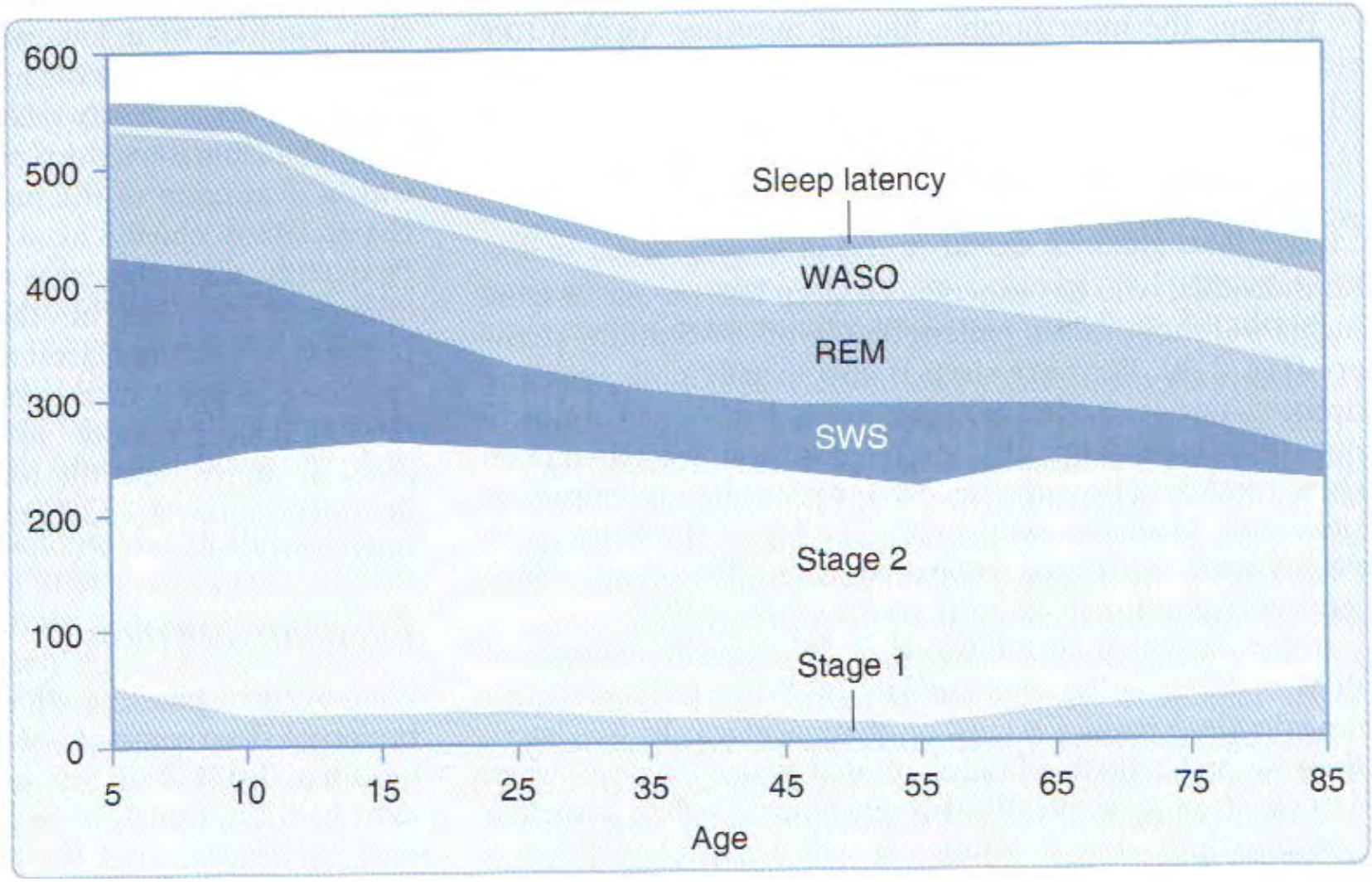
NORMAL SLEEP

= Paged



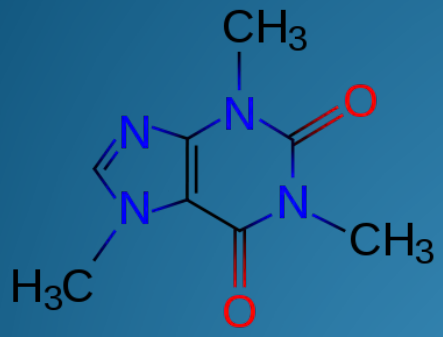
ON CALL SLEEP

Morning Rounds

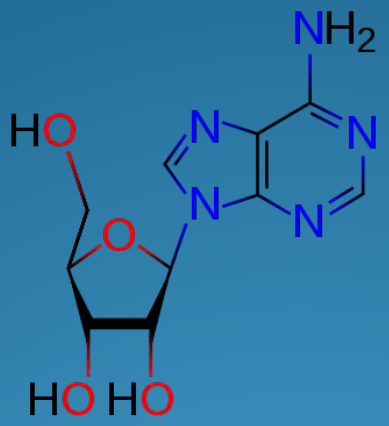


Process H/S: What makes us sleepy?

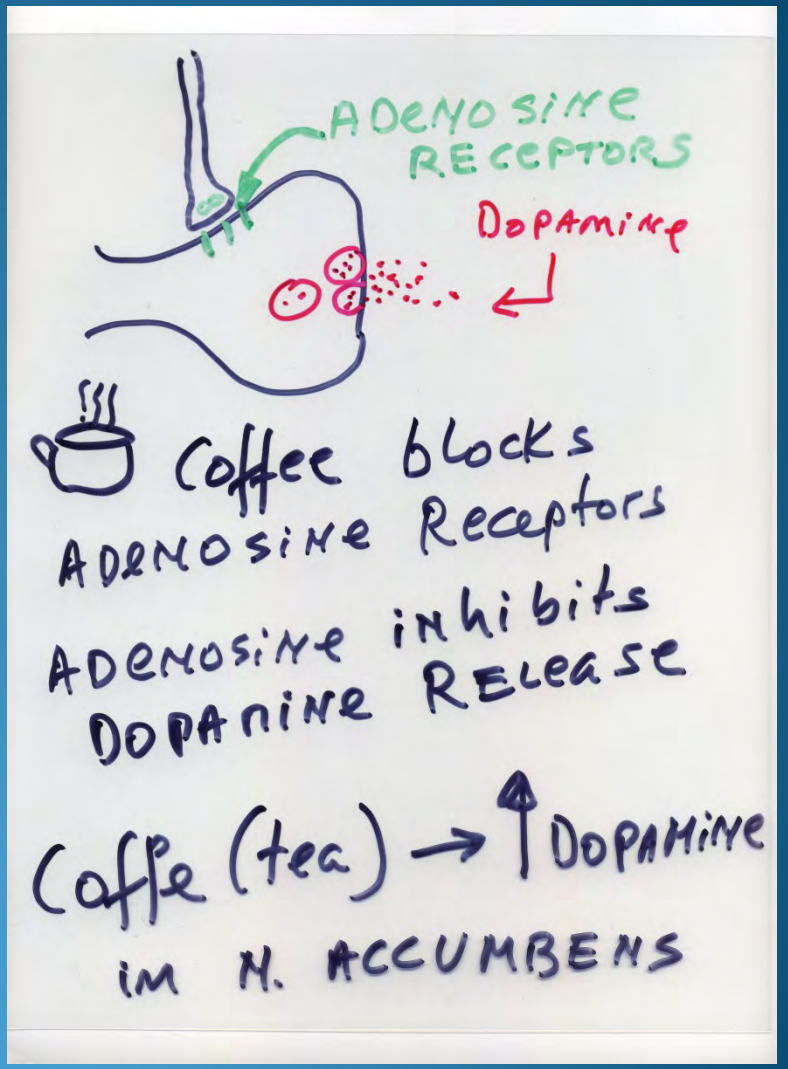
- Waking brain uses Adenosine Tri-Phosphate (ATP) for energy and this is ultimately degraded to Adenosine.
- Accumulation of Adenosine activates Adenosine A1 and A2a receptors which make us sleepy. The longer we stay awake the more Adenosine accumulates
- During early sleep, Adenosine is converted back to ATP and there is a rapid replenishment of brain ATP



Caffeine



Adenosine

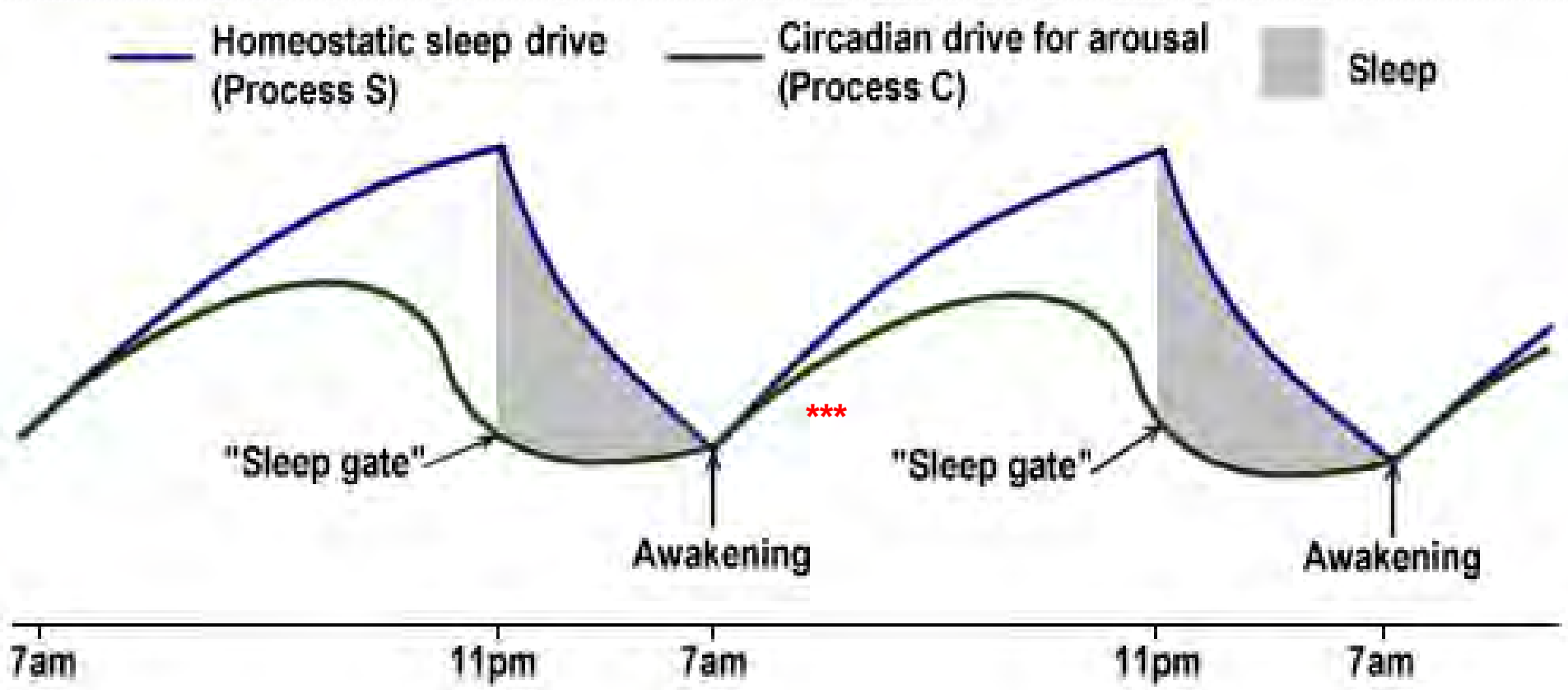


Process C: What regulates arousal during the day?

- The SCN has circadian oscillators (neurons which fire on an approximate 24 hour cycle).

- Zeitgebers: "time givers". *External time cues*
  - The retina has specialized light receptors which contain melanopsin (sensitive to blue light), signals from which reset the circadian oscillators.

Melatonin is produced in the pineal gland, from serotonin, and negatively feeds back on the circadian clock, causing it to change phase from wake to sleep


Homeostatic sleep drive
(Process S)
Circadian drive for arousal
(Process C)
Sleep
"Sleep gate"
Awakening
***
"Sleep gate"
Awakening
7am
11pm
7am
11pm
7am

Learning Objectives

1. List factors that put you at risk for sleepiness and fatigue.
2. Recognize signs of sleepiness and fatigue in yourself and others.
3. Describe the impact of sleep loss on residents' personal and professional lives, and on resident and patient safety.
4. Challenge common misconceptions among physicians about sleep and sleep loss.
5. Adapt alertness management tools and strategies for yourself and your program.

Morbidity and Mortality Weekly Report (*MMWR*)

CDC

Prevalence of Healthy Sleep Duration among Adults — United States, 2014

Weekly / February 19, 2016 / 65(6);137–141

Yong Liu, MD[1]; Anne G. Wheaton, PhD[1]; Daniel P. Chapman, PhD[1]; Timothy J. Cunningham, ScD[1]; Hua Lu, MS[1]; Janet B. Croft, PhD[1] (View author affiliations)

View suggested citation

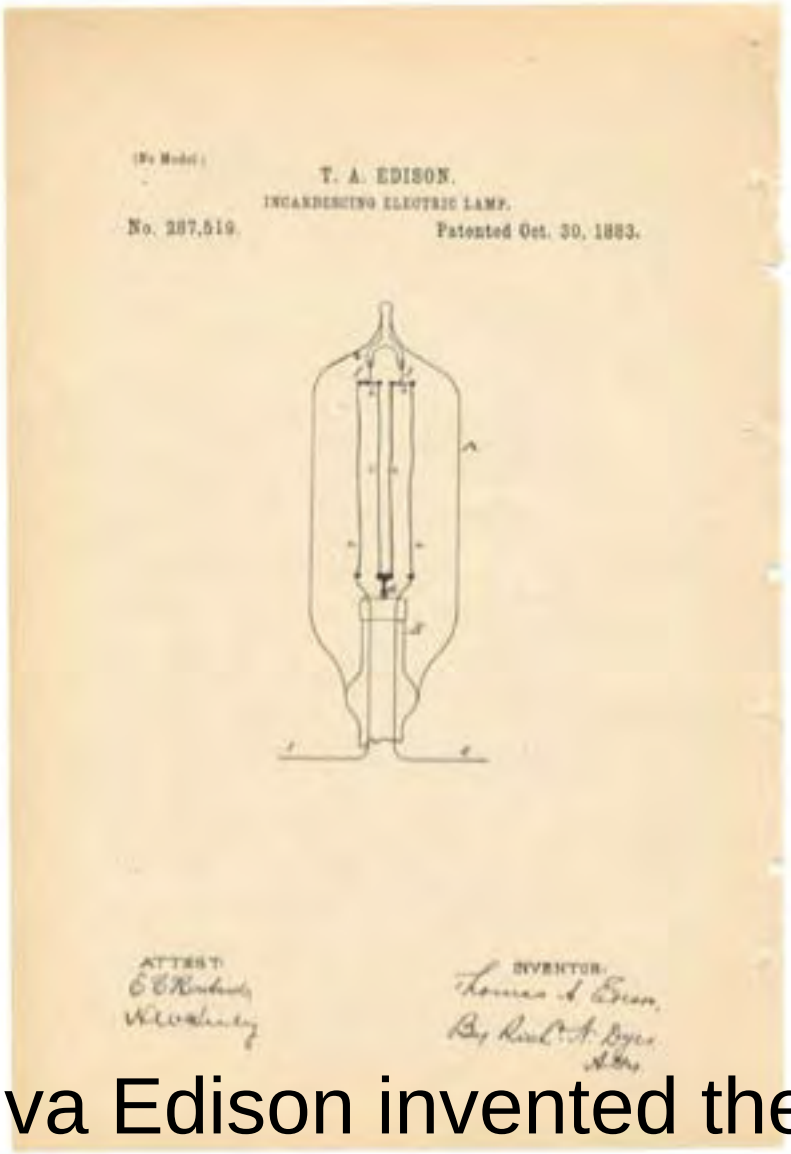
Summary

What is already known about this topic?

