

Effects of Traditional 24-30 Hour Shifts on Patient and Resident Safety:

The Case for a 16-Hour Limit

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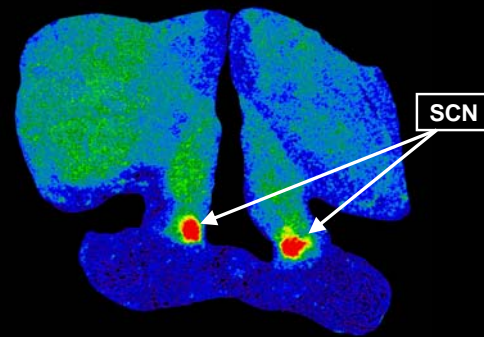


Patient Safety

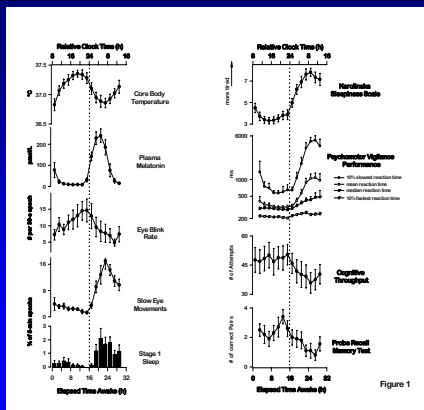
- To Err is Human
 - Institute of Medicine Report, 1999
 - 44,000 to 98,000 deaths annually from adverse events
- In past 5 years, substantial data collected on the effect of sleep deprivation on physicians' performance



Human Circadian Pacemaker in Suprachiasmatic Nucleus (SCN) of Hypothalamus

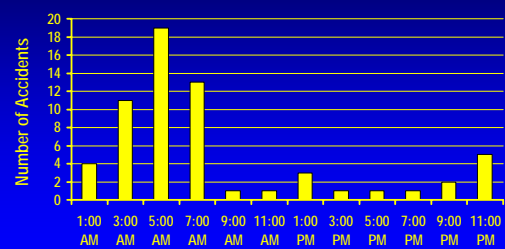


Courtesy of D. Weaver, Univ Massachusetts Medical School, Worcester, MA



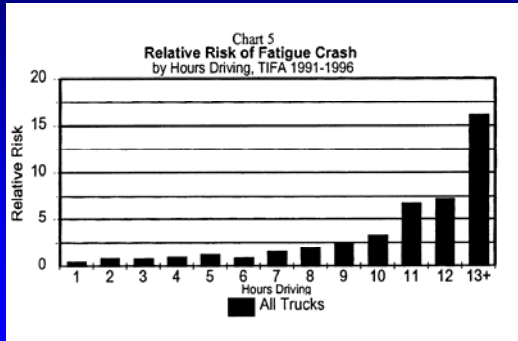
Cajochen C, Khalsa SBS, Wyatt JK, Czeisler CA, Dijk D-J. *Am J Physiol* 277: R640-R649, 1999

Temporal Distribution of Fatigue-related Single Vehicle Truck Accidents



National Transportation Safety Board Safety Study (SS-1995/01)

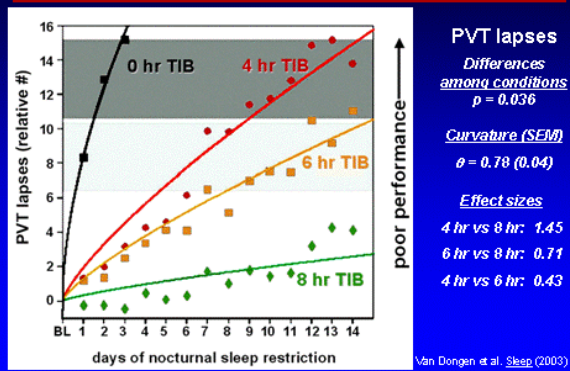
Consecutive Waking Hours



“...after [19] hours of sustained wakefulness (at 3 am) cognitive psychomotor performance decreased to a level equivalent to the performance impairment observed at a blood alcohol concentration of 0.05 %. ... After 24 hours of sustained wakefulness (at 8 am) cognitive psychomotor performance decreased to a level equivalent to the performance deficit observed at a blood alcohol concentration of roughly 0.10 %.”

