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Managing Work Schedules: An Alertness and Safety Perspective

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ABSTRACT

Around-the-clock activities ranging from essentials such as health care and public safety to conveniences like shopping are pervasive in modern society. These activities create significant physiologic challenges for workers in providing safe and productive operations. Humans are biologically designed to be awake during the day and to sleep at night. Work schedules that oppose this natural biologic rhythm generate physiologic disruptions that lead to significantly degraded performance and increased risks to health and safety. Such effects of continuous work schedules on individuals, organizations, and the public are frequently underestimated, contributing to incidents, accidents, and societal disasters. Still, some scientific and real-world considerations illustrate the intricacies of managing work schedules, including individual differences, organizational culture, and economic factors. Effectively addressing these risks is a complex and often contentious issue that requires a comprehensive and programmatic approach.

In many studies, workers in around-the-clock occupations report obtaining less than adequate amounts of sleep and experiencing sleepiness on the job. Approaches to address this issue must occur at all levels, from individuals to corporations to society. Individuals can obtain information on the topics of sleep, circadian rhythms, and alertness strategies, and organizations and society can facilitate such education. Organizations can also encourage the use of certain alertness strategies (such as naps) with support facilities and by institution of policy, and they can use scientifically based scheduling practices to minimize risks related to work schedules.

Individuals, organizations, and society all have important roles to play in the diagnosis and treatment of sleep disorders, many of which go unidentified. Effectively managing modern work schedules, and their associated sleep and circadian factors, offers an opportunity for sleep medicine to improve the health and safety of millions of individuals, corporations, and society.

Modern society has evolved into a world filled with around-the-clock activities that range from essentials such as health care, public safety, and power to conveniences such as shopping. These activities create significant physiologic challenges for the humans who must provide safe and productive operations. Human beings have evolved to be active during the day and to sleep at night. Therefore, any work schedule that opposes this natural biological programming will create physiologic disruptions that can lead to significantly degraded alertness, performance, and safety. These risks affect individuals, organizations, and the public and are frequently underestimated, leading to the potential for incidents, accidents, and societal disasters. Effectively addressing these risks is a complex and often contentious task that requires a comprehensive and programmatic approach.

First, a context will be provided to demonstrate why managing work schedules is both a health and safety issue and to show the extremely large number of people affected by these concerns. Next, effective approaches to address this issue will be outlined from both individual and organizational perspectives. Finally, the complexity of managing work schedules will be illustrated by identifying some scientific and real-world considerations that remain challenges to improving health and safety in around-the-clock settings.

WORK SCHEDULES AFFECT SLEEP, ALERTNESS, AND SAFETY

In work settings, it's all about safety. Obviously, the focus of a text on sleep medicine is health as it relates to the prevalence, risks, diagnosis, treatment, and other aspects of sleep disorders. Even "basic" research is presented in the context of clinical sleep medicine and its relevance to sleep disorders. However, although health and its promotion have become broadly acknowledged and integrated into work settings, the primary reason that occupational environments focus on work schedules is related to safety. This is the paramount concern in any work environment, and especially in safety-sensitive settings such as transportation, health care, and public safety. Even in life-threatening situations, where "getting the job done" is critical, the safety of everyone, especially the individual operator or provider, is a primary concern.[1] This book superbly addresses the health consequences of sleep loss, sleep disorders, and shift work. Therefore, the emphasis here will be on how work schedules affect sleep, alertness, and ultimately safety.

Any work not done in daytime, in standard working hours, or on a regular schedule has the potential to significantly affect both sleep and circadian rhythms. The operational issues are complex and are related to a variety of factors, such as the creation of acute sleep loss prior to a work period, the accumulation of a sleep debt across consecutive days, extended work periods or on-call schedules, and other issues to be outlined later. Some examples from transportation, health care, and public safety demonstrate how work schedules can create acute and cumulative sleep loss.

A variety of National Aeronautics and Space Administration (NASA) studies have examined the sleep and circadian disruption of commercial airline pilots.[2] For example, in one study,

long-haul international pilots averaged 7.3 hours of sleep during a home baseline period prior to a trip. However, while on their trip, these pilots averaged 5.3 hours of sleep during a primary sleep period that was supplemented by naps for a total of 6.5 hours of sleep per 24 hours.[3] Short-haul domestic pilots who had a 12.5 hour layover or off-duty period averaged 6.7 hours of sleep.[4] Overnight cargo pilots averaged 4.6 hours of sleep in their primary sleep period, which was supplemented to a total of 6.3 hours of total sleep per 24 hours. This was in comparison to the 7.5 hours of home baseline sleep that they obtained.[5] Overall, 85% of the pilots studied in different flight environments accumulated a sleep debt across their trip schedules. Their sleep debt ranged from 8 hours on short-haul schedules to 16 hours on long-haul flight schedules.[6]

The sleep-wake schedules of truck drivers in different operations also have been studied.[7] In one large study of commercial drivers operating on different schedules, the drivers averaged 3.8 to 5.4 hours of total sleep. For example, after 10 hours of day driving, the drivers averaged 5.4 hours of sleep during their 10.7 hours off-duty. After a 13-hour night drive, the drivers averaged 3.8 hours of sleep during the 8.6 hour off-duty period; after a 13-hour day drive, the drivers averaged 5.1 hours of sleep during their 8.9 hour off-duty period.

In a study of train engineers conducted by the Federal Railroad Administration, the crews averaged 6.1 hours of sleep with an off-duty period of 12 hours and only 4.6 hours of sleep with a 9.3-hour off-duty period.[8]

The sleep-wake schedules of health care providers have been studied with an increased interest in how this affects patient safety.[1,9,10] For example, emergency department attending physicians averaged 5.5 hours of sleep after a night shift compared to 8.3 hours of sleep after a day shift.[11] A study of surgical residents found that they averaged 5 to 6 hours of sleep while they were on call, whether the schedule was every other night, every third night, or every fourth night.[12] Eighty-nine percent of OB/GYN residents reported less than 4 hours of sleep while on call, and a group of anesthesiologists reported an average of 4.8 hours of sleep while on call.[13,14] In a recent study, hospital staff nurses reported getting 6.5 hours of sleep on workdays compared to 7.8 hours on days off.[15]

Police officers have been found to average 6.2 hours of sleep while working an 8-hour shift and 6.5 hours when on a 12-hour shift. In one survey, 53% of officers reported an average of 6.5 hours of sleep or less.[16,17] Firefighters averaged 5.1 hours of sleep when working on a night shift schedule compared to 7.1 hours when working on a day shift schedule.[18]

These examples from transportation, health care, and public safety demonstrate the acute sleep loss and cumulative sleep debt experienced in these work settings. In fact, the amount of sleep typically averaged on work days is significantly less than the adult average requirement of about 8 hours. This becomes a relevant safety issue because acute and cumulative sleep loss lead to decreased alertness and performance.[19-21] Laboratory research has clearly established this relationship. One integrated demonstration of these findings showed that 5 hours of sleep across 7 consecutive nights created significantly increased physiologic sleepiness, and these decrements were highly correlated with decreased psychomotor performance.[22] Recently, varying amounts of acute sleep loss (2, 4, 6, and 8 hours) were found to increase sleepiness more than ethanol and had effects comparable to those of ethanol on degrading psychomotor performance.[23] In this study, 2 hours of sleep loss equated to a breath ethanol concentration (BrEC) of .045%, which is the equivalent of ingesting 2 or 3 12-ounce beers. Four hours of sleep loss equated to a .095% BrEC, the equivalent of ingesting 5 or 6 12-ounce beers.

