

Sleep Deprivation and Resident Fatigue

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“Given the uncommon stresses inherent in fulfilling the demands of their training program, residents must be allowed sufficient opportunities to meet personal and family obligations, to pursue recreational activities, *and to obtain adequate rest.*”

From the Association of American Medical Colleges,
Compact Between Resident Physicians and Their Teachers, 2005

Sleep Deprivation

- ❑ Difficult to define for any given individual but can be the result of a quantitative, qualitative, or timing issue
 - ❑ Can be characterized as cumulative partial sleep deprivation vs. acute total sleep deprivation
 - ❑ Both types of sleep deprivation have similar effects but cumulative partial sleep deprivation may be harder to recognize
 - ❑ Exacerbates pre-existing sleep disorders, present in ~10% of the population
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Normal Sleep Duration?

- ❑ Variable with age and for each individual person
 - ❑ Young adults would spontaneously sleep an average of 8.5 hrs/night if given sufficient opportunity
 - ❑ Adult residents sleep ~ 2 hrs/night less than this amount
 - ❑ Increased mortality shown in individuals who sleep <4 hrs or >10 hrs nightly
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Consequences of Sleep Deprivation

- ❑ Significant changes in cognitive functioning: short term memory problems, impaired attention, and alteration of mental status resembling depression/anxiety
 - ❑ Measurable neuropsychological deficits in motor skills, attention, and information processing
 - ❑ Second leading cause of car accidents
 - ❑ Poorer quality of life
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Consequences of Sleep Deprivation

- ❑ Depression of ventilatory responses to hypercapnia and hypoxia in normal subjects
 - ❑ Decrease in respiratory muscle endurance
 - ❑ Impaired immune function with increases in TNF- α and IL-6
 - ❑ Increased hunger and appetite
 - ❑ Possible increased risk of cardiovascular disease, insulin resistance, diabetes, and certain cancers
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Consequences of Sleep Deprivation

- ❑ Dose response chronic sleep restriction experiment randomized 48 healthy adults to 4h, 6h, 8h sleep doses for 14 straight days or no sleep for 3 days
- ❑ Chronic restriction to 4-6 hrs resulted in significant cumulative dose-dependent deficits in cognitive performance on all tasks
- ❑ Subjective sleepiness ratings showed acute response to sleep restriction but only small ~~further increases on subsequent days~~

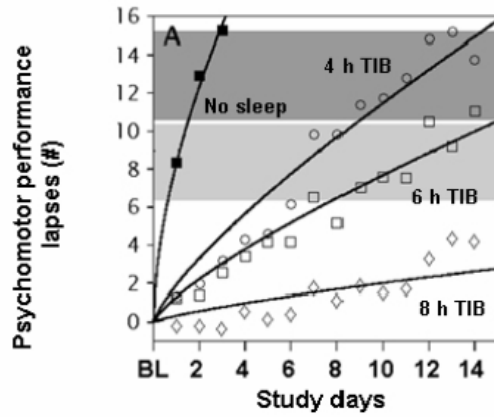
Sleep. 2003 Mar 15;26(2):117-26

Consequences of Sleep Deprivation

- ❑ Regardless of mode of sleep deprivation, lapses in behavioral alertness linearly related to cumulative duration of wakefulness more than 15.84 hrs
- ❑ Chronic restriction of sleep to 6h or less/night produced cognitive performance deficits equivalent to 2 nights of total sleep deprivation

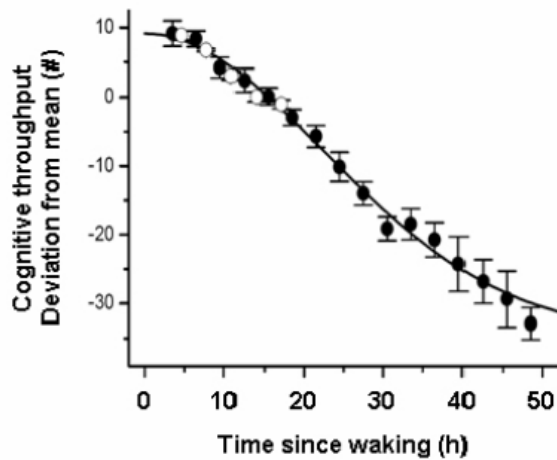
Sleep. 2003 Mar 15;26(2):117-26

C – Chronic sleep deprivation



Sleep. 2003 Mar 15;26(2):117-26

B – Acute sleep deprivation



Effects of 48 hrs of continual wakefulness on mean cognitive throughput, as measured by a simple 4 minute addition test

