Nurse and Physician Sleep Deprivation: Effects on Patient Safety, Provider Safety, and Long Term Health

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Disclosures

• Dr. Landrigan has been supported in part by the Children’s Hospital Association (CHA) for his work as an Executive Council Member of the Pediatric Research in Inpatient Settings (PRIS) Network, including studies of safety and quality of care.

• Dr. Landrigan has received honoraria / consultancies from multiple academic medical centers and professional societies for providing lectures and information on sleep deprivation, handoffs, and patient safety, and has served as an expert witness in cases regarding sleep deprivation and safety.

• The presentation will not involve discussion of unapproved or off-label, experimental or investigational use.
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
Is Healthcare Getting Safer?
Office of the Inspector General, 2010
– **180,000 deaths per year** due to adverse events
– **$4.4 billion dollars per year**

**North Carolina Patient Safety Study**
*Landrigan et al., NEJM 2010: 363:2124-34*
– 10-hospital study of 2341 randomly selected admissions from hospitals statewide
Fatigue and Error
DETERMINANTS OF ALERTNESS AND PERFORMANCE

- Biological Time of Day (circadian rhythms)
- Consecutive Waking Hours
- Nightly Sleep Duration
- Sleep Inertia
Human Circadian Pacemaker in Suprachiasmatic Nucleus (SCN) of Hypothalamus

Courtesy of D. Weaver, Univ. Massachusetts Medical School, Worcester, MA
DETERMINANTS OF ALERTNESS AND PERFORMANCE

- Biological Time of Day (circadian rhythms)
- Consecutive Waking Hours
- Night Sleep Duration
- Sleep Inertia
Acute Sleep Deprivation and Performance

Jewett et al., 2000
“...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 %.”

DETERMINANTS OF ALERTNESS AND PERFORMANCE

- Biological Time of Day (circadian rhythms)
- Consecutive Waking Hours
- Night Sleep Duration
- Sleep Inertia
Cumulative impact of daily sleep curtailment on risk of vigilance lapses & subjective alertness

Objective performance (PVT)

Van Dongen et al. Sleep 2003
Circadian Misalignment, Acute Sleep Deprivation, and Chronic Sleep Deprivation Interact: Combined Effects

DETERMINANTS OF ALERTNESS AND PERFORMANCE

- Biological Time of Day (circadian rhythms)
- Consecutive Waking Hours
- Night Sleep Duration
- Sleep Inertia
Sleep Inertia

Time Course of Deficits from Sleep Inertia

Subjective Alertness

Deviation from Mean (mm)

Cognitive Throughput

Deviation from Mean (# attempted)

Hours Since Scored Waketime

Aircraft Accident Data (Israeli Airforce)

Fighters

All aircraft

Hours since 6 am wake time

Jewett et al., J. Sleep Res., 1999

BRAIN WITHOUT ENOUGH SLEEP

Inferior parietal cortex: Integrates sensory info (from eyes, ears, touch..)

occipital cortex: Vision

Thalamus: relays sensory info to motor cortex

Pre-frontal cortex: judgment & control

~BAC 0.10%

Courtesy of T. Balkin, WRAIR, USAMRMC (data from Thomas et al., J Sleep Res, 2001); prepared by David Dinges and provided by ACGME
Occupationally Driven Sleep Deprivation
## What Professions are at Risk?