Short sleep duration (<7 hours per night) is associated with greater likelihoods of obesity, high blood pressure, diabetes, coronary heart disease, stroke, frequent mental distress, and death.

What is added by this report?

The first state-specific estimates of the prevalence of a ≥7 hour sleep duration in a 24-hour period show geographic clustering of lower prevalence estimates for this duration of sleep in the southeastern United States and in states along the Appalachian Mountains, which are regions with the highest burdens of obesity and other chronic conditions. Non-Hispanic black, American Indian/Alaska Native, and Native Hawaiian/Pacific Islander, and multiracial populations report a lower prevalence of ≥7 hours sleep compared with the rest of the U.S. adult population.



(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 287,519. Patented Oct. 30, 1883.

ATTEST:

INVENTOR:

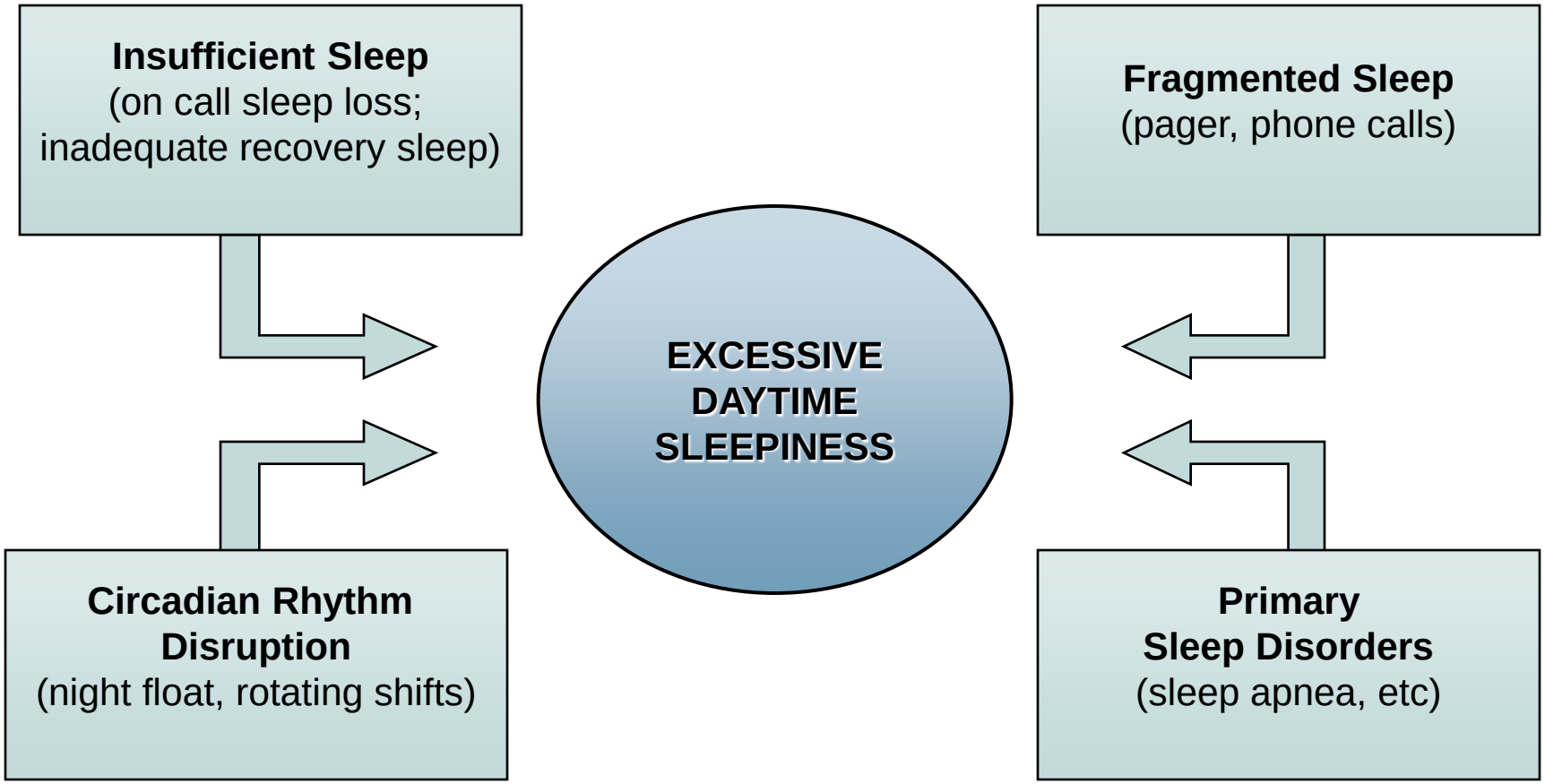
Thomas Alva Edison invented the light bulb
141 years ago

"For myself I never found need of more than four or five hours' sleep in the twenty-four. I never dream. It's real sleep."

dream. It's real sleep.

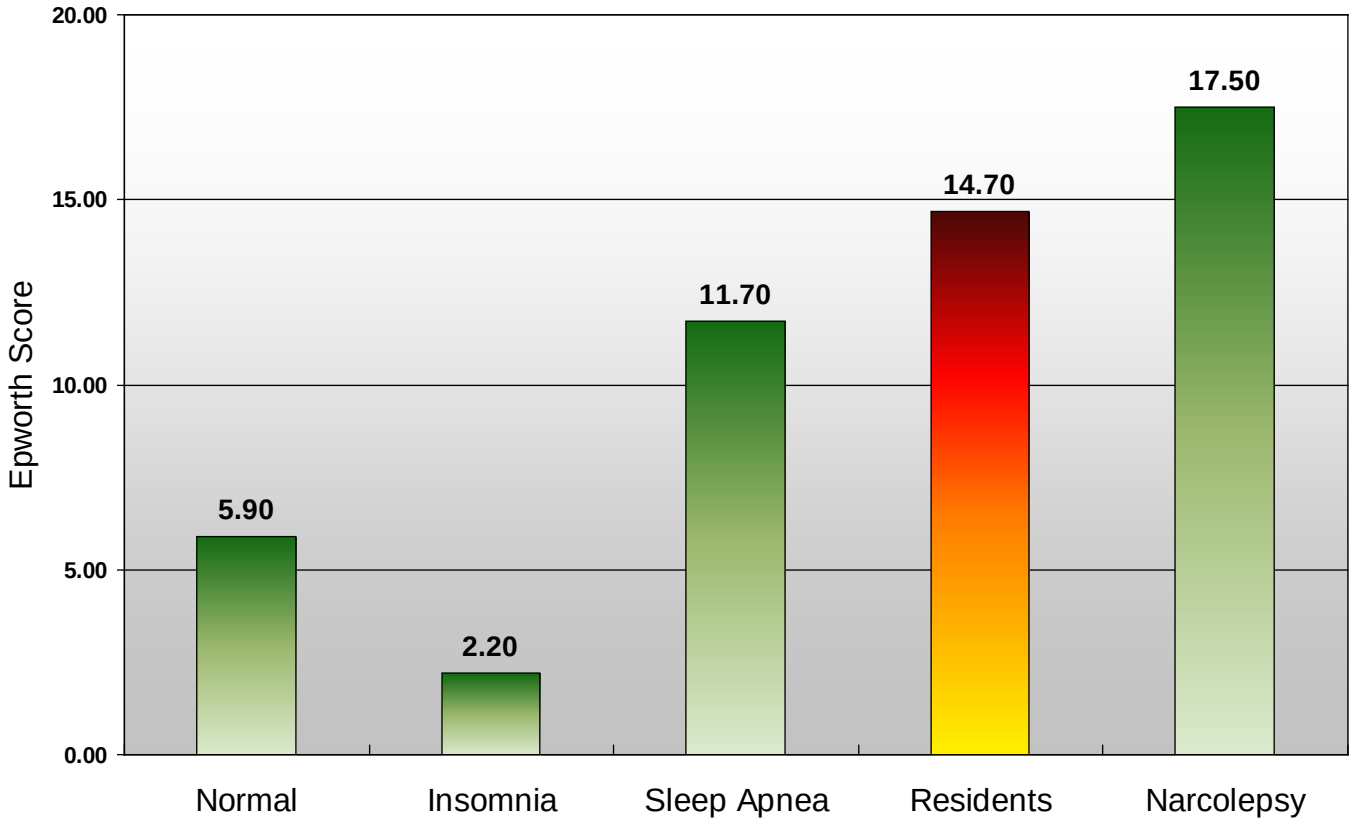
- Nick Holonyack inventer of the LED in 1962, 83 years after the light bulb

Risks from the nature of your job



Sleepiness in Residents

Sleepiness in residents is equivalent to that found in patients with serious sleep disorders.



Papp et al, Academic Medicine, 2002
Mustafa et al, Sleep and Breathing, 2005

Specialties Most Likely to Report Experiences of Sleep Deprivation

1.	Neurosurgery	4.06
2.	General Surgery	3.65
3.	Orthopedic Surgery	3.17
4.	Neurology	3.16
5.	OB/Gyn	3.10
6.	Pediatrics	3.01

Sleep deprivation scale:
1="Never"; 5="Almost daily"

Baldwin & Daugherty, Sleep, 2004

Cultural Norms and Sleep Need

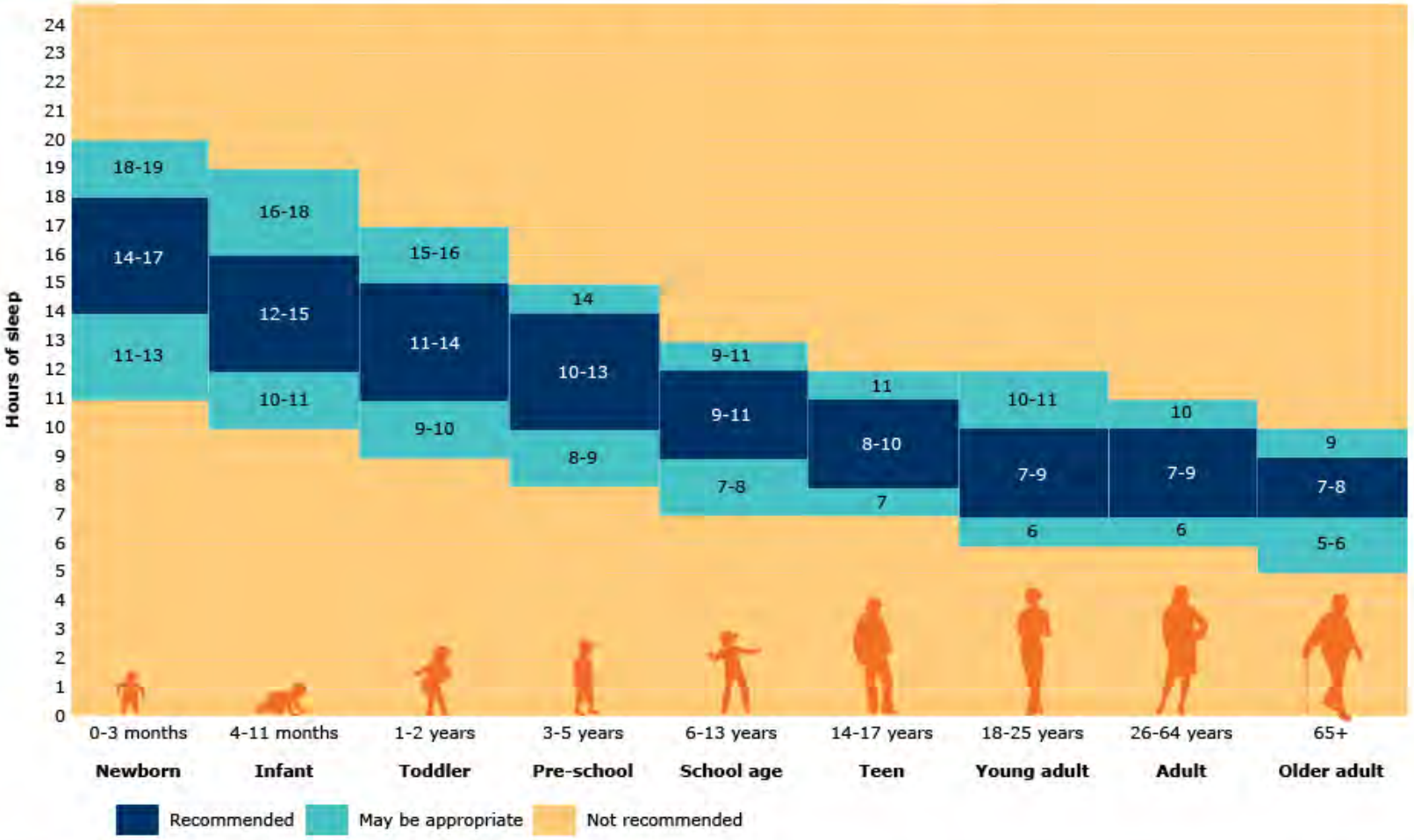
The culture of medicine says:

- Sleep is “optional” (and you’re a wimp if you need it)
- Less sleep = more dedicated doctor

Perception that reducing work hours

- Compromises patient care
- Reduces educational opportunity

Sleep duration recommendations by age from the National Sleep Foundation*



* These recommendations are very similar, but not identical to those from the American Academy of Sleep Medicine (AASM).[1,2]

1. *Paruthi S, Brooks LJ, D'Ambrosio C, et al. Recommended amount of sleep for pediatric populations: A statement of the American Academy of Sleep Medicine. J Clin Sleep Med 2016; 12:785.*
2. *Consensus Conference Panel, Watson NF, Badr MS, et al. Recommended amount of sleep for a healthy adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. J Clin Sleep Med 2015; 11:591.*

Sleep Needed vs. Sleep Obtained

Myth: "Like a lot of residents, I only need five hours of sleep, so none of this applies to us."

Fact: Sleep loss is cumulative; getting less than eight hours of sleep starts to create a "sleep debt" which must be paid off. May be true: vulnerability to sleep deprivation is heritable.

