Address correspondence to Dr Alon Y. Avidan, UCLA Department of Neurology, 710 Westwood Blvd, Room 1-169 RNRC, Los Angeles, CA 90095-6975, *avidan@mednet.ucla.edu*.

Relationship Disclosure: Dr Avidan is a member of the speakers bureaus of GlaxoSmithKline, Purdue Pharma, Teva Pharmaceuticals, and UCB, and serves as a consultant for Merck & Co. Inc.

Unlabeled Use of Products/Investigational Use Disclosure: Dr Avidan reports no disclosure.

Sleep and Fatigue Countermeasures for the Neurology Resident and Physician

Alon Y. Avidan, MD, MPH, FAASM

ABSTRACT

Purpose of Review: Fragmented sleep, prolonged work hours, misalignment of sleep-wake cycles, and an expectation to make medical decisions when alertness levels are reduced are pervasive in neurology residency training. Sleep loss in residency training can lead to cognitive and psychosocial impairment and accidents, compromise patient care, and reduce the trainee's quality of life. Neurology residents experience levels of hypersomnolence similar to residents in surgical specialties and have comparable subjective levels of sleepiness as persons with pathologic sleep disorders such as narcolepsy and obstructive sleep apnea. Over the past 2 decades, work-hour limitations were established to alleviate fatigue and sleepiness. However, the implementation of work-hour limitations alone does not guarantee alleviation of fatigue and may be insufficient without additional key measures to prevent, counteract, and control sleepiness when it strikes. This article provides effective strategies to combat sleepiness, such as modification of the on-call structure (night float), power naps, and caffeine, in neurologists in training and those who are at risk for excessive sleepiness.

Recent Findings: Despite two specific work-hour restrictions set by the Accreditation Council for Graduate Medical Education, the most recent in July 2011, little data exist about the efficacy of work-hour restrictions alone in improving fatigue and sleepiness. Curtailed work hours, while appearing attractive on the surface, have important financial, educational, and patient care imperfections and fail to address the core issue—sleepiness.

Summary: Historically, sleepiness and fatigue place both residents and patients at risk. Excessive sleepiness in residency training occurs because of sleep deprivation and a spectrum of other factors, such as mood disorders or even the anxiety of anticipating being woken up. An effective model to counteract sleep deprivation and its consequences is a multiplayer approach that uniquely targets and addresses the needs of all the stakeholders. A sleep medicine perspective is proposed along with other interventions to prevent adverse consequences.

Continuum (Minneap Minn) 2013;19(1):204–222.

INTRODUCTION AND HISTORICAL ANECDOTES

During his tenure as the first surgeon-in-chief at the Johns Hopkins Medical School in the 1800s, William Stewart Halsted (**Figure 11-1**) introduced a prolonged, variable training period and restrictive lifestyle in which residents literally lived in the hospital and worked around the clock with minimal opportunities for sleep and rest.[1] Two centuries later, serious questions

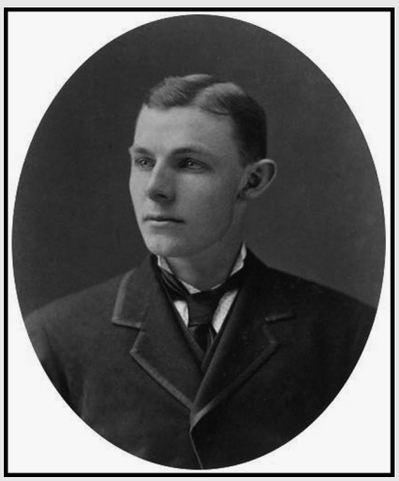

FIGURE 11-1 William Stewart Halsted, first surgeon-in-chief at Johns Hopkins Medical School in the 1800s, who introduced the concept of intense apprenticeship around the clock without work-hour regulations. Until the 1980s, this was the structure of most residency training programs in the United States.

Photograph courtesy of the Yale University Manuscripts & Archives Digital Images Database, Yale University, New Haven, CT. *en.wikipedia.org/wiki/File:William_Stewart_Halsted_Yale_College_class_of_1874.jpg*.

have arisen about this traditional practice. Specifically, emerging data have begun to raise questions about the impact of sleep loss and fatigue on patient safety and trainees' lives and learning opportunities.

We now recognize that the relentless hospital shifts, decreased opportunities for sleep, and minimal recuperation time traditionally experienced by trainees as well as physicians in practice can impact health and well-being, increase the likelihood of medical errors, reduce the quality of the educational experience, and lead to poor quality of life.[2,3] These findings have been the impetus for policy development regarding this issue. New York was the first state to ratify resident work-hour legislation, an action that evolved from the 1989 recommendations of the Bell Commission, a task force established by the New York State Commissioner of Health to investigate the death of a young woman named Libby Zion at a New York City teaching hospital in 1988.[4] At the time that these political developments were occurring in New York, public interest in the issue of sleep loss and fatigue in medical training was galvanized by the National Academy of Sciences' Institute of Medicine report "To Err is Human," released in the spring of 2000, which stressed the need to investigate and address human factors, such as sleep deprivation, that are potentially involved in violations of patient safety.[5] Political pressure and public concern alone, however, could not form the basis for a rational and informed discussion of the issue of sleep and fatigue in medical training without the addition of a third element, namely, an expanded understanding of the science of sleep loss and fatigue. The existence of ample supporting data from research regarding the effects of sleep loss and fatigue in humans from field studies in other occupations and from studies directly addressing residency training, was critical to the formulation of an empirically based approach to this issue.

Reports of widespread violations of the New York regulations and concern about the ability of medical education and professional organizations to enforce compliance with Resident Review Committee work-hour standards helped propel the filing of a petition with the Occupational Health and Safety Administration by several trainee groups in the spring of 2001. Similar requirements were incorporated into legislative bills, introduced by Rep John Conyers in the House of Representatives (HR 3236) and Sen Jon Corzine in the Senate (S 2614). In response to mounting pressure, in September 2001, the Accreditation Council for Graduate Medical Education (ACGME) charged its Work Group on Resident Duty Hours and the Learning

KEY POINTS

- Historically, residents have faced sleep loss and fatigue related to long working hours at the hospital. Recent regulations restrict on-duty scheduling in an effort to reduce sleepiness and improve safety.
- While data regarding ACGME work-hour stipulations among neurology trainees seem to trend toward improved quality of life in trainees, this comes at the cost of degradation of education opportunities and patient care.

Environment with developing a set of recommendations regarding common requirements for resident duty hours across accredited programs in all medical specialties. These recommendations, which went into effect on July 1, 2003, included an 80-hour workweek, continuous duty hours limited to 24, and 1 day in 7 free of patient duties, and they were inspected, discussed, and interpreted in the community of neurologists.[6–11] Recent data suggest a trend toward improved quality of life, but a sense of discontent about the repercussions on patient care and education has arisen.[12,13]

In 2008, coinciding with the 5-year anniversary of the previous ACGME work-hours standards, the Institute of Medicine published a manuscript, "Resident Duty Hours: Enhancing Sleep, Supervision, and Safety," providing for additional changes, including new workload limits, greater supervision requirements and on-call duty restrictions."[14]

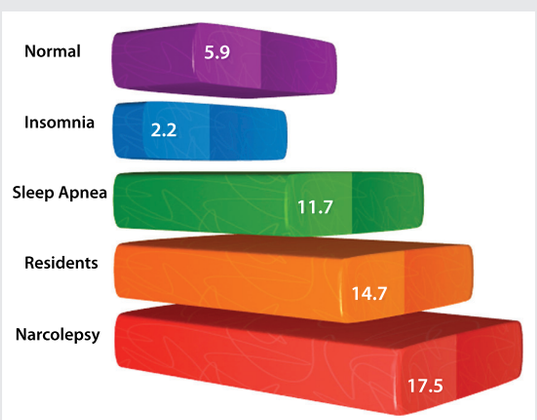

FIGURE 11-2 Data representing mean values for the Epworth Sleepiness Scale (ESS) for normal people and patients with a variety of sleep disorders (eg, insomnia, sleep apnea, and narcolepsy) compared with data reporting ESS values obtained in a multicenter survey of medical residents. An ESS score above 10 suggests clinically significant excessive sleepiness.

