Sleep, Alertness, and Fatigue Education in Medical Training

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In conjunction with
The American Academy of Sleep Medicine

Did 'microsleep' cause deadly NY train derailment?

Learning Objectives

- List factors that put you at risk for sleepiness and fatigue
- Describe the impact of sleep loss on residents' and faculty's personal and professional lives.
- Recognize signs of sleepiness and fatigue in yourself and others.
- Challenge common misconceptions among physicians about sleep and sleep loss.
- Adapt alertness management tools and strategies for yourself and your program.

??????????

- How many hours of sleep do you get on average?
- How many hours of sleep did you get on your last on-call night?
- How many hours of sleep did you get on your last post-call night?
- How many hours of sleep did you get on you last pre-call night?

?????????

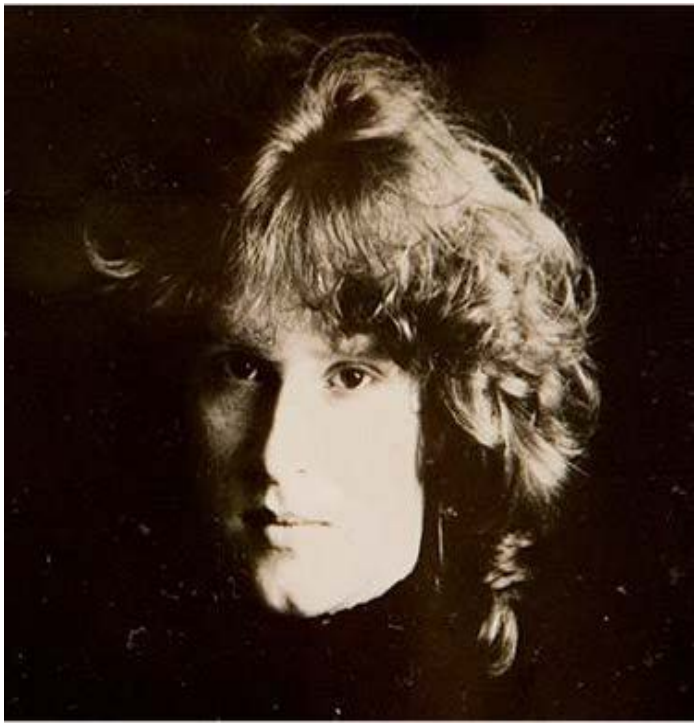
Situation	Would never doze	Slight chance of dozing	Moderate chance of dozing	High chance of dozing
1. Sitting and reading	0	1	2	3
2. Watching TV	0	1	2	3
3. Sitting and inactive in a public place (theater or meeting)	0	1	2	3
4. As a passenger in a car for an hour without a break	0	1	2	3
5. Lying down to rest in the afternoon when circumstances permit	0	1	2	3
6. Sitting and talking to someone	0	1	2	3
7. Sitting quietly after lunch (without alcohol)	0	1	2	3
8. In a car, while stopped for a few minutes	0	1	2	3

Historical Background

- Pop Quiz:
  - This person is:

Libby Zion 1965-1984

- 18 yo college freshman; depression, phenelzine
- URI, fever, jerking
- Cornell ER 3 a.m., intern (40 other pts); 36 hours work shifts
- Meperidine, restraints
- Hours without evaluation; temp 108º; death



The Bell Commission

- 1987 – NY state commission, headed by Dr. Bertrand Bell
- 1989 – NYS adopted recommendations that doctors in training:
  - work ≤ 80 hours a week
  - no more than 24 hours in a row
  - significantly more on-site supervision from senior physicians

Historical Background

- The National Academy of Sciences IOM Report “To Err is Human” - 98,000 patients die each year secondary to medical errors; human factors - sleep deprivation one of the causes.

- Expanding knowledge in sleep and circadian biology

ACGME

2003 – Duty hour standards implemented

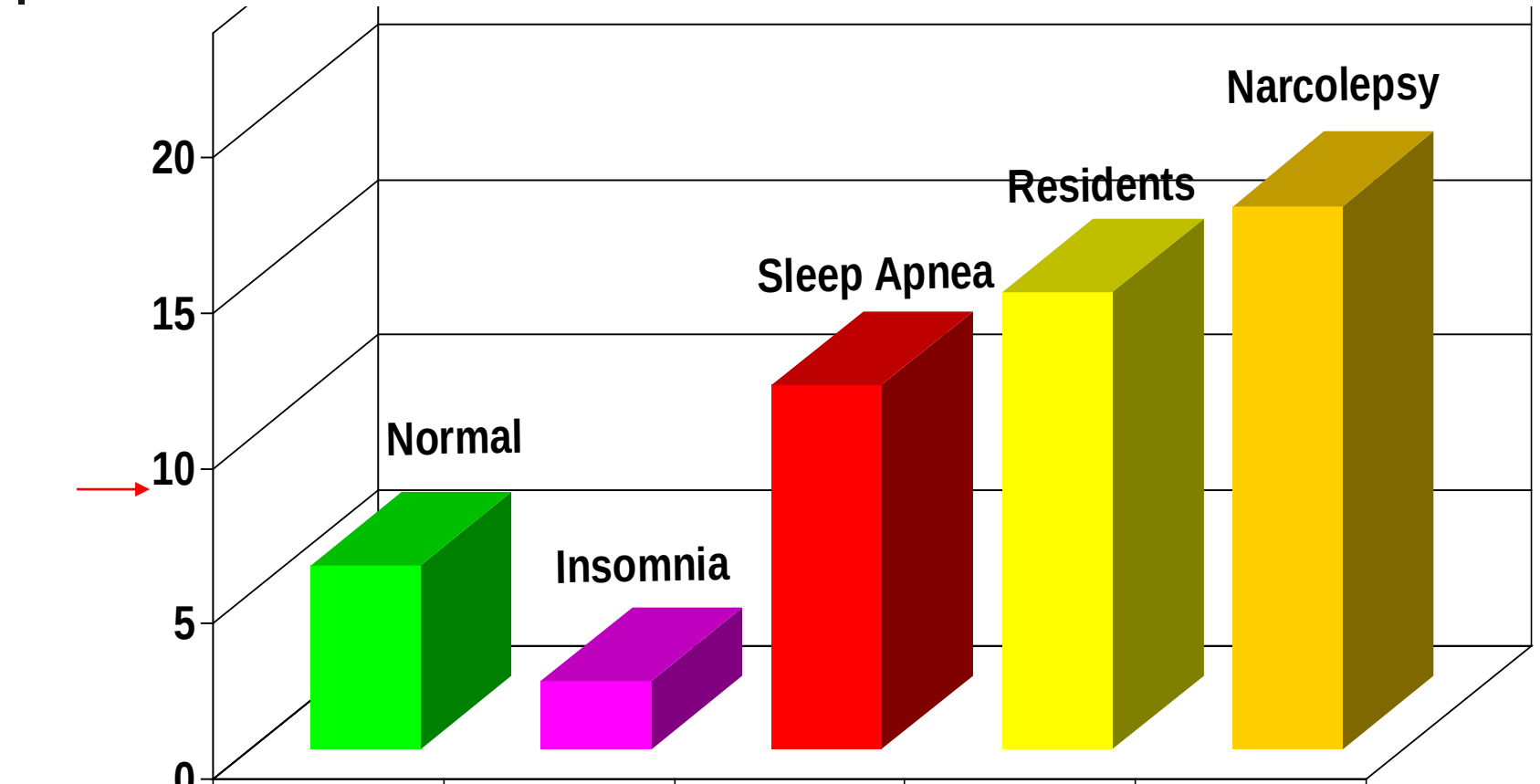
2008 - IOM Task Force releases report

2009 - ACGME Task Force on Quality Care & Professionalism

2010 – Revised standards take effect

- Duty hours as a surrogate marker for fatigue
- *Need a simple 'fitness for duty' test – cognitive and psychomotor function*

Epworth Sleepiness Scale



	Normal	Insomnia	Sleep Apnea	Residents	Narcolepsy
Mean	5.90	2.20	11.70	14.70	17.50

Negative effects of experimental sleep deprivation

- Neurobehavioral performance
  - Sustained attention
  - Reaction time
  - Vigilance
- Cognitive performance
  - Memory
  - Reasoning
  - Problem solving

Negative effects of experimental sleep deprivation

- After one night of missed sleep 25% decline from baseline, after two nights of missed sleep 40% decline from baseline