<table>
<thead>
<tr>
<th>Profession</th>
<th>Shift Workers (1000s)</th>
<th>% of Total Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>2021</td>
<td>24.4</td>
</tr>
<tr>
<td>Top Occupations</td>
<td>1900</td>
<td>28.5</td>
</tr>
<tr>
<td>Food preparation &amp; serving</td>
<td>1568</td>
<td>40.4</td>
</tr>
<tr>
<td>Sales &amp; related occupations</td>
<td>1464</td>
<td>15.2</td>
</tr>
<tr>
<td>Office &amp; administrative support</td>
<td>1458</td>
<td>9.9</td>
</tr>
<tr>
<td>Health care practice &amp; technical</td>
<td>1138</td>
<td>24.6</td>
</tr>
<tr>
<td>Protection services</td>
<td>1125</td>
<td>50.6</td>
</tr>
<tr>
<td>Management</td>
<td>612</td>
<td>9.8</td>
</tr>
<tr>
<td>Cleaning &amp; maintenance</td>
<td>609</td>
<td>17.5</td>
</tr>
<tr>
<td>Personal care &amp; service</td>
<td>542</td>
<td>28.1</td>
</tr>
<tr>
<td>Health care support</td>
<td>534</td>
<td>28.0</td>
</tr>
<tr>
<td>Installation, maintenance &amp; repair</td>
<td>488</td>
<td>11.4</td>
</tr>
<tr>
<td>Construction &amp; extraction</td>
<td>256</td>
<td>9.8</td>
</tr>
<tr>
<td>Community &amp; social services</td>
<td>237</td>
<td>12.7</td>
</tr>
<tr>
<td>Arts, entertainment, media &amp; sports</td>
<td>221</td>
<td>14.7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>14,173</strong></td>
<td><strong>17.5</strong></td>
</tr>
</tbody>
</table>

Shift Work Coping Problems
Personal Factors

- Age ≥50 years
- "Morning-type" person ("lark")
- Heavy domestic workload
- Second job ("moonlighting")

- History of...
  - Sleep disorders
  - Medical illness

Degrees of Excessive Sleepiness

Falling asleep or nodding off...

- During conversation
- Eating a meal
- Driving
- Walking
- Watching a movie
- Attending a concert
- In a meeting
- Riding in a car
- Watching TV
- Reading
- During conversation
- During daily activities requiring moderate attention
- During times of rest or when little attention is required

Relative Risk for Injuries and Accidents

By Shift

Relative Risk

Morning | Afternoon | Night

1.0 | 1.1 | 1.3

By Successive Nights

Relative Risk

1 | 2 | 3 | 4

0.8 | 0.9 | 1.2 | 1.4

100 Car Study
Virginia Tech and NHTSA

- Naturalistic study of 100 cars for one year
- 82 crashes, 761 near-crashes
- Fatigue contributing cause in: **20% of all MVCs** & **16% of all near-crashes**
- Suggests could be as many as **8,000 fatigue-related fatal crashes** in U.S. each year

http://www.vtti.vt.edu/PDF/100-Car_Fact-Sheet.pdf
Resident Physicians, Sleep Deprivation, and Safety
## Physiological Consequences of Healthcare Provider Schedules

<table>
<thead>
<tr>
<th>Biological Time of Day (circadian phase)</th>
<th>Misalignment of circadian phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Hours Awake</td>
<td>Acute total sleep deprivation scheduled frequently</td>
</tr>
<tr>
<td>Nightly Sleep Duration</td>
<td>Chronic partial sleep deprivation resulting in cumulative sleep debt</td>
</tr>
<tr>
<td>Sleep Inertia</td>
<td>Performance often required within minutes of awakening</td>
</tr>
</tbody>
</table>
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>

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

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

Harvard Work Hours, Health, and Safety Study: Results

Motor Vehicle Crashes

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

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

Percutaneous Injuries

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

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

• **1 of every 5 interns** admitted making a fatigue-related mistake that *injured a patient* (↑700% when interns worked >24 hours in a row)

• **1 of every 20 interns** admitted making a fatigue-related mistake that *resulted in a patient’s death* (↑300% in months interns worked five >24 hour shifts)

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

A

<table>
<thead>
<tr>
<th></th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intern A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Intern B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern C</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

B

<table>
<thead>
<tr>
<th></th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intern 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Serious Medical Errors

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

Effects of Reducing or Eliminating Shifts >16h on Patient Safety and Quality of Care: a Systematic Review