Impairment of attention and working memory become evident when individuals are limited to **six hours of sleep per night***

http://dx.doi.org/10.5665/sleep.2074

Heritability of Performance Deficit Accumulation During Acute Sleep Deprivation in Twins

DISCUSSION

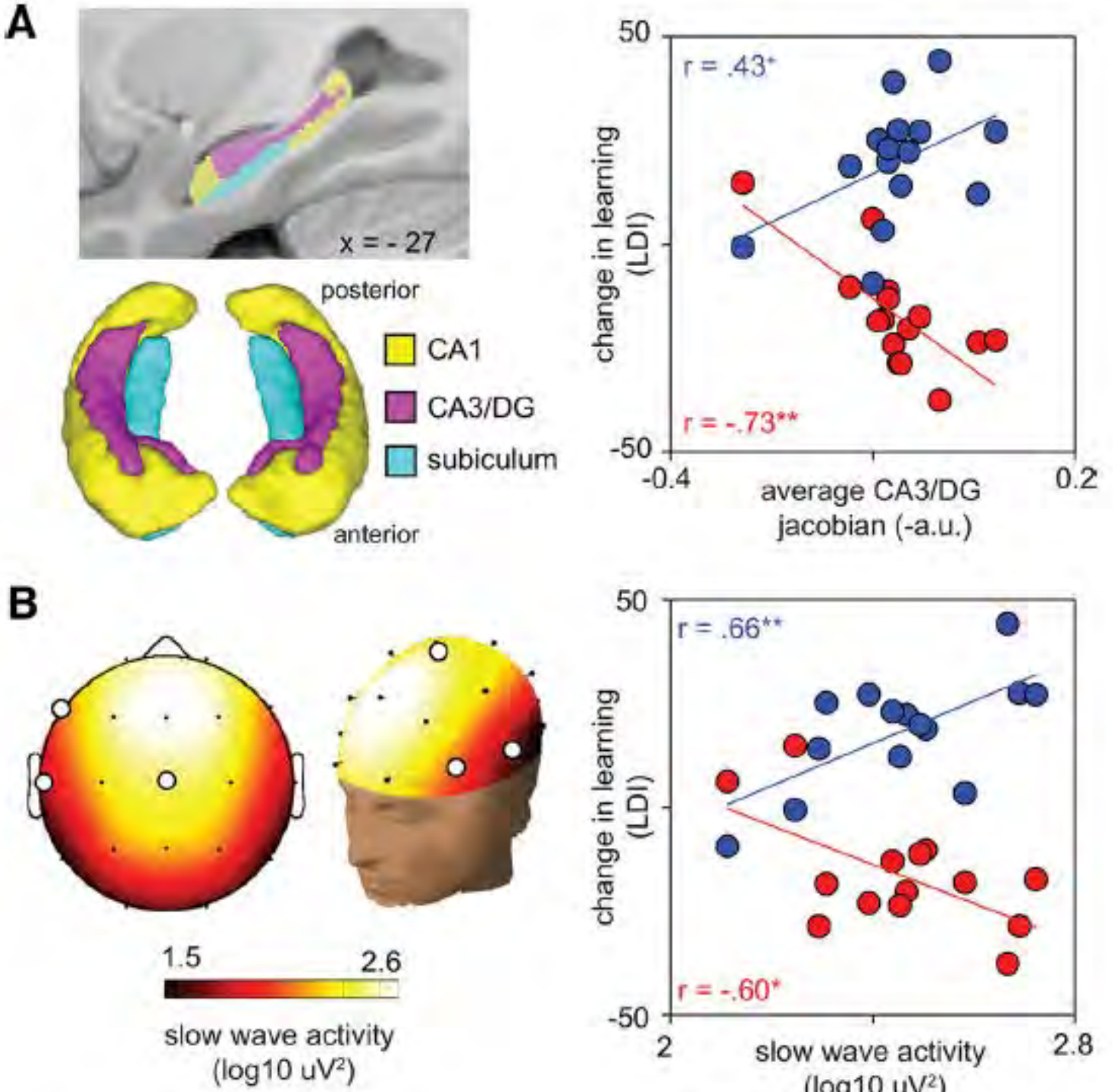
The results of this study in twins show that behavioral impairment produced by sleep deprivation is a highly heritable trait in humans. We found a strong heritable component to the decrements in PVT performance during continuous sleep deprivation. Over the 38-hr sleep deprivation period, MZ twins

These results in humans confirm the seminal study of Franken et al.[11] that the response to sleep deprivation in mice is a highly heritable trait. Using recombinant inbreds between strains with different amounts of rebound of EEG delta power during recovery sleep after sleep deprivation, a quantitative trait locus for that trait that was genome-wide significant was identified on mouse chromosome 13.[11] The locus accounted for 49% of the genetic variance in that trait. An *in-silico* analysis of

SLEEP 2012;35(9):1223-1233.

Significance Statement

Sleep deprivation does not impact all people equally. Some individuals show cognitive resilience to the effects of sleep loss, whereas others express striking vulnerability, the reasons for which remain largely unknown. Here, we demonstrate that structural features of the human brain, specifically those within the hippocampus, accurately predict which individuals are susceptible (or conversely, resilient) to memory impairments caused by sleep deprivation. Moreover, this same structural feature determines the success of memory restoration following subsequent recovery sleep. Therefore, structural properties of the human brain represent a novel biomarker predicting individual vulnerability to (and recovery from) the effects of sleep loss, one with occupational relevance in professions where insufficient sleep is pervasive yet memory function is paramount.

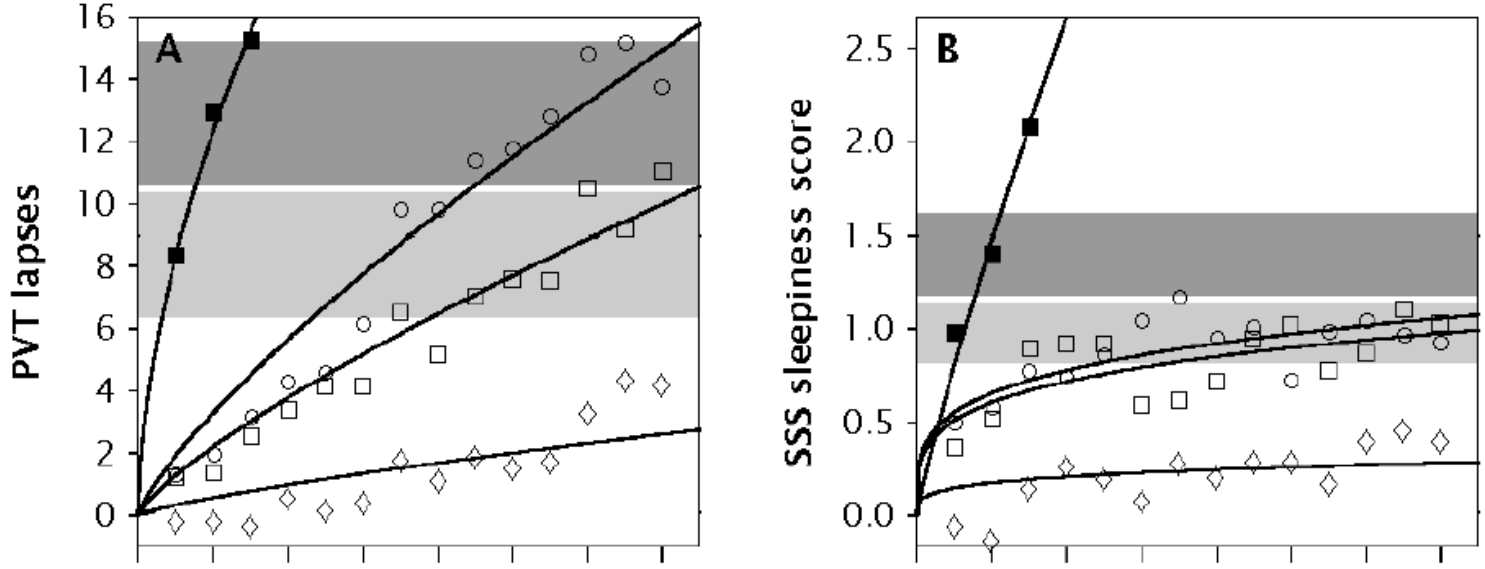


Adaptation to Sleep Loss

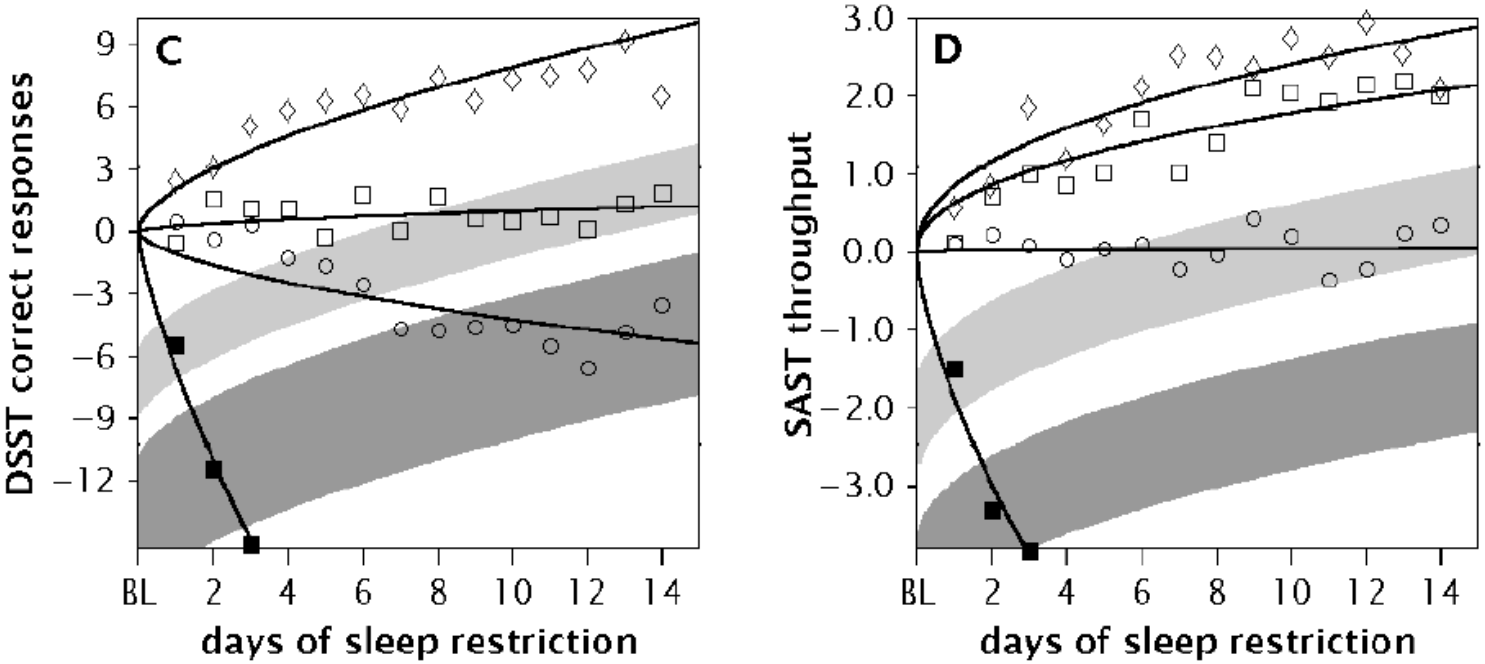
Myth: "I've learned not to need as much sleep during my residency."

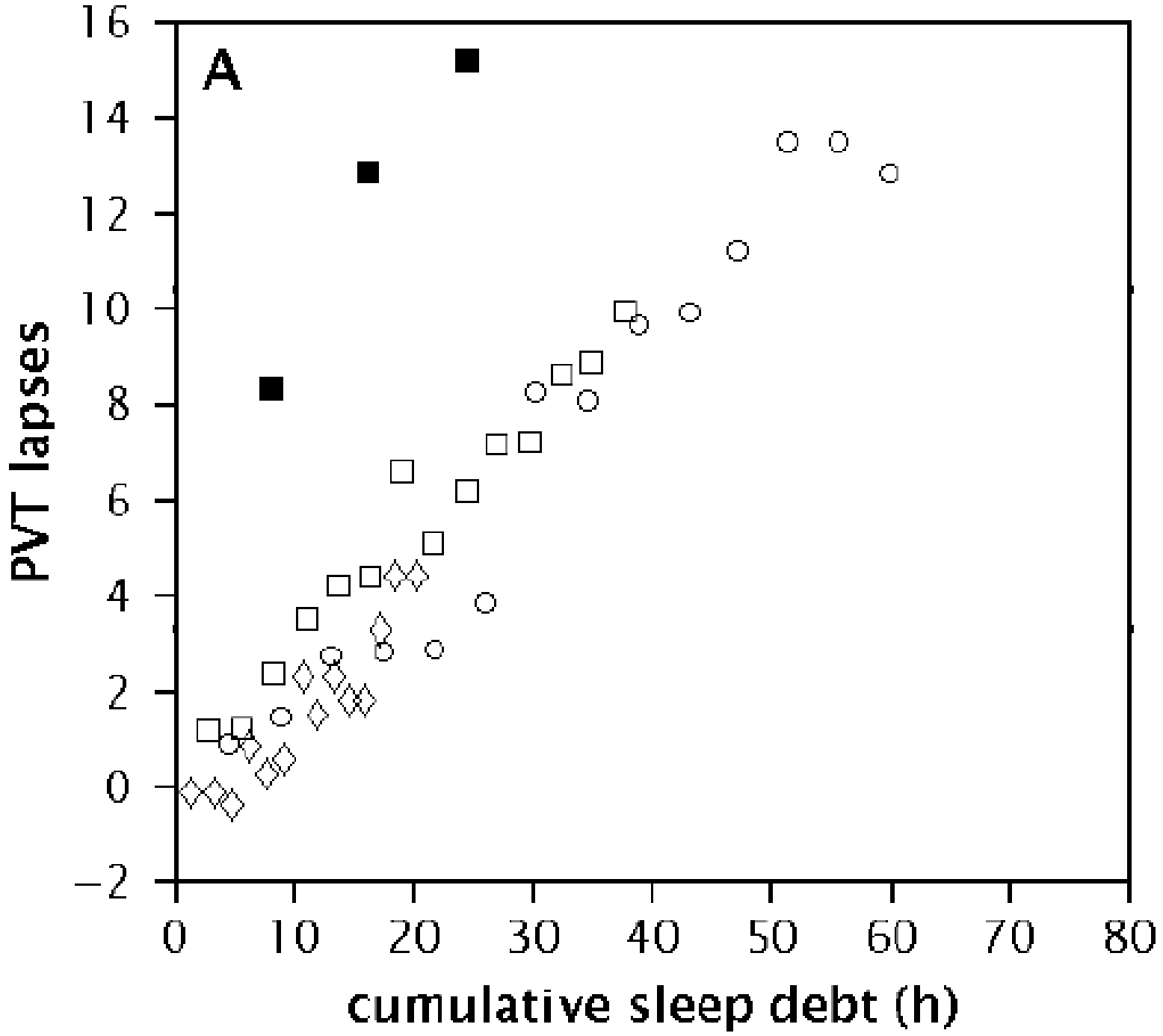
Fact: Sleep needs are genetically determined and cannot be changed. *Human beings do not "adapt" to getting less sleep than they need.**

Fact: learning may reduce errors, but *optimal consistent* performance worsens with sleep debt!