Sleep. 1999 Jun; S94-S95

Effect of 24–30 Hours of Acute Sleep Loss on Various Types of Performance Based on a Meta-Analysis of 60 Sleep-Deprivation Studies of Physicians and Nonphysicians

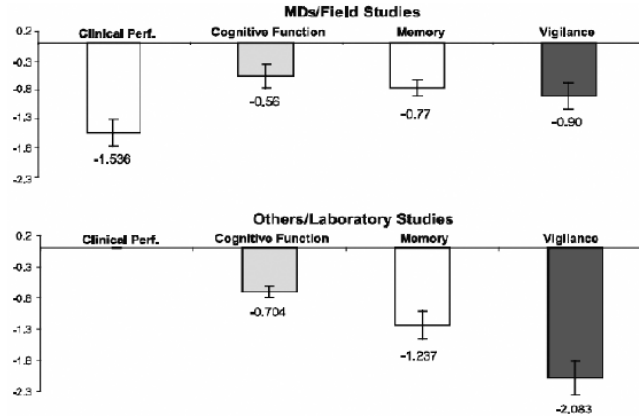


Figure 5. The figure shows the effect of 24–30 hours of acute sleep loss on various types of performance based on a meta-analysis of 60 sleep-deprivation studies of physicians (top panel) and nonphysicians (bottom panel). The average effect sizes are shown for each performance type and are corrected for measurement error and standard error of the corrected effect sizes. Following 24–30 hours on duty, physicians' clinical performance deteriorated by ~1.5 standard deviations as compared to when 'rested' (top panel). As most of these data were collected under 'field' conditions, however, physicians in the 'rested' condition were unlikely to be non-fatigued, which may explain the greater effect of sleep deprivation observed under more highly controlled laboratory conditions (bottom panel).

Circadian Misalignment and Resident Schedules

- ❑ Suprachiasmatic nuclei in hypothalamus acts as an endogenous circadian pacemaker to drive alertness during the day and sleepiness at night
- ❑ Rapid changes in work schedules from days to nights and vice versa cause a permanent state of "jet lag"
- ❑ Prolonged wakefulness (>16 hr) + circadian misalignment likely responsible for fatigue-related errors or accidents, which often occur at night

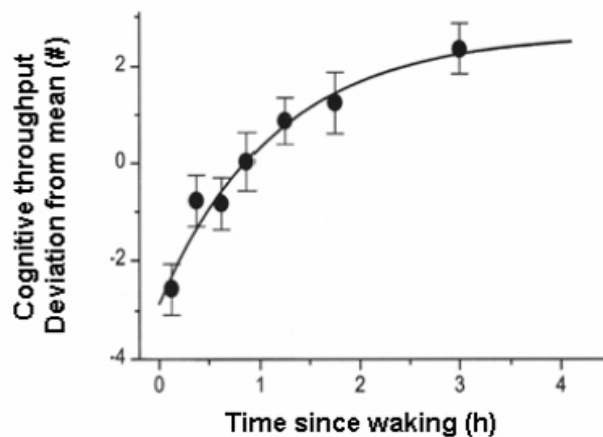
Jt Comm J Qual Patient Saf. 2007 Nov;33(11 Suppl):7-18

Sleep Inertia and the Pager

- ❑ Sleep inertia refers to the cognitive impairment present immediately on awakening from sleep
- ❑ The first 15-30 min after waking are a vulnerable period and performance decrements can exceed those after 24 hrs of continuous wakefulness
- ❑ Highlights risk of residents committing fatigue-related errors when woken from sleep by a page

Jt Comm J Qual Patient Saf. 2007 Nov;33(11 Suppl):7-18

D – Sleep inertia

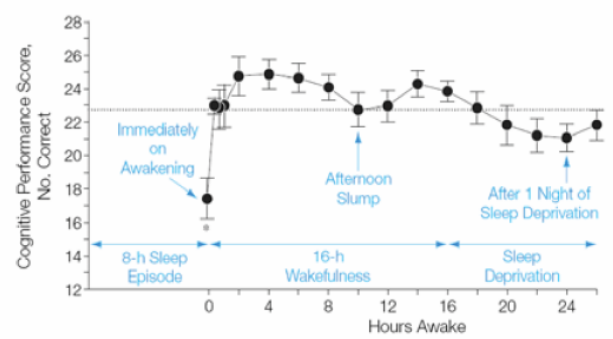


Sleep inertia during 1st 4 hrs of wakefulness after an 8 hr sleep – takes 2+ hrs to reach maximal performance; highest risk of fatigue-related error in 1st 30 min after awakening