The acute and cumulative sleep loss found in various work settings has been associated with sleepiness on the job. In NASA studies, 80% of regional pilots and 71% of corporate and business aviation pilots reported "nodding off" in the cockpit during a flight.[24,25] In another NASA study of long-haul pilots, 154 occurrences of physiologic microevents (i.e., alpha or theta electroencephalogram [EEG] or slow eye movements) were recorded during the last 90 minutes of a 9-hour flight.[26] A study of air traffic controllers conducted by the Federal Aviation Administration (FAA) found that 48% report "they often fell asleep unintentionally."[27]

Police officers also report falling asleep on duty. For example, 80% report dozing off at a stop light once a week,[28] 26% nod off during daytime activities, and 41% fall asleep during a night shift.[29] An Alertness Solutions survey found that 85% of officers reported "unintentionally" nodding off while on duty (unpublished findings).

In a multiple sleep latency test (MSLT) study of anesthesia residents, the residents were found to have an average postcall sleep latency of 5.5 minutes.[30] However, their average baseline (no-call condition) sleep latency was 6.5 minutes, and difference between postcall and no-call MSLT, was not statistically significant. This demonstrated that both the acute (post-call) and cumulative (chronic) effects of sleep loss (baseline, no-call condition) created significant physiologic sleepiness in these residents. With increased total sleep, the residents' average sleep latency increased to a normal range (12.8 minutes).

Overall, 60% to 70% of shift workers report difficulty with sleep, sleepiness on the job, or actually falling asleep unintentionally while at work.[31]

This sleep loss and decreased alertness degrades safety, the real-world outcome of most significance. Incidents and accidents due to sleep loss, fatigue, and circadian disruption have been identified in every mode of transportation and most around-the-clock operational environments. An extensive literature describing these fatigue-related, sleep-loss, and circadian-based incidents and accidents is available, including in this text.[9,32-38] These include major societal disasters such as the grounding of the *Exxon Valdez,* the Three Mile Island nuclear accident, the space shuttle *Challenger* accident, and more.[36,39-41] Other data also demonstrate the associated safety risks. For example, in one study 41% of medical trainees reported having made a fatigue-related error.[14] In Alertness Solutions surveys of health care providers, 19% reported worsening a patient's condition and 30% reported injuring themselves because of fatigue. In a survey of police officers, Alertness Solutions found that 44% reported acting in an unsafe manner or taking unnecessary risks because of fatigue (unpublished findings). Extended work hours have been associated with a threefold increase in on-the-job accident and injury rates, and workers with sleepiness complaints had a more than twofold increased risk for an occupational injury.[42,43]

WHO IS AFFECTED?

Data regarding the number of people who are affected by these issues typically are discussed in the context of "shift work."

Traditionally, this has focused on the number of individuals working variable hours, nonfixed day shift, or alternate shifts. For example, one study of 1997 data published in 2000 indicated that 28% of the U.S. workforce, about 25 million people, worked variable hours.[44] In a September 2002 study, 22.2% of men and 21.4% of women worked schedules other than fixed day shifts.[45] In this analysis, to count as occurring in one of the four shift categories, at least half the hours worked had to fall into the criteria times for the reference week. Therefore, it is possible that 49% of the hours could have occurred outside the specific "shift" category. In another report, 14.5%, or 14.5 million full-time wage and salary workers, were categorized as working an "alternate" shift.[46] This percentage was reduced from a report 10 years earlier that found 18% working an alternate shift.[46]

Shift work has evolved from longstanding views related to swing- and night-shift work that occurred primarily as a result of the Industrial Revolution. Historically, electric lighting and machines made it possible for manufacturing and assembly line operations to expand into around-the-clock activities. However, the modern workforce has evolved far beyond these traditional views of shift work. Box 57–1 identifies some of the common schedule factors that affect the modern workforce and that can create sleep and circadian disruption, with subsequent effects on alertness and safety.

Even a cursory consideration of the factors identified in Box 57–1 clearly shows that the issues associated with modern work schedules extend far beyond traditional perspectives. In fact, many occupational settings that would have never been previously identified as "shift-work" environments do have to confront the physiologic challenges posed by the issues in Box 57–1. For this reason, it is unlikely that we have any accurate or relevant data to determine how many workers in the United States must confront the known sleep and circadian disruptions that can be associated with managing modern work schedules. One poignant example of this workforce evolution is the extensive amount of air travel that is now commonplace in many occupational settings. Whereas traditional "shift work" activities were generally ground based, the sleep and circadian disruptions associated with domestic and international travel can have similar physiologic outcomes. People in the United States take more than 161 million domestic trips on airplanes every year, and 47% of these trips are likely to be business or work related.[47,48]

Box 57–1. Work-Schedule Factors That Affect Sleep, Circadian Rhythms, and Alertness

- Early start times
- Extended work periods
- Amount of work time within a shift or duty period
- Less than 8 hours off between work periods
- Number of consecutive work periods
- Insufficient recovery time off between consecutive work periods
- Night work through window of circadian low
- Daytime sleep periods
- Day-to-night or night-to-day transitions (schedule stability)
- Changing work periods (e.g., starting and ending times, cycles)
- On-call or reserve status
- Schedule predictability (i.e., available in advance)
- Time zone changes
- Unplanned work extensions

No data are available on how many people have work schedules affected by the factors identified in Box 57–1. Therefore, there are no reliable estimates of the number of Americans who experience sleep and circadian disruptions related to their work schedules. However, some extrapolation from existing data sources suggests that significantly more people are affected than generally considered. A 2001 American Work Force report identified approximately 135 million workers in the United States in 2000.[49] If roughly 78% are on a fixed day schedule, then 30 million workers would be working outside this 9-to-5 day.[45] Since only 50% of the work hours had to fit this category, then the other 50% could have been outside this fixed day schedule. This could represent another 53 million workers for a total of 83 million people who are working outside a standard, fixed day schedule. Of course, data on who works these schedules regularly, occasionally, or on demand is also unknown.