*Van Dongen et al, Sleep, 2003




A
PVT lapses
cumulative sleep debt (h)
16
14
12
10
8
6
4
2
0
−2
0
10
20
30
40
50
60
70
80

Impairment of attention and working memory become evident when individuals are limited to **six hours of sleep per night***

14 days of 6 hours sleep per night = 2 nights of total sleep deprivation

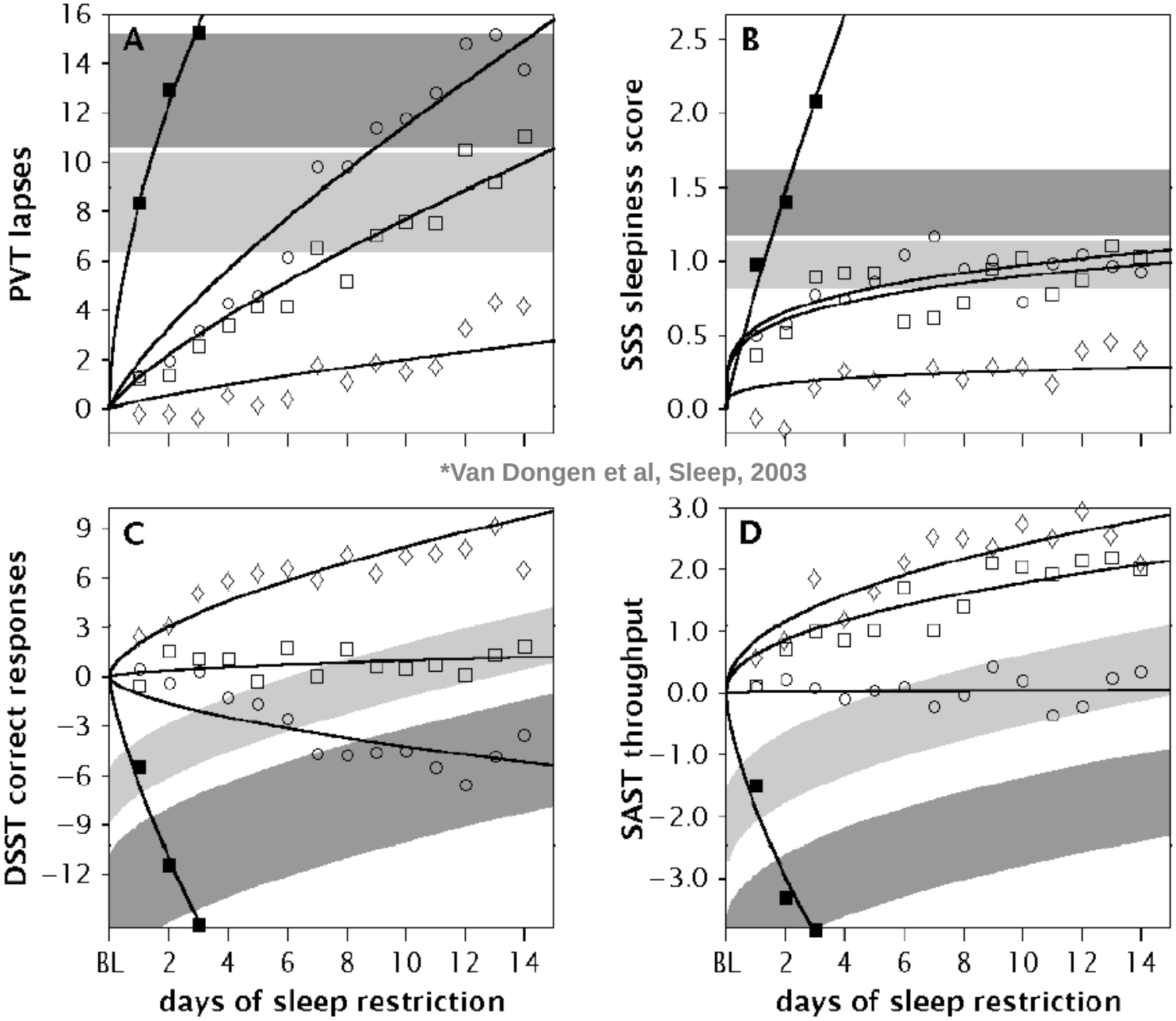
7 days of 5 hours of sleep per night= 1 night of total sleep deprivation

Cumulative wakefulness of > 15.84 hours predicted performance lapses

Recognizing Sleepiness in Yourself and Others

Recognize the Warning Signs of Sleepiness

- Falling asleep in conferences or on rounds
- Feeling restless and irritable with staff, colleagues, family, and friends
- Having to check your work repeatedly
- Having difficulty focusing on the care of your patients
- Feeling like you really just don’t care



*Van Dongen et al, Sleep, 2003

Sleepiness in Resident Physicians

Steven K. Howard, MD, David M. Gaba, MD, Mark R. Rosekind, PhD, and Vincent P. Zarcone, MD

Abstract

Purpose. To assess the levels of physiologic and subjective sleepiness in residents in three conditions: (1) during a normal (baseline) work schedule, (2) after an in-hospital 24-hour on-call period, and (3) following a period of extended sleep.

Method. In 1996, a within-subjects, repeated-measures study was performed with a volunteer sample of 11 anesthesia residents from the Stanford University School of Medicine using three separate experimental conditions. Sixteen residents were recruited and 11 of the 16 completed the three separate experimental conditions. Daytime sleepiness was assessed using the Multiple Sleep Latency Test (MSLT).

Results. MSLT scores were shorter in the baseline (6.7 min) and post-call (4.9 min) conditions, compared with the extended-sleep condition (12 min, $p = .0001$) and there was no significant difference between the baseline and post-call conditions ($p = .07$). There was a significant main effect for both condition ($p = .0001$) and time of day ($p = .0003$). Subjects were inaccurate in subjectively identifying sleep onset compared with EEG measures (incorrect on 49% of EEG-determined sleep episodes).

Conclusion. Residents' daytime sleepiness in both baseline and post-call conditions was near or below levels associated with clinical sleep disorders. Extending sleep time resulted in normal levels of daytime sleepiness. The residents were subjectively inaccurate determining EEG-defined sleep onset. Based on the findings from this and other studies, reforms of residents' work and duty hours are justified.

Acad. Med. 2002;77:1019–1025.

Microsleeps

- Unintentional episodes of sleep, typically between 5-to-14 seconds in duration
- **Cause:** Sleep debt, sleep deprivation.
- **Behavioral Correlates:** Head nods, drooping eyelids.
- Subjective “unawareness” or “spacing out” sensation

Harrison, Y., and Horne, J. A. EEG Clin Neurophysiol, 1996
Risser, M. R., Ware, J. C., and Freeman, F. G. Sleep, 2000

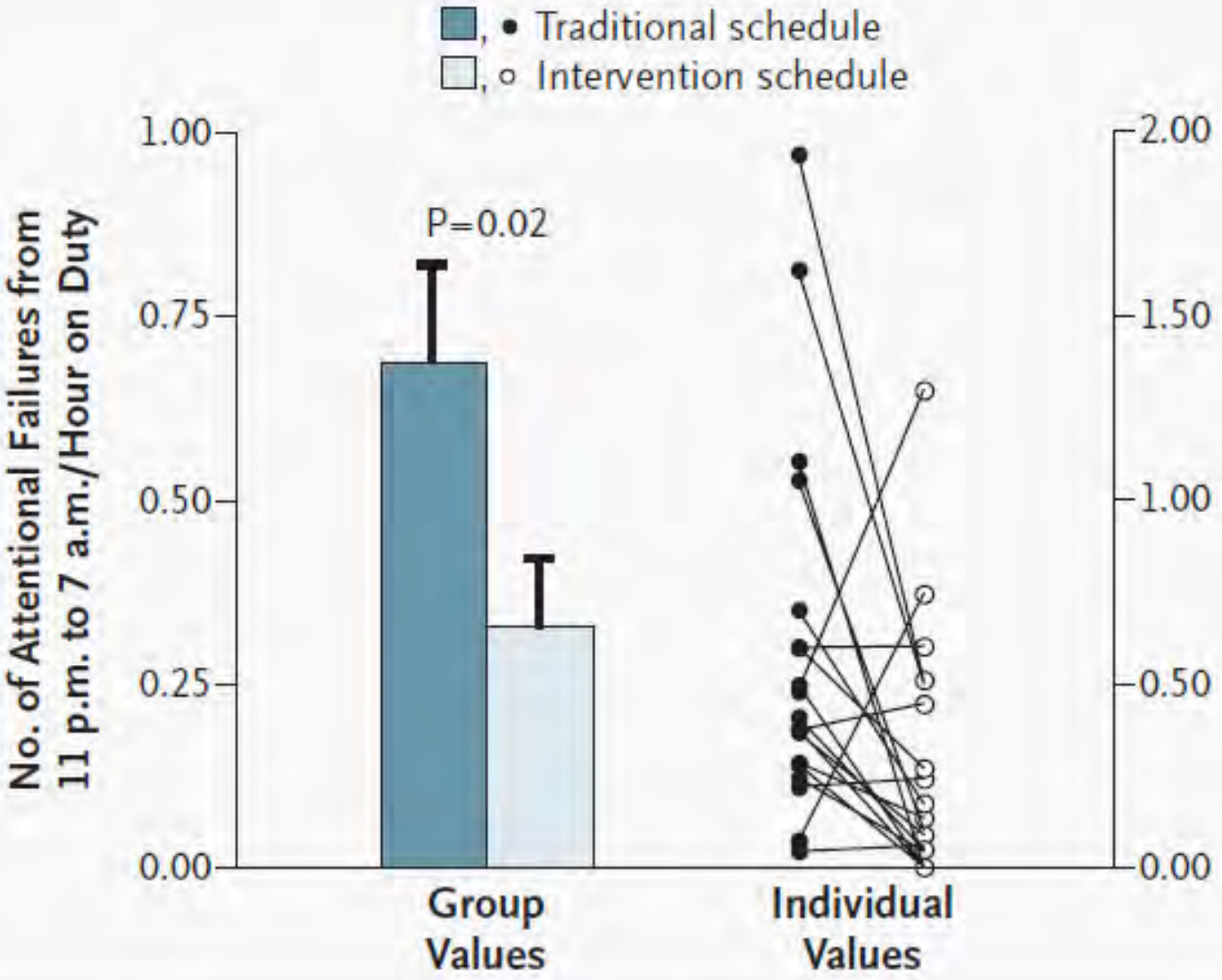


Figure 5. Mean (+SE) Number of Attentional Failures among the 20 Interns as a Group and Individually while Working Overnight (11 p.m. to 7 a.m.) during the Traditional Schedule and the Intervention Schedule.

Estimating Sleepiness

Myth: “I can tell how tired I am and I know when I’m not functioning up to par.”

Fact: The sleepier you are, the *less accurate* your perception of degree of impairment.

Fact: You can fall asleep briefly (“microsleeps”) without knowing it!

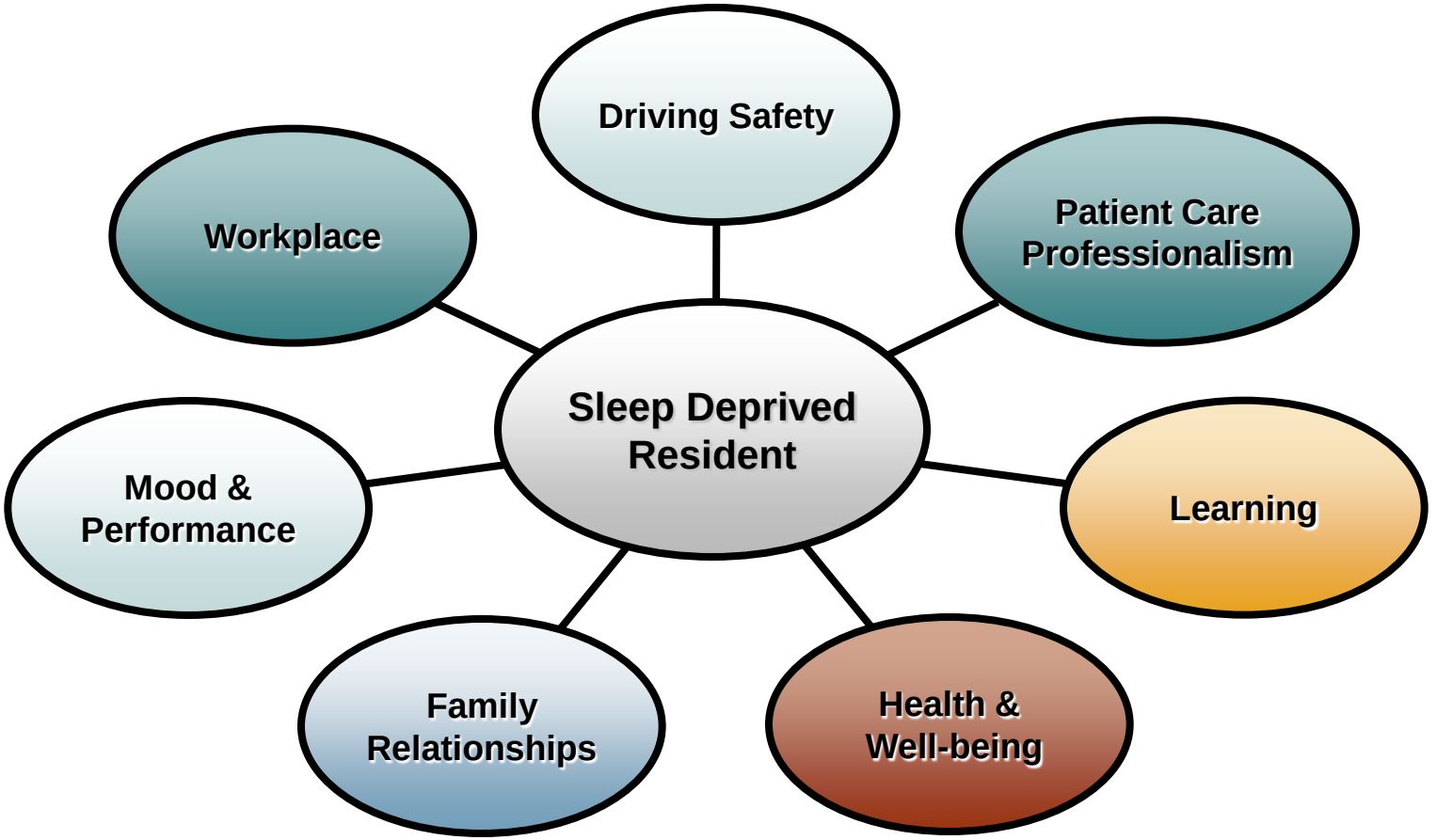
***Howard et al Academic Med, 2002**

Diagnostic criteria for insufficient sleep syndrome

Diagnostic criteria A-F must be met:	
A	The patient has daily periods of irrepressible need to sleep or daytime lapses into sleep or, in the case of prepubertal children, there is a complaint of behavioral abnormalities attributable to sleepiness.
B	The patient's sleep time, established by personal or collateral history, sleep logs, or actigraphy, is usually shorter than expected for age.
C	The curtailed sleep pattern is present most days for at least three months.
D	The patient curtails sleep time by such measures as an alarm clock or being awakened by another person and generally sleeps longer when such measures are not used, such as on weekends or vacations.
E	Extension of total sleep time results in resolution of the symptoms of sleepiness.
F	The symptoms are not better explained by another untreated sleep disorder, the effects of medications or drugs, or other medical, neurologic, or mental disorders.

Reproduced with permission from: American Academy of Sleep Medicine. International Classification of Sleep Disorders, 3rd ed, American Academy of Sleep Medicine, Darien, IL 2014. Copyright © 2014 American Academy of Sleep Medicine.