J Sleep Res. 1999 Mar;8(1):1-8

Relative Impact of Sleep Inertia and Acute Sleep Deprivation on Cognitive Performance

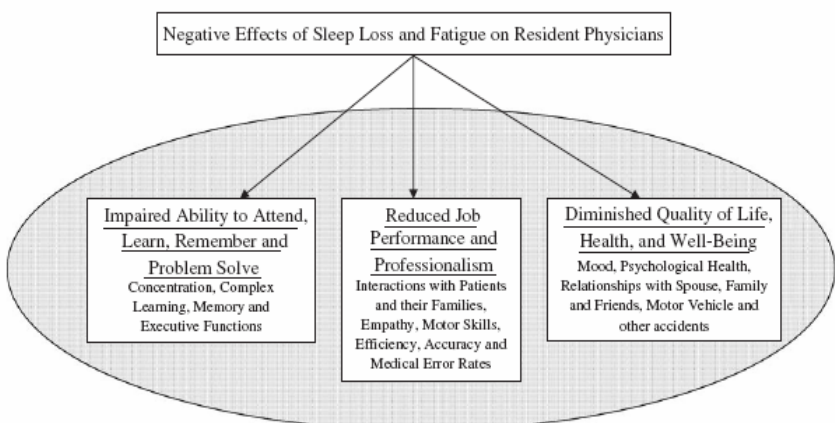
S



Cognitive performance worst immediately after waking and more impaired than following 24 hrs of continuous wakefulness

JAMA. 2006 Jan 11;295(2):163-4

Consequences of Sleep Deprivation for Residents



Sleep Med Rev. 2006 Oct;10(5):339-45

Consequences of Sleep Deprivation for Residents

- GW Small first described features of a stress syndrome common among graduate physicians:
 - Episodic cognitive impairment
 - Chronic anger
 - Pervasive cynicism
 - Family discord
 - More recent data stresses prevalence of anxiety, depression, obsessive-compulsive trends, hostility, and alcohol/substance abuse
-
- Psychosomatics. 1981 Oct;22(10):860-9
J Surg Res. 1992 Sep;53(3):268-71

Consequences of Sleep Deprivation for Residents

- Physicians in-training working traditional schedules with recurrent 24 hr shifts:
 - Make more medical and diagnostic errors
 - Have more attentional failures
 - Suffer more needlestick injuries
 - Increase their risk of a motor vehicle crash
 - Experience a deterioration in performance on both clinical and nonclinical tasks, similar to having a blood alcohol level of 0.05-0.10%

Jt Comm J Qual Patient Saf. 2007 Nov;33(11 Suppl):7-18

Sleep Deprivation and Performance

- ❑ 20 interns studied in ICU/CCU during both traditional and intervention schedule
- ❑ Intervention interns worked 19.5 hrs/wk less, slept 5.8 hrs/wk more, and slept more in the 24 hrs preceding each work hr
- ❑ Duration of sleep
 - 6.6 +/- 0.8 hrs/day during traditional schedule
 - 7.4 +/- 0.9 hrs/day during intervention schedule

N Engl J Med. 2004 Oct 28;351(18):1829-37

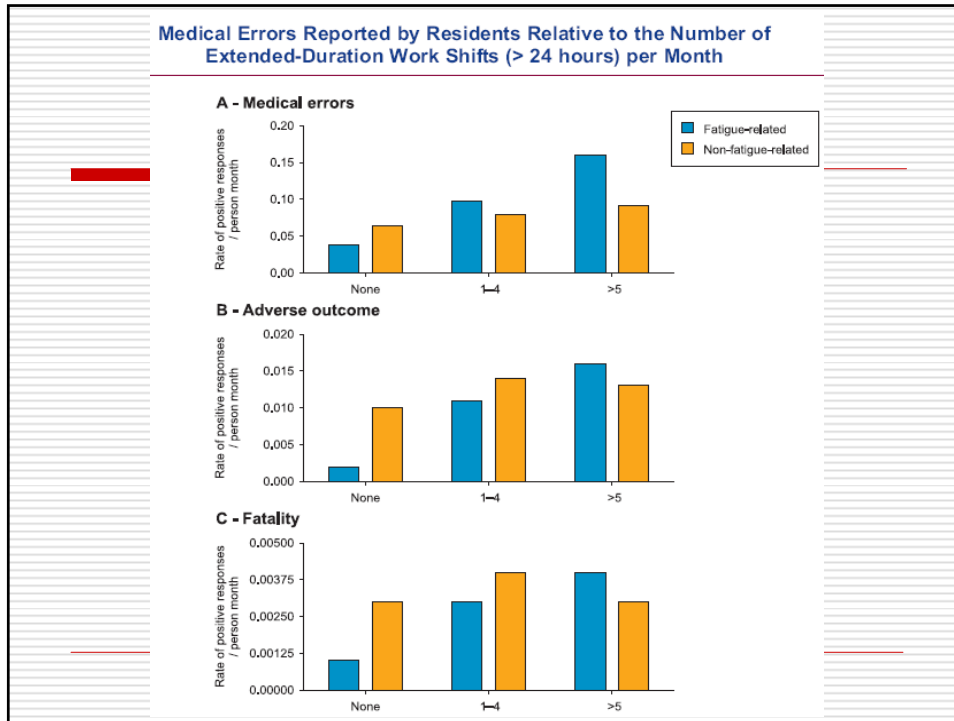
N Engl J Med. 2004 Oct 28;351(18):1838-48