- D. Dawson and K. Reid, *Nature* 388: 235, 1997.

Nightly Sleep Duration: Cumulative Impact of Daily Sleep Curtailment



Residents: Alcohol vs. Sleep

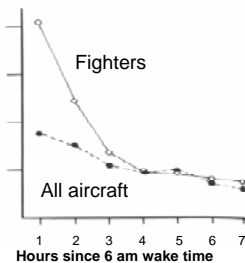
- 34 pediatric residents, within-subject design comparing performance after 4 weeks of:
 - light call (44h/wk, not post-call, blood EtOH .04-.05% vs.
 - heavy call (80-90h/wk, post-call (mean 3h sleep), placebo

	Light call	Light call w/ alcohol	Heavy call w/ placebo	p
PVT median reaction time (ms)	225.9	248.4	242.3	.19
Continuous performance test (mean # of commission errors)	27.2	46.5	40.6	.02
Simulated driving mean lane variability (feet)	5.5	6.2	6.8	.06
mean speed variability (mph)	2.4	3.2	4.2	.01
median # of off-road incidents	0	1	1	.55

Aredt et al. *JAMA*. 2005;294:1025-1033

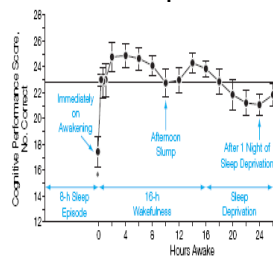
Sleep Inertia

Aircraft Accident Data (Israeli Airforce)



Ribak et al., *Aviat. Space Environ. Med.*, 1983

Time Course of Deficits from Sleep Inertia



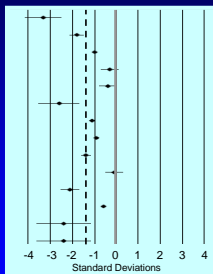
Wertz et al., *JAMA* 2006

Physiological Consequences of Healthcare Provider Schedules

Biological Time of Day (circadian phase)	Misalignment of circadian phase
Number of Hours Awake	Acute total sleep deprivation scheduled frequently
Nightly Sleep Duration	Chronic partial sleep deprivation resulting in cumulative sleep debt
Sleep Inertia	Performance often required within minutes of awakening

Resident Performance and Fatigue

Philibert I. *Sleep* 2005; 28: 1392-1402.



•Effect of Sleep Deprivation on Physicians' Mean Clinical Performance: Results of 14 Studies

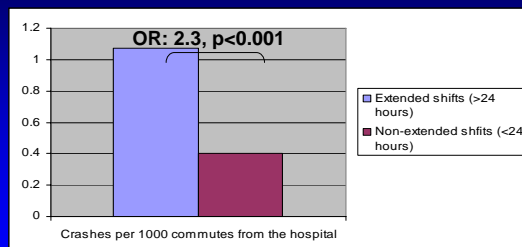
- Meta-analysis 60 studies (959 MDs, 1028 non-MDs)
 - For MDs, 24 hours with no sleep leads to major performance drops to:
 - 15th percentile of rested MD performance level
 - 7th percentile on *clinical* tasks

Harvard Work Hours, Health, and Safety Study: Part 1

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

Barger, L. K. et al. *N Engl J Med* 2005; 352:125-134

Motor Vehicle Crash Risk in Interns on Commute Home from Hospital



Barger, L. K. et al. *N Engl J Med* 2005; 352:125-134

Dose-Response Relationship

- For **each additional** extended duration work shift scheduled per month, interns had:
 - 8.8% increased monthly risk of *any* Motor Vehicle Crash;
 - 16.0% increased monthly risk of a Motor Vehicle Crash *on the commute home from work*
 - **Therefore, q3 schedule (10 overnights per month) = 160% increase over baseline risk**