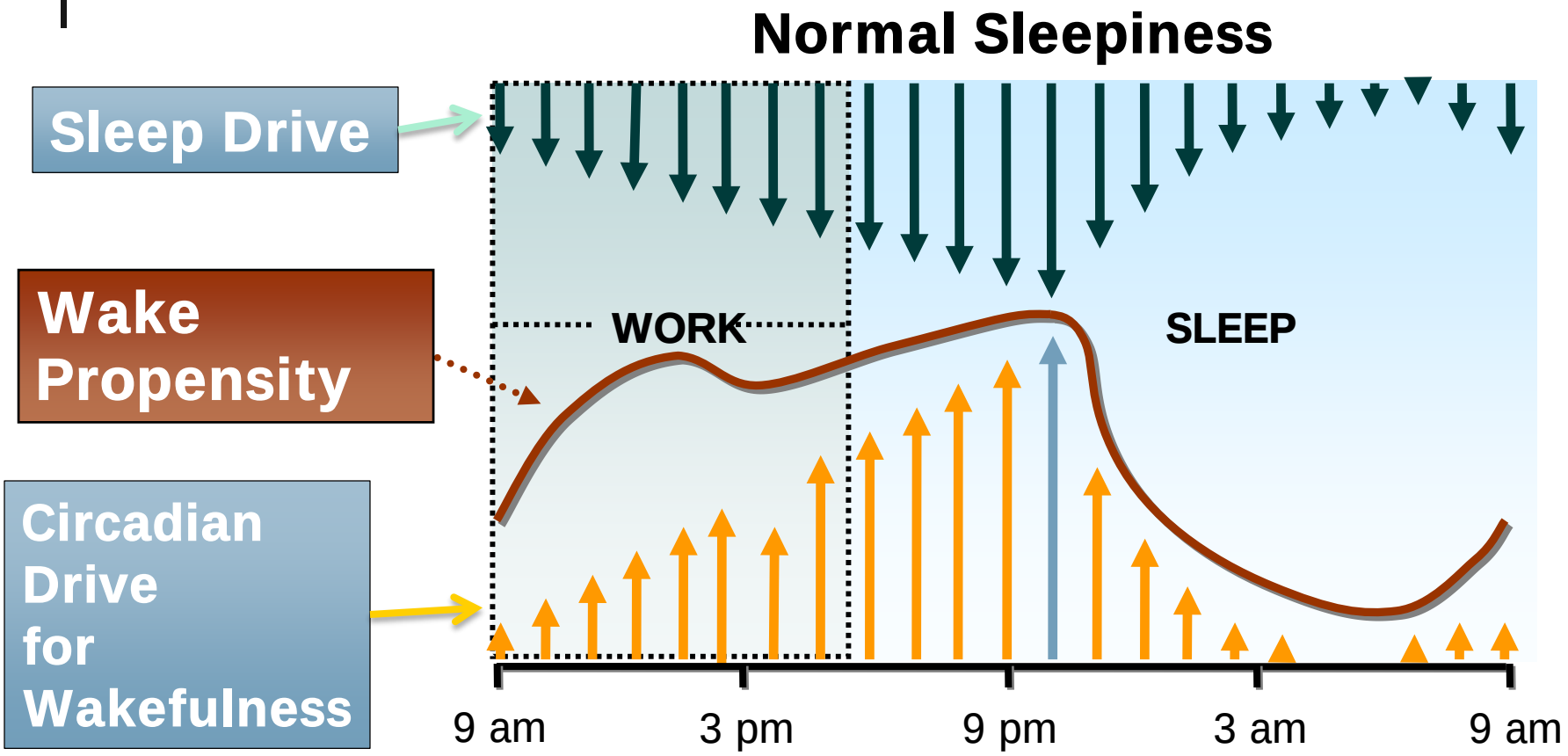
- Chronic partial restriction of sleep to 5 hours or less per night produces cognitive performance deficits similar to that of total sleep deprivation.

What causes sleepiness?

Common beliefs:

- It's the boring noon conferences
- It's the room- it's too:
  - Dark
  - Warm
  - Cool
- It's the food
  - Too much carbohydrates
  - Too much sugar

Physiologic Determinants of Sleepiness



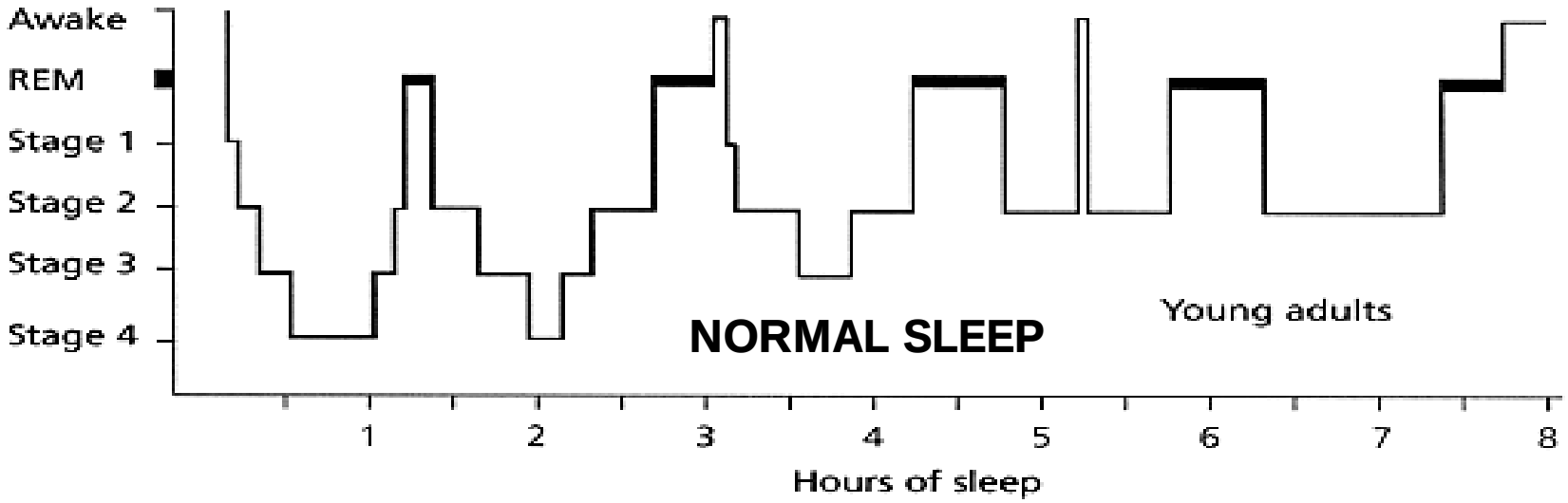
Adapted from: Kryger MH, et al. Principles and Practices of Sleep Medicine. 2000.

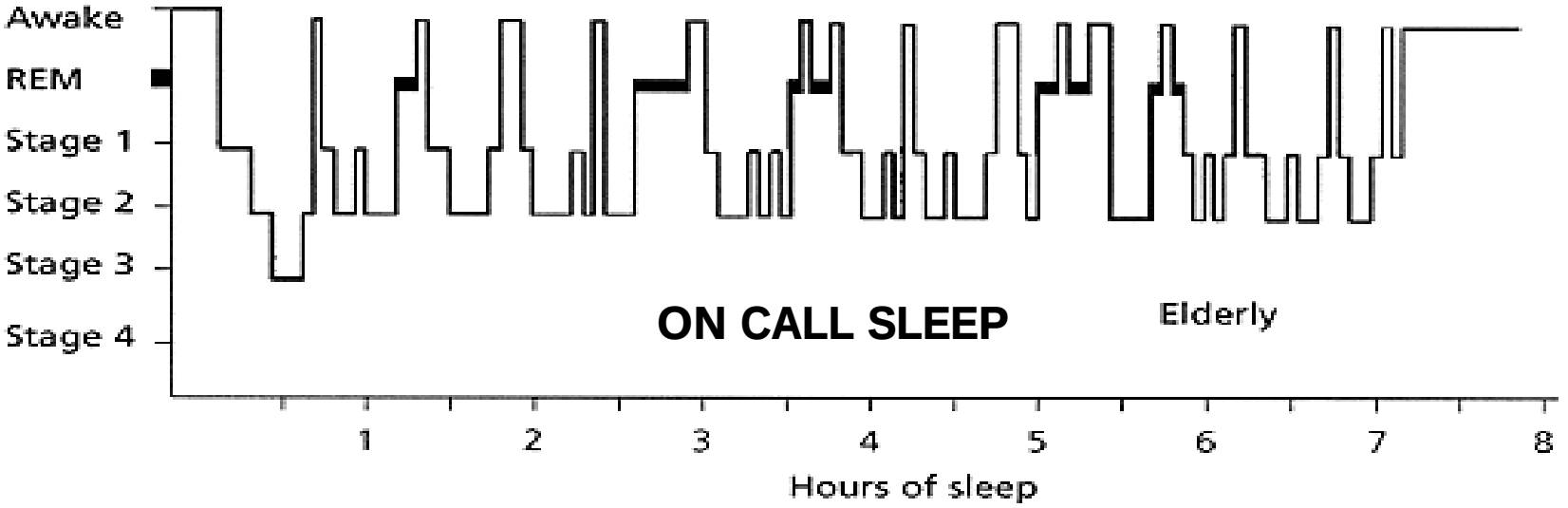
Stages of Sleep

Non-REM Sleep:

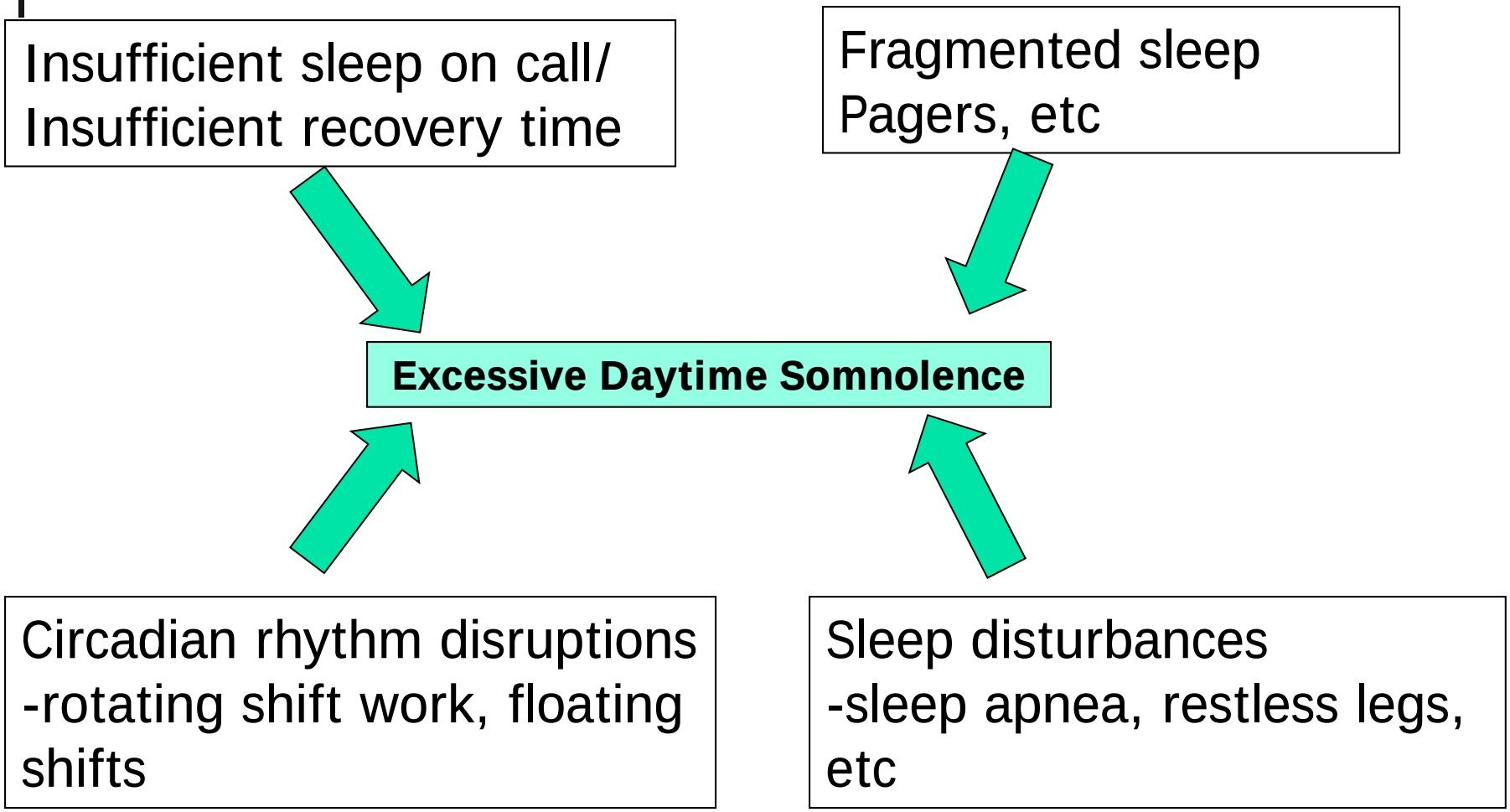
- Stage 1
  5-10 minutes; occurs at sleep-wake transition
- Stage 2
  20 minutes; initiation of true sleep
- Stages 3 and 4
  30-40 minutes deep sleep; most restorative stage of sleep
- REM Sleep:
  70-90 minutes after falling asleep;
  Associated with dreaming;
  Bursts of rapid eye movement