Sleep Deprivation and Performance

- ❑ Interns had <1/2 the rate of attentional failures during on-call nights on intervention schedule
- ❑ Interns made significantly more medical errors on traditional schedule:
 - 35.9% more serious medical errors
 - 56.6% more unintercepted serious errors
 - 20.8% more serious medication errors
 - 5.6 times the number of serious diagnostic errors

N Engl J Med. 2004 Oct 28;351(18):1829-37

N Engl J Med. 2004 Oct 28;351(18):1838-48



Risk of Motor Vehicle Crashes (MVCs)

- Prospective nationwide web-based survey in 2002-3
 - 2737 interns (79% medical specialties, 69% car commuters) completed monthly surveys re: work hrs, extended work shifts (>24 hrs), MVCs, near-miss incidents, and incidents involving involuntary sleeping
 - Average weekly work hrs: 70.7 +/- 26.0 hrs
 - Average monthly no. of extended shifts: 3.9 +/- 3.4

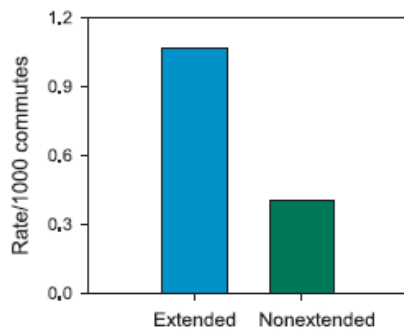
N Engl J Med. 2005 Jan 13;352(2):125-34

Table 1. Risk of Motor Vehicle Crashes and Near-Miss Incidents after Extended Shifts.*

Variable	Extended Work Shifts (≥24 hr)	Nonextended Work Shifts (<24 hr)
Crashes		
No. reported	58	73
No. of commutes	54,121	180,289
Rate (per 1000 commutes)	1.07	0.40
Odds ratio (95% CI)	2.3 (1.6–3.3)	1.0
Near-miss incidents		
No. reported	1,971	1,156
No. of commutes	54,121	180,289
Rate (per 1000 commutes)	36.42	6.41
Odds ratio (95% CI)	5.9 (5.4–6.3)	1.0

*A within-person case-crossover analysis was used to assess the risks of motor vehicle crashes and near-miss incidents among interns during commutes after extended shifts as compared with nonextended shifts. A two-by-two table was constructed for each intern who reported either a crash or a near-miss incident, consisting of the number of crashes or near-miss incidents after an extended shift, the number of crashes or near-miss incidents after a nonextended shift, the number of extended shifts that did not precede a crash or a near-miss incident, and the number of nonextended shifts that did not precede a crash or a near-miss incident. CI denotes confidence interval.

A - Motor vehicle crashes



B - Near-miss accidents

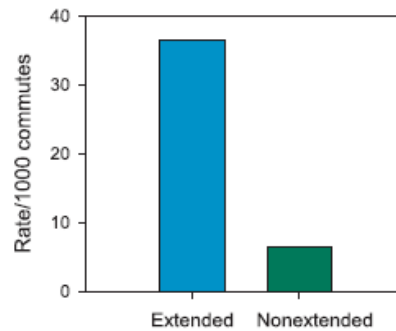


Table 2. Odds Ratios for Falling Asleep while Driving or while Stopped in Traffic, According to the Monthly Number of Extended Work Shifts.^a