Levine AC, Adusumilli J, Landrigan CP. Sleep 2010; 33: 1043-1053

<table>
<thead>
<tr>
<th>Outcome type</th>
<th>Number of studies with outcome</th>
<th>Significant improvement</th>
<th>No change</th>
<th>Significant decrement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident Quality of Life</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Resident Education</td>
<td>14</td>
<td>4</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Patient Safety / Quality</td>
<td>11</td>
<td>7</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>
Attending Physicians
Rates of Complications by Attending Physicians After Performing Nighttime Procedures

Rothschild JM et al., JAMA 2009; 302(14):1565-1572

• 10-year retrospective study of attending surgeons and ob/gyns at BWH
• Rates of complications in Post-nighttime procedures (n=1876) compared with rates in control procedures (n=7497)
• Overall, no significant difference in complication rates (5.4% post-nighttime vs. 4.9% control),
• However, amount of sleep obtained on call significant…
### Duration of Sleep Opportunity and Complications

<table>
<thead>
<tr>
<th>No. of Hours</th>
<th>Procedures/Total (%)</th>
<th>Adjusted Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 OR</td>
<td>62/728 (8.5)</td>
<td>2.70 (1.13 – 6.48)</td>
<td>.03</td>
</tr>
<tr>
<td>&gt; 6 OR</td>
<td>6/191 (3.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-6 L/D</td>
<td>20/589 (3.4)</td>
<td>0.96 (0.47 – 1.95)</td>
<td>.91</td>
</tr>
<tr>
<td>&gt; 6 L/D</td>
<td>13/368 (3.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-6 All</td>
<td>82/1317 (6.2)</td>
<td>1.72 (1.02 – 2.89)</td>
<td>.04</td>
</tr>
<tr>
<td>&gt; 6 All</td>
<td>19/559 (3.4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Slide courtesy of J Rothschild, MD, MPH*
Nurses, Sleep Deprivation, and Safety
Nurse Sleep Deprivation and Patient Safety
Rogers et al. (Health Affairs 2004)

- Survey of 393 randomly selected members of the American Nursing Association
- Work hours and errors reported for 5,317 shifts.
- 39% of shifts exceeded 12.5 hours
- Shifts of >12.5 hrs were associated with a tripling of reported medical errors (OR=3.29, P=.001)[23].
Nurse Sleep Deprivation and Patient Safety (cont.)
Scott et al. (Am J Crit Care 2006)

- Survey of 502 randomly selected nurses from the American Association of Critical Care Nursing
- 6017 shifts reported
- 67% of shifts exceeded 12 hours.
- Shifts >12.5 hrs were associated with a doubling of error (OR=1.94, p=.03).
Sleep and Nurse Safety
Trinkoff et al. (Infect Control Hosp Epidemiol 2007)

• Survey of 2,273 nurses
• 16.3% reported a needle stick injury
• Likelihood of needle stick injury correlated with:
  – hours worked per day
  – weekends worked per month
  – night shifts
  – working 13 or more hours per day
Nurses, Sleep Deprivation, and Health
Shift Work and the Risk for Coronary Heart Disease in 79,109 Nurses


<table>
<thead>
<tr>
<th>Relative Risk (95% CI)</th>
<th>No Shift Work</th>
<th>Any Shift Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal CHD</td>
<td>1.00</td>
<td>1.23</td>
</tr>
<tr>
<td>Nonfatal MI</td>
<td>1.00</td>
<td>1.41</td>
</tr>
<tr>
<td>Total CHD</td>
<td>1.00</td>
<td>1.38</td>
</tr>
</tbody>
</table>

*P < 0.05 vs no shift work.
Coronary Artery Calcification and Sleep Duration

- Short sleep duration strongly associated with risk of coronary calcification, a subclinical predictor of coronary artery disease

King CR et al. JAMA 2008;300:2859-2866
Habitual Sleep Duration and Weight Gain: Nurses Health Study