Consequences of Sleep Deprivation

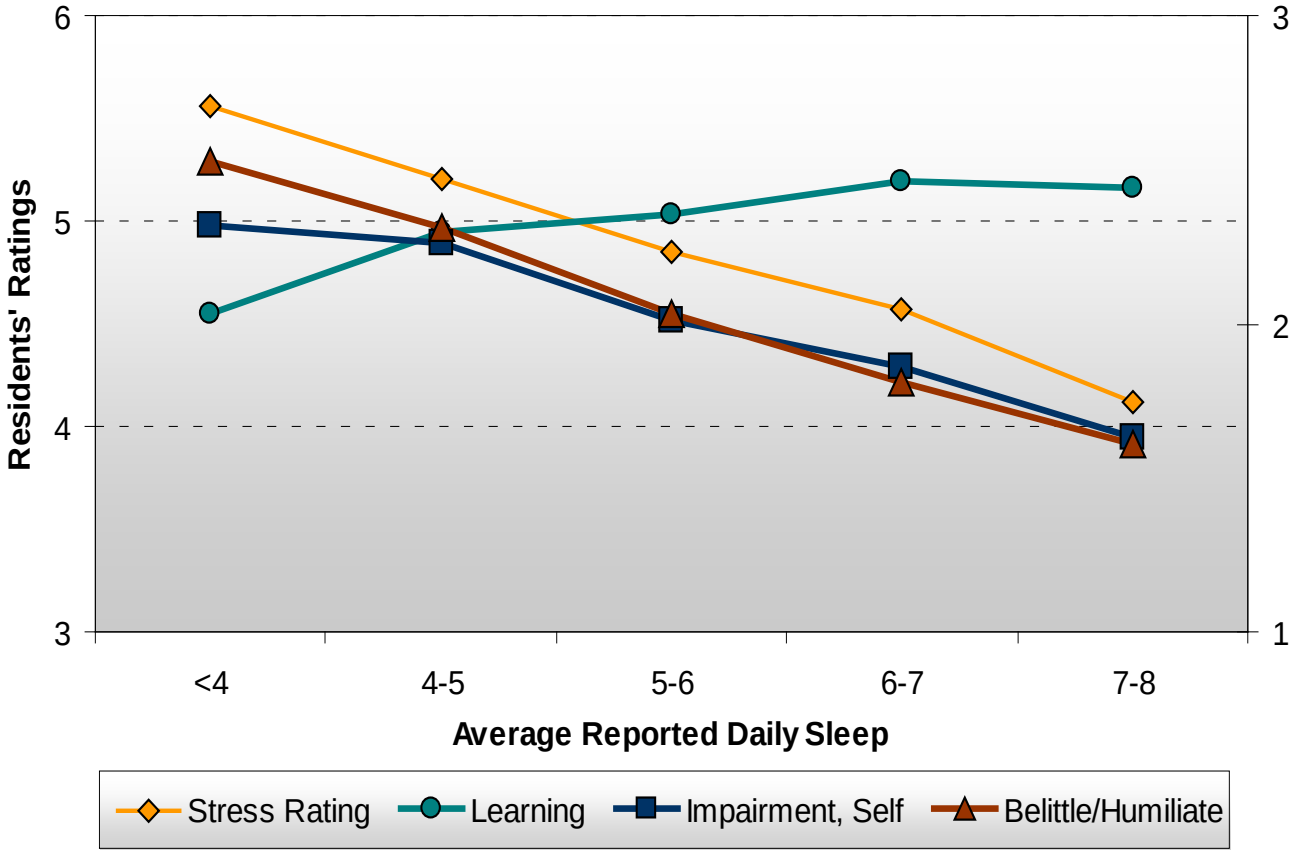


Impact on Learning

“Your own patients have become the enemy…because they are the one thing that stands between you and a few hours of sleep.”

Papp et al, Academic Medicine, 2002

Average Hours of Sleep per Night Impacts Residency Experience



***As Nightly Sleep Increases*:**

- Learning ability increases
- Stress rating decreases
- Sense of being "impaired" decreases
- Reports of feeling "belittled or humiliated" decrease

Baldwin & Daugherty, Sleep, 2004

Impact on Professionalism

“Your own patients have become the enemy…because they are the one thing that stands between you and a few hours of sleep.”

Papp et al, Academic Medicine, 2002

Residents Averaging Less Than Five Hours of Sleep per Night

Were *significantly* more likely to report:	Odds Ratio
Involvement in a malpractice suit	2.02
Use of medication to stay awake	1.91
Serious conflict with other residents	1.86
Accidents/injuries	1.84
Making a serious medical error	1.74
Noticeable weight change	1.59
Increased use of alcohol	1.52
Serious conflict with nursing staff	1.47

Baldwin & Daugherty, Sleep, 2004

Friedman et al., N Engl J Med 1971

SPECIAL ARTICLE

THE INTERN AND SLEEP LOSS

RICHARD C. FRIEDMAN, M.D., J. THOMAS BIGGER, M.D., AND DONALD S. KORNFELD, M.D.

Abstract To investigate the effects of sleep deprivation on medical interns, an electrocardiographic arrhythmia-detection task and questionnaires assessing mood and subjectively perceived psychophysiologic state were administered.

In comparison to their performance when rested, interns deprived of sleep were significantly less able to recognize arrhythmias on the electrocardiographic task. Mood was significantly affected by sleep loss; deprived interns felt increased sadness and decreased vigor, egotism and social affection. In addition, numerous psychopathologic symptoms developed, and they judged themselves to have abnormalities in cognitive, perceptual and physiologic areas of function.

It is apparent that interns deprived of normal sleep may experience transient psychopathology and impaired efficiency of performance.

was described by an intern as follows: "I am so tired I forget what the name is on the chart I am writing in. As a result I write progress notes in the wrong charts and try to correct myself in the morning."

Impact on Performance and Patient Safety

nviron Med 2000;57:649–655

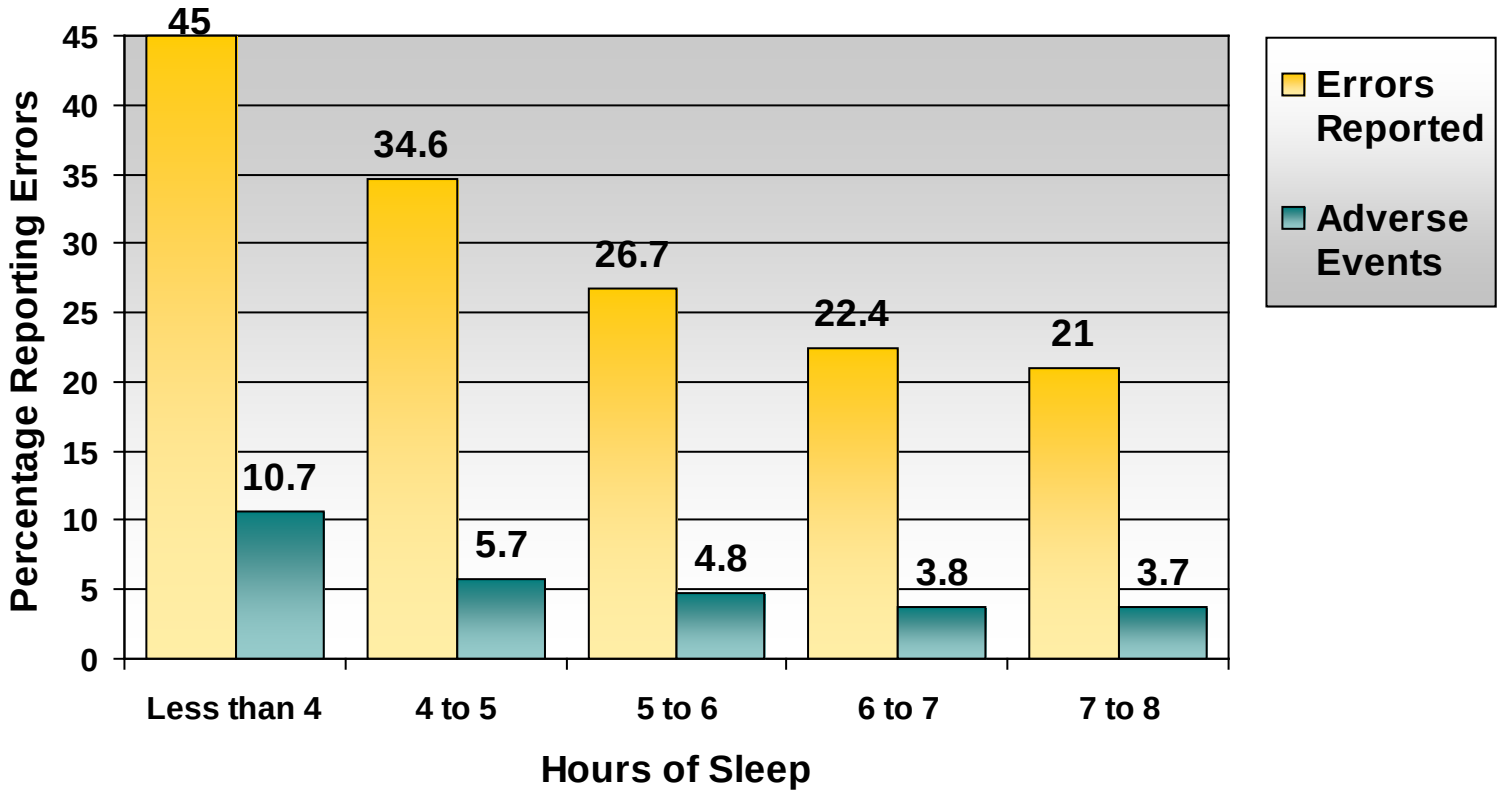
Abstract

Objectives—To compare the relative effects on performance of sleep deprivation and alcohol.

Methods—Performance effects were studied in the same subjects over a period of 28 hours of sleep deprivation and after measured doses of alcohol up to about 0.1% blood alcohol concentration (BAC). There were 39 subjects, 30 employees from the transport industry and nine from the army.

Results—After 17–19 hours without sleep, corresponding to 2230 and 0100, performance on some tests was equivalent or worse than that at a BAC of 0.05%. Response speeds were up to 50% slower for some tests and accuracy measures were significantly poorer than at this level of alcohol. After longer periods without sleep, performance reached levels equivalent to the maximum alcohol dose given to subjects (BAC of 0.1%).

Resident Self-reported Errors by Average Daily Hours of Sleep



Baldwin & Daugherty, Sleep, 2004

Sleep Deprivation & Errors in Detection of Cardiac Arrhythmias on ECG

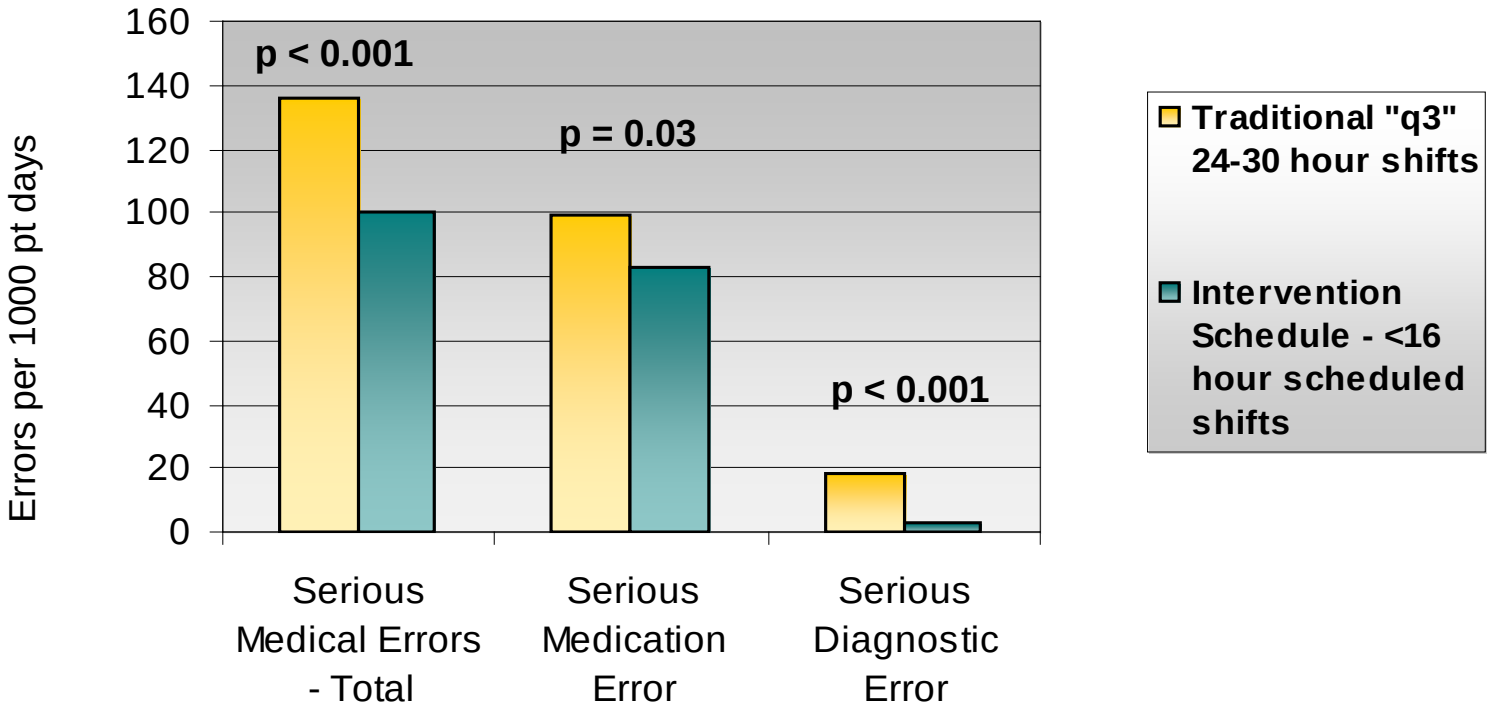
Medical Interns	Rested	Sleep Deprived
Sleep Amount in Prior 32 h	7.0 h (5.5 – 8.5 h)	1.8 h (0 – 3.8 h)*
Errors on ECG Sustained Attention Task	5.21 ± 0.93	9.64 ± 1.41*

***p<.0001**

Friedman et al., N Engl J Med 1971

Intern Sleep and Patient Safety Study

Results: 36% more serious errors on traditional schedule, including *five times* as many serious diagnostic errors