Any discussion of who is affected by work schedules must also include the diverse entities that assume the cost of outcomes. Traditionally, discussions regarding shift work focused on the issues related to the individual worker. However, it is clear that work schedules affect individuals, employers, and the public. The primary focus on individuals has typically been related to health issues, such as increased risk for gastrointestinal and cardiovascular diseases, reproductive health problems, and cancer.[50-53] The organizational focus is usually on safety and work hours, and the public interest is safety for individuals and for society more generally. This is an expanded and critical perspective because it emphasizes that the organizational and societal roles in effectively managing work schedules equals that of the individual. It is this "shared responsibility" approach that offers an opportunity to bring disparate entities together for constructive change regarding these issues rather than deteriorate into finger pointing and blame. No one entity alone—individual, organization, or society—can fully or effectively manage the challenges posed by modern work schedules. The need for a comprehensive approach that involves shared responsibility is further highlighted by the complexity of real-world operational environments.

THERE IS NO MAGIC BULLET

Effectively managing the sleep and circadian disruption associated with work schedules is a complex, and often contentious, endeavor. Five factors illustrate the complexity of addressing this issue. First, there are diverse operational requirements both across work settings and within specific environments. For example, aviation environments include domestic and short-haul, international, air cargo, corporate, and on-demand flying; fixed-wing craft and helicopters; and other flight activities. Second, there are individual differences among the operators, such as age, experience, and sleep need. Third, sleep and circadian physiology is complex, as clearly illustrated by the content of this book. Fourth, historical and cultural factors affect work schedules; one such factor is the classic attitude, "that is how I learned it" or "it has always been done that way."

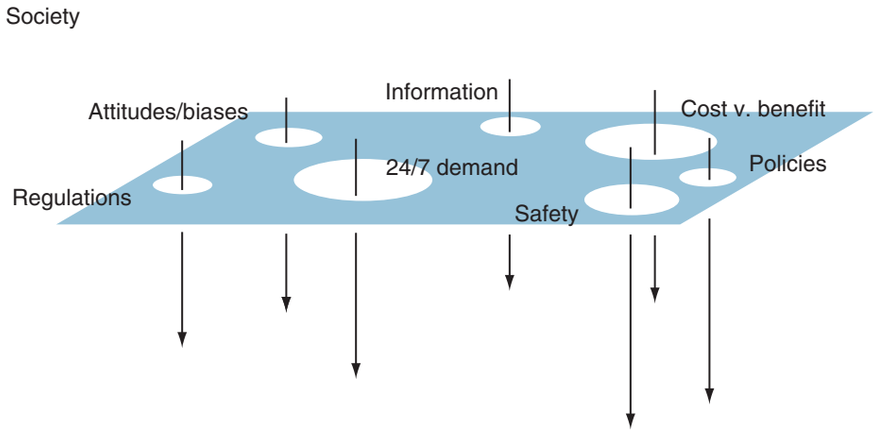

Figure 57–1. Alertness Risk Management (ARM) Model: Risk factors associated with society. Copyright Alertness Solutions 2004.

Fifth, economics can be a powerful consideration for all parties involved in defining work schedules. For individuals, the work schedule will affect income level, quality of life, and family relations. For the organization, work schedules can define workforce size and requirements (i.e., fixed personnel costs), productivity and output, and operational flexibility to meet changing corporate needs.

Together these five factors demonstrate the complexity of effectively managing the sleep and circadian disruption associated with work schedules. This complexity precludes a simple or single solution or a one-size-fits-all approach to managing fatigue in operational settings.

To expand further on this real-world complexity, an Alertness Risk Management (ARM) model based on Reason[54] is portrayed in Figures 57–1 to 57–5. It illustrates some examples of the risks associated with different levels of alertness, the complexity of their interaction, and how, when the factors coincide, an alertness-related incident or accident can occur.

The initial five factors identified and the expanded risk examples portrayed in the ARM clearly demonstrate the need for a comprehensive approach to effectively managing the sleep and circadian disruptions associated with modern work schedules. A comprehensive alertness management program (AMP) to address these issues would include education, alertness strategies, scheduling, healthy sleep, and policies and scientific foundation.[9,55-57] An overview of how to apply this comprehensive approach to individual, organizational, and societal issues related to managing work schedules is outlined next.

ALERTNESS MANAGEMENT

An Individual Perspective

Education

Perhaps the most crucial starting point for individuals is to become educated about the personal health and safety risks associated with sleep and circadian disruption. Previous National Sleep Foundation data have shown that generally people are uninformed and hold misconceptions about even the most basic sleep knowledge.[58] It is important for individuals to know the basics of sleep need, cumulative sleep debt, circadian windows of alertness and performance vulnerability, effects of sleep loss, and more. This knowledge-based education

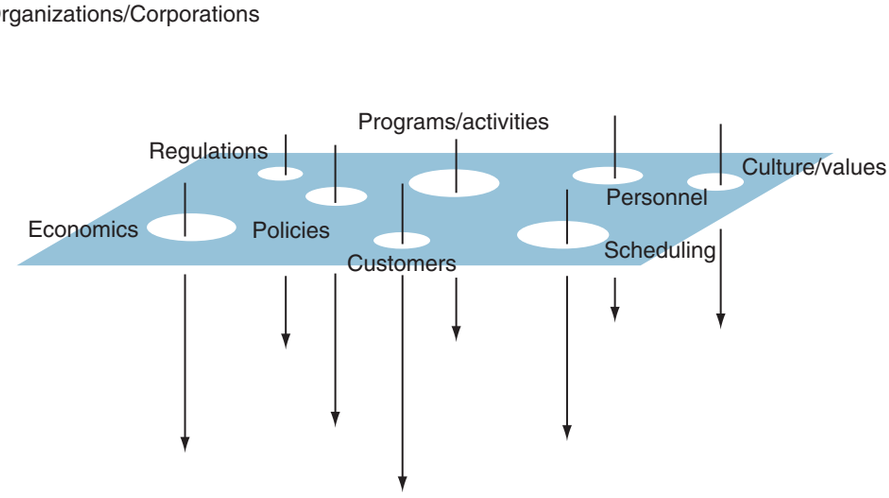

Figure 57–2. Alertness Risk Management (ARM) Model: Risk factors associated with organizations or corporations. Copyright Alertness Solutions 2004.