- Sleep duration in 1986 predicted subsequent weight gain over 15 year period

Gastrointestinal Disorders in Night-Shift Workers

Prevalence of Ulcers in Workers Experiencing Insomnia or Excessive Sleepiness

% of Workers

<table>
<thead>
<tr>
<th></th>
<th>Day Shift</th>
<th>Rotating Shift</th>
<th>Night Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Workers</td>
<td>6.0</td>
<td>12.5</td>
<td>15.4</td>
</tr>
</tbody>
</table>

* $P < 0.05$ vs no insomnia or ES

Functional Bowel Disorders

% of Nurses

<table>
<thead>
<tr>
<th></th>
<th>Day Shift</th>
<th>Rotating Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Nurses</td>
<td>20</td>
<td>38</td>
</tr>
</tbody>
</table>

† $P = 0.04$ vs day shift.


# Studies Demonstrating a Significant Risk for Cancer Among Shift Workers

<table>
<thead>
<tr>
<th>Type of Cancer</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breast cancer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night shift ≥0.5 year</td>
<td>1.5*</td>
<td>1.3 – 1.7</td>
<td>1</td>
</tr>
<tr>
<td>Night shift &gt;6 years</td>
<td>1.7*</td>
<td>1.3 – 1.7</td>
<td></td>
</tr>
<tr>
<td>“Graveyard shift” (any)</td>
<td>1.6*</td>
<td>1.0 – 2.5</td>
<td>2</td>
</tr>
<tr>
<td>Shift work ≥5.7 hours/week</td>
<td>2.3*</td>
<td>1.0 – 5.3</td>
<td></td>
</tr>
<tr>
<td>Rotating nights; ≥30 years</td>
<td>1.36*</td>
<td>1.04 – 1.78</td>
<td>3</td>
</tr>
<tr>
<td>Rotating shift work: &gt;20 years</td>
<td>1.79*</td>
<td>1.06 – 3.01</td>
<td>4</td>
</tr>
<tr>
<td><strong>Prostate cancer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotating shift work</td>
<td>3.0*</td>
<td>1.2 – 7.7</td>
<td>5</td>
</tr>
</tbody>
</table>

*P <0.05 vs comparator group.

Shift Work and Depression

No Insomnia or Excessive Sleepiness

Insomnia and/or Excessive Sleepiness

% of Subjects

Day  Rotating  Night

11.8  31.8  14.5
25.0  32.7  

*P <0.05 vs no insomnia or excessive sleepiness.
Missed Family and Social Activities

Day Shift | Rotating Shift | Night Shift
--- | --- | ---
No Insomnia or ES: 0.6 | No Insomnia or ES: 1.0 | No Insomnia or ES: 1.5
Insomnia and/or ES: 3.6 | Insomnia and/or ES: 10.1 | Insomnia and/or ES: 8.6

*P <0.05 vs no insomnia or ES.
From Science to Health Policy....
Resident Duty Hours: Enhancing Sleep, Supervision, and Safety

- Study commissioned by Congress, released by IOM in December 2008
- Concluded that it is unsafe for residents to work over 16 hours in a row without sleep
- Two solutions proposed:
  - Mandatory 5h nap during a 30h shift
  - 16h shift limit
- Also called for improved handoff processes, increased supervision, and ongoing research to test best practices for implementation
2011 ACGME Duty Hour Standards

- 16h consecutive work limit for Interns
- PGY2s and higher continue to work 28h shifts
- Improve handoffs and teamwork
- New standards for supervision, workload
Nurses and Work Hours Policy

• IOM has recommended limiting nurse shifts to no more than 12 consecutive hours
• No national regulations in the U.S. have addressed nurse work hours
• VA Hospitals limit nurses to 12h maximum shifts
European Working Time Directive

- 13 hours in a row maximum
- 48-56 hours per week
Work Hour Limits: Safety-sensitive US 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
- **Medical interns**: maximum 16 hours
Solutions
Rotating shift work schedules that disrupt sleep are improved by applying circadian principles.