Landrigan et al. N Engl J Med 2004

Sleep, Vol. 19, No.4, 1996

Meta-analysis of 20 studies: Psychomotor vigilance and cognitive testing

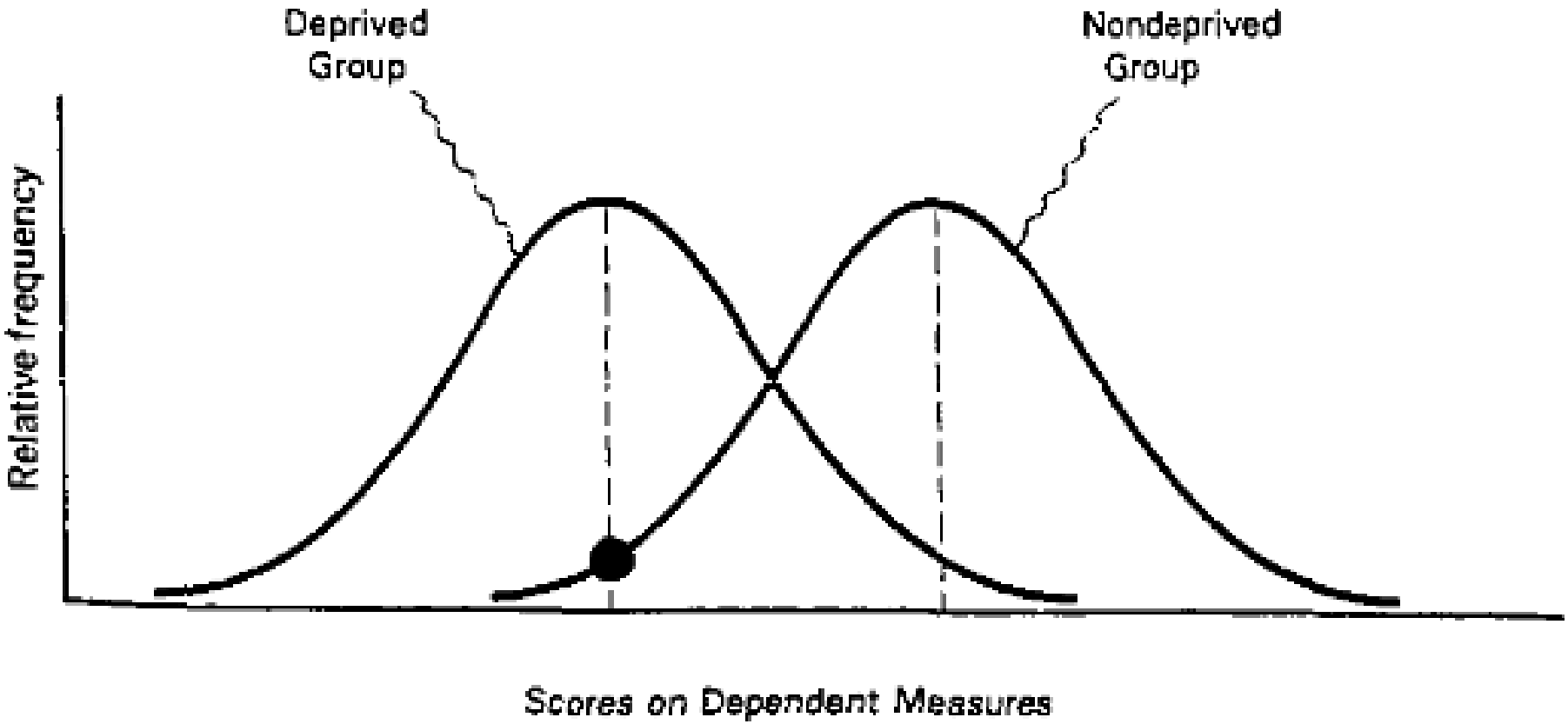


FIG. 1. Illustration of the overall difference between sleep-deprived and non-sleep-deprived subjects.

Residency Specific Data

- **Surgery:** 20% more errors and 14% more time required to perform simulated laparoscopy post-call (two studies)

  Taffinder et al, Lancet, 1998; Grantcharov et al, BMJ, 2001

- **Internal Medicine:** efficiency and accuracy of ECG interpretation impaired in sleep-deprived interns

  Lingenfelser et al, Med Educ, 1994

- **Pediatrics:** time required to place an intra-arterial line increased significantly in sleep-deprived

  Storer et al, Acad Med, 19891

Residency Specific Data

- **Emergency Medicine:** significant reductions in comprehensiveness of history & physical exam documentation in second-year residents

  Bertram N Y State J Med 1988

- **Family Medicine:** scores achieved on the ABFM practice in-training exam correlated with pre-test sleep amounts

  Jacques et al J Fam Pract 1990

Impact on Personal Health and Safety

Resident Well-being

- Depression and burnout rates
  - Pregnancy complications from sleep deprivation and fatigue
    *J Fam Pract.*1990;31:618-622. 12 fold risk of premature labor but not premature delivery.
  - Resident depression has been associated with chronic sleep deprivation and increased from 4% to 30% over one year (Rosen, et al, Acad Med, 2006)
  - Up to ¾ of residents report burnout symptoms, with positive associations with increased workload and work hours (Thomas, JAMA, 2004)

Sleep Deprivation

- Cardiovascular Disease
  - Hypertension, MI, Strokes, high cholesterol
  - Impotence.
  - Shortened lifespan.

- Decreased Immunity
  - Cancer
  - Especially Breast Cancer in Female Shift workers

http://www.nyahnyah.net/fb/sum/25akitomiffed.jpg

Sleep Duration and Quality: Impact on Lifestyle Behaviors and Cardiometabolic Health:

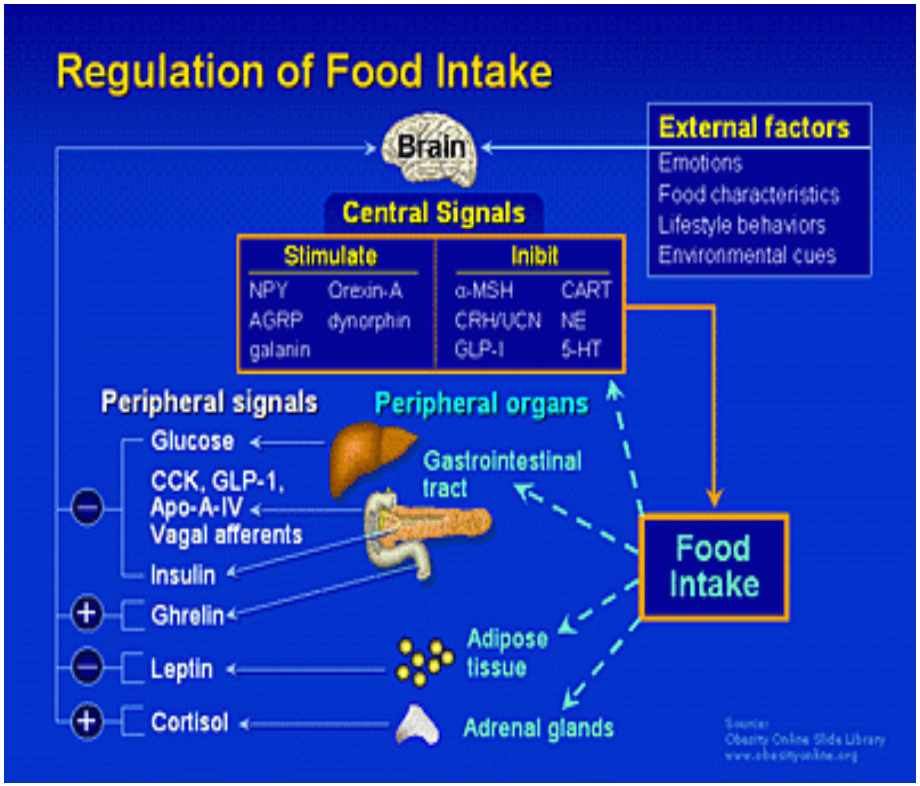
A Scientific Statement From the American Heart Association

Associations Between Sleep Duration and Disorders and Incident CVD

Disorder	Short Sleep	Long Sleep	Insomnia	SDB
Diabetes mellitus	+	+	+	+
Hypertension	+	X	NA	NA
CHD	+	+	NA	X
Stroke	+	+	NA	+

Circulation. 2016 November 01; 134(18): e367–e386. doi:10.1161/CIR.0000000000000444.

Sleep debt can cause weight gain (~30 lbs) and Diabetes

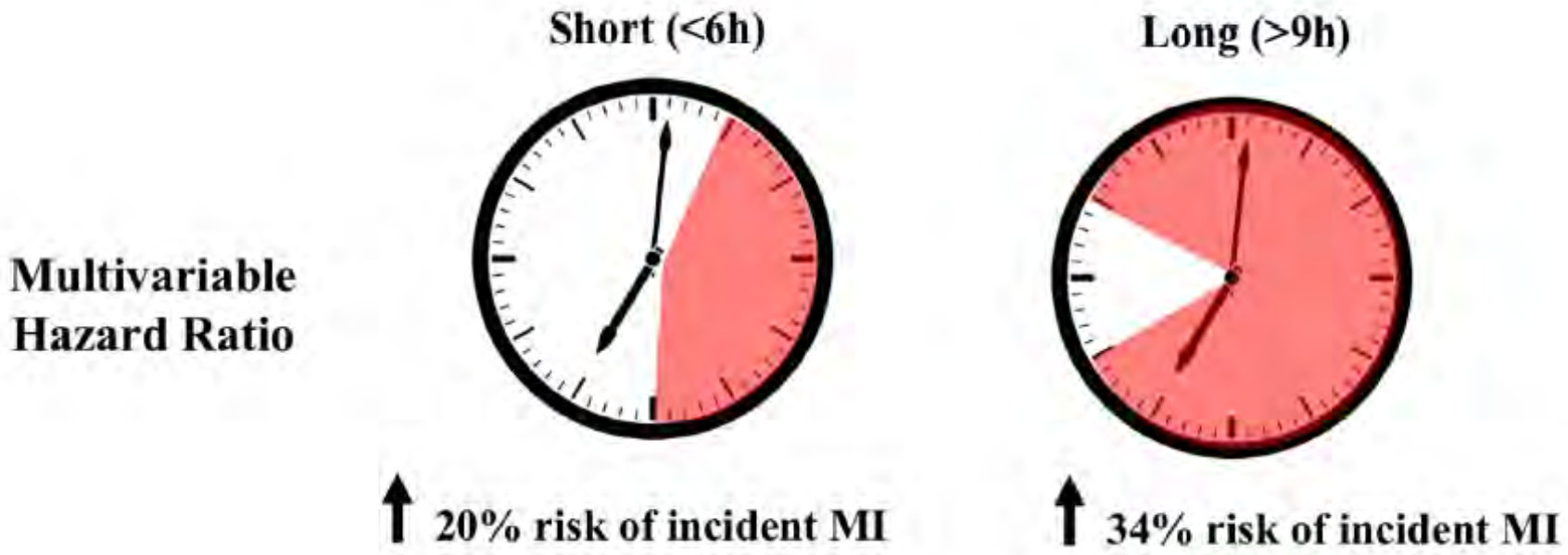


- Sleep loss decreases leptin levels
  - an appetite depressor hormone
- Sleep loss increases ghrelin levels
  - an appetite stimulator hormone

Table 1

Impact of Sleep Restriction on Food Intake

Study	Participants	Sleep Intervention	Outcome (Sleep Restriction)
Benedict et al,[63] 2011	14 Men	24 h with 8 h TIB or TSD	Greater morning hunger
	Normal weight		No difference in energy intake at afternoon buffet
	Mean age, 23 y		
Bosy-Westphal et al,[57] 2008	14 Women	2 Nights of >8 h TIB followed by consecutive nights of 7, 6, 5, and 4 h TIB	Energy intake was increased by 415 kcal/d relative to baseline
	8 Normal weight, 3 overweight, 3 obese		
	Mean age, 27.5 y		
Brondel et al,[58] 2010	12 Men	48 h with 8 or 4 h TIB	Energy intake was increased by 559 kcal/d
	Normal weight		
	Mean age, 22 y		
Calvin et al,[56] 2013 *	11 Men, 6 women	Reduce sleep to 2/3 habitual sleep or maintain habitual sleep, 8 d	Energy intake was increased by 559 kcal/d relative to baseline
	Normal weight		
	Mean age, ≈25 y		
Markwald et al,[59] 2013	8 Men, 8 women	5 d of 5 or 9 h TIB	Energy intake was increased by 6% (182 kcal/d)
	Normal weight		
	Mean age, 22.4 y		
Nedeltcheva et al,[60] 2009	6 Men, 5 women	14 d of 5.5 h or 8.5 h TIB	Total energy intake was increased by 297 kcal/d (NS); snack intake was increased by 221 kcal/d
	Overweight		
	Mean age, 39 y		
Schmid et al,[64] 2009	15 Men	2 d with 4 or 8 h TIB	Energy intake was similar, but fat intake was increased
	Normal weight		
	Mean age, 27 y		
Spaeth et al,[61] 2013 *	Sleep restriction: 15 men, 16 women	Sleep restriction: 1 baseline night (8 h TIB) followed by 4 nights of 4 h TIB and 2 nights of 10 h TIB Control, 10 h TIB	Energy intake was increased by ≈511 kcal/d when bedtime was delayed and sleep restricted to 4 h TIB
	Control: 4 men, 2 women		
	Normal weight to overweight		
	Mean age, ≈34 y		
St-Onge et al,[62] 2011	13 Men, 13 women	5 Nights of 4 h TIB or 9 h TIB	Energy intake was increased by 296 kcal/d
	Normal weight		
	Mean age, ≈35 y		



In 461,347 UK Biobank (UKB) participants free of relevant cardiovascular disease, aged 40-69 follow-up of 7.04 years.

J Am Coll Cardiol. 2019 September 10; 74(10): 1304–1314. doi:10.1016/j.jacc.2019.07.022.

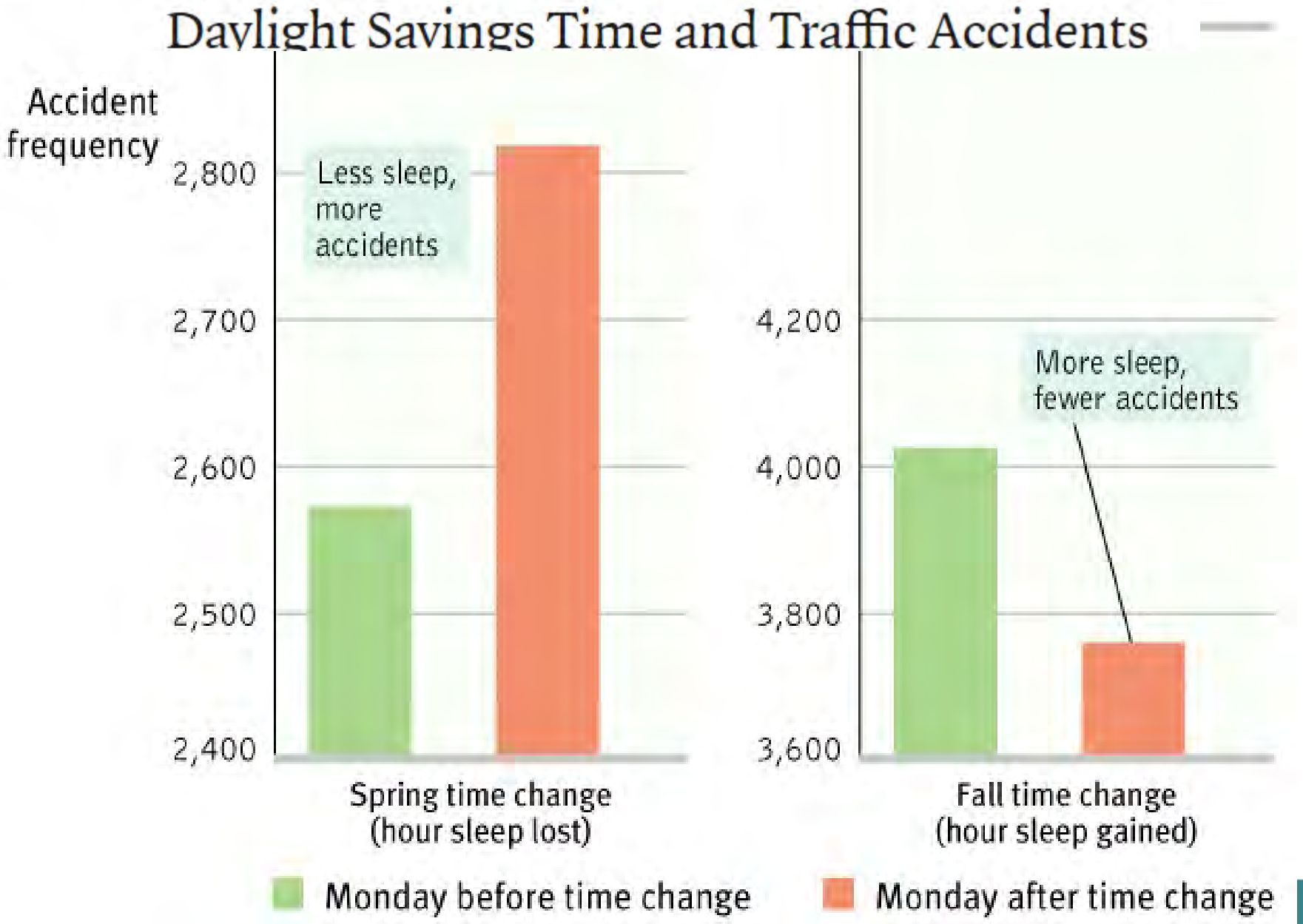
Drowsy Driving: Effects of Sleep Deprivation on Physician Safety