Data from Papp KK, Stoller EP, Sage P, et al. Acad Med.[26] journals.lww.com/academicmedicine/pages/articleviewer.aspx?year=2004&issue=05000&article=00007&type=abstract.

The ACGME solicited comments regarding the policy[15] and eventually adopted these new changes in July 2011. Since then, stakeholders, including program directors and residents, have had discussions about where exactly to set the bar when balancing training requirements and educational opportunities with the assurance of patient safety and sleepiness and fatigue countermeasures.[16–22]

EXTENT OF EXCESSIVE SLEEPINESS IN RESIDENTS

The Epworth Sleepiness Scale (ESS) (**Appendix A**), an eight-item questionnaire, asks respondents to rate their likelihood of "dozing" from 0 to 3 under several specific conditions, with 3 indicating the highest likelihood of sleepiness. The highest possible score is 24. The generally accepted value for the upper limit of "normal" is 10 to 11. Values between 11 and 13 are considered to be mild sleepiness; between 14 and 17, moderate sleepiness; and over 17, severe sleepiness.[23,24]

When compared to the general population, residents exhibited sleepiness indices that are equivalent to those found in some clinical populations of patients with sleep apnea and narcolepsy (**Figure 11-2**, **Figure 11-3**).[26,27]

CAUSES OF EXCESSIVE SLEEPINESS IN RESIDENTS

Wakefulness and sleep are states that are regulated by a balance of the homeostatic drive for sleep and circadian influences on alertness and controlled by an interaction of external and internal stimuli (**Figure 11-4**).[28] Appropriate sleep duration and proper circadian wakefulness contribute to optimal mental performance.[29] When residents do not attain sufficient sleep (ie, less than 5 hours of sleep per night), the homeostatic drive to sleep increases precipitously, inducing increased susceptibility

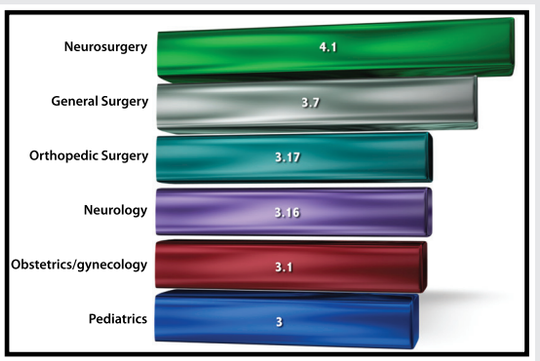

FIGURE 11-3 Specialties most likely to report experiences of sleep deprivation. Sleepiness in neurology residents is comparable to that of surgical specialties such as orthopedic surgery. Specialties associated with the least amount of sleepiness include dermatology, pathology, and radiology.

Data from Baldwin DC Jr, Daugherty SR. Sleep.[27] *www.journalsleep.org/ViewAbstract.aspx?pid=25943*.

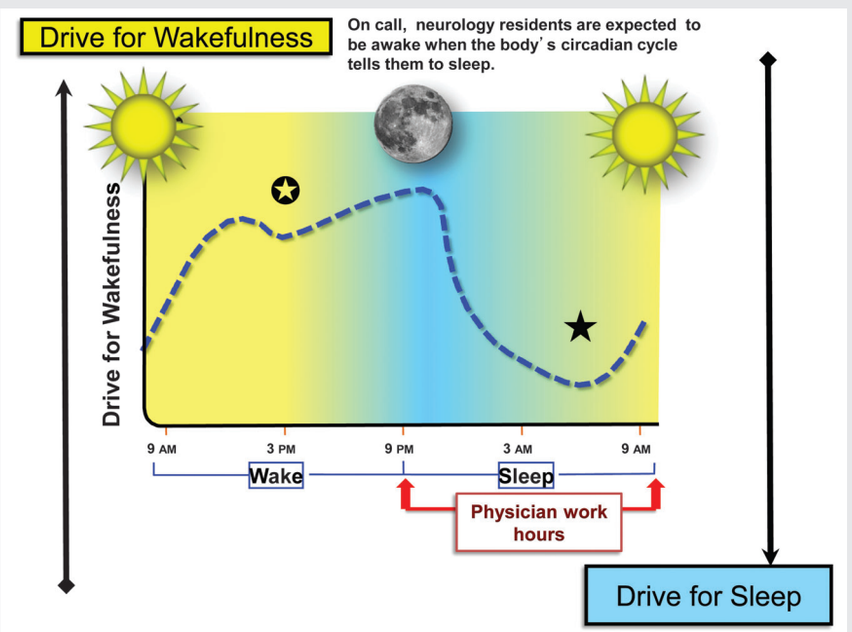

FIGURE 11-4 Two-process model depicting how the sleep-wake cycle is driven by a gradually increasing sleep load that is being concurrently opposed by alerting signals generated by the suprachiasmatic nuclei. During the day, the sleep drive accumulates until it reaches a critical threshold. Wake propensity is the integrated function of the homeostatic sleep load and the opposing circadian alerting signal. The drive for wakefulness increases throughout the day, with a midafternoon dip (✪), until about 9:00 PM or 10:00 PM, when it drops during the normal sleep time (★). For on-call residents, who need to sleep during the day, the drive for wakefulness can result in difficulties falling asleep and maintaining sleep and in fragmented sleep. Residents are at risk for sleepiness during the night as the normal circadian drive for wakefulness decreases at 9:00 PM or 10:00 PM, when they are expected to be awake and at work.

KEY POINT

- Subjective sleepiness in residents is alarming as it is similar to that found in cohorts of sleep patients—particularly those with narcolepsy and sleep apnea—who exhibit pathologic levels of hypersomnolence.

KEY POINT

- Causes of hypersomnolence in residents are most likely circadian factors leading to diminished alertness during the nighttime; insufficient sleep; interrupted and fragmented sleep when on call; and comorbid medical, psychiatric, and primary sleep disorders.

to sleep[30] and diminution in cognitive functioning. The end result is an increased tendency to fall asleep in improper situations, including morning rounds, lectures, and driving home at the conclusion of the call duty. As shown in **Figure 11-4**, the circadian drive for wakefulness increases throughout the daytime, with a midafternoon decline, until the late evening hours (9:00 PM to 10:00 PM), when it dips down during the habitual sleep time. Residents who are on call at night or during the night-float rotation and need to sleep during the day may experience a drive for wakefulness that leads to difficulties initiating and maintaining sleep, as well as fragmented sleep. During the night while the resident is awake and at work, the normal circadian drive for wakefulness is low.

Excessive daytime sleepiness in residency training may be a consequence of a spectrum of underlying factors that occur independently or as comorbidities (**Figure 11-5**) (**Case 11-1**). Primary causes include insufficient sleep and fragmented sleep on call nights (**Figure 11-6**). An insufficient sleep quantity may result when the resident obtains less sleep than is sufficient for optimal rest (8 hours a night). Insufficient sleep represents the most important primary cause for sleepiness in neurology residency training. Yet, even when sleep duration is sufficient, residents may still experience excessive sleepiness if their sleep is of poor quality. Fragmented sleep in residents during on-call nights may be caused by interruptions from repeated phone calls, pager beeping, and even the anticipation of being on call despite sufficient opportunities to sleep.

Comorbid sleep disturbances may be due to primary sleep disorders, such as obstructive sleep apnea, delayed sleep-phase syndrome, narcolepsy, restless legs syndrome, and insomnia.[33] Residents may also be taking CNS-acting medications, which cause sleepiness. Mood disorder is an important contributor to daytime sleepiness and every resident

FIGURE 11-5 Potential causes of excessive sleepiness in resident physicians.

