Improving Sleep Hygiene of Medical Interns

Can the Sleep, Alertness, and Fatigue Education in Residency Program Help?

Vineet M. Arora, MD, MA; Emily Georgitis, BS; James N. Woodruff, MD; Holly J. Humphrey, MD; David Meltzer, MD, PhD

Background: Because of concerns regarding sleep deprivation, the Accreditation Council for Graduate Medical Education limits duty hours and endorses education regarding sleep loss for residents. We assessed the effectiveness of a 60- to 90-minute lecture, the Sleep, Alertness, and Fatigue Education in Residency (SAFER) program, on sleep loss and recovery sleep in residents adhering to Accreditation Council for Graduate Medical Education duty hours.

Methods: From July 1, 2003, through June 24, 2005, interns from the inpatient medicine service at the University of Chicago were asked to wear wristwatch activity monitors. In March 2005, interns received the SAFER program intervention. We used fixed-effects linear regression to estimate within-subject mean sleep per call day (on-call, pre-call, postcall, and second-day postcall sleep). These estimates were compared with recommended minimum levels of preventive (7 hours of pre-call) and recovery (16 hours during the 2 days after call) sleep in healthy populations using 2-tailed t tests. These analyses were repeated to test the effect of the SAFER program.

Results: Fifty-eight of 81 interns (72%) participated for 147 intern-months (63%). Interns on call slept an average of 2.84 hours (95% confidence interval, 2.75-2.93 hours). Interns obtained less than recommended amounts of recovery sleep (14.06 hours [95% confidence interval, 13.84-14.28 hours]; P < .001). Intern preventive sleep was also less than recommended (6.47 hours [95% confidence interval, 6.39-6.56 hours]; P < .001). Interns attempted to compensate for their acute sleep loss; for each hour of on-call sleep loss, they received 18 minutes (95% confidence interval, 7-30 minutes) more recovery sleep (P = .003). The SAFER program had no significant beneficial effect on intern sleep.

Conclusions: Under the current duty-hour regulations of the Accreditation Council for Graduate Medical Education, residents continue to be sleep deprived. The SAFER program has no impact on resident precall or postcall sleep.

Arch Intern Med. 2007;167(16):1738-1744

©2007 American Medical Association. All rights reserved.
similarly requires that all residents receive education on the effects of sleep deprivation on health and medical care.

To respond to this need, the American Academy of Sleep Medicine developed the Sleep, Alertness, and Fatigue Education in Residency (SAFER) program, which is available for purchase and is currently used by several teaching hospitals. The SAFER program is a 60- to 90-minute lecture covering the neurobiological characteristics of sleep-wake activity, the effects of sleep loss on the personal and professional lives of residents, and effective countermeasures to reduce fatigue and improve performance. Although the effectiveness of this program has not been established, it is reasonable to be concerned that a 1-time, 1-hour lecture may not have lasting effects on behavior. There is good reason to question the effectiveness of an educational program designed to improve sleep hygiene. In the single study to date that assesses the effect of an educational program on sleep hygiene, the educational program effected no change on the sleep habits of law-enforcement officers. Furthermore, educational programs may not be effective in the presence of long-standing myths regarding the ability of individuals to overcompensate for sleep deprivation. Residents, in particular, have been reported to believe that they can perform well under sleep-deprived conditions. This is also consistent with the observation that sleep-deprived individuals often do not recognize themselves as being tired or even asleep.

This study aims to assess whether medical interns obtain adequate levels of preventive and recovery sleep in the setting of acute sleep deprivation. In addition, this study will also assess whether implementation of the sleep education (SAFER) program among residents in internal medicine at the University of Chicago improved the sleep practices of the interns. We hypothesized that (1) medical interns do not obtain adequate levels of preventive or recovery sleep and (2) the SAFER program, designed by the Academy of Sleep Medicine to improve sleep hygiene in residents, does not affect the sleep hygiene (defined as preventive and recovery sleep) of medical interns.

**METHODS**

**STUDY DESIGN**

From July 1, 2003, through June 24, 2005, we conducted a prospective cohort study of the internal medicine first-year residents (interns) from rotations at the inpatient general medicine service at the University of Chicago Hospital. The institutional review board approved this study. Interns served on the 1-month general medicine inpatient rotation 3 or 4 times per year. During these rotations, interns were assigned to teams consisting of 1 attending physician, 1 resident, and 2 interns, who each took call every fourth night. On-call interns cared for patients assigned to their team and provided night coverage for patients treated by the interns who had left the hospital. Interns were encouraged to forward the care of their patients to a night-float resident from midnight to 7 AM so that they could finish their remaining work and obtain uninterrupted sleep for a few hours. All interns were required to comply with the ACGME duty-hour restrictions.