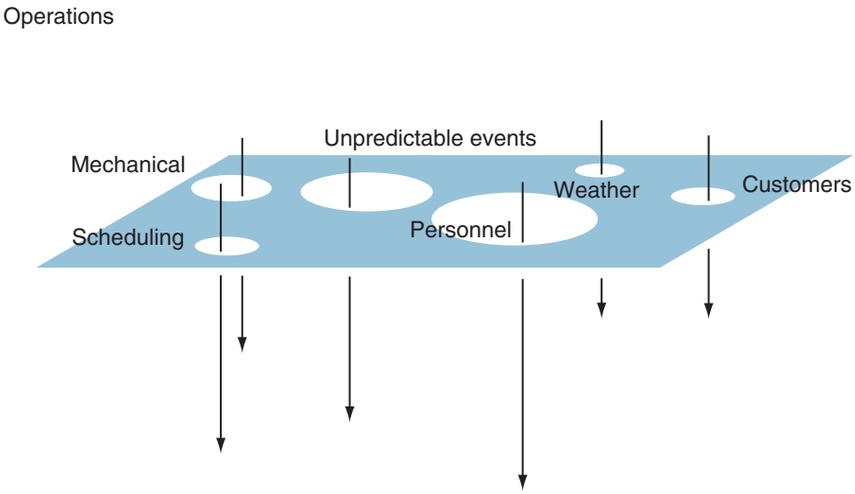

Figure 57–3. Alertness Risk Management (ARM) Model: Risk factors associated with operational demands. Copyright Alertness Solutions 2004.

should be complemented by a tailored personal identification of the signs and symptoms experienced as a result of sleep and circadian disruptions. There is a critical transition from identifying a sign and symptom to taking action.

Alertness Strategies

A variety of strategies have been empirically studied and shown to increase alertness and performance. These strategies include planned naps, caffeine, good sleep habits, managing the sleep environment, exercise, light and dark exposure, activity breaks, diet, sedative-hypnotic and stimulant medications, and sleep scheduling.[9,57,59] The effective use of these strategies requires that individuals understand the specifics of each one—for example, the length of naps, the doses of caffeine that boost alertness and the amounts in different drinks and food, what constitutes good sleep habits versus those that will disrupt sleep, potential benefits and adverse effects of prescription medications, and the timing of exposure to light and dark. Once people are knowledgeable about the effective use of these alertness strategies, they must take two important implementation steps. First, individuals should test the strategy at home, outside the work settings, to find out what works best for them. Second, an "alertness strategies plan" can be developed that involves proactively determining when and how to use strategies to manage the challenges of a specific work schedule.

Scheduling

Scheduling can be the greatest challenge from an individual perspective, depending on the amount of control that the worker has in determining his or her own specific schedule. The tremendous number of external factors that determine work needs can leave little individual flexibility in choices. However, one basic choice available to someone is whether to work in a particular setting that has schedules that create significant individual disruption. In some cases, especially due to economic needs, individuals have minimal choices. In some circumstances, seniority, specific job skills, rotating positions, and changing corporate requirements do provide choice and even input to schedule design.

Any work environment has workers with average hours and those who work less or more. Sleep and circadian rhythm can be disrupted by considerable overtime, extended hours, minimal vacation, and other work "opportunities" that can represent increased income for an individual as well as increased risks

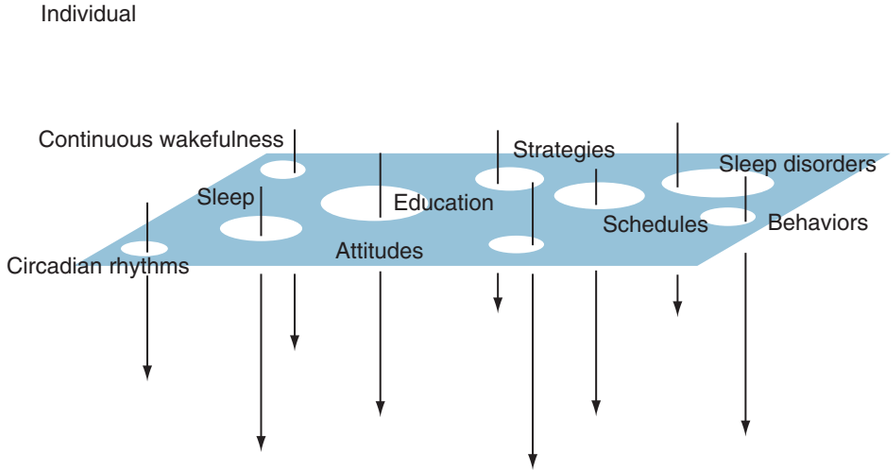

Figure 57–4. Alertness Risk Management (ARM) Model: Risk factors associated with the individual operator. Copyright Alertness Solutions 2004.

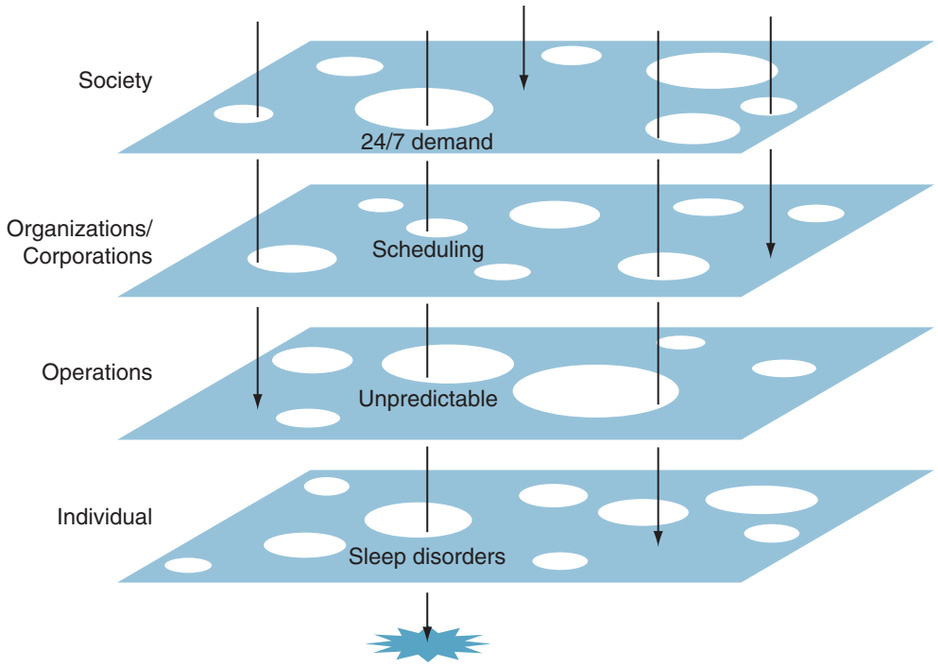

Figure 57–5. Alertness Risk Management (ARM) Model: An accident or incident can occur when the risk factors "line up." Copyright Alertness Solutions 2004.

to alertness, health, and safety. Shared responsibility is critical: An individual worker can seek every opportunity to increase work hours and income, and an organization or corporation can limit these opportunities in order to reduce potential health and safety risks. Conversely, in busy or emergency situations, individuals who are willing to work beyond schedule requirements can represent a significant resource for a corporation.