A car driving 60 miles per hour will travel more than 250 feet during a three-second micro-sleep

Harvard Work Hours, Health, and Safety Study – Results

- For *each* extended duration work shift scheduled *per month* interns had:
  - 8.8 % (3.2%-14.4%) increased monthly risk of any motor vehicle crash
  - 16% (7.6%, 24.4%) increased monthly risk of a motor vehicle crash on the commute from work
  - **1,417 person-years monthly survey data collected from 2,737 interns nationwide in 2002-2003**

Barger, L. K. et al. N Engl J Med 2005



Potential Legal Implications for House Staff and Hospitals

- In New Jersey, “driving after having been without sleep for a period in excess of **24 consecutive hours**” now explicitly considered **reckless**
- Laws pending in several other states to make drowsy driving a felony
- Several “high profile” cases in courts accuse hospitals responsible for fatigue-related crashes even after staff have left

Recognize Signs of Driving While Drowsy

- Trouble focusing on the road
- Difficulty keeping your eyes open
- Nodding
- Yawning repeatedly
- Drifting from your lane, missing signs or exits
- Not remembering driving the last few miles
- Closing your eyes at stoplights

Drowsy Driving: What Does and Does Not Work

- What works:
  - AVOID driving if drowsy.
  - If you are really sleepy, get a ride home, take a taxi, or use public transportation.
  - Take a 20 minute nap and/or drink a cup of coffee before going home post-call
  - Pull off the road at a safe place, take a short nap.
  - Use GME paid 1 way free ride by UBER/Taxi
- What doesn't work:
  - Turning up the radio
  - Opening the car window
  - Chewing gum
  - Blowing cold air (water) on your face
  - Slapping (pinching) yourself hard
  - Promising yourself a reward for staying awake

Alertness Management Strategies

Caffeine

- Reduces some sleep-related deficits at doses of 75-150 mg
- *Strategic* consumption is key
- Effects within 15 – 30 minutes; half-life 3 to 7 hours
- Use for temporary relief of sleepiness
- Cons:
  - Can disrupt subsequent sleep (more arousals)
  - Tolerance may develop
  - Diuretic effects

*Bonnet et al SLEEP 2005

How Much Caffeine Is in Coffee?

PER 8oz CUP

@TASTEOFHOME

Air Force scientists battle aviator fatigue

By Tech. Sgt. J.C. Woodring, Air Force Print News / Published April 30, 2004

OPEN ACCESS Freely available online

PLOS | ONE

Dolphins Can Maintain Vigilant Behavior through Echolocation for 15 Days without Interruption or Cognitive Impairment

Brian K. Branstetter[1]*, James J. Finneran[2], Elizabeth A. Fletcher[3], Brian C. Weisman[2], Sam H. Ridgway[1]

1 National Marine Mammal Foundation, San Diego, California, United States of America, **2** U.S. Navy Marine Mammal Program, Space and Naval Warfare Systems Center Pacific, San Diego, California, United States of America, **3** Maritime Services Division, Science Applications International Corporation, San Diego, California, United States of America

Abstract

In dolphins, natural selection has developed unihemispheric sleep where alternating hemispheres of their brain stay awake. This allows dolphins to maintain consciousness in response to respiratory demands of the ocean. Unihemispheric sleep may also allow dolphins to maintain vigilant states over long periods of time. Because of the relatively poor visibility in the ocean, dolphins use echolocation to interrogate their environment. During echolocation, dolphin produce clicks and listen to returning echoes to determine the location and identity of objects. The extent to which individual dolphins are able to maintain continuous vigilance through this active sense is unknown. Here we show that dolphins may continuously echolocate and accurately report the presence of targets for at least 15 days without interruption. During a total of three sessions, each lasting five days, two dolphins maintained echolocation behaviors while successfully detecting and reporting targets. Overall performance was between 75 to 86% correct for one dolphin and 97 to 99% correct for a second dolphin. Both animals demonstrated diel patterns in echolocation behavior. A 15-day testing session with one dolphin resulted in near perfect performance with no significant decrement over time. Our results demonstrate that dolphins can continuously monitor their environment and maintain long-term vigilant behavior through echolocation.

Citation: Branstetter BK, Finneran JJ, Fletcher EA, Weisman BC, Ridgway SH (2012) Dolphins Can Maintain Vigilant Behavior through Echolocation for 15 Days without Interruption or Cognitive Impairment. PLoS ONE 7(10): e47478. doi:10.1371/journal.pone.0047478

Editor: Brock Fenton, University of Western Ontario, Canada

Received February 29, 2012; **Accepted** September 17, 2012; **Published** October 17, 2012

Reducing the Impact of Sleep Loss

Avoid *starting out* with a sleep deficit!

– Even during light or no call rotations, residents do not obtain adequate sleep (average 6.38 hrs)*

*Arnedt, JAMA, 2005

Healthy Sleep Habits

- Realize that circadian rhythms and sleep needs are non-negotiable
- Go to bed and get up at about the same time every day.
- Develop a pre-sleep routine.
- Use relaxation to help you fall asleep.
- Protect your sleep time; enlist your family and friends!
- Get 7 - 9 hours before anticipated sleep loss

Healthy Sleep Habits

- Sleeping environment:
  - Cooler temperature
  - Dark (eye shades, room darkening shades)
  - Quiet (unplug phone, turn off pager, use ear plugs, white noise machine)
- Avoid going to bed hungry, but no heavy meals within three hours of sleep.
- Get regular exercise, but avoid heavy exercise within three hours of sleep.
- Avoid using alcohol to help you fall asleep; it induces sleep onset but disrupts sleep later on

Napping

Pros: Temporarily improve alertness.

Types: Preventative (pre-call), operational (on the job)

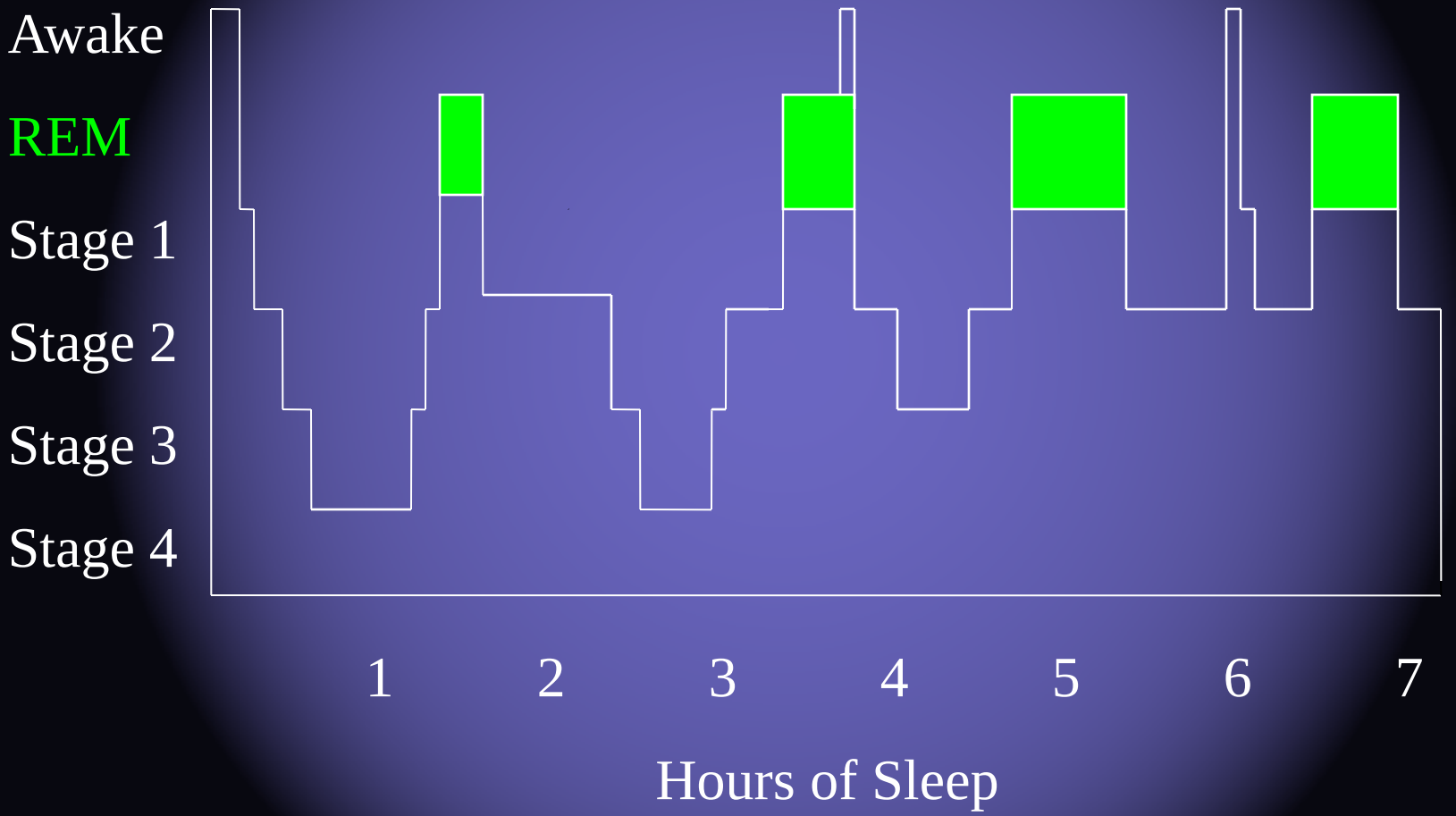
Length: Short naps should be no longer than 30 minutes to avoid sleep inertia*

Timing: Take advantage of circadian “windows of opportunity” (2-4 am and 2-4 pm)

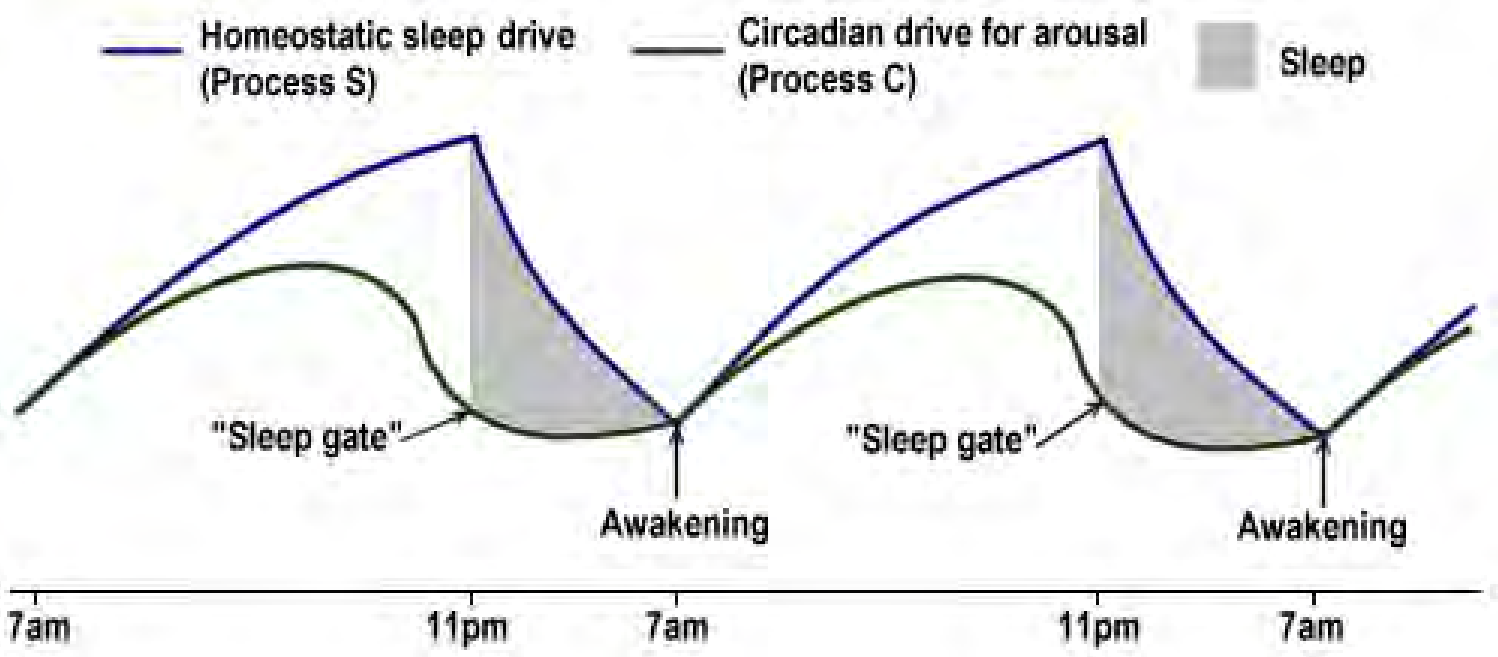
***Note:** individuals who are sleep-deprived may go into deep sleep sooner and thus may be more likely to experience sleep inertia

*Tietzel A, Lack L. SLEEP 2001

Normal Sleep Cycle in Young Adults



- The Two Process Model for Sleep Regulation



Adapting to Night Shifts

Myth: "I get used to night shifts right away; no problem."

Fact: It takes at least a week for circadian rhythms and sleep patterns to adjust.

Fact: Recovery from on-call sleep loss generally takes at least two nights of extended sleep to restore baseline alertness.

shift change. For example:

SCHEDULE	SLEEP TIME
Current Shift (7 AM – 7 PM)	8 PM – 3 AM
Night 1 of Transition	9 PM – 4 AM
Night 2 of Transition	10 PM – 5 AM
Night 3 of Transition	11 ON – 6 AM
New Night Shift (6 PM – 7 AM)	9 AM – 4 PM

How to Survive Night Float

- Protect your sleep.
- Nap before work.
- Consider “splitting” sleep into two four hour periods.
- Have as much exposure to bright light as possible when you need to be alert.
- If you want to go home and sleep, avoid light exposure in the morning after night shift (be cool and wear dark glasses driving home from work).

Program-Level Measures to Reduce Fatigue

Work Hour Limits for Other Occupations in the U.S.