Sleep Fragmentation Affects Sleep Quality

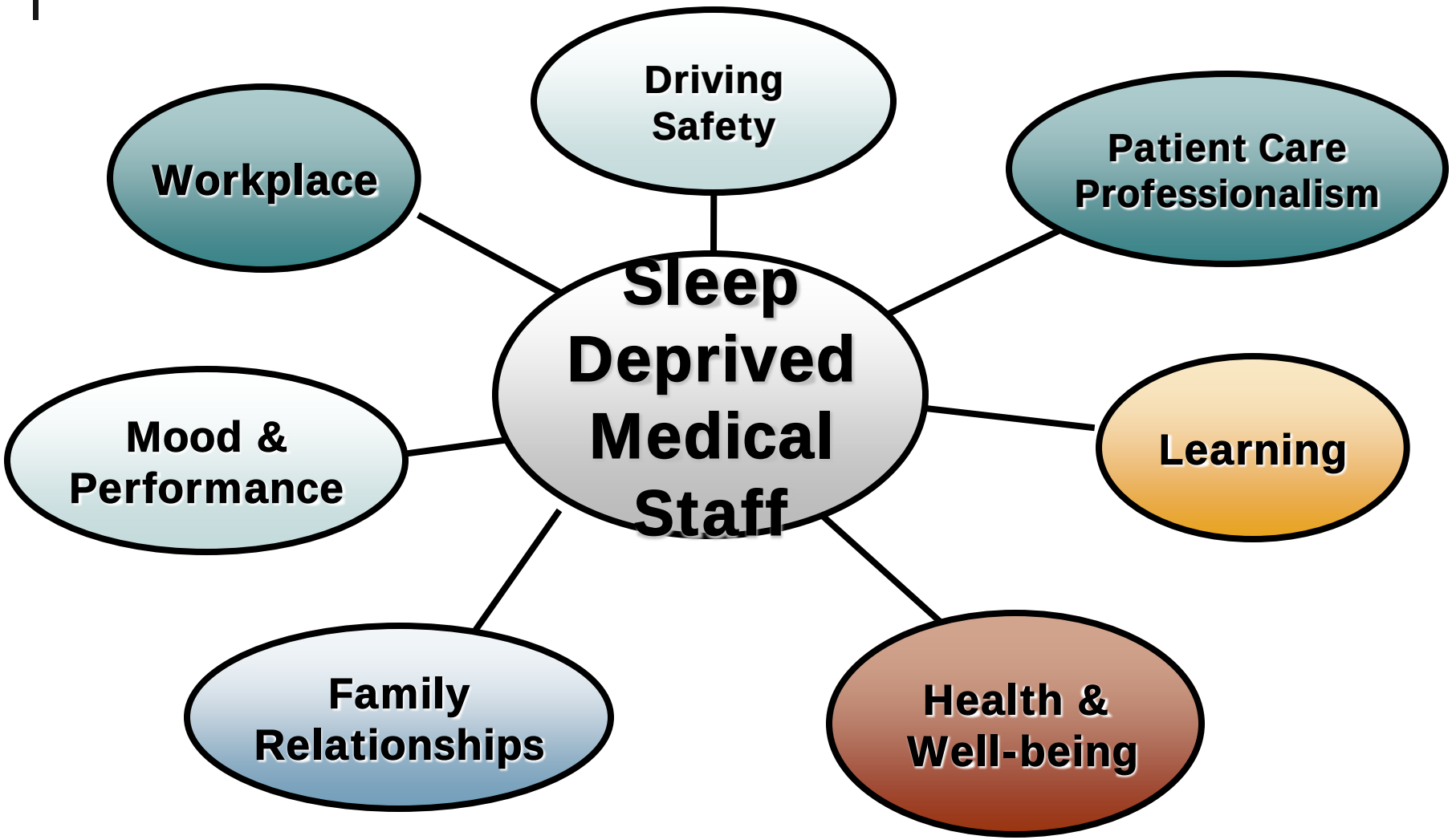




Sleep Deprivation in Medicine

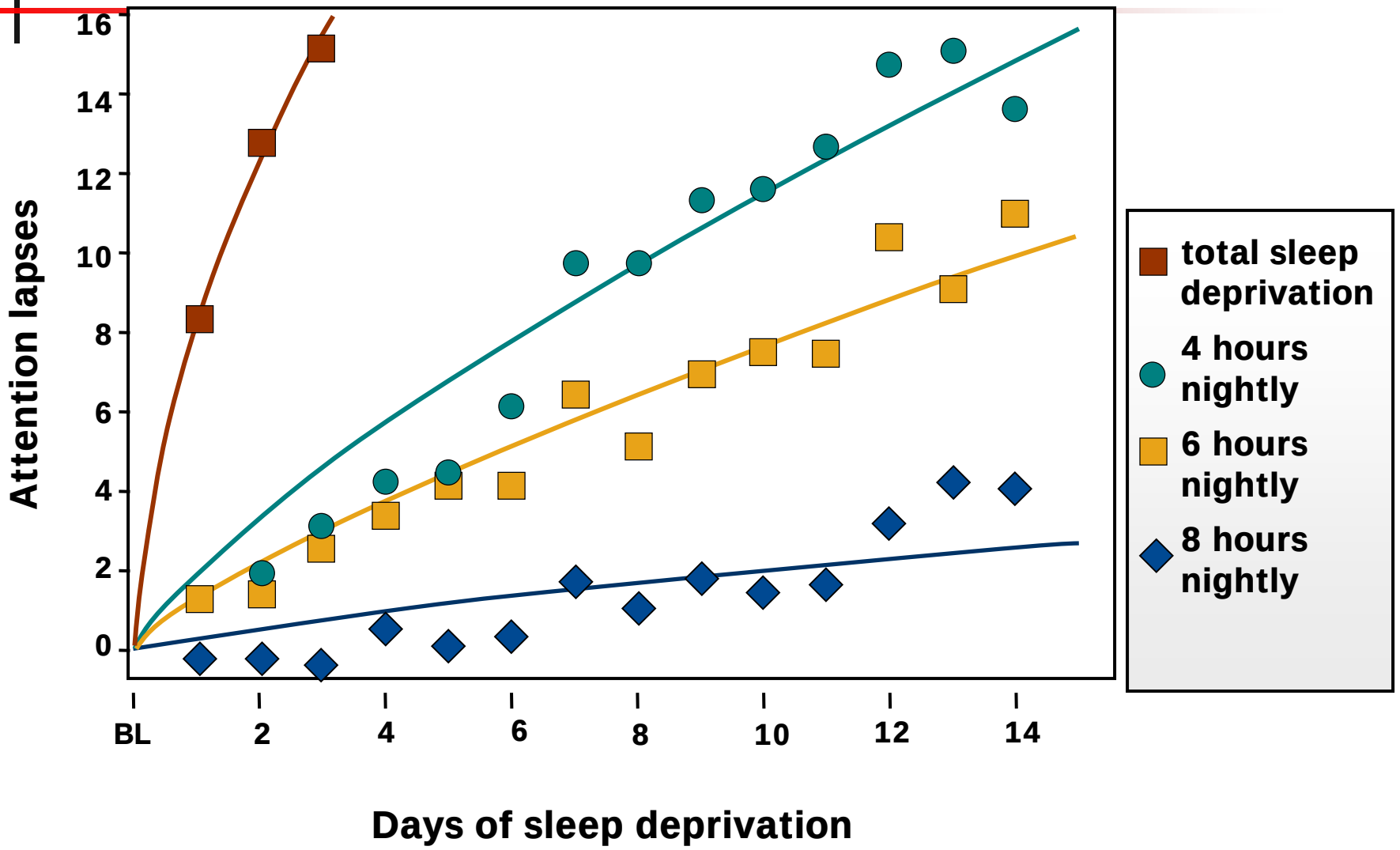


Consequences of Sleep Deprivation



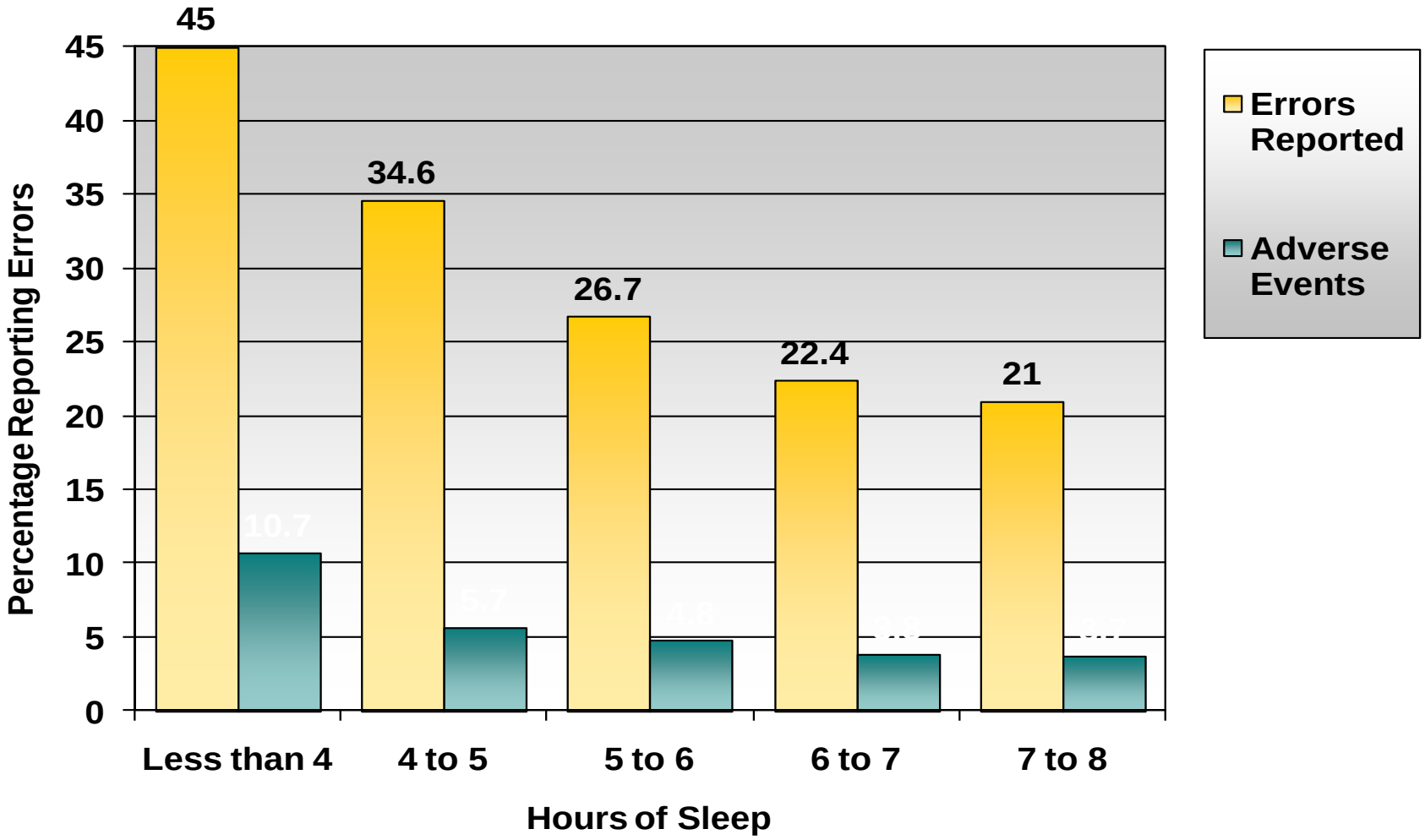
Affects on *PATIENTS*

Sleep Deprivation Decreases Attention



Van Dongen et al, Sleep, 2003

Resident Self-reported Errors by Average Daily Hours of Sleep

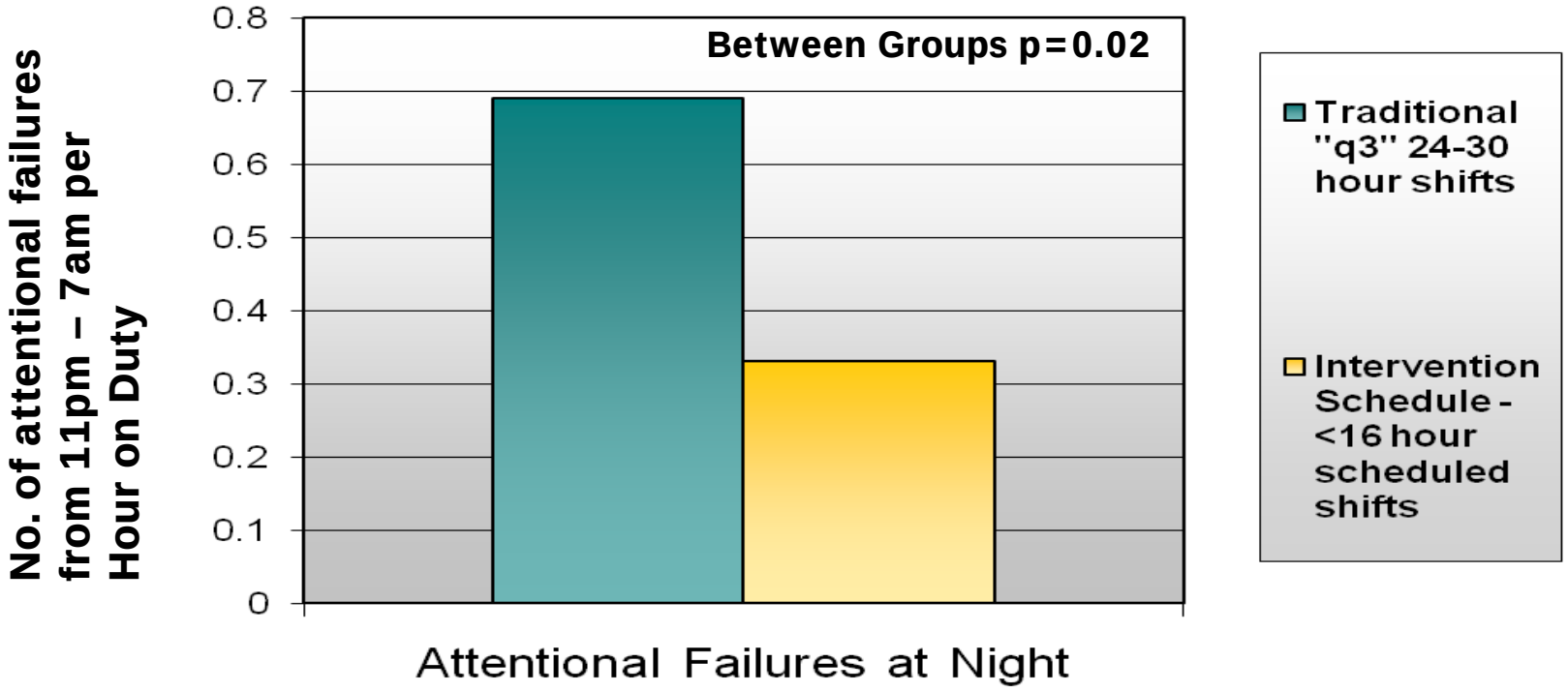


Baldwin & Daugherty, Sleep, 2004

Intern Sleep and Patient Safety Study

•Randomized trial comparing interns' alertness and performance on traditional "q3" schedule with 24-30 hour shifts (ACGME-compliant) *vs.* 16 hr max schedule