Healthy Sleep

This text outlines the prevalence, signs and symptoms, diagnosis, and treatment of known sleep disorders. Primary symptoms of these disorders include disturbed sleep and increased waking sleepiness, with subsequent effects on performance, health, and safety. In spite of their prevalence, many of these sleep disorders are undiagnosed or misdiagnosed. Therefore, many individuals have existing, undiagnosed sleep disorders known to affect waking alertness and performance. The associated signs and symptoms of these disorders are exacerbated when these individuals work schedules that further disrupt their sleep and circadian rhythms. It is critical that individuals learn about potential sleep disorders that may affect them and seek help from accredited sleep medicine professionals to identify and treat underlying causes of sleepiness.

Policies and Scientific Foundation

Individuals should seek information on appropriate policies that affect these alertness-management issues. For example, are there corporate policies on the use of planned naps or how work status is affected for employees with sleep apnea? Without explicit policies in these alertness-management areas, employees may hesitate to use strategies or seek diagnosis and treatment. It also is important that individuals use information and strategies that have a known scientific foundation. When exploring sleep, sleep disorders, alertness, and work schedules, people can be overwhelmed by the claims for an "easy fix" or the latest "cure." Each claim should be examined or researched for appropriate scientific data that substantiate its safety and effectiveness.

Family and Support Network

Persons managing the challenges of work schedules should incorporate family and friends into a support network that provides another asset for their efforts. This could take the form of family education about sleep and circadian rhythms, participation in planning alertness strategies, or support in protecting an identified sleep opportunity. Rather than only viewed as another "stress" associated with challenging work schedules, family and friends can be another asset for effectively managing schedules.

An Organizational Perspective

Education

The most important foundation for any alertness management program is education. This education should be provided to everyone in the organization. Although there is a natural tendency to focus on the operational personnel (e.g., drivers, pilots, officers, nurses), it is critical that all members of the organization share a common knowledge and appreciation for the health and safety issues associated with work schedules. This provides a shared information base among operational personnel, managers, schedulers, and other employees who are either affected by or have an effect on work schedules. The alertness management education activities should be implemented through different corporate forums and in varied formats. Programs viewed as just another "safety issue of the month" will have little substantial effect on individual behavior or corporate activities. The organization must determine whether this education is voluntary or required and what evaluation

mechanisms might be used to assess the effectiveness of the educational activities.

Alertness Strategies

Several activities related to alertness strategies require corporate attention. The organization must identify alertness strategies that it explicitly supports and intends to implement. Once identified, these strategies should be visibly supported through appropriate policies or other actions. For example, if planned naps are encouraged during breaks or prior to a commute home, are there appropriate facilities to support this strategy? If adjusting light levels in certain operational environments is part of a corporate strategy, defining responsibility for facility changes and oversight is critical. It is important that corporations determine any relevant federal or industry policies that affect organizational efforts. Any disconnection or conflict among policies can undermine efforts to implement corporate alertness strategies.

Scheduling

Organizations can assess their output or operational needs as a determining factor for designing work schedules. This can lead to identifying personnel requirements, coverage needs, productivity objectives, and so on.

An organization has a range of work schedule options available to consider for meeting its identified needs. These options include fixed schedules and rotation shifts. Fixed schedules include permanent day, evening, and night shifts. Rotating shifts can rotate fast or slow and forward or backward (day, swing/evening, night or night, swing/evening, day). It is critical that an organization examine the full range of scheduling factors that can affect sleep and circadian physiology. Often the emphasis is on the duty or shift length (8 or 10 or 12 hours). Although shift length is one important factor that can affect fatigue and safety, many more factors also should be considered in designing the schedule. A list of some core work-schedule factors are presented in Box 57–2.

These schedule-design factors, while not all-inclusive, do demonstrate that sleep and circadian physiology are affected by much more than just how long an employee is on duty. The complexity and challenges of designing a schedule is fully illustrated when considering how to merge organizational requirements with these core schedule factors that can affect sleep and circadian rhythms.

Box 57–2. Factors in Work Schedule Design

Minimum opportunity for rest or off-duty sleep
Shift length
Work time within duty period
Consecutive work days
Recovery opportunities
Work cycles of days on and days off
Duty time of day versus night
Start and end times of duty periods
Day-to-night duty transitions
Overtime or extended-duty periods
On-call or reserve status and procedures
Duty and recovery opportunities over extended periods

Healthy Sleep

Undiagnosed sleep disorders represent significant health and safety risks for corporations. At a minimum, corporations should provide information about the signs and symptoms of sleep disorders, assistance in locating accredited sleep medicine professionals, and help in determining health insurance coverage for evaluation and treatment. More direct and significant benefits can be obtained by having the corporation support healthy sleep activities. For example, a corporate health promotion program that focuses on sleep apnea can provide individual as well as organizational health and safety benefits. A corporation should determine what activities might be voluntary and which operational personnel would benefit from focused efforts. For these activities to succeed, it is critical that explicit corporate policies be determined and communicated. These organizational policies should be consistent with federal regulations and industry standards.

Policies and Scientific Foundation

As described in the sections on alertness strategies and healthy sleep, any aspect of a corporation's AMP that can be supported with explicit policies should be. If alertness management activities are unclear, unsupported, or interpreted as potentially negatively affecting personnel, there will be little progress toward change. However, clear policies that are communicated broadly and visibly supported will provide tremendous support for a corporation's AMP. It may be that areas of a corporation's AMP will require the corporation to develop a policy because none currently exists. This represents an opportunity to be proactive and potentially create best practices that could lead to industry standards.

It is also critical that a corporation's AMP be based on appropriate scientific data where appropriate. To determine what program elements to implement, management can refer to neutral and objective scientific data. However, it is also crucial to acknowledge that data do not exist to address every operational environment or contingency. Therefore, scientific knowledge can be used to guide operational decisions and actions but may not always address the specific issue in question.

Family and Support Network

Corporations should consider mechanisms that extend the organizational activities into the home. Providing AMP activities that involve family and friends will support individual efforts to engage these networks as an asset in managing work schedules. These activities can include education events, outreach efforts, and corporate communications. Some of the benefits of these activities are clear: Consider the opportunity to have family informed of the signs and symptoms of sleep disorders (e.g., snoring) and their role in encouraging diagnosis and treatment.