- Intervention changed workers’ rotation from “phase advance” to “phase delay”, and increased time on rotation to 21 days.
- Significant improvements in worker satisfaction and productivity (22%, p<0.001) after change.

Philadelphia Police Department

- Circadian-based scheduling intervention (change from phase advance to phase delay)
- At Baseline:
  - Over 50% of officers reported moderate to severe problem with sleep quality
  - Over 70% admitted falling asleep on the job during the night shift
- Post-intervention:
  - Four-fold reduction in poor quality sleep
  - 29% decline in sleep episodes at work
  - 40% decline in patrol car crashes
  - 38% increase in family satisfaction
Systemic Interventions

• Eliminate shifts >12 hours
• Limit the number of consecutive night shifts
  – The fewer, the better
  – >4 12-hour night shifts associated with greatly increased risk of performance lapses
• Provide sufficient time off between shifts
  – Minimum 10 hours
• Provide adequate time off for recovery after string of nights
• Match staffing needs to workload
• Schedule rotating workers to rotate “clockwise”
• Screen workers for sleep disorders
• Educate workers about the risks of sleep deprivation on the job and drowsy driving
8 vs. 12 hour nursing shifts
Stimpfel AW et al. Health Affairs 2012; 31:2501-09

• Survey of 22,275 nurses
  - Multi-State Nursing Care and Patient Safety Study
• 65% worked shifts of 12-13 hours
• As compared with 8h shifts, 12h shifts associated with
  - Significant increase in risk of burnout
  - Increased risk of job turnover
  - Decreased patient satisfaction with overall care, communication, pain control
What can staff nurses do?

• Sleep when you can!
  • Optimize sleep hygiene

• **Nap** before night shifts

• Sleep as soon as you can after night shifts

• Caffeine can help if used wisely
  • Small, frequent doses are best
  • Minimize use when not working
Reducing the Effects of Sleepiness When Commuting

• Shift workers, including physicians and nurses, have a greatly increased risk of suffering a motor vehicle crash on the drive home from work (Barger LK, et al. N Engl J Med. 2005;352:125-134; Gold DR et al., Am J Pub Health 1992;82:1011-4)

• Measures for the hospital
  – Facilitate establishment of taxi services / car pools
  – Provide a place for workers to nap before driving home

• Measures for the health care provider
  – Minimize commuting: move closer to the work place or use public transportation
  – Avoid traveling at high speeds on highways
  – If you feel sleepy when driving, pull over and nap
    • rolling down the window and turning up the radio will not work
ROSTERS—Randomized Order Safety Trial Evaluating Resident Schedules

CCC MPI: Charles A. Czeisler, Ph.D., M.D.*
CCC MPI: Christopher P. Landrigan, M.D., M.P.H.
DCC PI: Katie Stone, Ph.D.

CCC: Brigham & Women’s Hospital, Harvard Medical School
DCC: California Pacific Medical Center Res. Inst.
PICU Sites: Children’s Hospital Boston, Harvard Medical School; Children’s Hospital Cincinnati; Children’s Hospital Colorado, University of Colorado Boulder, University of Colorado Denver; Lurie Children’s Hospital Chicago, Northwestern University; University of Iowa; University of Virginia

* Dr. Czeisler is/was a consultant to Bombardier, Boston Red Sox, Boston Celtics, Celadon Group, Cephalon/Teva, Gerson Lehman Group, Michael Jackson’s mother and children, Koninklijke Philips Electronics, Minnesota Timberwolves, National Football League Charities, Novartis, Somnus, Vanda Pharmaceuticals Inc. and Zeo.; receives royalties from NEJM, McGraw Hill, Penguin Books and Philips Respironics; has an equity interest in Vanda Pharmaceuticals Inc. and Somnus; is an expert witness in legal cases; and is the incumbent of a professorship at Harvard that was endowed by Cephalon, Inc.
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