Effects of Traditional 24-hour Work Shifts on Physician and Patient Safety

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Patient Safety

• To Err is Human
  – Institute of Medicine Report, 1999
  – estimated 44,000 to 98,000 deaths annually from adverse events
• Report notably silent on issue of sleep deprivation due to lack of empiric data at that time
• Considerable accumulation of information in past 3-4 years
Sleep Deprivation and Errors in Detection of Cardiac Arrhythmias on ECG

<table>
<thead>
<tr>
<th>Medical Interns</th>
<th>Rested</th>
<th>Sleep Deprived</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep in prior 32 h</td>
<td>7.0 h (5.5-8.5 h)</td>
<td>1.8 h (0-3.8 h)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Errors on ECG sustained attention task</td>
<td>5.21 ± 0.93</td>
<td>9.64 ± 1.41</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Impaired speed and errors in performance: laparoscopic surgical simulator

• 17-hour overnight call duty in a surgical department

• Median reported sleep time 1.5 h (range 0-3 h)

Resident Performance and Fatigue

- 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

- **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

Harvard Work Hours, Health, and Safety Study: Results

Motor Vehicle Crashes

OR: 2.3 (95% CI, 1.6-3.3)

Percutaneous Injuries

OR: 1.6 (95% CI, 1.5-1.8)

Barger LK et al. NEJM 2005; 352:125-134

Ayas, et al. JAMA 2006; 296:1055-1062
Harvard Work Hours, Health, and Safety Study (continued)

- **Objective:** To determine if interns report making more harmful medical errors when working 24-hour shifts
  - Odds of reporting a harmful fatigue-related error was 7-fold higher when working five or more 24h shifts in a month (compared with self when working no 24h shifts)
  - Odds of a *fatal* error due to fatigue 4-fold higher

![Graph](https://example.com/graph.png)

Intern Sleep and Patient Safety Study

• Randomized Controlled Trial comparing interns’ alertness and performance on traditional “q3” schedule with 24-30 hour shifts (ACGME-compliant) vs. 16 hr max schedule

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

Residents: Alcohol vs. Sleep

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

*Arnedt et al. JAMA. 2005;294:1025-1033*
Are Current ACGME Work Hour Limits sufficient to solve the problem?

• $\leq 80$ hours per week, averaged over 4 weeks
• $\leq 30$ hours in a row, including time for hand-offs of care and education
• 1 day off in 7, averaged over 4 weeks
Effect of Duty Hour Standards on Interns’ Work and Sleep

Landrigan C.P., et al. JAMA 2006;296:1063-1070
Database Studies of ACGME Standards: Effects on Mortality

- Shetty and Bhattacharya, *Ann Int Med* 2007,
  - Community Hospital Patients (N=1,511,945)
  - No effect surgical patients
  - 0.25% reduction in mortality for medical patients

- Volpp et al., *JAMA* 2007
  - VA Patients (N = 318,636)
  - No effect surgical patients
  - 0.7 – 0.9% reduction in mortality for medical patients

- Volpp et al., *JAMA* 2007
  - Medicare Patients (N = 8,529,595)
  - No effect, surgical or medical patients
Compliance with Duty Hour Standards

- **83.6% of interns in violation of standards**
  - 85.4% of programs; 90.8% of hospitals
- **44.0% of all intern-months in violation**
  - 61.5% of inpatient intern-months in violation

Landrigan C.P., et al. JAMA 2006;296:1063-1070
Work Hour Limits in Other Safety-Sensitive Industries

- **Truckers**: maximum 11 hours in a row
- **Pilots**: maximum 8h per 24 (domestic routes)
- **Nuclear Power**: maximum 12 hours
- **Train engineers**: maximum 12 hours
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*
  - Sign-out errors can be improved substantially with structured sign out. *Petersen et al., Joint Comm J on QI 1998*
Quality of the Sign-out Process: A tri-center study


- 37% of surveyed residents said that sign-out occurred in a quiet place most of the time
- 52% provided written and verbal sign-out 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
Communication During Post-operative Patient Hand Off in the Pediatric Intensive Care Unit

Mistry KP, Landrigan CP, Goldmann DA, Bates DW

- Audio recording and analysis of 150 post-op sign-outs
- **100%** of sign-outs contained at least one error
Effectiveness of Eliminating 24-hour shifts
Intern Sleep and Patient Safety Study

Randomized Trial with the following 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
Intern Sleep and Pt Safety Study, Part 2

- **Randomized Controlled Trial of ACGME limits vs. 16h limit**
- Interns made 36% more serious errors on traditional schedule, including *5 times* as many serious diagnostic errors

Elimination of 24-hour Shifts for Internal Medicine Residents

Horwitz et al., Ann Int Med 2007; 147: 97-103

- Effects of Redesigned System that used hospitalist service to eliminate 24h shifts for residents
- Decrease of 1.92 pharmacy interventions to prevent error per 100 patient days (p<0.001)
- Decreased ICU admissions
- Increased discharges to home or rehabilitation facility vs. other settings
The Path Forward – Eliminating 24-hour shifts

• Field & lab studies, across disciplines, show consistent performance decline after 12-16h
• In a randomized controlled trial, residents’ working ACGME-compliant 24-30 hour shifts make 36% more serious errors and 460% more serious diagnostic errors than those scheduled to work ≤16h shifts
• Residents working 24h shifts have twice the odds of crashing their cars, and suffer 61% more needlestick injuries
• Perform at a level commensurate with a blood alcohol of 0.05-0.10%; drop in performance of 1.5 to 2 standard deviations
• Sleep deprivation impairs learning
• Sign-out systems can be greatly improved to minimize hand-off errors
European Working Time Directive

- 13 hours in a row maximum
- 48-56 hours per week
New Zealand
- 72 hours per week limit
- 16 hours in a row
- in place for 20 years
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