Case 11-1

A 30-year-old neurology resident on the stroke service was noted to be late to morning report on a daily basis for 2 weeks. She had difficulty remembering details about her patients and often failed to note important facts relating to their care. During the didactic sessions, she rarely participated and became confused when quizzed about cases presented. This behavior was out of character for her as she had an excellent neurology foundation as a neuroscience PhD student and received honors during her neurology acting internship as a medical student. On several occasions, she was noted to make judgment errors when administering tissue plasminogen activator to her patients without following protocol. These errors were intercepted by the senior resident on the team but were brought to the attention of the inpatient attending neurologist, who discussed these issues with the neurology residency program director.

The program director met with the resident, who arrived to the appointment tearful. She reported that she was exhausted from being on call and felt overwhelmed. As this was the fourth month of her residency, she was eager to identify solutions to remedy the difficulties. She indicated that she felt dejected because she did not have enough time to spend with her two children and husband. She reported a 13.6-kg (30-lb) weight gain since beginning her residency training and had the sensation of choking and shortness of breath at night. Upon awakening in the morning, she was very sleepy and often had a headache. She craved chocolate and other candy and described consuming up to five cups of coffee per day. She reported problems falling asleep at night and was worried about her performance. She rarely had time to read about her patients and felt that her knowledge base was below what was expected of her. She was afraid to ask for help because she did not want to appear weak in the eyes of her classmates. She lived about 30 miles from the hospital and often spent 1.0 to 1.5 hours each day commuting. Over the past few weeks she had begun using caffeine tablets and energy drinks that helped address her sleepiness, but she would ''crash'' 2 to 3 hours later. She made up for lost sleep on the weekends, taking 3- to 4-hour naps on Saturdays and Sundays when finishing rounds in the hospital, but she could not fall asleep until 1:00 AM or 2:00 AM on these days. She was contemplating quitting residency because these difficulties were causing marital discord, depression, and a poor quality of life. She was no longer enthusiastic about a profession in neurology.

Comment. This hypothetical case summarizes a number of key issues leading to fatigue and burnout in neurology residency training. It draws attention to key domains affected by sleep deprivation: professional, educational, psychosocial, lifestyle, and quality of life.

Causes of sleepiness in this resident could be related to (1) sleep deprivation, (2) possible untreated sleep apnea, (2) delayed sleep-phase circadian rhythm disorder, (3) depression, and (4) poor sleep hygiene. Even when not on call, this resident is at risk for sleepiness, highlighting the argument that work-hour limitations by themselves have not helped curtail sleepiness in this individual. Her sleep deprivation is likely leading to endocrine dysregulation of energy homeostasis, which may lead to weight gain and obesity[31] and could play a role in the emergence of sleep-disordered breathing.[32] The resident should have a formal sleep clinic evaluation, undergo a sleep study since obstructive sleep apnea is suspected, work with a clinical psychologist on improving her sleep hygiene and identifying relaxation techniques at bedtime, limit caffeine consumption, and take strategic power naps. The resident may also be referred to the graduate medical education office to see an educational counselor who could assist in remedying her educational techniques and in finding strategies to help her spend more time with her family. The program director, together with the residency program, is responsible for identifying other measures to assist the resident through this difficult period by tailoring remedial educational sessions, altering her schedule to allow for more elective time as treatment is underway, and encouraging the chief residents to continue to support and monitor her progress.

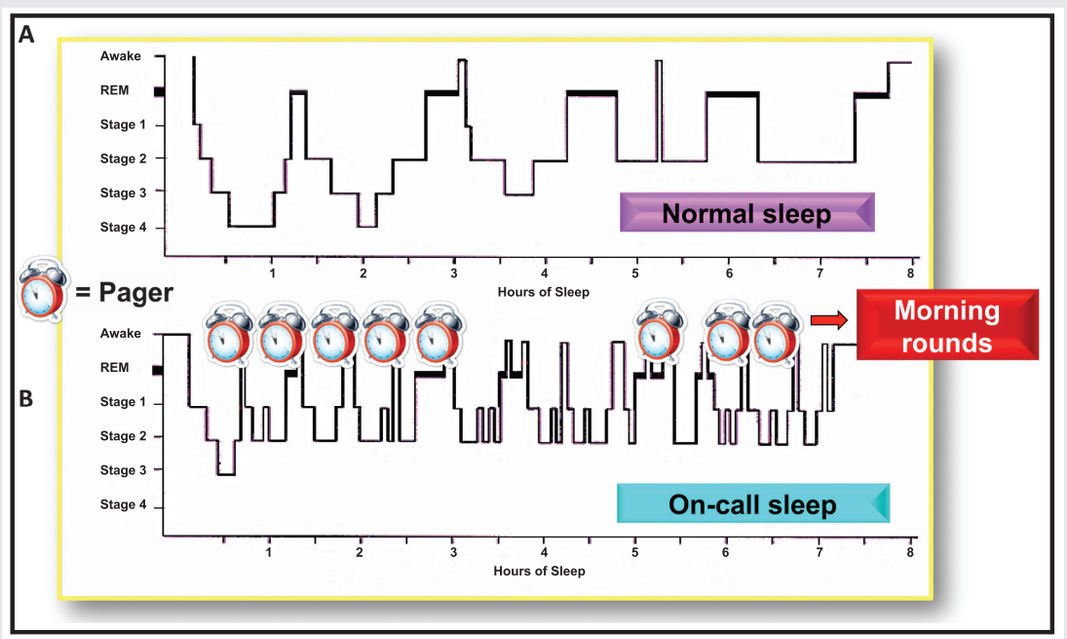

FIGURE 11-6 Sleep fragmentation during on-call night. Two hypnograms, a graphic representations of sleep stages as a function of time of night, are shown. Hypnogram *A* shows the sleep hypnogram of a normal sleeper. The Y axis depicts stages of sleep as the individual falls into deeper sleep proceeding from wake into stage 1 and 2 (light sleep), and stages 3 and 4 (non-REM sleep stage N3 or deep/slow-wave sleep). Hypnogram *B* shows the sleep hypnogram of a typical resident on call. Sleep is very fragmented by frequent interruptions during the night. As a result, the resident does not obtain an adequate period of consolidated sleep, spends very little time in the restorative stages of sleep (slow-wave and REM), and wakes up very sleepy just in time for morning rounds.

reporting sleepiness should be screened for it.

CONSEQUENCES OF SLEEP LOSS

Sleep deprivation in neurology residents may be caused by a number of factors and has important consequences, as described in **Table 11-1**. Specific domains impacted include personal, health, cognitive and neurobehavioral, professional, and patient care. Interestingly however, one recent article found that sleep-deprived neurology residents did not experience significant cognitive impairment related to tasks of short duration.[34] The authors note that stressful work environments (as those on the neurology ward) may promote partial adaptation, and the methods used for the assessment of performance may not be applicable in the population studied because they are designed for patients with neuropsychiatric syndromes.[34]

Numerous reports on sleep loss and fatigue in medical training are available, including performance studies that evaluate specific effects on a variety of performance measures. These outcome variables may be broadly categorized as effects on neurocognitive and psychomotor functioning in the laboratory setting, performance of simulated work-related and occupational tasks in actual work settings, and mood and psychological state. The design of most of these studies involves comparisons between precall (ie, rested) and postcall (ie, sleep deprived) performance in a group of residents. Other interventions include the comparison of schedule types from a study by Landrigan and