Question	0 Extended Work Shifts				1-4 Extended Work Shifts				≥5 Extended Work Shifts			
	No. of Person-Months	No. of Person-Months with Positive Response	Rate of Positive Response	Odds Ratio	No. of Person-Months	No. of Person-Months with Positive Response	Rate of Positive Response	Odds Ratio (95% CI)	No. of Person-Months	No. of Person-Months with Positive Response	Rate of Positive Response	Odds Ratio (95% CI)
Did you nod off or fall asleep while driving?	3035	199	0.066	1.00	3068	286	0.093	1.82 (1.73-1.93)	6933	872	0.126	2.39 (2.31-2.46)
Did you nod off or fall asleep while stopped in traffic?	3039	311	0.102	1.00	3078	508	0.165	1.74 (1.68-1.81)	6944	1608	0.232	3.69 (3.60-3.77)

^aData are from interns' monthly reports on extended shifts. The number of person-months varies because nonresponses were eliminated from the analysis. Rates represent the proportion of months in which participants reported one or more incidents of nodding off or falling asleep, regardless of how many incidents were reported. CI denotes confidence interval.

Risk of Motor Vehicle Crashes

- ❑ In summary, the odds that interns will have a MVC on the commute after an extended work shift is more than double the odds after a nonextended shift
- ❑ Near-miss incidents more than five times as likely to occur after an extended work shift

N Engl J Med. 2005 Jan 13;352(2):125-34

Risk of Motor Vehicle Crashes

- May have legal implications i.e. drivers can be convicted of vehicular homicide for driving when impaired by sleepiness
- NJ has added to reckless driving definition: "driving after having been without sleep for a period in excess of 24 consecutive hours"
- An employer's responsibility for fatigue-related MVCs can continue after an employee has left work

N Engl J Med. 2005 Jan 13;352(2):125-34

UCLA Data

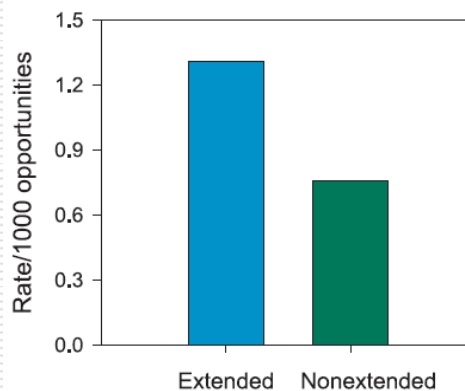
- 2007 UCLA graduate medical education survey of 744 residents (78% of the housestaff):
 - 19.5% responded "yes" to "have you fallen asleep while driving as a result of work-related fatigue in the past year?"
 - <50% of residents reported that they would take a nap at the hospital prior to driving home if they were feeling very fatigued after a shift
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Risk of Percutaneous Injuries (PIs)

- ❑ PIs more frequent from 6:30-17:30 after working overnight (1.31/1000) compared with same times on previous day (0.76/1000) - OR 1.61
- ❑ Extended work injuries occurred after mean of 29.1 consecutive work hrs vs. 6.1 hrs
- ❑ Injuries more frequent at night (1.48/1000 vs. 0.70/1000, OR 2.04)
- ❑ Primary reasons attributed by residents were lapse in concentration (64%) and fatigue (31%)

JAMA. 2006 Sep 6;296(9):1055-62

C - Percutaneous injuries



Attempts to Fix the Problem

- Some departments offer round-trip cab vouchers to residents on request
- A lecture on the SAFER (Sleep, Alertness, and Fatigue Education in Residency) program had no beneficial effect on intern sleep
- A nap intervention for interns 2 wks/mo. (leading to 41 more min of sleep/on-call night) reduced subjective post-call fatigue but no other outcomes evaluated

Arch Intern Med. 2007 Sep 10;167(16):1738-44

Ann Intern Med. 2006 Jun 6;144(11):792-8

Fixing the Problem?

- Resident education/fatigue management programs
- Minimizing post-call procedures or operations
- Encouraging pre-call naps prior to night shifts
- ?Further reduction of work hrs using the Sleep Research Society recommendations (European healthcare workers limited by law to 13 consecutive hrs of work and 48-56 hrs work/wk)
- ~~Scientificallly designed work schedules~~
- A change in attitude

Summary

- ❑ Sleep deprivation can be acute or chronic and leads to cognitive impairment, neuropsychological deficits, and decreased quality of life
- ❑ Despite the "80 hour work week," residents regularly work extended shifts which lead to a higher rate of medical errors, MVCs, and PIs
- ❑ The solution remains unclear but likely involves resident education, redesign of work schedules, further work-hour reform, and infrastructural changes

THE END