A Societal Perspective

Education

Significant progress has been made in providing health information on the importance of diet, exercise, smoking, and other issues, but education on sleep, circadian rhythms, and

sleep disorders severely lags behind. For society to benefit from the already extensive knowledge available in these areas, an explicit effort must be made to integrate activities into all levels of the education system. These efforts should support alertness-education efforts in all aspects of society, beyond formal educational institutions to work settings and all relevant settings confronted by these issues.

Alertness Strategies

Strategies known to effectively promote alertness and performance should be supported and explicitly encouraged. Societal acknowledgment and clear encouragement for addressing work-schedule issues will provide sanctions and permission to overtly engage alertness strategies.

Scheduling

A challenging problem confronts modern society: Around-the-clock activities bust be conducted in a safe and productive manner. It would be heresy to consider ceasing night or around-the-clock operations given modern society's reliance on these activities for the most basic of requirements. Yet the health and safety risks posed by these work schedules are not fully appreciated and certainly not widely addressed in occupational settings. However, this disconnection between need, acknowledgement, and action results in significant societal costs to health and safety for individuals, organizations, and society. Future efforts can focus on aligning societal needs with managing work schedules that will promote alertness, health, and safety in the context of around-the-clock operational requirements.

Healthy Sleep

Like education and alertness strategies, healthy sleep is another area where a societal priority needs to be established that will promote the diagnosis and treatment of sleep disorders. All aspects of this issue should be addressed, for example, educating health care providers, providing insurance coverage for diagnostic procedures and treatment, developing new treatment approaches, conducting research to determine the most effective treatments, and pursuing innovative activities that will identify and treat the significant numbers of undiagnosed individuals.

Policies and Scientific Foundation

Extensive scientific knowledge currently exists regarding the health and safety issues related to managing work schedules. This scientific knowledge can lead societal change, as it has in many other health-related areas, and should be a guide for the specific actions undertaken. Knowledge gaps should be addressed by appropriate research, although application of the formidable existing scientific literature should be a priority. Wherever possible, explicit policies that support alertness management activities and cultural change should be established, visibly enacted, and integrated into ongoing around-the-clock operations. At some point, society will have to confront the liability issues (broadly defined) associated with the work schedules currently required by around-the-clock demands.

ONGOING SCIENTIFIC AND OPERATIONAL CONSIDERATIONS

There is extensive scientific information available to guide effective management of work schedules, but many remaining relevant issues have received minimal attention. The following examples of these ongoing considerations demonstrate the need for further research and operational evaluation of these diverse issues.

Compressed Schedules

The general societal tendency is to compress work schedules for more time off. Although compressed schedules are attractive to workers as a means for having more "home time," the effects on sleep and circadian factors have not been examined. One example is the "quick change over" used typically at the end of a work cycle. In a backwards shift rotation there is a minimum rest period followed by the final duty period of the cycle. Although this can provide more time off, one study found an average of 5.1 hours of sleep obtained during the 8 hours off between the quick change.[60]

Long-Term Effects of Chronic Sleep Loss and Circadian Disruption

Most studies of work schedules involve either short periods of study or laboratory simulations. Of course, individuals work these schedules for months and years over the course of their lives. Although there are some data on long-term health effects of shift work, the potential outcomes from chronic sleep loss and circadian disruption associated with modern work schedules remain generally unknown.

Prescription Medications

There are two obvious applications for the use of prescription medications in addressing work schedule issues: promoting sleep and promoting wakefulness. There are safe, effective short-acting sedative/hypnotic medications (see Chapter 37) that can provide improved sleep in challenging circumstances. For example, workers with day sleep periods or during off-duty transitions between schedules could benefit from increased quantity and quality of sleep by using a prescription sleep medication. The use of a sleep medication could reduce the amount of acute sleep loss experienced prior to a work period. Currently, none of the prescription sleep medications has an indication for use in managing work schedules or specifically to treat shift work sleep disorder.

The first U.S. Food and Drug Administration (FDA)-approved medication for treating shift work sleep disorder is modafinil, which promotes wakefulness. The product insert suggests a dose of 200 mg to be taken 1 hour before the start of the shift. Given the extensive number of work schedule factors that can affect sleep, circadian rhythms, alertness, and performance (see Box 57–1 and Box 57–2), a safe, effective prescription medication that promotes wakefulness could have beneficial applications in many settings and circumstances. For example, unforeseen circumstances that extend work periods, on-call situations, or significant circadian disruption

represent opportunities for a wakefulness-promoting medication to improve alertness and performance.

The issue of using prescription medications to address sleep and alertness issues related to work schedules is a prime example of the ongoing scientific and operational considerations that need attention. With the available scientific literature as a foundation, more clinical research is required to establish the safety and effectiveness of prescription medications in operational use. Future research efforts in this area should reflect actual work scenarios and operational complexity, so that findings can guide safe, effective, and responsible use of prescription medications. Appropriate cautions should be fully acknowledged, and every possible strategy that can promote alertness, performance, and safety should be given consideration and, where suitable, used to its full benefit.

Subjective Disconnection

The current scientific literature clearly demonstrates that there is usually a discrepancy between subjective reports of sleep, alertness, and performance compared to objective measures.[61-63] Generally, people are by objective measures less alert and have more reduced performance compared to their subjective report. This is important because people report that their performance and alertness are better than their actual levels. This disconnection can inhibit a decision to engage an alertness strategy: "don't need it, doing fine." Therefore, the role of sleep loss and circadian disruption and the effects of fatigue will be underestimated and workers will be at risk.

Worker as Patient

Most individuals do not perceive their work experience as making them a patient. There are, of course, many occupational health issues that are known and addressed. However, although many people are significantly affected by sleep loss and circadian disruption from the work-schedule factors in Box 57-1 on a daily basis, few seek intervention for these issues in the health care system. Of course, many of these work-related scheduling issues would not be amenable to a health care intervention. The combination of not perceiving these factors as health and safety risks and the subjective disconnection previously described is the primary reason that workers, organizations, and society continue to be at risk for incidents, accidents, and illnesses.

Sleep Apnea

Sleep apnea is one example of a well-established health and safety risk that is generally ignored in occupational settings. Estimates indicate that of the possible 18 million people with sleep apnea in the United States, less than 10% to 20% are identified and treated.[32,64] Every day, these individuals suffer the personal health consequences of not having their sleep apnea diagnosed, and thus they extend the safety risks to themselves, their coworkers, and the general public.