TABLE 11-1 Consequences of Sleep Loss in Neurology Residency Training

▶ **Personal**
Less time with family and loved ones leading to depression and stress
▶ **Health**
Substances to counteract sleepiness/sleeplessness leading to substance use, misuse, or abuse
Increased likelihood for weight gain because of chronic sleep deprivation
Pregnancy-related complications (eg, pregnancy-induced hypertension, abruptio placentae and preterm labor, and adverse fetal outcomes)
Increased risk of morbidity and mortality related to drowsy driving accidents
▶ **Cognitive and Neurobehavioral**
Inattention
Reduced reaction time
Decreased vigilance
Impaired memory
Decreased motivation
▶ **Professional Duties**
Impaired ability to perform procedures
Reduced ability to interpret data
Loss of professionalism
Degradation of communication skills when interacting with patients, colleagues, and staff
▶ **Medical Education and Professional Development**
Impaired retention of information
Reduced information processing and medical decision making
Decline in the motivation to learn
▶ **Patient Care**
Decreased quality of patient care
Increased likelihood for diagnostic and therapeutic errors

colleagues[35] as is illustrated in **Figure 11-7**. Baldwin and Daugherty's study data depict the troubling correlation between reduced sleep time and error and adverse event reporting in their cohort of a national random sample of postgraduate year (PGY) 1 and PGY2 residents (**Figure 11-8**).[27] Despite the fact that their study was conducted before the ACGME work-hour regulations of 2003 and 2011 went into effect, it depicts a correlation between sleep loss and less optimal residency training experience. As shown in **Figure 11-9**,[27] satisfaction with overall residency experience is reduced when total sleep time is diminished. This dissatisfaction with the residency experience is probably driven by an increased stress rating during residency, working in an impaired state, and fears of feeling belittled or humiliated. These measures as well as learning improved in a dose-response fashion when sleep time increased. **Table 11-2**[27,36] depicts trends surrounding a number of important variables affecting patient care and safety reported by residents averaging 5 hours or less per night.[27]

When reviewing the current literature describing sleep deprivation in physicians in training the following may be concluded:

1. Physicians in training, particularly those at more junior levels of training and in the surgical specialties, *regularly experience high levels of sleep deprivation* in the hospital setting. These individuals are regularly asked to function and

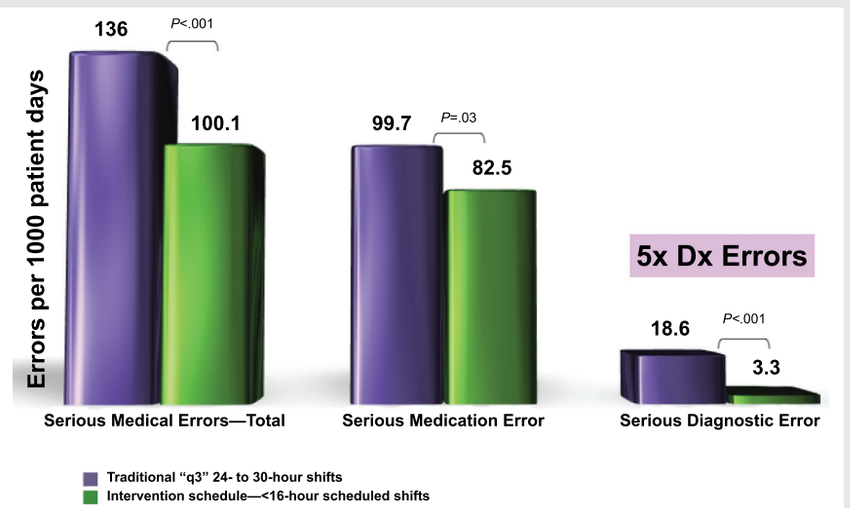

FIGURE 11-7 Intern sleep and patient safety study. Landrigan and colleagues studied a group of 20 interns under two conditions: a traditional schedule with 30-hour shifts scheduled every other shift, and an intervention schedule in which shifts were limited to 16 hours. Medical errors were determined by direct observation of interns and chart review, voluntary reports, and computerized event-detection monitoring. Errors were categorized as including procedural, medication, and diagnostic errors. The study included 2203 patient-days, 634 admissions, and 5888 hours of direct observation. The number of serious errors made by the interns was 35.9% higher during the traditional schedule than during the intervention schedule. The rate of diagnostic (Dx) errors was 5.6 times higher during the traditional schedule than during the intervention schedule.

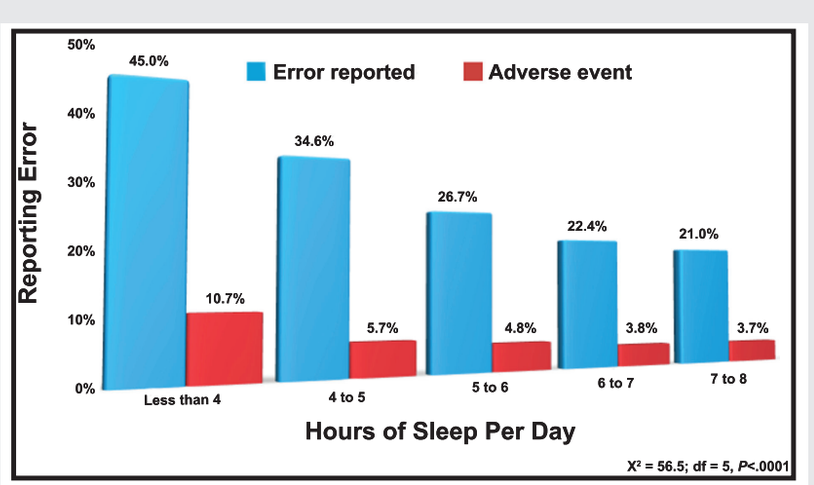

FIGURE 11-8 Self-reported resident errors by average daily hours of sleep. This national multispecialty survey demonstrates that reduced sleep hours correlated with increased error reporting and greater likelihood of having caused an adverse event.

Data from Baldwin DC Jr, Daugherty SR. Sleep.[27] *www.journalsleep.org/ViewAbstract.aspx?pid=25943*.

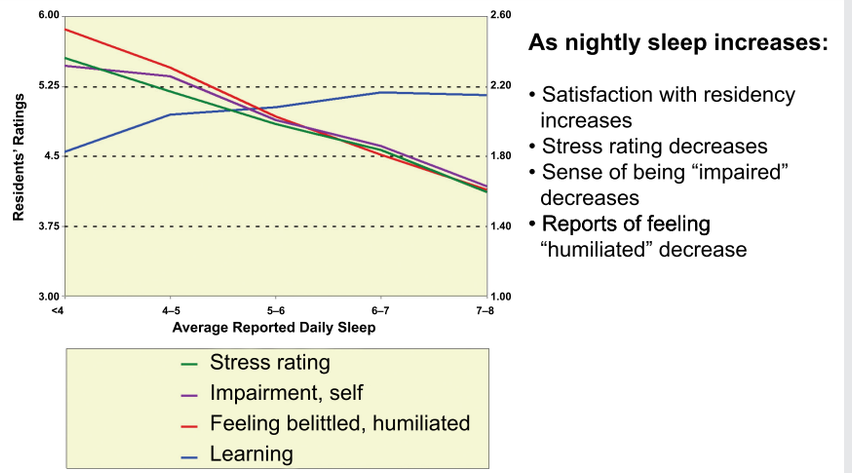

FIGURE 11-9 Average hours of sleep per night impacts residency experience. In this large, national multispecialty survey, a dose-response relationship was found between average hours of sleep per night and key subjective parameters. Reported satisfaction with overall residency experience increased with improved sleep time: ratings of personal stress, reports of working while personally impaired, and experiences of feeling belittled and humiliated at work decreased with greater hours of sleep. The opposite trend is seen with less sleep time.

Data from Baldwin DC Jr, Daugherty SR. Sleep.[27] *www.journalsleep.org/ViewAbstract.aspx?pid=25943*.

work in circumstances that could lead to impaired levels of alertness.