Harvard Work Hours, Health, and Safety Study: Part 2

EXPERIMENTAL QUESTION:

Would ICU patients fare better when the physicians caring for them consisted of:

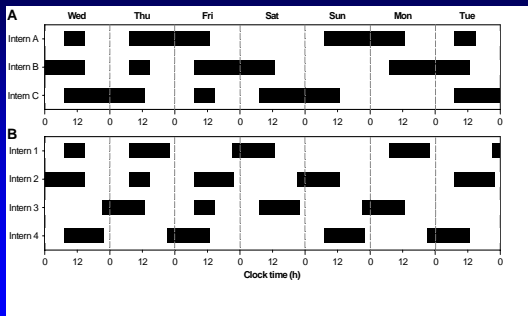
1. Current standard TRADITIONAL team of 3 residents working on a Q3 schedule which minimized handoffs by relying on **repetitive 30-hour scheduled work shifts**; or
2. An INTERVENTION team of 4 residents working on a schedule which increased handoffs in order to limit scheduled work shifts to **no greater than 16 hours**

PUBLIC FAVORS LIMITING WORK HOURS FOR DOCTORS

2002 NATIONAL SLEEP FOUNDATION POLL

- More than half said doctors should work **<10 hour shifts**
- **86% would likely feel anxious** about their safety if they learned their surgeon had been **on duty >24 hours**
- **70% would likely ask for a different doctor**
- 60% would be unlikely to assume procedure will go well

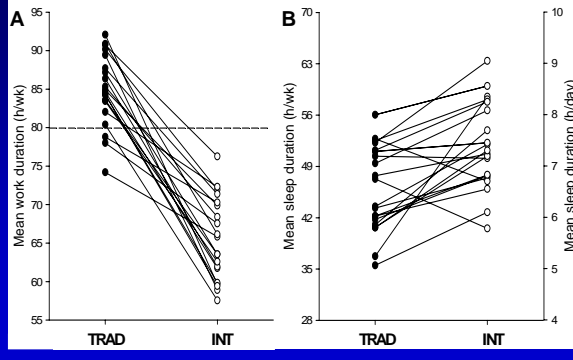
Traditional (A) vs. Intervention (B) Intern Schedule



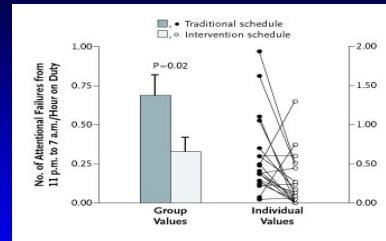
Landrigan, C. P. et al. N Engl J Med 2004;351:1838-1848



Results: Sleep and Work Duration



Attentional Failures at Night: 11pm-7am



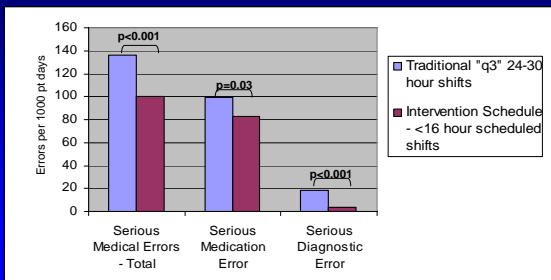
•0.69 (traditional) vs. 0.33 (intervention) attentional failures per hour, $p=0.02$

•Non-significant trend toward decreased day / evening attentional failures as well

Lockley, S. W. et al. N Engl J Med 2004;351:1829-1837

Intern Sleep and Pt Safety Study, Part 2

•Interns made 36% more serious errors on traditional schedule, including 5 times as many serious diagnostic errors



Landrigan, C.P. et al. N Engl J Med 2004;351:1838-1848

Are the ACGME duty hour standards sufficient to solve the problem?