**DATA COLLECTION**

Sleep data were obtained using wristwatch activity monitors (Actiwatch; Mini Mitter, Bend, Oregon). Actigraphy is a valid and convenient alternative to polysomnography for detecting sleep, including in shift workers and especially when polysomnography is not tolerated. Subjects were instructed to wear these wristwatch monitors 24 h/d for the duration of their general medicine month. Actigraphy data were downloaded weekly at an intern conference into an actigraphy-based sleep-scoring software program (Actiware Software; Mini Mitter), which enables calculations of total sleep time. Intern call schedules were used to match sleep to the specific day in the call cycle (ie, precall, postcall, second-day postcall, or on-call day). Sleep obtained the night before call (precall sleep) was defined as preventive sleep. Recovery sleep was calculated from the addition of the sleep obtained in the 2 nights after call (postcall and second-day postcall sleep). From hospital paging logs, the time (in minutes) that interns forwarded their pager alerts to night-float physicians was abstracted to yield protected sleep time, which constituted an opportunity to obtain uninterrupted sleep. The total shift duration on call was also calculated. Because of the major adjustments interns must make as they begin a medical internship in July, only the data obtained from August to the following June were included in both years of this study.

**INTERVENTION**

On March 3, 2005, the SAFER program was presented by a faculty member (V.M.A.) during a routine lunchtime conference for the residents. Attendance was documented for residents and interns (in study year 2). Per the SAFER program protocol, an Epworth Sleepiness Scale and an anonymous 14-item pretest were administered before the lecture. During the lecture, the meaning of the Epworth Sleepiness Scale and content corresponding to the test questions were discussed. At the end of the program, the answers to the test were reviewed and the answer key was given to the participants to ensure that the salient points were understood.

**DATA ANALYSIS**

To assess whether medical interns obtain adequate levels of preventive and recovery sleep in the face of acute sleep deprivation, we used fixed-effects linear regression models, controlling for intern, to estimate the mean sleep time in minutes for each day in an intern’s call cycle. We compared these estimated means to the recommended means for the corresponding day of the call cycle using 2-tailed t tests. Recommended means were defined as a minimum of 7 hours (420-540 minutes) of precall sleep (preventive sleep) and 16 hours (960 minutes) for recovery sleep (8 hours of postcall and 8 hours of second-day postcall sleep) suggested by the American Academy of Sleep Medicine. Because of the potential effects of season and experience on intern sleep while on call and out of the hospital, estimates of how sleep varied by month were also calculated using regression models with indicator variables for each month.

To assess whether the SAFER program had an effect on the sleep hygiene of interns, we performed precall-postcall within-subject analyses on our outcomes of interest. Because the SAFER program encourages preservation of sleep before and after a period of acute sleep deprivation, the specific outcomes examined included precall and postcall sleep times. The SAFER program also encourages taking maintenance naps, or naps on the job during long shifts, such as the protected sleep time pro-
vided to on-call interns by night-float coverage. As a result, we also examined whether the use of maintenance naps, as defined by the use of night-float coverage by on-call interns, increased after the SAFER program was administered. We conducted fixed-effects multivariate linear regression, controlling for intern, month, night-float coverage, and the number of calls taken in that month, to assess the effect of the SAFER presentation on sleep time under each call condition. All statistical tests were performed using Intercooled Stata software (version 7.0; StataCorp, College Station, Texas), with statistical significance defined as \( P < .05 \).

**RESULTS**

From July 1, 2003, through June 30, 2005, 81 interns (40 in the first year and 41 in the second) rotated in the in-
patient general medicine service. Fifty-eight interns (72%) (35 in the first academic year and 23 in the second) participated in the study, wearing a wristwatch sleep monitor for at least 1 month for a total of 147 intern-months (62.8% of 234 possible intern-months). The wristwatch data were obtained on 2638 of 4340 nights sampled (60.8%). Intern compliance with wearing the wristwatch varied by call day, with interns most likely to wear the watch when they were on call (795/1085 call days [73.3%]) and least likely to wear the watch on their postcall day (599/1085 call days [55.2%]). Average shift duration on call was 29.7 hours (95% confidence interval, 29.57-29.85 hours).