2. In general, restricted sleep compromises the *efficiency* or *speed* of neurocognitive and psychomotor task completion to a greater extent than the accuracy of performance. In surgical specialties, this is termed the *operative inefficiency*. Interestingly,

TABLE 11-2 Odds Ratio of Adverse Consequences Associated With Insufficient Sleep[a]

Residents Averaging Fewer Than 5 Hours of Sleep Per Night Were Significantly More Likely to Report	Odds Ratio
Involvement in a malpractice case	2.02
Use of medication to stay awake	1.91
Serious conflict with others	1.86
Accidents or injuries	1.84
Making a serious medical error	1.74
Noticeable weight change	1.59
Increased use of alcohol	1.52
Serious conflict with other residents, attending or supervising physicians, and nursing staff	1.47

[a] Data from Baldwin DC Jr, Daugherty SR. Sleep.[27] *www.journalsleep.org/ViewAbstract.aspx?pid=25943*; Baldwin DC Jr, et al. Acad Med.[36] *journals.lww.com/academicmedicine/pages/articleviewer.aspx?year=2003&issue=11000&article=00018&type=abstract*.

KEY POINT

- Consequences of sleep loss in residency training include disturbances in neurocognitive and psychomotor functioning as well as reduced satisfaction with work experience, increased stress, weight gain, pregnancy-related complications, and increased risk of accidents inside and outside the hospital.

in the short term, increased mental effort appears to diminish these effects.

3. Residents, unfortunately, do not develop *tolerance, immunity, resistance,* or *adaptation* to chronic sleep loss over time. Specifically, studies of medical residents that have focused on the relative impact of fatigue in different populations did not demonstrate any improvement or stabilization of impairment with advancing levels of training.
4. One of the key findings and perhaps the most consistent conclusion in the literature on this topic is the impact of sleep deprivation on mood in resident physicians, which mirrors what is understood about the impact of sleep deprivation in humans in general.
5. Adverse physical health consequences associated with sleep deprivation in residents consist of increased somatic complaints; changes in weight; and self-reported increases in stress level, accidents and injuries, and alcohol and stimulant use.[37] Pregnancy-related complications include pregnancy-induced hypertension, abruptio placenta and preterm labor, and adverse fetal outcomes (low birth weight and intrauterine growth retardation).[38] The data also confirm an increased risk of morbidity and mortality related to *drowsy driving accidents* in residents.[39]

COUNTERMEASURES FOR SLEEPINESS AND FATIGUE IN RESIDENCY TRAINING

As already discussed, data confirm the important relationship between cumulative sleep deprivation and patient care, medical error, accidents, professionalism, and the well-being of trainees themselves. Regulation of work hours and other operational changes such as scheduling adjustments would therefore seem to be sufficient and appropriate steps in rectifying these concerns; however, this is not the case.

Literature on sleep deprivation based on anecdotal and empiric evidence suggests that operational or systems changes in and of themselves neither correct nor guarantee well-rested and optimally functioning residents.

A number of key reasons for this observation are as follows:

1. It is evident from recent experiences that operational or systems changes may be very difficult to execute and maintain.
2. Despite the ACGME work-hour stipulations in 2003 and 2011, no evidence documents that the protection of residents from longer hours at work translates to more-rested residents and fewer medical errors.
3. The culture of medical training continues to advocate that residents learn to adapt to the fatigue and rigor of being on call with no formal teaching of countermeasures in residency training or in medical school. The requirement by the ACGME that ''faculty and residents must be educated to recognize the signs of fatigue and sleep deprivation and must adopt and apply policies to prevent and counteract its potential negative effects on patient care and learning'' implies that that these resources are available in every residency program. In fact, a recent study by Avidan and Silber[40] demonstrates that as many as 40% of US neurology residency programs do not have a board-certified sleep neurologist in their program and up to 7% of programs do not provide lectures on sleep disorders in their curriculum. Without standardized requirements for sleep lectures in the curriculum or formal teaching modules on fatigue countermeasures, programs may send an implicit message to their trainees that sleep

countermeasures have to be learned independently or perhaps are not sufficiently important to be included in the curriculum.

4. Work-hour regulations, stipulations, rulings, and other operational changes cannot by definition govern residents' autonomy or behavior outside of the workplace or dictate personal priorities regarding adequate sleep and, therefore, cannot ensure that trainees are protected from insufficient sleep.
5. Creative solutions, such as the night-float on-call coverage system, have not been established to counteract fatigue.

Interestingly, studies on resident performance found that, contrary to the presumed expectations, residents who were provided with an intervention consisting of protected "coverage" time for sleep (lasting 4 hours) did not obtain more sleep, as measured by ambulatory EEG recording, than residents who were not given this protected sleep time.[41] The authors concluded that the residents in the intervention group used their protected time to catch up on work, but not to sleep. Night-float systems are operationally difficult to achieve in smaller neurology programs or programs in which the residents are required to cover a number of teaching hospitals. For example, at UCLA, our residents rotate and take call at three different hospitals and have two different services at the main teaching hospital. When we last examined the night-float option, we realized that it would be difficult to integrate, especially given that our internal review of the neurology residency program occurred concurrently with the ACGME work-hour stipulations of July 2011. Other concerns raised included the risk of intellectual isolation during the night-float rotation and loss of educational opportunities, given that our didactic conferences take place when the covering resident would be required to leave the hospital.

COUNTERMEASURES

Table 11-3[42–53] provides a summary of the literature based on the focus of the intervention to counteract fatigue and sleepiness, examples of specific interventions, and potential barriers.

Historically, industries such as transportation and aviation, whose employees face similar challenges in fatigue management, have evaluated and adopted strategically placed fatigue management strategies or countermeasures in an effort to lessen the potential effects of sleep loss on employees. The most effective universal countermeasure that targets sleepiness is to obtain more sleep or to nap. Sleep-related behavioral strategies to enhance alertness in occupational settings have included use of a variety of sleep schedules, including fixed and split-sleep periods, on-demand and carefully timed consumption of caffeine, timed light therapy, and teaching the principles of sleep hygiene.[44,54]

The principal objective of any recommendations to counteract sleepiness and fatigue in residency training is to ensure that trainees consistently obtain sufficient sleep to allow them to assume their duties and learn at an optimal level. Neurology residency programs need to provide educational opportunities to teach their trainees as well as faculty about interventions regarding the consequences of sleep loss and fatigue. All stakeholders, including residents, program directors, and attending physicians, as well as medical school faculty, hospital administrators, and hospital personnel, should be provided with resources and tools focusing on alertness management strategies at a variety of recurring venues. Education is key in

KEY POINTS

- In neurology residencies, implementation of a night-float system may be operationally difficult, and data about its efficacy in improving sleepiness are equivocal.
- The only reliable way to counteract and reverse the physiologic need for sleep is to sleep.
- Countermeasures for sleep and fatigue in residency training consist of a number of interventions focusing on strategies to improve alertness, such as strategically placed 15- to 20-minute short naps (also known as power naps), caffeine intake, and light exposure.