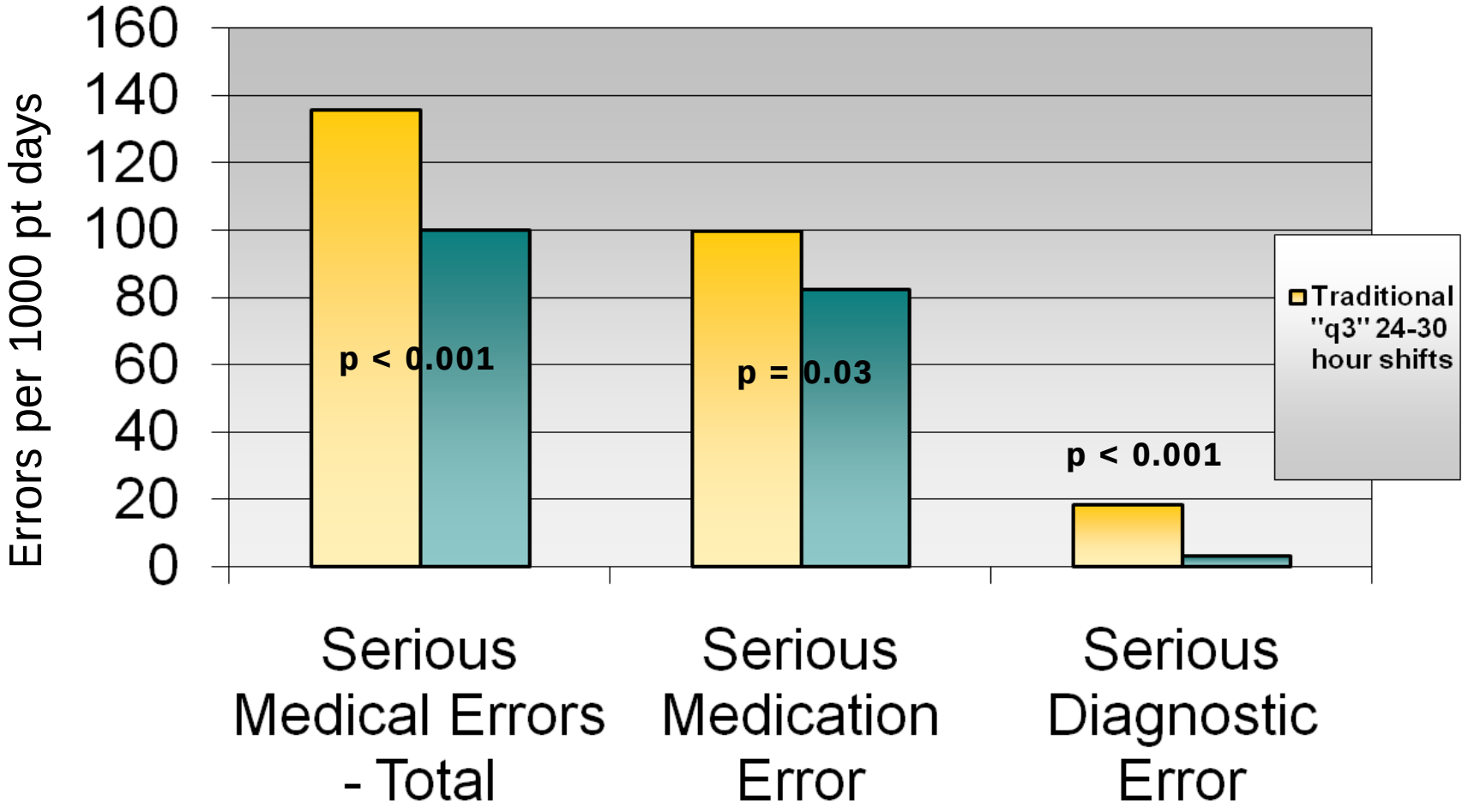
•Results: *Twice as many* EEG-documented attentional failures at night on traditional schedule



Lockley et al. N Engl J Med 2004

Intern Sleep and Patient Safety Study

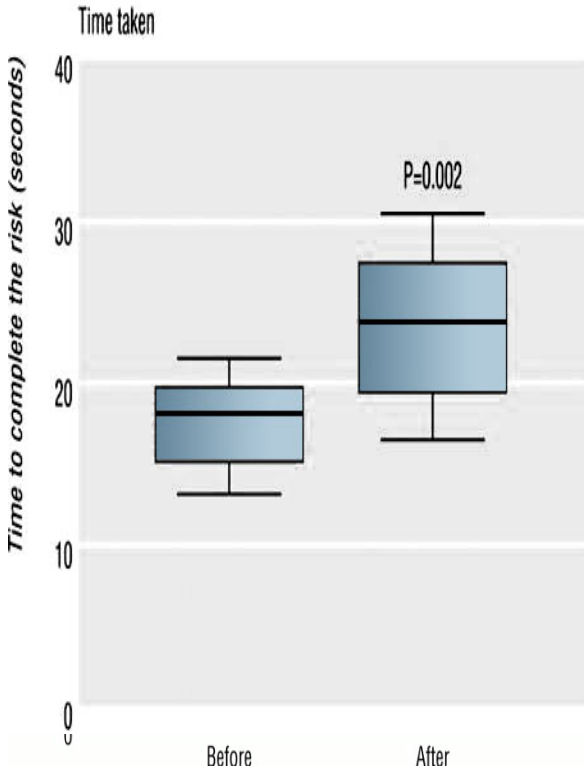
Results: 36% more serious errors on traditional schedule, including *five times* as many serious diagnostic errors

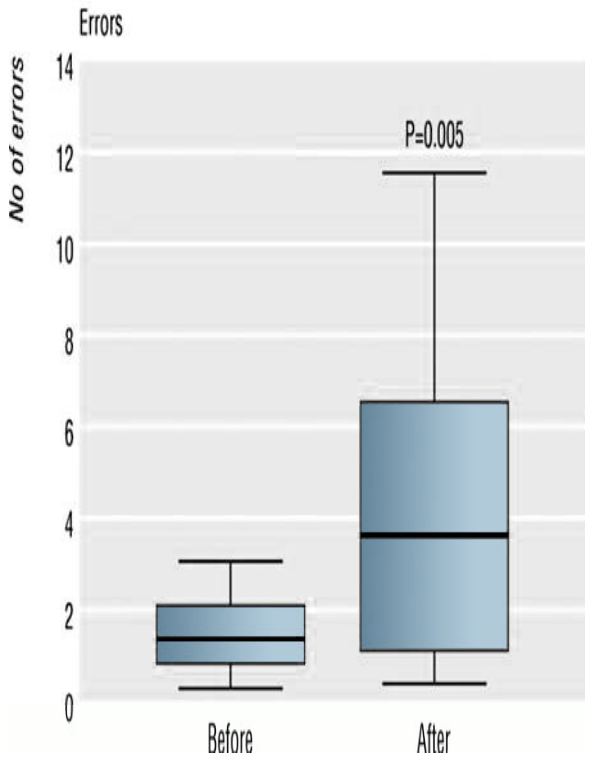


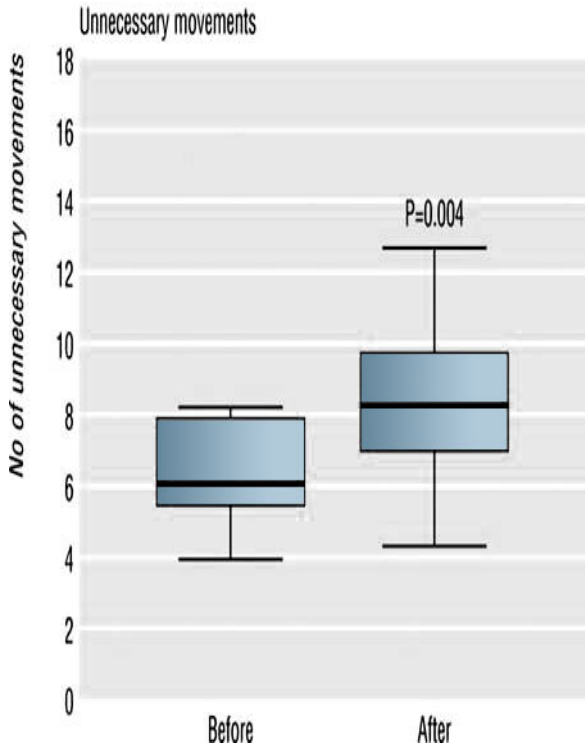
Landrigan et al. N Engl J Med 2004

Impaired Speed and Errors in Performance: Laparoscopic Surgical Simulator

Pre and post 17-hour overnight call duty in a surgical department (median reported sleep time 1.5 h; range 0-3 h)







Grantcharov TP et al, BMJ, 2001

Risk of complications by attending physicians after performing nighttime procedures

- 86 consultant surgeons, 134 OB-GYN
- No significant increase in complications in postnighttime procedures vs. control
- However, in consultant surgical cases with <6 hours sleep
  - Substantially elevated rate of complications
  - 6.2% vs. 3.4%
  - OR 1.72
- Concern - Sleep hours assessed retrospectively

Rothschild, JAMA 2009

Impact of Resident Work-Hour Restrictions on Outcomes of Cardiac Operations

- 1562 patients 1997-2007
- Prior to 2003 vs. post 2003
- Controlled for patient-specific confounding factors
- Post-reform
  - Significantly lower 30-d mortality rate
  - Slightly lower 6-month mortality rate
  - Multivariate analysis ➔significantly lower 30-d and 6-mo mortality