Data confirmed that on-call interns experienced acute sleep deprivation (mean of 2.84 hours obtained while on call). However, interns obtained less-than-adequate amounts of preventive and recovery sleep. Intern preventive sleep, defined as precall sleep, was a mean of 6.47 hours. Although only half an hour short of the recommended minimum of 7 hours for a normal, healthy population, this level is likely clinically significant in a chronically sleep-deprived population. Recovery sleep was estimated at a mean of 14.08 hours (95% confidence interval, 13.84-14.28 hours). The model included sleep data from 795 of 1085 call days (73.3%) obtained from 58 of 81 interns (71.6%). On-call sleep averages for October, November, December, January, February, March, April, May, and June were significantly higher than those for August (P < .05). Limit lines indicate 95% confidence interval.

Intern sleep varied significantly by month. On-call sleep ranged from a mean of 2.16 hours in August to 3.56 hours in June (P < .001) (Figure 2). Although interns failed to meet the recommended amount of sleep on average, interns’ recovery sleep varied with the degree of on-call sleep loss. For every hour of acute on-call sleep loss, interns slept an additional 13 minutes on their postcall night (P = .005) (Table 2). Recovery sleep also increased a mean of 18 minutes (P = .003) for every hour of acute sleep loss on call (Table 2). For every hour of acute sleep loss on call, intern preventive sleep increased by 5 minutes (P = .03).

Using a multivariate, fixed-effect, linear regression controlling for intern, month of the year, and the number of calls taken that month, the data showed that the SAFER program did not significantly increase the amount of sleep interns received during any of the call conditions (Table 3). The estimated mean precall sleep with the SAFER program was 6.63 hours compared with 6.47 hours without the program. A nonsignificant trend was observed for increased on-call sleep with the SAFER program (3.27 vs 2.85 hours; P = .10), with a corresponding reduction of nearly 90 minutes in recovery sleep (12.56 vs 14.08 hours; P = .08).

Paging data showed that interns rarely used nightfloat coverage to obtain maintenance naps (21.5% in the first year vs 0% in the second year). More often, interns chose to sign over only their cross-coverage patients, continuing to be interrupted for the care of their own patients throughout the night. After the SAFER presenta-

### Table 1. Intern Sleep by Call Day: Comparison With Recommended Levels^a^

<table>
<thead>
<tr>
<th>Sleep Type</th>
<th>No. of Interns</th>
<th>Nights Observed, No. (%)</th>
<th>Mean No. of Observations per Intern</th>
<th>Average Sleep Time (95% CI), h</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-call</td>
<td>58</td>
<td>795 (73)</td>
<td>13.7</td>
<td>2.84 (2.75-2.93)</td>
</tr>
<tr>
<td>Pre-call preventive</td>
<td>58</td>
<td>623 (57)</td>
<td>10.7</td>
<td>6.47 (6.39-6.56)</td>
</tr>
<tr>
<td>Post-call</td>
<td>57</td>
<td>599 (55)</td>
<td>10.5</td>
<td>7.16 (7.00-7.33)</td>
</tr>
<tr>
<td>Second-day post-call</td>
<td>58</td>
<td>621 (57)</td>
<td>10.7</td>
<td>6.97 (6.84-7.10)</td>
</tr>
<tr>
<td>Recovery^d^</td>
<td>56</td>
<td>507 (47)</td>
<td>9.1</td>
<td>14.06 (13.84-14.28)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

^a^The following recommended sleep levels are derived from the American Academy of Sleep Medicine for a normal, healthy population: 7 to 9 precall hours; 8 postcall hours; 8 second-day postcall hours; and an average of 16 hours of total recovery. Longer periods of sleep are likely needed for a chronically sleep-deprived population.

^b^Indicates the number (percentage) of nights when sleep data were obtained from the wristwatches (variations due to intern noncompliance or technical failure).

^c^P < .001, when comparing hours slept with recommended levels.

^d^Defined as the sum of postcall sleep and second-day postcall sleep.
Our results provide objective quantitative measures of intern sleep and fatigue through a prospective cohort study on a general medicine service at an academic hospital after the implementation of duty-hour restrictions. Using actigraphic measurement of sleep, we are able to provide a quantitative assessment of interns’ sleep hygiene, including specific estimates of preventive and recovery sleep. Our findings confirm that, in the setting of restricted duty hours, medical interns still experience acute sleep deprivation and do not receive recommended amounts of preventive or recovery sleep. In addition to mandating duty-hour limits, the ACGME requires that residency programs offer their residents an educational presentation on sleep deprivation.1 Our analysis found no strong statistically significant evidence of an effect of the SAFER program on sleep. Although the limited size of our study prevents us from ruling out the presence of a small positive or negative effect of the SAFER program on sleep, we can reject the presence of a large beneficial effect. The nonsignificant trends observed suggest that, although the SAFER program may encourage interns to preserve their sleep while on call, recovery sleep could be compromised.