- ≤ 80 hours per week, averaged over 4 weeks
- ≤ 30 hours in a row, including time for hand-offs of care and education
- 1 day off in 7, averaged over 4 weeks

Safety-sensitive US industries

- Truckers : maximum 11 hours in a row
- Pilots : maximum 8h per 24 flying domestic routes
- Nuclear Power : maximum 12 hours in a row
- Train engineers: maximum 12 hours

Concerns about ACGME standards

- The traditional schedule in the Intern Sleep and Safety Study **was compliant** with the ACGME Standards
 - Many more attentional failures and errors than a schedule that restricted work to 16 consecutive hours
- 24+ hour shifts continue to be endorsed
- Preliminary studies among pediatric, neurology, and otolaryngology residents suggest compliance may be less than reported by the ACGME
- **Have the ACGME duty hour standards led to measurable change?**

What are the Personal and Legal Implications of Residents Working >24 Hours?

Resident Car Crashes

- Dr. Valentin Barbulescu: Senior resident from New York who died in a one-car crash after falling asleep at the wheel post-call from the CCU
- Heather Brewster: Student permanently brain damaged after being rear-ended by a resident from Rush-Presbyterian in Chicago who fell asleep at the wheel after having been awake for 34 of the preceding 36 hours



Potential Legal Implications for House Staff

- In New Jersey, "driving after having been without sleep for a period in excess of **24 consecutive hours**" now explicitly considered **reckless**
- Similar laws pending in several other states
- Brewster case pending in Illinois court system

Potential Legal Implications for Hospitals

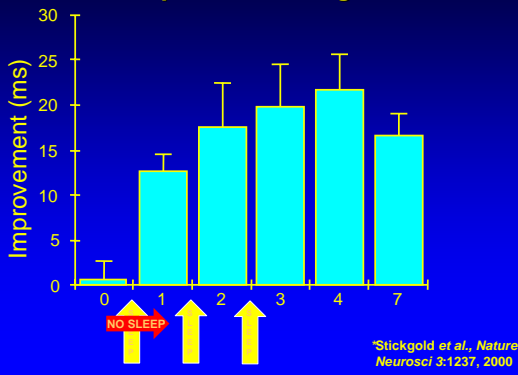
- Courts in two states have ruled that an employer may be held responsible for fatigue-related crashes even after workers have left
 - similar to concept of restaurants / bars being potentially liable for alcohol-related crashes if they served alcohol to a driver
- Employers have been sued and settled for as much as \$10 million in a similar case

Effectiveness of Taxi Services as a Countermeasure

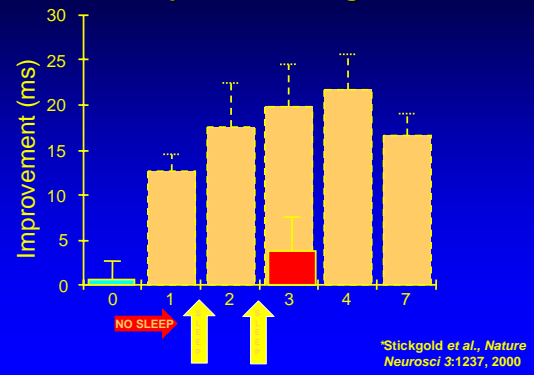
- U Michigan and BWH Have Taxi programs
 - use limited
- Mild to moderate impairment due to sleep deprivation consistently underestimated by young adults
 - Residents in particular prone to this effect (Saxena and George, Sleep 2005)
 - Medical culture may increase this risk

What about potential impact of sleep loss on Medical Education?

Visual Discrimination Learning Requires Sleep after Training*



Visual Discrimination Learning Requires Sleep after Training*



Quality vs. Quantity of Learning

- Residents working longer hours report decreased satisfaction with learning environment and decreased motivation to learn

Baldwin et al 1997

What about the Cost of Hiring more Residents or Other Providers?