Consultant Surgeon Sleep Hours and Patient Outcomes in Cardiac Surgery

- January 2004 – December 2009
- Collected sleep hours, 6 surgeons, 32-55 yo
- All CABG, valves, combined, aortic surgeries
- 90% power to detect 4% difference
- 4047 consecutive procedures
- 0-3 hours, 3-6 hours, >6 hours
- *No difference in mortality or major complication rate*

  - *Chu et al, Arch Surg, 2011*

Consultant Surgeon Sleep Hours and Patient Outcomes in Cardiac Surgery

- ? Related to compensatory mechanisms to combat sleep deprivation
  - More experience
  - Dexterity more routine
  - “Team sport”

- Future studies need to investigate these points

Chu et al, Arch Surg, 2011

Affects on *YOU*

Residents Averaging Less Than Five Hours of Sleep per Night

	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

Harvard Work Hours, Health, and Safety Study – Methods

- **National survey**
  - Quantify the work schedules and determine if increased hours are associated with increased risk of house staff injury
  - Monthly surveys
    - Work hours, crashes, and injuries
    - Correlation of work hours and motor vehicle crashes
  - **1,417 person-years monthly survey data collected from 2,737 interns nationwide in 2002-2003**

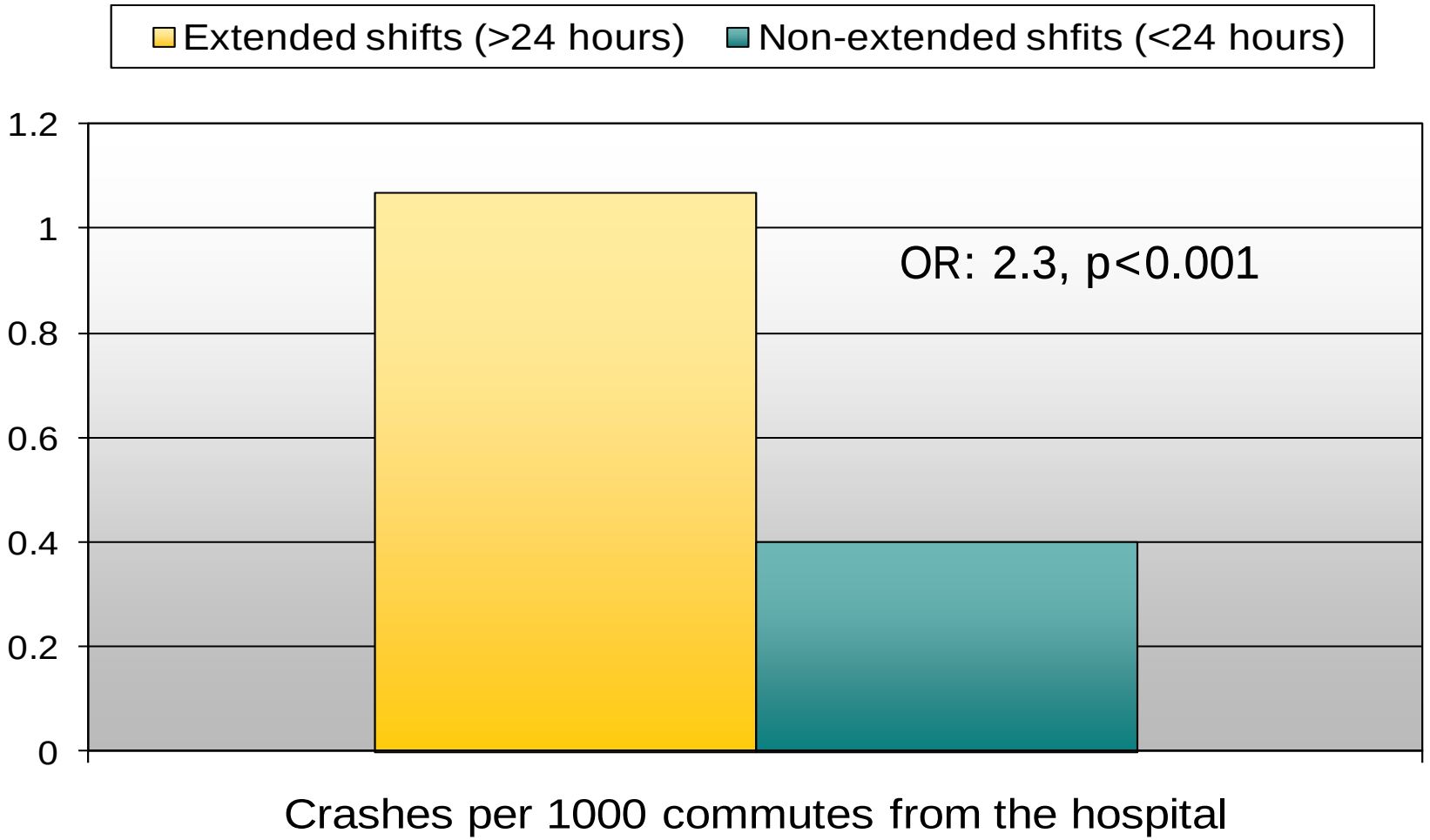
Barger, L. K. et al. N Engl J Med 2005

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

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

Motor Vehicle Crash Risk in Interns on Commute Home from Hospital



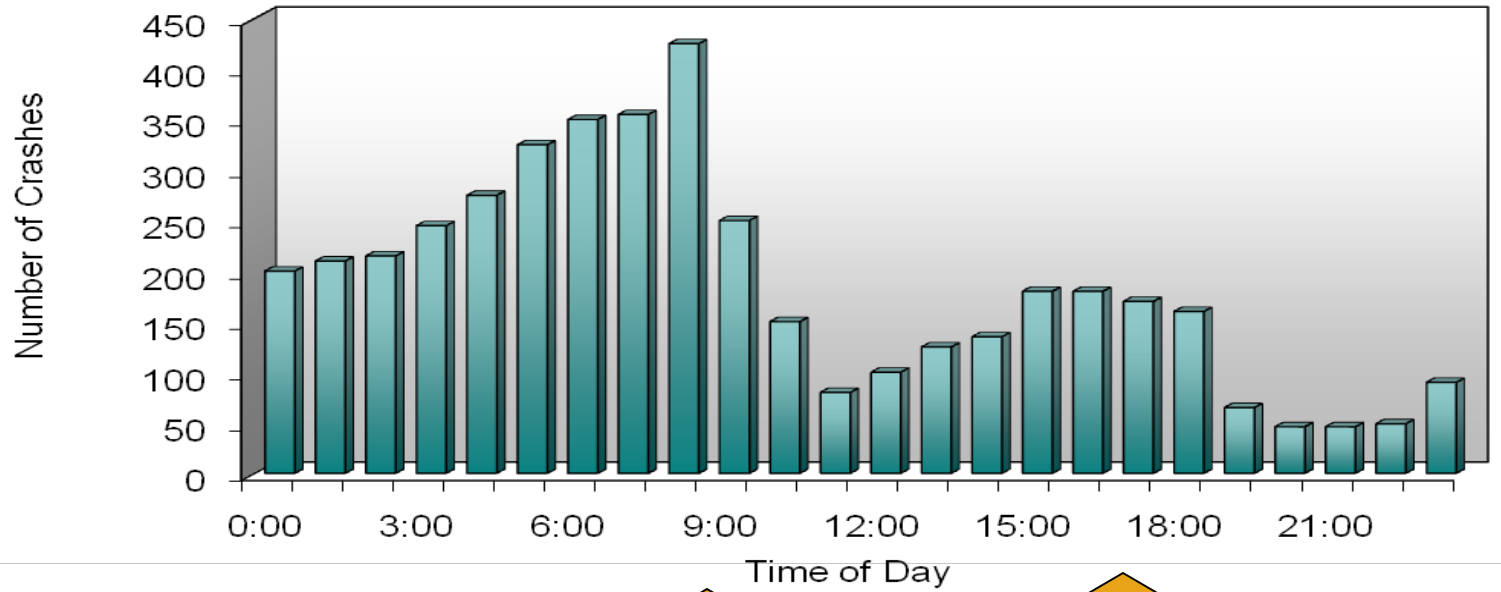
Barger, L. K. et al. N Engl J Med 2005

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** and vehicular homicide
- 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.

Risk Factors for Drowsy Driving

- Driving long distances without breaks
- Driving alone or on a boring road
- Driving at high risk times of day



Pack et al Accid Anal Prev 1995

Driving home post-call

Recognize Signs of Driving While Drowsy (DWD)

- 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 - 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 - 20 minute recovery time.
  - Stop driving if you notice the warning signs of sleepiness, pull off the road at a safe place, take a short nap.

Drowsy Driving: What Does and Does Not Work

- 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

It only takes a

FOUR SECOND

lapse in attention

to have a

drowsy driving crash

Recognizing Sleep Deprivation

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

Recognizing Sleep Deprivation

- A decline in performance starts after about 15-16 hours of continued wakefulness.
- Lowest alertness after being up all night is between 6AM and 11AM.
- Sleepy people underestimate their level of sleepiness and overestimate their alertness
- The sleepier you are, the less accurate your perception of degree of impairment.
- You can fall asleep briefly (“microsleeps”) without knowing it.