These findings raise important questions about how to alleviate resident sleep deprivation effectively, which is important to ensure the health of medical trainees and safe patient care. The negative health consequences of sleep deprivation on residents, such as motor vehicle accidents and obstetric complications, is well documented.3,4 More recent studies focus on the detrimental effects of extended duty shifts on residents’ health and patient care.8,27-33 Together, these studies suggest that further restrictions may be warranted to alleviate sleep deprivation in house staff.

The findings from this study suggest that duty-hour restrictions alone may not be effective in achieving this goal. Although an inverse relationship between total hours worked and sleep has been documented, there may be a variety of reasons that residents are not able to use off-duty time to obtain the necessary levels of preventive and recovery sleep.29 First, residents may have a high level of personal obligations, including relationship and family pressures. Sleep is unlikely to be the highest priority, even in the setting of acute and chronic sleep deprivation in residency. For example, many interns may choose to tend to other personal activities in lieu of obtaining additional sleep. Residents may also use extra time for education outside of their on-duty time spent in the hospital. In the currently mandated 80-hour work week, the remaining 88 hours per week (roughly 12.5 hours per day) may not be enough to obtain adequate sleep and maintain a healthy lifestyle. For instance, a resident who obtains the recommended levels of sleep (average of 7-9 h/d) would have only 3 to 5 h/d for eating, personal hygiene, other personal errands (eg, paying bills and shopping), commuting to and from work, and any other social or family obligations. Also, residents may have

### Table 2. Preventive and Recovery Sleep: Response to 1 Hour of On-Call Sleep Loss

<table>
<thead>
<tr>
<th>Sleep Type</th>
<th>No. of Interns</th>
<th>No. of Observations</th>
<th>Change in Sleep Time (95% CI), min</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precall preventive</td>
<td>58</td>
<td>569</td>
<td>5 (1 to 10)</td>
<td>.03</td>
</tr>
<tr>
<td>Postcall</td>
<td>56</td>
<td>567</td>
<td>13 (4 to 21)</td>
<td>.005</td>
</tr>
<tr>
<td>Second-day postcall</td>
<td>58</td>
<td>556</td>
<td>2 (−5 to 9)</td>
<td>.62</td>
</tr>
<tr>
<td>Recovery</td>
<td>55</td>
<td>479</td>
<td>16 (7 to 30)</td>
<td>.003</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

*Number of observations used in regression models (on-call sleep and day of interest were obtained).

*Based on a multivariate, fixed-effects linear regression controlling for intern, night-float coverage, number of call days that month, and month of the year.

*Defined as the sum of postcall sleep and second-day postcall sleep.

### Table 3. Effect of the SAFER Program on Intern Sleep by Call Day

<table>
<thead>
<tr>
<th>Call Day</th>
<th>No. of Interns</th>
<th>No. of Observations</th>
<th>Estimated Average Sleep Time, h</th>
<th>SAFER-Control Sleep Time Difference (95% CI), min</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precall</td>
<td>58</td>
<td>623</td>
<td>6.63</td>
<td>6.47</td>
<td>9 (−29 to 48)</td>
</tr>
<tr>
<td>On-call</td>
<td>58</td>
<td>795</td>
<td>3.27</td>
<td>2.85</td>
<td>25 (−5 to 56)</td>
</tr>
<tr>
<td>Postcall</td>
<td>57</td>
<td>599</td>
<td>6.51</td>
<td>7.13</td>
<td>−37 (−108 to 35)</td>
</tr>
<tr>
<td>Second-day postcall</td>
<td>58</td>
<td>621</td>
<td>6.72</td>
<td>7.05</td>
<td>−20 (−70 to 31)</td>
</tr>
<tr>
<td>Recovery</td>
<td>56</td>
<td>507</td>
<td>12.56</td>
<td>14.08</td>
<td>−91 (−195 to 13)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; SAFER, Sleep, Alertness, and Fatigue Education in Residency.

*Derived from multivariate, fixed-effect linear regression models using the number of observations and controlling for intern, night-float coverage, number of call days that month, and month of the year.