Inpatient Costs of Adverse Events

- Harvard Medical Practice Study
 - annual cost of AEs to New York State: \$878 million
- Inpatients with ADEs (*Bates, JAMA 1997*)
 - Increase in length of stay of about 2 days
 - \$2400 per ADE
 - \$4500 per preventable ADE
 - Annual BWH costs: \$5.6 million
 - excludes costs of long term injuries and malpractice

Cost-Effectiveness of Scheduling Interventions

- If ACGME standards lead to 5.1% - 8.5% decrease in adverse events, they will be cost neutral for society (*Nuckols and Escarce, JGIM 2005*)
- Interventions that are more successful at reducing adverse events will offset the costs of these interventions

What about the risks of lost continuity of care?

Problems in Care Continuity

- Night float admission patients had longer LOS and more tests ordered (*Lofgren et al. J Gen Intern Med. 1990*)
- Work hour limits and presumed resulting discontinuities associated with increased hospital complications and test ordering (*Laine et al. JAMA 1993*)
- Cross coverage associated with an increased risk of errors (OR 6.0) (*Petersen et al., Ann. Int. Med 1994*)
 - Signout errors can be improved substantially with structured sign out (*Petersen et al., Joint Comm J on QI 1998*)

Post-operative Sign-out Errors

Mistry K, Landrigan CP, Goldmann DA, Bates DW, unpublished data

- Audio recordings of Anesthesia to ICU signouts
- Very high incidence of errors in communication of critical information

Signout Process : A survey of residents at BWH

Carty M, Smith C, Schnipper JL, Harvard Education Day 2004, unpublished data

- 37% said that signout occurred in a quiet place most of the time
- 52% provided written and verbal signout on every patient
- Only 55% of night-float residents said that when called about a patient, the relevant information could be found in the sign-out

Ongoing Implementation Efforts

SICU Intervention Study

- New project : Implementation grant by AHRQ
- Effectively Implement shortened schedules in ICUs, and enhance sign-out process
- 3 junior residents and 1 PA
- limit to 56 hours per week, 13-14 hours in a row

Other Programs Implementing Scheduling Interventions

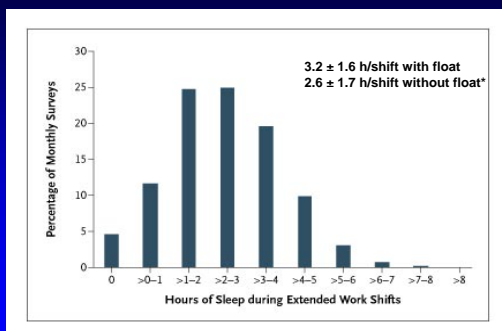
- BWH Department of Surgery, MA
 - On ALL rotations, maximum shift length of 12h
 - SICU is the only rotation with traditional 30h shifts
- MGH Department of Medicine, MA
 - 24h rotations eliminated in >90% of rotations
 - Mixture of 16h and 12h patterns
- Summa Health Systems Medicine, OH
 - Gradual elimination of 24h shifts; max 18h
- Coney Island and Lincoln Hospitals, NY
 - 12-16h consecutive work, all rotations

1990 BWH Night-Float study Provision of 4-h protected time for sleep

- Night float from 2am-6am covering all admissions and continuing care
- Resident sleep measured by EEG
- Intervention did not improve total sleep time - mean 224 minutes pre-intervention vs 212 post
 - Paperwork catch-up in protected time vs “grab every minute” in unprotected set up
- Sleep quality did improve on EEG

Richardson et al., *Sleep*, 1996

Work shift duration



Barger et al., *N Engl J Med* 2005

The Case for a 16 Hour Limit

- Field & laboratory studies, across disciplines, consistently show deterioration after 12-16h
- Residents' working 24-30h make 36% more serious errors (including 5 times as many diagnostic errors) and have twice the odds of crashing their cars
 - Perform at a level commensurate with a blood alcohol of 0.05-0.10; drop in performance of 1.5 standard deviations
- Sign-out systems can be improved to minimize hand-off errors
- Preventing adverse events ultimately saves money