TABLE 11-3 Sleepiness and Fatigue Countermeasures[a]

Focus of Intervention	Intervention	Comments and Examples	Potential Barriers
Improved alertness	Power naps	Short prophylactic naps (before and during night shift) lasting 15–20 min are therapeutic and can ameliorate performance decrement.	Work schedule may not be conducive to incorporate power naps.
	Caffeine	Readily available. Strategic consumption is the key. Effects appear within 15–30 min; half-life is 3–7 h. May be used for temporary relief of sleepiness (initial 1–3 h of work time).	Diuretic action, tolerance, dependence, mood disturbances, unpredictable gastrointestinal absorption, may erode sleep quality and cause arousals at night.
		Caffeine (4 mg/kg) 30 min before night shift in combination with napping can be very helpful.	
		Drip coffee (7 oz), 110–175 mg; cola (8 oz), 30–45 mg; tea (8 oz), 10–70 mg; Starbucks Grande, 320 mg; Mountain Dew (8 oz), 57 mg; Red Bull (331 mL), 80 mg.	
	Light exposure	Bright light exposure has an immediate alerting effect and should be maximized during work time. Exposure to bright light should be minimized during the day in residents on night-float rotations, especially when driving or walking home in the morning.	Light exposure in the hospital setting is highly variable, and consistent results may not be achieved.
	Wake-promoting agents	Approved to treat excessive sleepiness in shift work schedule disorder. Role in residency training has not been established.	The use of wake-promoting agents in residency training has not been clearly established and may infringe on physician autonomy.
Increased sleep duration	Educational programs to improve sleep knowledge	The only way to definitively reverse the physiologic need for sleep is to sleep.	Physicians receive little education on normal sleep and sleep hygiene.
			A notion exists that physicians need to learn how to ''manage'' without sleep.
	Improved sleep hygiene	Maintain a regular sleep-wake cycle. Regularly exercise early in the day. Increase exposure to bright light during the day.	Sleep hygiene may not be optimal because of the demands of the residency program and family obligations.

Continued on next page

TABLE 11-3 *Continued*

Focus of Intervention	Intervention	Comments and Examples	Potential Barriers
Increased sleep duration (continued)	Improved sleep hygiene (continued)	Avoid exposure to bright light during the night. Avoid heavy meals within 3 h of bedtime. Enhance the sleep environment. Avoid caffeine, alcohol, and nicotine. Keep a relaxing routine.	
	When appropriate, hypnotic therapy at night	Address comorbid insomnia. Ensure short-acting agents as opposed to hypnotics with long half-lives.	Certain hypnotics, especially sedating antidepressants, may lead to sedation in the morning.
	Avoidance of sleep deprivation before on-call responsibilities	Always try to obtain 7.5–8.0 h of sleep before on-call duty.	Personal and educational responsibilities and time with family and loved ones sometimes lead to sleep deficit.
	Optimized sleep environment	Protect sleep environment; reduce noises; darken room, set a comfortable temperature. Ensure call rooms are protected, cleaned, and available for power naps.	Call rooms are sometimes noisy. Custodian schedule may not consistently allow preparation of clean call room around the clock.
Safety measures	Safety measures in the hospital	Recognize the warning signs of sleepiness: falling asleep on rounds; inattention; forgetfulness; difficulty focusing; restlessness; irritability; inefficiency at work (in surgical specialties, ''operative inefficiency''); conflicts with staff, colleagues, family, and friends. Warning signs include microsleeps (brief intrusions of EEG harbingers of sleep into wakefulness).	Persons with moderate to severe sleep debt may fall asleep even while rating themselves quite alert.
	Safety measures outside the hospital	Avoid driving when sleepy. Nap or have a cup of coffee before driving. Live within close proximity to the hospital to avoid opportunities for drowsy driving. Use public transportation, car pool, or taxi to and from the hospital for on-call duty.	Living within close proximity to a training hospital is not always possible when multiple training sites are involved. Sometimes it is not practical to share a ride or take public transportation. Cost can be a significant issue for far-away sites.

Continued on next page

TABLE 11-3 *Continued*

Focus of Intervention	Intervention	Comments and Examples	Potential Barriers
Circadian realignment on night float	Maximize exposure to bright light at work; avoid exposure in the morning following the night shift	Align circadian rhythm of alertness with the night work and sleepiness with daytime sleep schedule.	Nighttime illumination is usually suboptimal to impact alertness.
	Avoidance of sleep debt at the start of the night float	Avoid starting night float duty following insufficient sleep recovery.	Residents on ''jeopardy'' rotation or those who cross-cover for sick colleagues may be at risk for sleep deprivation before their expected call time.
	Melatonin	Improves duration of daytime sleep	Consistent data (dose, timing) in resident physicians have not been clearly established.
	Guidelines and standardization of work-hour limitations	Ensures that residents are able to perform at their optimal level on a consistent basis across all programs.	Operational or system changes that place limits on work hours in and of themselves do not guarantee well-rested and optimally functioning residents.
		Restricted work hours improve residents' quality of life.	Work-hour stipulations cannot by definition govern residents' behavior outside of the workplace.
			Definitive support that improved work hours translate to increased sleep time is lacking.
Maximize educational opportunities	Videotaped lectures and grand rounds	Take advantage of technology to provide conferences at different times (eg, video recording, recording PowerPoint slides with audio/notes online, podcasts of grand rounds).	May be associated with increased cost. Not available at all programs.
	Rotating curriculum	Structure the educational curriculum to repeat and reinforce material at different venues using a variety of approaches. Help protect resident education time whenever possible.	

[a] Data from Caldwell JA, et al, Aviat Space Environ Med.[42] *ingentaconnect.com/content/asma/asem/2009/00000080/00000001/art00007*; Rose SH, Curry TB, Mayo Clin Proc.[43] *www.ncbi.nlm.nih.gov/pmc/articles/PMC2770906/*; Rosekind MR, et al, Behav Med.[44] *www.tandfonline.com/doi/abs/10.1080/08964289.1996.9933753?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%3dpubmed*; Russo MB, Aviat Space Environ Med.[45] Scott LD, et al, Nurs Res.[46] *journals.lww.com/nursingresearchonline/pages/articleviewer.aspx?year=2010&issue=07000&article=00004&type=abstract*; Balkin TJ, et al, Aviat Space Environ Med.[47] *ingentaconnect.com/search/download?pub=infobike%3a%2f%2fasma%2fasem%2f2004%2f00000075%2fA00103s1%2fart00026&mimetype=text%2fhtml*; Batejat DM, Lagarde DP, Aviat Space Environ Med.[48]; Kushida CA, Curr Treat Options Neurol.[49] *link.springer.com/article/10.1007/s11940-006-0025-7*; Schweitzer PK, et al, Sleep.[50] *www.journalsleep.org/ViewAbstract.aspx?pid=26415*; Walsh JK,et al, J Sleep Res.[51] *onlinelibrary.wiley.com/doi/10.1111/j.1365-2869.1995.tb00233.x/abstract*; Zee PC, Roth T, Potomac Center for Medical Education and Rockpointe Corporation.[52]; Owens J AA, et al, American Academy of Sleep Medicine.[53]

addressing behavioral change on the individual level. The trainee needs to not only comprehend the reasoning for the changes in order to ''buy into'' them but also accept personal responsibility for instituting them. Education regarding sleep deprivation and countermeasures needs to be embraced at the institutional and systemwide levels as it represents a critical force driving change. From a social dynamic position, a key identified barrier to enhancing compliance with work-hour stipulations is the culture of the workplace, which needs to support and motivate the changes in individuals. Education, an important vehicle for driving changes in lifestyle or personal behaviors that impact alertness, can attain the objective in a collaborative as opposed to a regulatory approach.