Drowsy Driving

The data are overwhelmingly clear that drowsy driving poses a significant safety risk for society. In particular, drowsy driving related to work schedules—whether going to work, on the job, or driving home—deserves to be examined more closely and addressed. Alertness Solutions surveys have found alarming levels of drowsy driving on the job: 41% of health care workers reported nodding off while driving and 39% reported a near-miss or accident due to being tired; 20% of a corporate fleet reported nodding off and 14% reported a near-miss or accident; and 45% of police officers reported nodding off and 30% reported a near-miss or accident. These reports were in relation to driving to and from work and specifically involved fatigue or being tired. Occupational settings should consider how work schedules contribute to this significant safety risk and actions that can lead to improving the safety of its workforce.

CONCLUSION

Modern work schedules have evolved dramatically from their roots as traditional shift work to meet historical manufacturing and line operations. There are few data to estimate the actual number of workers challenged by the sleep and circadian disruption engendered by the many modern work-schedule factors that affect these physiologic systems. Current data likely underestimate an issue that could affect 30 to 80 million people in the United States. The sleep loss and circadian disruption associated with today's work schedules create significant health and safety risks for individuals, organizations, and society. The complexity of these issues is best addressed through a comprehensive alertness management approach that involves a shared responsibility among all stakeholders. This approach can be applied to individuals, corporations, and society and provide an opportunity to effectively manage the health and safety risks associated with around-the-clock operations. There remain many challenges as further data are needed to address known work-schedule issues and as current scientific knowledge is more extensively applied to existing risks. Effectively managing modern work schedules and their associated sleep and circadian factors offers an opportunity for sleep medicine to improve the health and safety of millions of workers, corporations, and society.

> ***Clinical Pearl***
>
> *At least one quarter of American workers have schedules that disrupt sleep and circadian rhythms and lead to reduced alertness, performance, safety, and health. Evaluating individuals with sleep and alertness complaints related to their work schedules should include assessment of at least the following: their knowledge about sleep, circadian rhythms, and fatigue-related safety risks; their use and the effectiveness of alertness strategies (e.g., caffeine, naps); specifics of their schedule and work-rest pattern; and the potential of undiagnosed sleep disorders (e.g., sleep apnea). An effective clinical intervention may involve actions focused on each of these areas for optimal outcomes.*

REFERENCES

1. Institute of Medicine, Committee on Quality of Health Care in America: To Err is Human: Building a Safer Health System. Washington, DC, National Academy Press, 1999.
2. Crew factors in flight operations: The initial NASA-Ames field studies on fatigue. Aviat Space Environ Med 1998;69(9 Suppl): B1-B60.

3. Gander PH, Gregory KB, Miller DL, et al: Flight crew fatigue V: Long-haul air transport operations. Aviat Space Environ Med 1998; 69:B37-B48.
4. Gander PH, Gregory KB, Graeber RC, et al: Flight crew fatigue II: Short-haul fixed-wing air transport operations. Aviat Space Environ Med 1998;69:B8-B15.
5. Gander PH, Gregory KB, Connell LJ, et al: Flight crew fatigue IV: Overnight cargo operations. Aviat Space Environ Med, 1998; 69:B26-36.
6. Gander PH, Rosekind MR, Gregory KB: Flight crew fatigue VI: A synthesis. Aviat Space Environ Med 1998;69:B49-B60.
7. Mitler MM, Miller JC, Lipsitz JJ, et al: The sleep of long-haul truck drivers. N Engl J Med 1997;337:755-761.
8. Thomas G, Raslear T, Kuehn G: The effects of work schedule on train handling performance and sleep of locomotive engineers: A simulator study. (No. DOT/FRA/ORD-97-09). Washington, DC, U.S. Department of Transportation, Federal Railroad Administration, 1997.
9. Howard SK, Rosekind MR, Katz JD, et al: Fatigue in anesthesia: Implications and strategies for patient and provider safety. Anesthesiology 2002;97:1281-1294.
10. Gaba DM, Howard SK: Patient safety: Fatigue among clinicians and the safety of patients. N Engl J Med 2002;347:1249-1255.
11. Smith-Coggins R, Rosekind MR, Hurd S, et al: Relationship of day versus night sleep to physician performance and mood. Ann Emerg Med 1994;24:928-934.
12. Sawyer RG, Tribble CG, Newberg DS, et al: Intern call schedules and their relationship to sleep, operating room participation, stress, and satisfaction. Surgery 1999;126:337-342.
13. Defoe DM, Power ML, Holzman GB, et al: Long hours and little sleep: Work schedules of residents in obstetrics and gynecology. Obstet Gynecol 2001;97:1015-1018.
14. Gaba DM, Howard SK, Jump B: Production pressure in the work environment. California anesthesiologists' attitudes and experiences. Anesthesiology 1994;81:488-500.
15. Rogers AE, Scott LD, Hwang WT, et al: Sleep durations reported by 392 hospital staff nurses. In The Paradox of Sleep: An Unfinished Story. An International Meeting in Honor of Michel Jouvet. Abstracts for Symposia, Round Tables and Posters. September 3-4, 2003, Lyon, France. 2003.
16. Peacock B, Glube R, Miller M, et al: Police officers' responses to 8 and 12 hour shift schedules. Ergonomics 1983;26:479-493.
17. Vila B: Tired cops: The importance of managing police fatigue. Washington, DC, Police Executive Research Forum, 2000.
18. Paley MJ, Tepas DI: Fatigue and the shiftworker: Firefighters working on a rotating shift schedule. Hum Factors 1994;36: 269-284.
19. Bonnet MH: Sleep deprivation. In Kryger MH, Roth T, Dement WC (eds): Principles and Practice of Sleep Medicine. Philadelphia, WB Saunders, 2000, pp 53-71.
20. Roehrs T, Carskadon MA, Dement WC, et al: Daytime sleepiness and alertness. In Kryger MH, Roth T, Dement WC (eds): Principles and Practice of Sleep Medicine. Philadelphia, WB Saunders, 2000, pp 43-52.
21. Van Dongen HPA, Dinges DF: Circadian rhythms in fatigue, alertness, and performance. In Kryger MH, Roth T, Dement WC (eds): Principles and Practice of Sleep Medicine. Philadelphia, WB Saunders, 2000, pp 391-399.
22. Dinges DF, Pack F, Williams K, et al: Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. Sleep 1997;20:267-277.
23. Roehrs T, Burduvali E, Bonahoom A, et al: Ethanol and sleep loss: A "dose" comparison of impairing effects. Sleep 2003; 26:981-985.
24. Rosekind MR, Co EL, Gregory KB, et al: Crew Factors in Flight Operations XIII: A Survey of Fatigue Factors in Corporate/ Executive Aviation Operations. NASA Technical Memorandum #2000-209610. Moffett Field, Calif, NASA Ames Research Center, 2000.
25. Co EL, Gregory KB, Johnson MJ, et al: Crew Factors in Flight Operations XI: A Survey of Fatigue Factors in Regional Airline Operations. NASA Technical Memorandum #208799. Moffett Field, Calif, NASA Ames Research Center, 1999.
26. Rosekind MR, Graeber RC, Dinges DF, et al: Crew Factors in Flight Operations IX: Effects of Planned Cockpit Rest on Crew Performance and Alertness in Long-Haul Operations. NASA Technical Memorandum #108839. Moffett Field, Calif, NASA, 1994.
27. FAA Air Traffic Control Shiftwork Survey Results. Alexandria, Va: Human Resources Research Organization, 2001.
28. Maas JB, Wherry ML, Axelrod DJ, et al: Power Sleep. New York, Random House, 1998, p 110.
29. Cochrane G: The effects of sleep deprivation. FBI Law Enforcement Bulletin 2001;70:22-25.
30. Howard SK, Gaba DM, Rosekind MR, et al: The risks and implications of excessive daytime sleepiness in resident physicians. Acad Med 2002;77:1019-1025.
31. Akerstedt T, Torsvall L: Shift work. Shift-dependent well-being and individual differences. Ergonomics 1981;24:265-273.
32. Wake Up America: A National Sleep Alert. Executive Summary and Executive Report. Washington, DC, National Commission on Sleep Disorders Research, 1993.
33. National Transportation Safety Board. Evaluation of U.S. Department of Transportation. Efforts in the 1990s to Address Operator Fatigue (No. SR-99/01). Washington, DC, National Transportation Safety Board, 1999.
34. Dinges DF: An overview of sleepiness and accidents. J Sleep Res 1995;4:4-14.
35. Mitler MM, Carskadon MA, Czeisler CA, et al: Catastrophes, sleep, and public policy: Consensus report. Sleep 1988;11:100-109.
36. Mitler MM, Dement WC, Dinges DF: Sleep medicine, public policy, and public health. In Kryger MH, Roth T, Dement WC (eds): Principles and Practice of Sleep Medicine. Philadelphia, WB Saunders, 2000, pp 580-588.
37. Lauber JK, Kayten PJ: Sleepiness, circadian dysrhythmia, and fatigue in transportation system accidents. Sleep 1988;11:503-512.
38. Rosekind MR, Neri DF, Dinges DF: From laboratory to flight-deck: Promoting operational alertness. In Fatigue and Duty Time Limitations—An International Review. London, Royal Aeronautical Society, 1997, pp 7.1-7.14.
39. National Transportation Safety Board. Marine Accident Report—Grounding of the U.S. Tankship EXXON VALDEZ on Bligh Reef, Prince William Sound, Near Valdez, Alaska, March 24, 1989 (No. NTSB/MAR-90/04). Washington, DC, National Transportation Safety Board, 1990.
40. Presidential Commission. Report of the Presidential Commission on the Space Shuttle Challenger Accident, vol. 2, Appendix G. Washington, DC, U.S. Government Printing Office, 1986.
41. Moss TH, Sills DL: The Three Mile Island nuclear accident: Lessons and implications. Ann N Y Acad Sci 1981;365:1-341.
42. Akerstedt T: Work injuries and time of day—National data. Proceedings of a Consensus Development Symposium entitled "Work Hours, Sleepiness and Accidents." Stockholm, Sweden, 8-10 Sept. 1994, p 106.
43. Melamed S, Oksenberg A: Excessive daytime sleepiness and risk of occupational injuries in non-shift daytime workers. Sleep 2002;25:315-322.
44. Beers TM: Flexible schedules and shift work: Replacing the "9-to-5" workday? Monthly Labor Review 2000;123:33-40.
45. Presser HB, Altmanhe B: Work shifts and disability: A national view. Monthly Labor Review, 2002;125:11-24.
46. Bureau of Labor Statistics: U.S. Department of Labor. Workers on Flexible and Shift Schedules in 2001 Summary. Available at: http://www.bls.gov/news.release/flex.nr0.htm. Accessed February 5, 2004.