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
- Extremely dangerous in situations when continual alertness is demanded (driving, operating).

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

Did 'microsleep' cause deadly NY train derailment?

Anesthesia Resident Study

- Residents did not perceive themselves to be asleep almost half of the time they had actually fallen asleep.

- Residents were wrong 76% of the time when they reported having stayed awake.

  - Howard et al 2002

Adaptation to Sleep Loss

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

Fact: Sleep needs are genetically determined – specific polymorphisms in *PER3* gene

Fact: Human beings do not "adapt" to getting less sleep than they need.*

Fact: Although performance of tasks may improve somewhat with effort, *optimal* performance and *consistency* of performance do not! (e.g., post-call performance on a neurocognitive battery does not differ by training year)

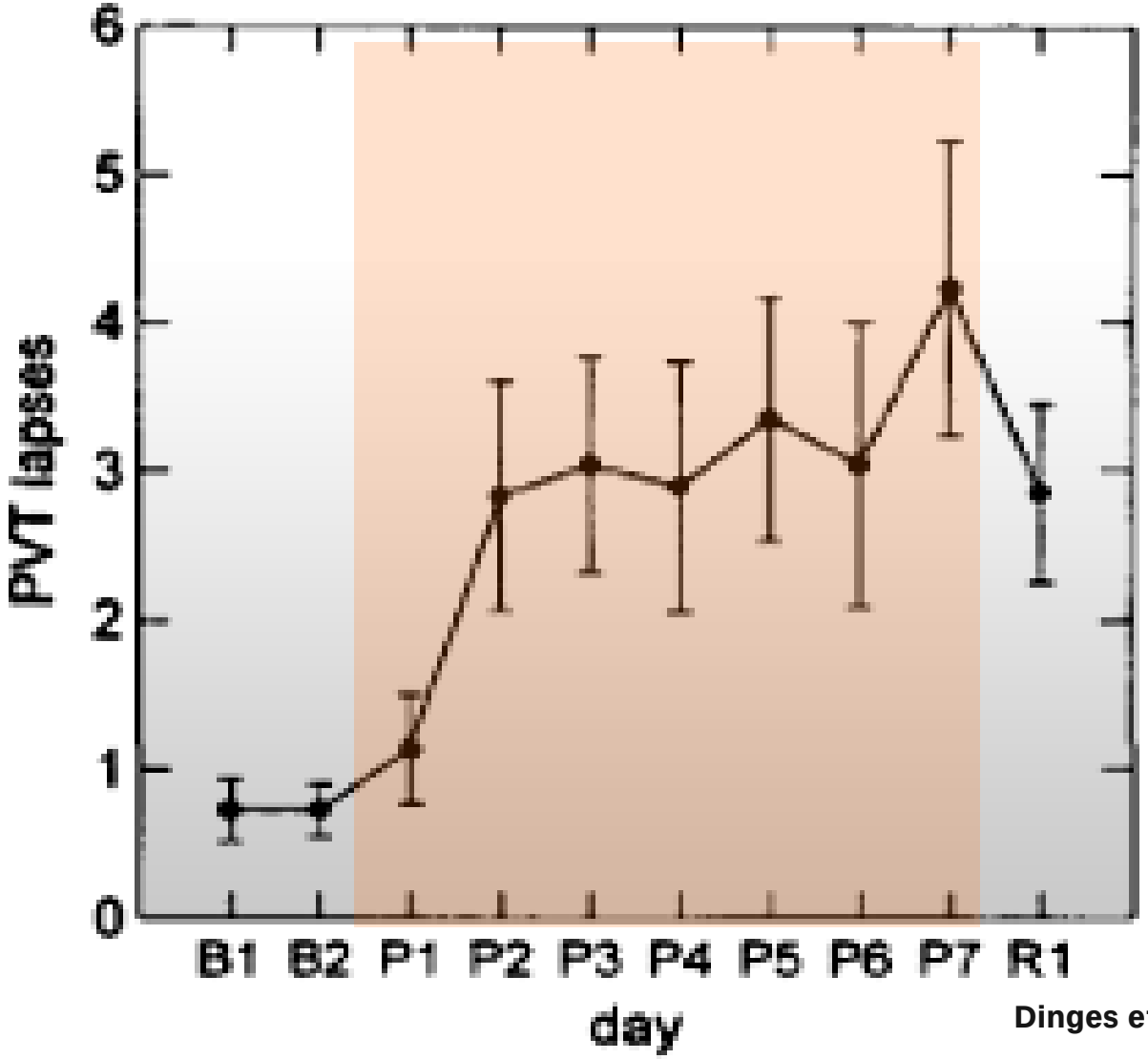
*Arnedt, JAMA, 2005

Recovery from Sleep Loss

- **Myth:** "All I need is my usual five to six hours the night after call and I'm fine."

- **Fact:** Sleep debt develops and recovery from on-call sleep loss generally takes at least two nights of extended sleep to restore baseline alertness.

The Effects of Sleep Loss are Cumulative



Psychomotor vigilance task (PVT) performance during baseline (B), sleep restriction (P) and recovery (R)

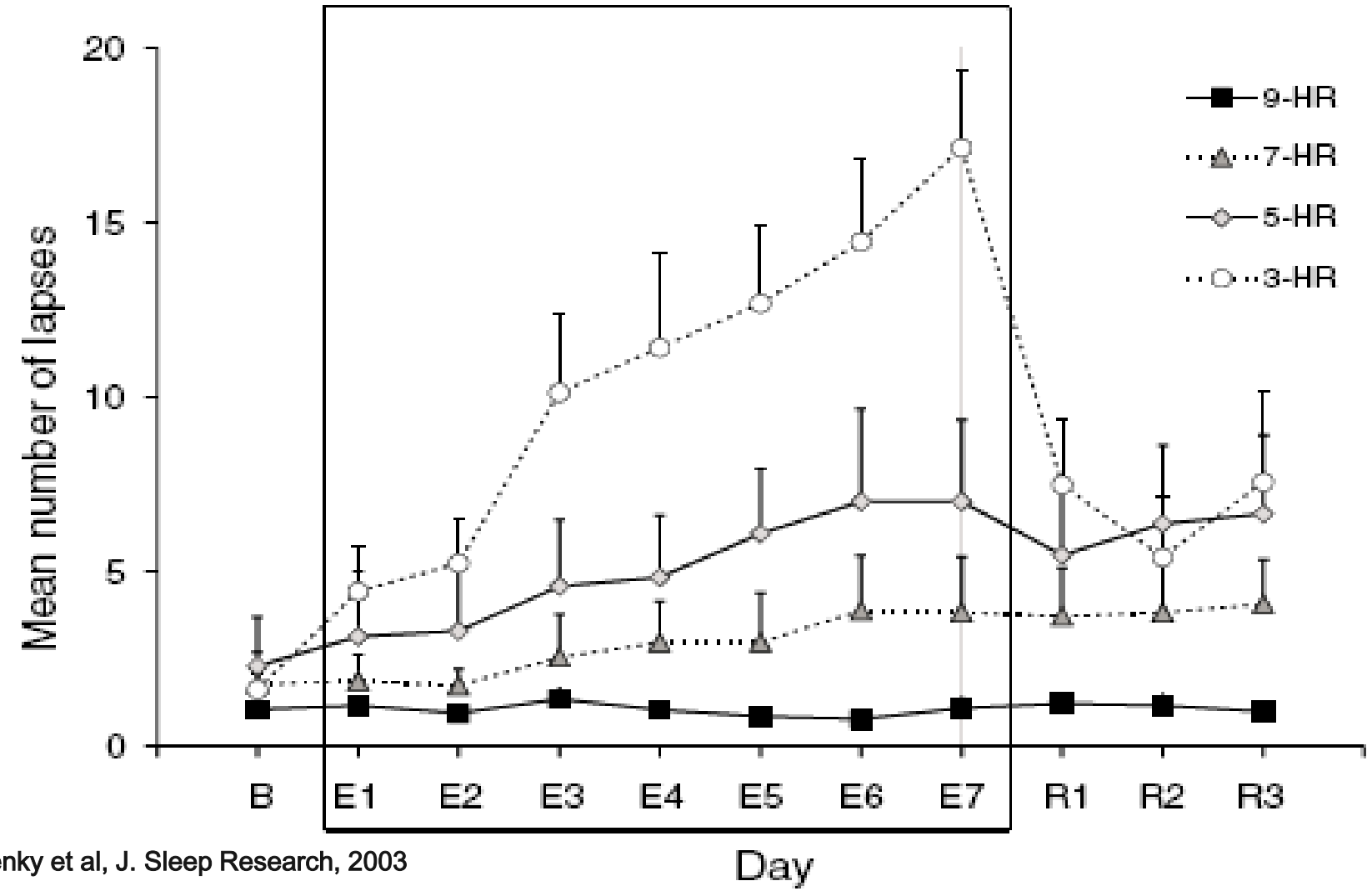
Dinges et al, SLEEP, 1997

Deterioration of Neurobehavioral Performance in Resident Physicians During Repeated Exposure to Extended Duration Work Shifts.