- Truckers: maximum 11h continuous driving
- Pilots: maximum 8h per 24 flying domestic routes
- Nuclear Power plant workers: maximum 12h shift
- Train engineers: maximum 12h shift

Work Hour Limits for Physicians in Other Countries

- **European Working Time Directive** (law which applies to practicing physicians & residents in all EU countries)
  - Maximum of **48-56 hours per week** and *13 consecutive hours*
- **New Zealand Employer - Resident Contract**
  - Maximum **72 hours weekly** and *16 consecutive hours*

2010 ACGME Duty Hour Standards

- Retention of the 80 hr work week (averaged over 4 weeks)
- Reduction of PGY-1 shifts to no more than 16 hrs
- Stricter requirements for duty hour exceptions
- More specific levels of PGY-1 supervision
- Graduated requirements for minimum time off between duty periods
- Expanded requirements for patient hand-offs

Maintaining Opportunities for Education

- **Conferences:**
  - Schedule at times where floats can attend also/ Videotape so residents can watch when more alert

- **Achieving competency: education is about learning how to do something right; not the number of times it is done.**
  - Use simulators and computerized resources
  - High risk procedures done by incoming team not the night team.

- **Attending time:**
  - Incorporate into every rotation, including floats

Reducing the Impact of Sleep Loss

Avoid *starting out* with a sleep deficit!

– Even during light or no call rotations, residents do not obtain adequate sleep (average 6.38 hrs)*

*Arnedt, JAMA, 2005

The Effect of Restricting Residents' Duty Hours on Patient Safety, Resident Well-Being, and Resident Education: An Updated Systematic Review

Lauren Bolster, MD
Liam Rourke, PhD

ABSTRACT

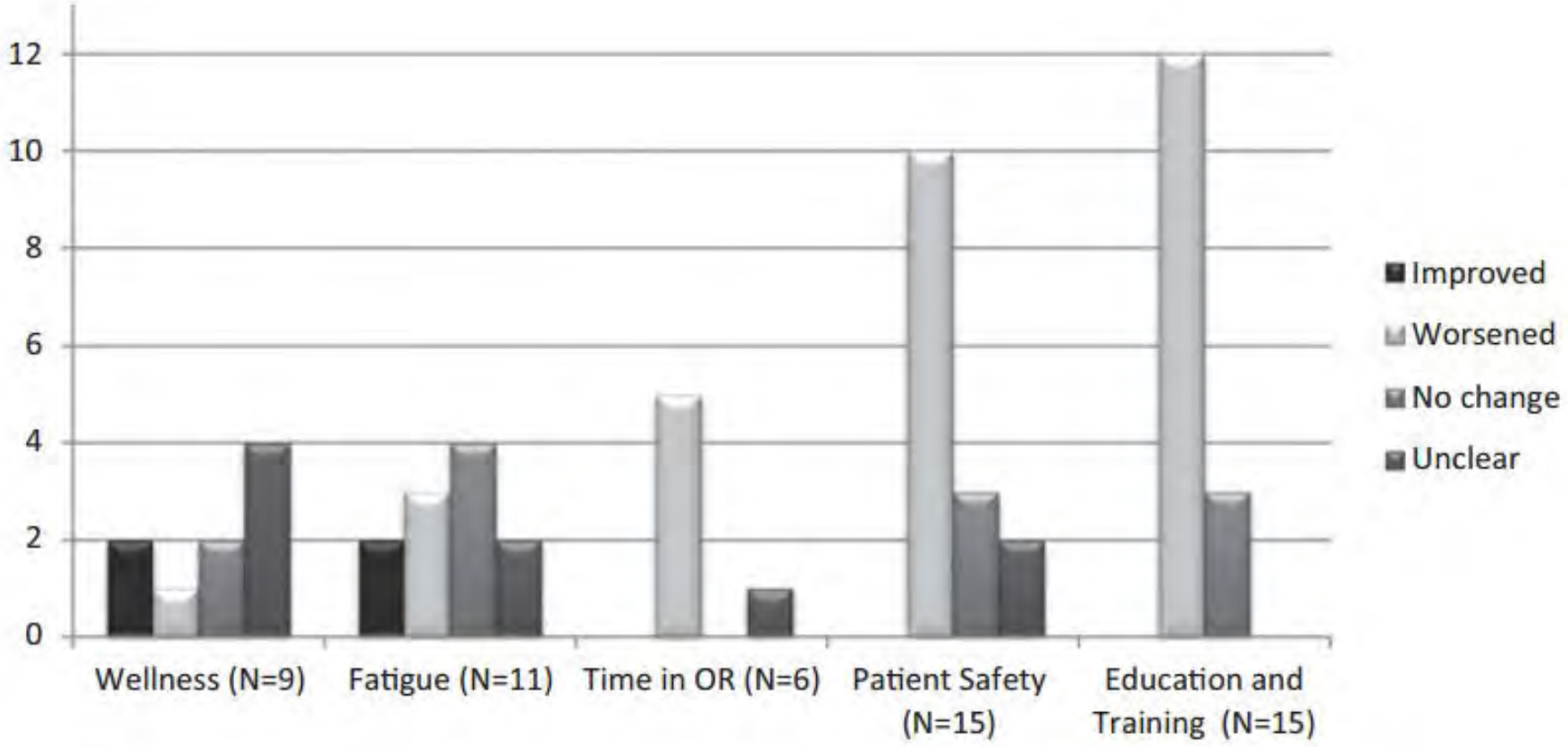
Background Despite 25 years of implementation and a sizable amount of research, the impact of resident duty hour restrictions on patients and residents still is unclear. Advocates interpret the research as necessitating immediate change; opponents draw competing conclusions.

Objective This study updates a systematic review of the literature on duty hour restrictions conducted 1 year prior to the implementation of the Accreditation Council for Graduate Medical Education's 2011 regulations.

Methods The review draws on reports catalogued in MEDLINE and PreMEDLINE from 2010 to 2013. Interventions that dealt with the duty hour restrictions included night float, shortened shifts, and protected time for sleep. Outcomes were patient care, resident well-being, and resident education. Studies were excluded if they were not conducted in patient care settings.

Results Twenty-seven studies met the inclusion criteria. Most frequently, the studies concluded that the restrictions had no impact on patient care (50%) or resident wellness (47%), and had a negative impact on resident education (64%). Night float was the most frequent means of implementing duty hour restrictions, yet it yielded the highest proportion of unfavorable findings.

Conclusions This updated review, including 27 recent applicable studies, demonstrates that focusing on duty hours alone has not resulted in improvements in patient care or resident well-being. The added duty hour restrictions implemented in 2011 appear to have had an unintended negative impact on resident education. New approaches to the issue of physician fatigue and its relationship to patient care and resident education are needed.



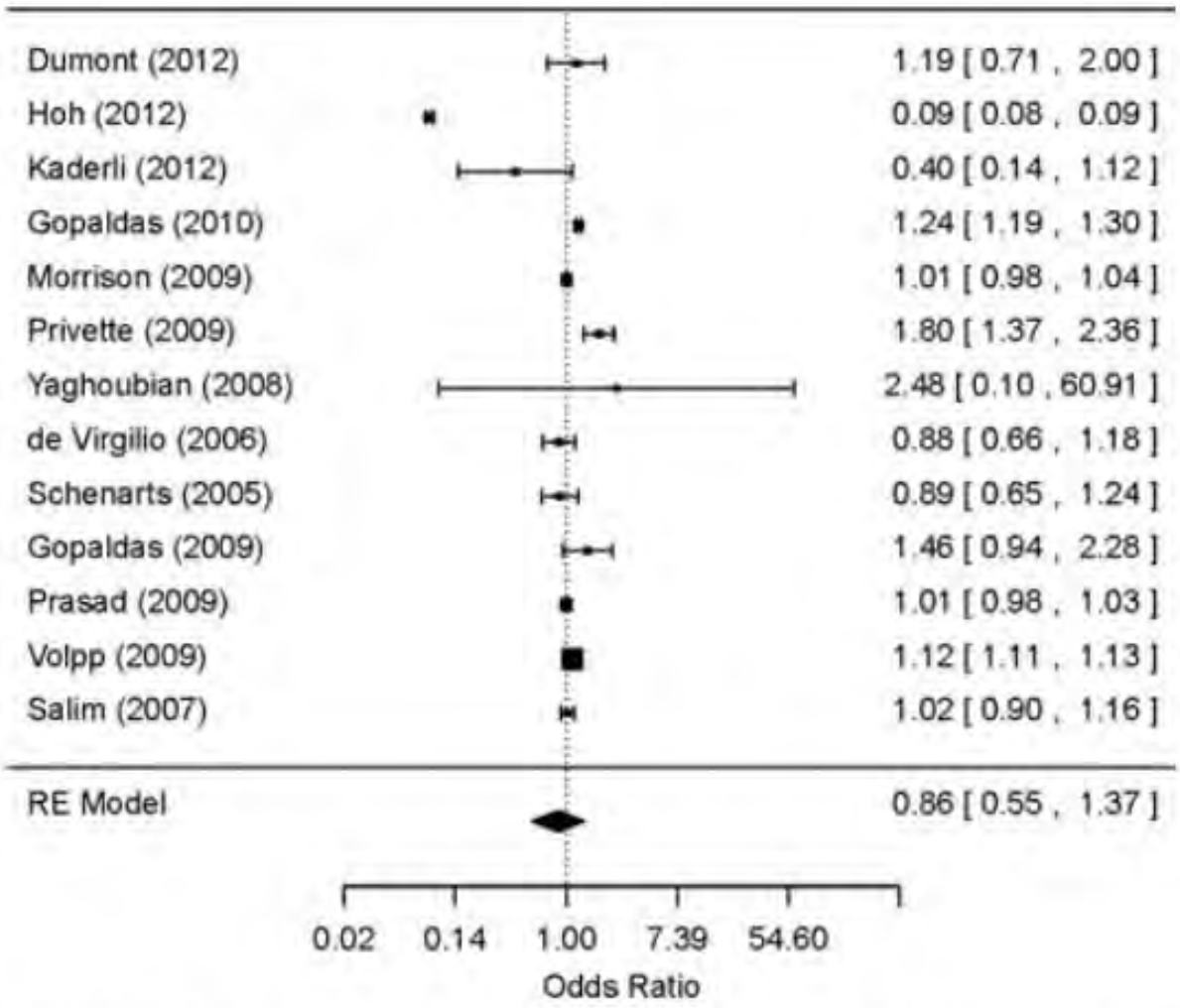


FIGURE 3. Forest plot describing the effect of RDH restrictions on patient mortality.

Annals of Surgery • Volume 259, Number 6, June 2014

Better Rested, but More Stressed? Evidence of the Effects of Resident Work Hour Restrictions

WHAT'S NEW

This study provides evidence that the 2011 work hour rules can significantly change resident sleep patterns and lead to more rested interns while at work. However, there may be increased work compression and adverse consequences in education and professionalism.

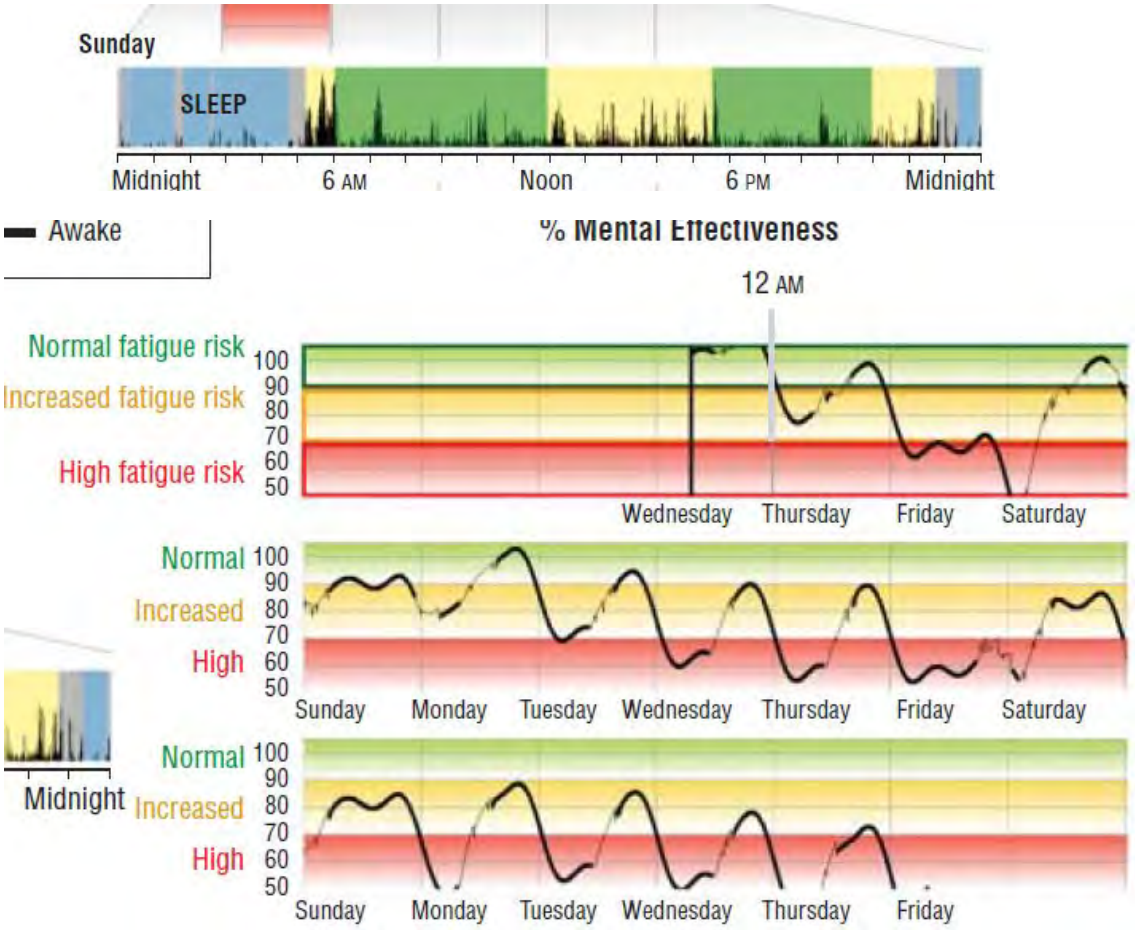
ACADEMIC PEDIATRICS 2012;12:335–343

2017 ACGME Duty Hour Standards

- Create a culture of support: shared responsibility for fatigue management in the training program
- Support resident well-being
- When sleepiness interferes with your performance or health, *talk to your supervisors and program director*.

Surgeon Fatigue

A Prospective Analysis of the Incidence, Risk, and Intervals of Predicted Fatigue-Related Impairment in Residents



man factor accident risk and cost ($R = -0.93$).[14] The SAFTE model is used by the US Department of Defense, the US Army, the US Air Force, the US Navy, the US Marine Corps, and the Federal Railroad Association.

Arch Surg. 2012;147(5):430-435

Cultural Norms and Sleep Need

The culture of medicine says:

- Sleep is “optional” (*and you are not paid to sleep*)
- Less sleep = more dedicated doctor

Perception that napping or resting

- Compromises patient care

"Patients have a right to expect a healthy, alert, responsible, and responsive physician."

January 1994 statement by American College of Surgeons

Re-approved and re-issued June 2002

"Providers have a right to experience a healthy, alert, well-rested and highly functional lifestyle."

January 2020 BC statement by Jigme M. Sethi MD FCCP

BC=before covid

You can go back to sleep now.