47. Bureau of Transportation Statistics: 1995 American Travel Survey. Washington, DC, U.S. Department of Transportation, 1997.
48. Air Transport Association: Air Travel Survey. Washington, DC, Air Transport Association, 1998.
49. U.S. Department of Labor: Report on the American Work Force. Washington, DC, U.S. Department of Labor, 2001.
50. Davis S, Mirick DK, Stevens RG: Night shift work, light at night, and risk of breast cancer. J Natl Cancer Inst 2001;93:1557-1562.
51. Nurminen T: Shift work and reproductive health. Scand J Work Environ Health 1998;24(Suppl 3):28-34.
52. Knutsson A: Health disorders of shift workers. Occup Med (Lond) 2003;53:103-108.
53. Scott AJ, LaDou J: Shiftwork: Effects on sleep and health with recommendations for medical surveillance and screening. Occup Med 1990;5:273-299.
54. Reason J: Human Error. New York, Cambridge University Press, 1990.
55. Rosekind MR, Flower DJC, Gregory KB, et al: General occupational implications of round-the-clock operations. In Kushida CA (ed): Sleep Deprivation. New York, Marcel Dekker, in press.
56. Rosekind MR, Gander PH, Gregory KB, et al: Managing fatigue in operational settings. 2: An integrated approach. Behav Med 1996;21:166-170.
57. Rosekind MR, Boyd JN, Gregory KB, et al: Alertness management in 24/7 settings: Lessons from aviation. Occup Med 2002;17: 247-259.
58. National Sleep Foundation: 1998 Omnibus Sleep in America Poll. Washington, DC, National Sleep Foundation, 1998.
59. Rosekind MR, Gander PH, Connell LJ, et al: Crew Factors in Flight Operations X: Alertness Management in Flight Operations (No. NASA/TM-1999-208780). Moffett Field, Calif, National Aeronautics and Space Administration, 1999.
60. Totterdell P, Folkard S: The effects of changing from a weekly rotation to a rapidly rotating shift schedule. In Costa G, Cesana GC, Wedderburn A, Kogi K (eds): Shiftwork: Health, Sleep, and Performance. Frankfurt am Main, Peter Lang Verlag, 1990.
61. Carskadon MA, Dement WC: Effects of total sleep loss on sleep tendency. Percept Mot Skills 1979;48:495-506.
62. Howard SK, Gaba DM, Smith BE, et al: Simulation study of rested versus sleep-deprived anesthesiologists. Anesthesiology 2003;98:1345-1355.
63. Sasaki M, Kurosaki Y, Mori A, et al: Patterns of sleep-wakefulness before and after transmeridian flight in commercial airline pilots. Aviat Space Environ Med 1986;57:B29-B42.
64. Young T, Evans L, Finn L, et al: Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep 1997;20:705-706.