- Prospective, repeated measures, within subject
- MICU and CCU; 34 PGY-1s (23 men)
- 3 week, Q3 schedule with alternating 24-30 shifts and 8-hour shifts
- PSVT before, during and after each shift
- Sleep/work/wake logs showed cumulative sleep loss
- Response times deteriorated over a 24-30 hour shift ($P<0.0005$), and cumulatively ($P<0.01$)
- Controlling for time of day, there was significant acute (time on shift) and chronic (successive EDWS) interaction on response times ($P<0.05$)

Anderson C, et al, Sleep, 2004

Recovery Sleep and Attention



Belenky et al, J. Sleep Research, 2003

Fatigue Management and Countermeasures

The most effective countermeasure for sleepiness is

sleep.

Reducing the Impact of Sleep Loss

- Avoid *starting out* with a sleep deficit!
- Get adequate sleep pre-call
  - 7-9 hours
  - Avoids sleep deficit
- Allow adequate recovery
  - 2 nights of extended sleep after period of sleep deprivation

Management strategies

- Adapting to night float
  - Protect your sleep time
  - Nap before work
  - Consider splitting sleep into 2 four hour periods
  - Have as much exposure to bright light as possible when you need to be alert
  - Avoid light exposure in the morning after night shift

Management strategies

- Adapting to night shifts
  - Realize it takes at least a week for circadian patterns to adjust
  - Physical and mental symptoms similar to jet lag
  - Forward rotation of shifts makes it easier to adapt

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” (2-5 am and 2-5 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

Napping

- Brief naps prior to 24 hours of sleep loss
- 15-minute naps every 2 to 3 hours can significantly ameliorate the performance decrements during 48 hours of total sleep deprivation.
- 2-hour naps every 12 hours help sustain performance over 80 hours of sleep deprivation

MetroNap Sleep Pod

SleepPhones™

pajamas for your ears

Effects of Intraoperative Breaks on Mental and Somatic Fatigue: A RCT

- Complex laparoscopic surgery
- 5 minutes every half hour
- 51 procedures
  - Release of pneumoperitoneum or conventional conduct
- Stress hormones in saliva – pre- and post-op
- Mental performance, error scores, musculoskeletal strain, continuous ECG

- Engelmann et al, Surg Endosc, 2011

Effects of Intraoperative Breaks on Mental and Somatic Fatigue: A RCT

- No prolongation of surgery
- Lower cortisol levels
- Lower intraoperative events ($p<0.05$)
- Decreased objective error-performance scores
- Decreased pain and strain scores

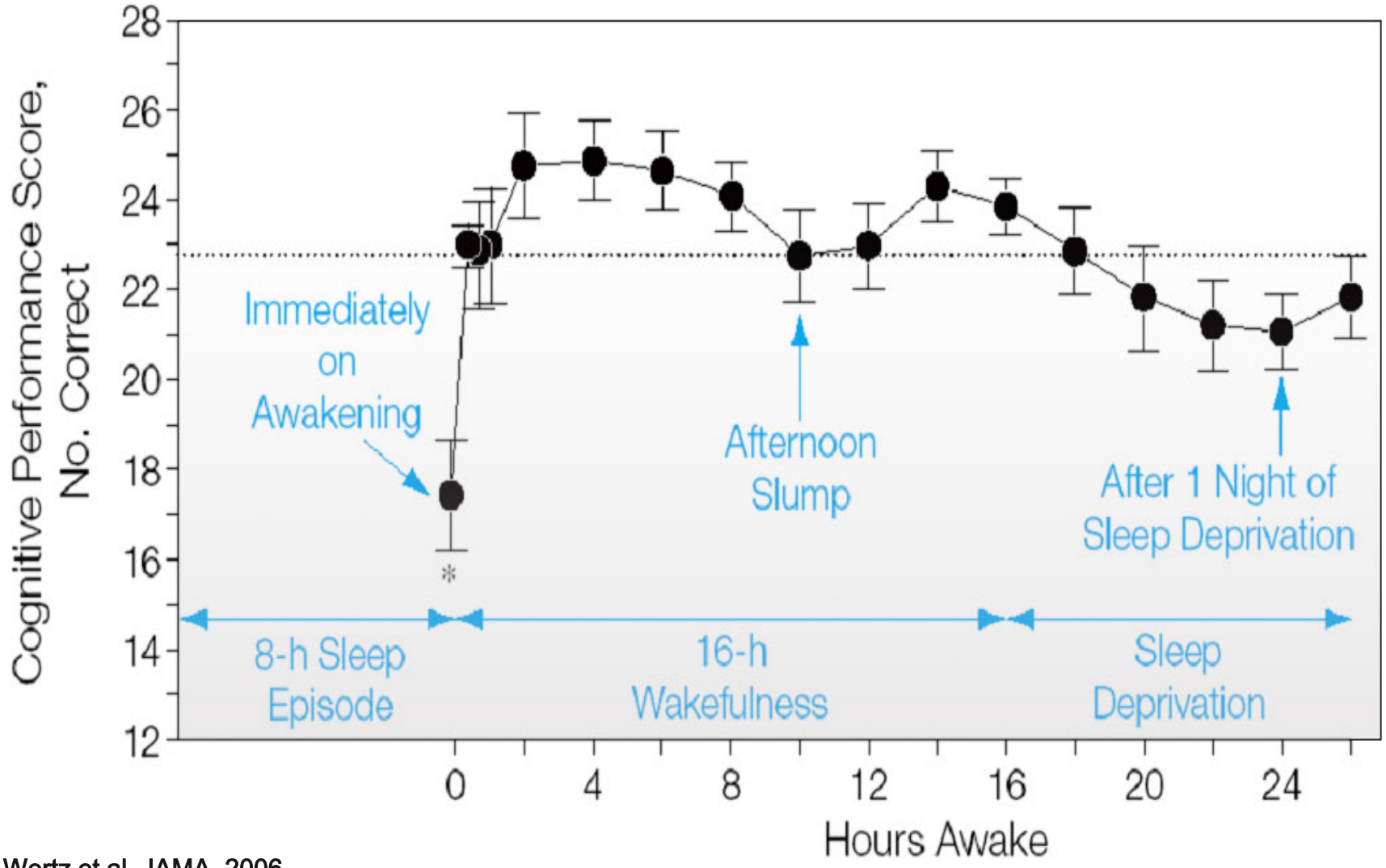
- Engelmann et al, Surg Endosc, 2011

Sleep Inertia

- State of impaired cognition, grogginess, disorientation experienced upon waking from sleep
  - Increased if awakened from slow wave sleep
- Studies suggest severe cognitive impairments lasting up to 10 minutes after awakening*
  - Worse than performance after 26 hr sleep deprivation
  - Residual effects up to two hours
  - Blocked by caffeine

*Wertz, JAMA, 2006
Tassi and Muzet, Sleep Med Rev, 2000

Cognitive Performance on Awakening From Sleep Compared with Subsequent Sleep Deprivation



Wertz et al, JAMA, 2006

Caffeine

- Reduces some sleep-related deficits at doses of 75-150 mg
- *Strategic* consumption is key (?use of slow-release)
- 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
- 1000-1500mg/day – caffeinism - dependency

*Bonnet et al SLEEP 2005

Caffeine Content

Product	Serving Size	Caffeine (mg)
Cola	*8 oz*	*30 -- 45*
Tea	*8 oz*	*10 – 70*
Orange soda	*8 oz*	*0 – 40*
Mountain Dew	*8 oz*	*57*
Red Bull	*330 ml*	*80*
Drip Coffee	*7 oz*	*110 – 175*
Starbucks Grande	*16 oz*	*260*
No-Doze	*1 tab*	*100*
Vivarin	*1 tab*	*200*

Caffeine and Taurine

- Single-blind cross-over study
- Surgical “novices” – trained to proficiency on MIS Trainer – Virtual Reality lap simulator
- Baseline, sleep-deprived for 24 hours
- Given placebo, 150 mg caffeine, 150 mg caffeine plus 2 gm taurine
  - Placebo – took longer, less economical with movements, slower reaction times and more errors
  - Caffeine – restored time taken, reaction time improved (both C and C+T) but errors remained high. Subjective sleepiness improved

Modafinil (Provigil)

- 39 healthy male residents
- Parallel, double-blind, randomized, placebo-controlled
- One night sleep deprivation
- MIST-VR
- Modafinil improved performance on higher cognitive tests
- No improvement on clinical psychomotor performance.

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

Sleep loss, medical education and patient safety

- Providing safe patient care during residency is a matter not just of hours at work, but also of
  - the amount of effective supervision,
  - the amount of sleep obtained, and
  - a balanced workload for the level of competence.

?????

- What can you do to improve your ability to come to work fit to work??

- Do you believe that you were “fit for duty” prior to starting your last shift.

Take home lessons

- No magic pill to replace sleep
- Fatigue is an impairment like alcohol or drugs.
- There are significant consequence to you, your family and your patients if you continually function in a sleep deprived state
- Know your own limits and be honest with yourself
- Learn how to adapt and utilize the management strategies
- Medical culture is changing
- We can’t eliminate fatigue and sleepiness in residency, but they can be managed

Effects of intraoperative breaks on mental and somatic operator fatigue: a randomized clinical trial

Fatigue vs. Alcohol

- 15 hours sustained wakefulness produces performance impairment = .05% BAC
- 24 hours = .10% BAC (Dawson & Reid, 1997; Williamson & Feyer, 2000).
- People with mild to moderate untreated sleep apnea performed worse than those with a 0.06% BAC (Powell, 1999)
- On 4 hours sleep, 1 beer can have the impact of a six-pack (Roehrs et al., 1994)

MetroNap Sleep Pod