Despite the call for enhanced sleep education, residents typically receive little or no formal teaching about normal sleep and circadian rhythms or the essential role of sleep in maintaining adequate health and performance in graduate medical education. Finding time to teach ''new'' fields, such as sleep medicine, is difficult when medical school curricula are already overcrowded.[55,56] Despite the high prevalence of sleep disorders, many physicians fail to diagnose and sometimes misdiagnose sleep disorders in their patients.[57,58] One community-based study reported rates as low as 0.1% in the recognition and diagnosis of sleep disorders.[59] While sleep knowledge surveys demonstrate a positive attitude toward sleep medicine, the data demonstrate that knowledge about sleep disorders is lacking among

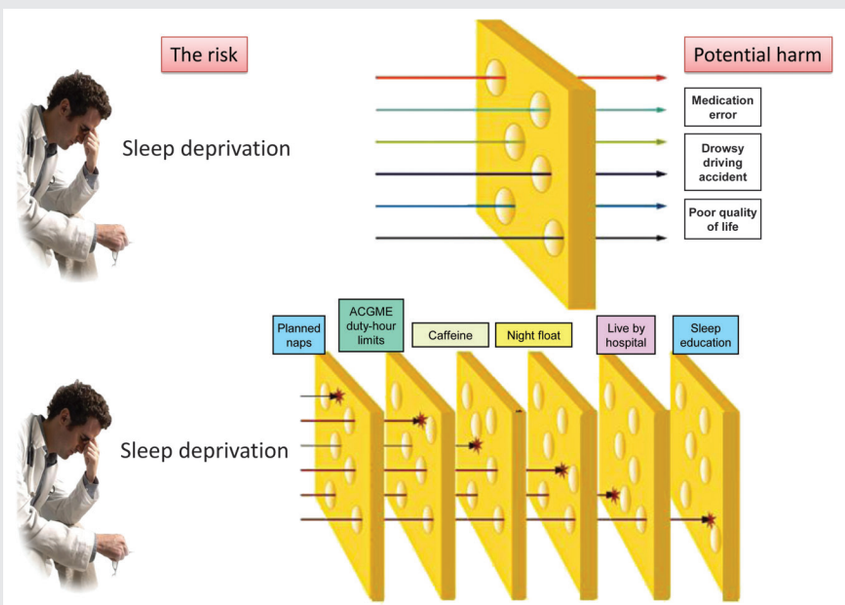

FIGURE 11-10 Application of the Swiss cheese model to the sleep deprivation–related consequences. The risk in this diagram is the sleep-deprived neurology resident, while the potential harm represents possible consequences related to the risk. The model shows that alignment of multiple layers (Swiss cheese) of ''protection'' are more effective in prevention of harm as opposed to one layer (eg, limiting work hours).

ACGME = Accreditation Council for Graduate Medical Education.

KEY POINTS

- In neurology residencies, integration of a standardized sleep medicine curriculum, including teaching modules on fatigue countermeasures, may assist residents in managing excessive sleepiness when it occurs.
- The Swiss cheese model attempts to intercept sleepiness-related errors by supporting the integration of a comprehensive multifaceted approach, including the use of alerting techniques such as power naps, sleep education, and operational measures to curtail work hours.

medical students and physicians alike.[60–63] Up to 90% of physicians rate their knowledge of sleep disorders as "fair" or "poor."[64,65] A study by the author reveals that medical textbooks available to physicians in practice fail to provide sufficient sleep content relative to other topics.[66] It may therefore be argued that to better manage sleep disorders in residency training, programs should set as a priority the enhancement of sleep medicine content in the curriculum, providing modules on basic principles of sleep and chronobiology; the impact of sleep deprivation; common myths and misconceptions about sleep loss and fatigue; an outline of the basic principles of sleep hygiene; implementation and use of well-established countermeasures; and specific systemwide operational changes. Application of the Swiss cheese model (**Figure 11-10**) to counteract the possibility that sleep deprivation will result in injury is a useful representation of the argument, provided that the management of the sleep-deprived neurologist must include a comprehensive multilayered approach using a number of specific countermeasures as described in **Table 11-3**.[42–53]

CONCLUSION

Several solutions and countermeasures have been proposed to mitigate the problem of fatigue in neurology residency. At present, work-hour limitation remains the only consistent and universal approach that is adopted and adhered to by residency programs. Because sleepiness may persist despite modification of work-hour schedules, all stakeholders need to ensure that effective countermeasures are integrated in a collaborative manner. Given that sleep disturbances are ubiquitous in neurology patients and, to a large extent, the physicians during their first years of residency who take care of many of them, all stakeholders must take effective action toward a resolution.

REFERENCES

1. Killelea BK, Chao L, Scarpinato V, Wallack MK. The 80-hour workweek. Surg Clin North Am 2004;84(6):1557–1572, x.
2. Veasey S, Rosen R, Barzansky B, et al. Sleep loss and fatigue in residency training: a reappraisal. JAMA 2002;288(9):1116–1124.
3. Howard SK, Gaba DM, Rosekind MR, Zarcone VP. The risks and implications of excessive daytime sleepiness in resident physicians. Acad Med 2002;77(10):1019–1025.
4. Asch DA, Parker RM. The Libby Zion case: one step forward or two steps backward? N Engl J Med 1988;318(12):771–775.
5. Committee on Quality of Care; Kohn LT, Corrigan J, Donaldson MS, eds. To err is human: building a safer health system. Washington, DC: National Academies Press, 2000.
6. Watson JC. Impact of the ACGME work hour requirements: a neurology resident and program director survey. Neurology 2005;64(2):E11–E15.
7. Kissela B, Peltier W. ACGME work hours regulations: a perspective from neurology program directors. Neurology 2004;62(1):E3–E4.
8. Larriviere D. Duty hours vs professional ethics: ACGME rules create conflicts. Neurology 2004;63(1):E4–E5.
9. Dodick DW, Capobianco D, Kash K, et al. Acgme, test thyself! Neurology 2009;73(21): 1811; author reply 1811.
10. Feske S. ACGME, test thyself! Neurology 2009;72(4):302–303.
11. Govindarajan R, Salgado E. New ACGME resident duty hour impacts neurology and family medicine residents alike. Fam Med 2011;43(10):745–746.
12. Schuh LA, Adair JC, Drogan O, et al. Education research: neurology residency training in the new millennium. Neurology 2009;72(4):e15–e20.
13. Freeman WD, Nolte CM, Matthews BR, et al. Results of the American Academy of Neurology resident survey. Neurology 2011;76(13):e61–e67.
14. Ulmer C, Wolman DM, Johns MME, eds. Committee on Optimizing Graduate Medical Trainee (Resident) Hours and Work Schedule to Improve Patient Safety, National Research Council. Resident duty hours enhancing sleep,

supervision, and safety. Washington, DC: The National Academies Press, 2009. *psnet.ahrq.gov/resource.aspx?resourceID=8815*. Accessed October 5, 2012.