*Defined as the sum of postcall sleep and second-day postcall sleep.
difficulty sleeping even if they wish to. For example, the intensity and constant sleep disruption of residency may contribute to an insomnia-type picture secondary to hyperarousal.34

Given these realities, improving resident sleep deprivation in the current system will likely require more intensive workplace interventions coupled with a shift in culture to emphasize the importance of proper sleep hygiene for house staff. Such workplace interventions might include the adoption of alternate scheduling practices or countermeasures that have been effective in alleviating sleep deprivation and fatigue in long-shift workers in other occupations. Such changes may include the use of shiftwork systems (as in nursing), or the use of a maintenance or an on-call nap (as in aviation).35 These interventions may also be targeted during the months at highest risk of sleep loss (eg, winter). Achieving a change in culture may be accomplished using methods to promote long-term behavioral change, such as audit, feedback, reminder, and reinforcement systems coupled with strong endorsements from faculty and program leaders.

This study has several limitations. Perhaps the most important is that it was conducted in a single residency program in 1 institution, which limits the ability to generalize the results. However, given the paucity of studies exploring resident off-duty sleep habits and the interest in protecting residents from the effects of sleep deprivation, these findings suggest that better evidence about the effectiveness of interventions such as the SAFER program is badly needed. As we await additional data, these findings may be useful to help inform program changes and policies designed to target resident sleep deprivation. Another limitation is the presence of missing data, predominantly due to noncompliance and, to a lesser degree, technical difficulties. Interns were also less likely to wear the watch when out of the hospital owing to self-conscious feelings. In addition, on their call day, they may anticipate sleep loss, which serves as a reminder to wear the watch. They may also be conscious that peers or administrators will be observing their compliance. Although the data are not missing completely at random (ie, more noncall days missing), there was no relationship between sleep and the rate of compliance (or the degree of missing observations) observed in our data. In the event of a technical failure, we sent the watch to the manufacturer to retrieve source data and gave the intern a functioning watch. Interns did not participate for every month they were on the general medicine rotation, which may have introduced an important source of selection bias. Interns may have chosen not to participate during the months they were most fatigued, and interns were less likely to participate in the second year of the study. Another limitation of this study was the difficulty in coordinating data collection with interns on a regular basis. Because of their heavy workloads and restricted duty schedules, we chose to integrate data collection into their routine work schedule by downloading data at a weekly intern conference whenever possible (Figure 1). Finally, although a 1-time educational lecture alone did not have a substantial effect on intern sleep, it is possible that subtle long-term effects on perceptions about appropriate sleep habits were present. Although we did not explore these effects, the provision of education remains important to increase awareness and educate residents about the detrimental effects of sleep deprivation.

CONCLUSIONS

The ACGME duty-hour restrictions aimed to reduce sleep deprivation in medical trainees. However, the current ACGME duty-hour limits, particularly in the absence of effective interventions to improve the sleep hygiene of medical trainees, may be inadequate to achieve this goal. Educational programs, although recommended, may not be effective in changing the sleep hygiene of medical trainees. To prevent the negative consequences of sleep deprivation in residents, adoption of proven countermeasures to fatigue and promotion of a culture that facilitates healthy sleep habits are warranted.

Accepted for Publication: April 15, 2007.
Correspondence: Vineet M. Arora, MD, MA, Department of Medicine, University of Chicago, 5841 S Maryland Ave, Mail Code 2007, Ste AMB W216, Chicago, IL 60637 (varora@medicine.bsd.uchicago.edu).
Author Contributions: Study concept and design: Arora, Humphrey, and Meltzer. Acquisition of data: Arora, Woodruff, Humphrey, and Meltzer. Analysis and interpretation of data: Arora, Georgitis, and Meltzer. Drafting of the manuscript: Arora, Georgitis, Woodruff, and Meltzer. Critical revision of the manuscript for important intellectual content: Arora, Humphrey, and Meltzer. Statistical analysis: Arora and Meltzer. Obtained funding: Arora, Humphrey, and Meltzer. Administrative, technical, and material support: Arora, Georgitis, Woodruff, Humphrey, and Meltzer. Study supervision: Arora and Meltzer.
Financial Disclosure: None reported.
Funding/Support: This study was supported by the Pritzker School of Medicine and the Department of Medicine at the University of Chicago.
Additional Contributions: Jennifer Higa, BA, and Kimberly Alvarez, BA, assisted in preparing this manuscript. Carrie Dunphy, MD, Vivian Chang, MD, and Fawaz Ahmad, MS, provided research assistance; and Eve Van Cauter, PhD, Kristen Knutson, PhD, and Armand Ryden, MD, provided watch technical support and resources. We thank the residents in the University of Chicago Internal Medicine Residency Program who participated in this study.

REFERENCES