15. Nasca TJ, Day SH, Amis ES Jr; ACGME Duty Hour Task Force. The new recommendations on duty hours from the ACGME Task Force. N Engl J Med 2010;363(2):e3.
16. De Martino RR, Brewster LP, Kokkosis AA, et al. The perspective of the vascular surgery trainee on new ACGME regulations, fatigue, resident training, and patient safety. Vasc Endovascular Surg 2011;45(8):697–702.
17. Flynn TC. Invited comment on: the surgical residency and ACGME reform: steep learning or sleep learning? Am J Surg 2011;202(3):372–373.
18. Alpert JS, Frishman WH. A bridge too far: a critique of the new ACGME duty hour requirements. Am J Med 2012;125(1):1–2.
19. Brown NM, Helmer SD, Yates CL, Osland JS. The revised ACGME laparoscopic operative requirements: how have they impacted resident education? Surg Endosc 2012;26(6):1737–1743.
20. Hoh BL, Neal DW, Kleinhenz DT, et al. Higher complications and no improvement in mortality in the ACGME resident duty-hour restriction era: an analysis of more than 107,000 neurosurgical trauma patients in the Nationwide Inpatient Sample database. Neurosurgery 2012;70(6):1369–1381; discussion 1381–1362.
21. Navathe AS, Silber JH, Small DS, et al. Teaching hospital financial status and patient outcomes following acgme duty hour reform [published online ahead of print]. Health Serv Res Aug 2 2012. doi:10.1111/j.1475-6773.2012.01453.x.
22. Waterman B. ACGME work-hour restrictions: a better quality of life, but at what cost? Am J Orthop (Belle Mead NJ) 2012;41(7): E102–E103.
23. Johns MW. Sleepiness in different situations measured by the Epworth Sleepiness Scale. Sleep 1994;17(8):703–710.
24. Johns MW. Sleep propensity varies with behaviour and the situation in which it is measured: the concept of somnificity. J Sleep Res 2002;11(1):61–67.
25. Mustafa M, Erokwu N, Ebose I, Strohl K. Sleep problems and the risk for sleep disorders in an outpatient veteran population. Sleep Breath 2005;9(2):57–63.
26. Papp KK, Stoller EP, Sage P, et al. The effects of sleep loss and fatigue on resident-physicians: a multi-institutional, mixed-method study. Acad Med 2004; 79(5):394–406.
27. Baldwin DC Jr, Daugherty SR. Sleep deprivation and fatigue in residency training: results of a national survey of first- and second-year residents. Sleep 2004;27(2):217–223.
28. Borbely AA, Achermann P. Sleep homeostasis and models of sleep regulation. [see comment]. J Biol Rhythms 1999;14(6): 557–568.
29. Carrier J, Monk T. Circadian rhythms of performance: new trends. Chronobiol Int 2000;17(6):719–732.
30. Jewett M, Dijk D, Kronauer R, Dinges D. Dose-response relationship between sleep duration and human psychomotor vigilance and subjective alertness. Sleep 1999;22(2): 171–179.
31. Schmid SM, Hallschmid M, Jauch-Chara K, et al. A single night of sleep deprivation increases ghrelin levels and feelings of hunger in normal-weight healthy men. J Sleep Res 2008;17(3):331–334.
32. Ursavas A, Ilcol YO, Nalci N, et al. Ghrelin, leptin, adiponectin, and resistin levels in sleep apnea syndrome: role of obesity. Ann Thorac Med 2010;5(3):161–165.
33. American Academy of Sleep Medicine. *International classification of sleep disorders, second edition: diagnostic and coding manual*. Westchester, IL: American Academy of Sleep Medicine, 2005.
34. Reimann M, Manz R, Prieur S, et al. Education research: cognitive performance is preserved in sleep-deprived neurology residents. Neurology 2009;73(21):e99–e103.
35. Landrigan CP, Rothschild JM, Cronin JW, et al. Effect of reducing interns' work hours on serious medical errors in intensive care units. N Engl J Med 2004;351:1838–1848.
36. Baldwin DC Jr, Daugherty SR, Tsai R, Scotti MJ Jr. A national survey of residents' self-reported work hours: thinking beyond specialty. Acad Med 2003;78(11):1154–63.
37. Daugherty SR, Baldwin DC Jr, Rowley BD. Learning, satisfaction, and mistreatment during medical internship: a national survey of working conditions. JAMA 1998;279(15): 1194–1199.
38. Klebanoff MA, Shiono PH, Rhoads GG. Outcomes of pregnancy in a national sample of resident physicians. N Engl J Med 1990;323(15):1040–1045.
39. Mansukhani MP, Kolla BP, Surani S, et al. Sleep deprivation in resident physicians, work hour limitations, and related outcomes:

a systematic review of the literature. Postgrad Med 2012;124(4):241–249.

40. Avidan A, Vaughn B, Silber MH. The current state of sleep medicine education in US neurology residency training programs: where do we go from here? J Clin Sleep Med, In press.
41. Richardson GS, Wyatt JK, Sullivan JP, et al. Objective assessment of sleep and alertness in medical house staff and the impact of protected time for sleep. Sleep 1996;19(9): 718–726.
42. Caldwell JA, Mallis MM, Caldwell JL, et al; Aerospace Medical Association Fatigue Countermeasures Subcommittee of the Aerospace Human Factors Committee. Fatigue countermeasures in aviation. Aviat Space Environ Med 2009;80(1):29–59.
43. Rose SH, Curry TB. Fatigue, countermeasures, and performance enhancement in resident physicians. Mayo Clin Proc 2009;84(11):955–957.
44. Rosekind MR, Gander PH, Gregory KB, et al. Managing fatigue in operational settings. 1: physiological considerations and countermeasures. Behav Med 1996;21(4):157–165.
45. Russo MB. Recommendations for the ethical use of pharmacologic fatigue countermeasures in the U.S. military. Aviat Space Environ Med 2007;78(5 Suppl): B119–B127; discussion B128–B137.
46. Scott LD, Hofmeister N, Rogness N, Rogers AE. An interventional approach for patient and nurse safety: a fatigue countermeasures feasibility study. Nurs Res 2010;59(4):250–258.
47. Balkin TJ, Kamimori GH, Redmond DP, et al. On the importance of countermeasures in sleep and performance models. Aviat Space Environ Med 2004;75(3 Suppl):A155–A157.
48. Batéjat DM, Lagarde DP. Naps and modafinil as countermeasures for the effects of sleep deprivation on cognitive performance. Aviat Space Environ Med 1999;70(5):493–498.
49. Kushida CA. Countermeasures for sleep loss and deprivation. Curr Treat Options Neurol 2006;8(5):361–366.
50. Schweitzer PK, Randazzo AC, Stone K, et al. Laboratory and field studies of naps and caffeine as practical countermeasures for sleep-wake problems associated with night work. Sleep 2006;29(1):39–50.
51. Walsh JK, Muehlbach MJ, Schweitzer PK. Hypnotics and caffeine as countermeasures for shiftwork-related sleepiness and sleep disturbance. J Sleep Res 1995;4(S2):80–83.
52. Zee PC, Roth T. Shift work sleep disorders in hospitals: reducing risk and improving outcome. Slide Set CME sponsored by Potomac Center for Medical Education and Rockpointe Corporation; 2011.
53. Owens J AA, et al. Alertness and fatigue education in residency esentation. PowerPoint presentation. 2003. American Academy of Sleep Medicine MEDSleep Education Products, Educational, PowerPoint Presentations; 2006.
54. Rosekind MR, Gander PH, Gregory KB, et al. Managing fatigue in operational settings 2: an integrated approach. Behav Med 1996;21(4):166–170.
55. Ozuah PO. Undergraduate medical education: thoughts on future challenges. BMC Med Educ 2002;2:8.
56. Rosen RC, Rosekind M, Rosevear C, et al Physician education in sleep and sleep disorders: a national survey of U.S. medical schools. Sleep 1993;16:249(3)–254.
57. BaHammam AS. Knowledge and attitude of primary health care physicians towards sleep disorders. Saudi Med J 2000;21(12):1164–1167.
58. Owens J. Introduction to special section: NIH Sleep Academic Award program. Sleep Med 2005;6(1):45–46.
59. Rosen RC, Zozula R, Jahn EG, Carson JL. Low rates of recognition of sleep disorders in primary care: comparison of a community-based versus clinical academic setting. Sleep Med 2001;2(1):47–55.
60. Kovaciç Z, Marendiç M, Soljiç M, et al. Knowledge and attitude regarding sleep medicine of medical students and physicians in Split, Croatia. Croat Med J 2002;43(1):71–74.
61. Mahendran R, Subramaniam M, Chan YH. Medical students' behaviour, attitudes and knowledge of sleep medicine. Singapore Med J 2004;45(12):587–589.
62. Mindell JA, Moline ML, Zendell SM, et al. Pediatricians and sleep disorders: training and practice. Pediatrics 1994;94(2 Pt 1):194–200.
63. Orr WC, Stahl ML, Dement WC, Reddington D. Physician education in sleep disorders. J Med Educ 1980;55(4):367–369.
64. Papp KK, Penrod CE, Strohl KP. Knowledge and attitudes of primary care physicians toward sleep and sleep disorders. Sleep Breath 2002;6(3):103–109.
65. Sateia MJ, Reed VA, Christian Jernstedt G. The Dartmouth sleep knowledge and attitude survey: development and validation. Sleep Med 2005;6(1):47–54. Epub 2004 Dec 25.
66. Teodorescu MC, Avidan AY, Teodorescu M, et al. Sleep medicine content of major medical textbooks continues to be underrepresented. Sleep Med 2007;8(3): 271–276. Epub 2007 Mar 21.