

Sleep HealthCenters® Newsletter

Lawrence J. Epstein, MD, Editor

October 2006

Sleep Loss, Drowsiness and Performance

By Shantha M.W. Rajaratnam, PhD

Dr. Rajaratnam has a doctorate in Psychology (Chronobiology). From 2004-2006, he has been a Visiting Assistant Professor in Medicine at Harvard Medical School, a Visiting Scientist in Medicine in the Division of Sleep Medicine at Brigham and Women's Hospital, and a member of Harvard Medical School's Work Hours, Health and Safety Group. He is also a Senior Lecturer in Psychology at Monash University in Australia, and is a Psychologist registered in Australia and the United Kingdom.



Sleep curtailment is an increasingly prevalent problem in our society. In the last issue of the Sleep HealthCenters® newsletter (July 2006), Douglas B. Kirsch, MD, presented data from the National Sleep Foundation "Sleep in America 2005" poll showing that adults are currently achieving on average about 6.9 hours of sleep each night, compared to the figure of 8 hours presented in 1959. This finding is consistent with other studies including a British study of 1,997 16-93 year olds, reporting a sample average of 7.04 (SD 1.55) hours of sleep per night (1).

The question of how much sleep an individual actually needs has been the subject of investigation in recent years. At the University of Surrey in England, we studied eight healthy male subjects in a 14-day laboratory protocol, during which they were exposed to extended sleep episodes (time in bed 16 hours) for nine consecutive days (2). Immediately before and after the nine-day sleep extension protocol, subjects were kept awake for 32.75 hours. During the extended sleep protocol, subjects eventually achieved about 8.7 hours of sleep per night after recovering from the initial sleep deprivation (see Figure 1). These data, taken together with the findings of Klerman and Dijk, support the proposition that habitual sleep duration of approximately 7 hours will result in chronic sleep loss in healthy, young individuals (3).

The substantial reduction in habitual sleep duration in recent times has considerable implications for health and safety. Health consequences, in particular impaired glucose tolerance and the increased risk of diabetes mellitus, were reviewed extensively in the last issue of the newsletter. In this issue of the newsletter, we consider the consequences of sleep loss and disruption of the sleep-wake cycle on performance and alertness.

The detrimental effects of sleep loss on alertness and performance have been demonstrated in a range of parameters. For example, total sleep deprivation has been shown to impair reaction time, vigilance, sustained attention, mental arithmetic, short-term memory recall, logical reasoning, tracking ability, word generation, vocal intonation, and mood (for review, see (4)). Electrophysiological and neural imaging techniques have begun to elucidate the neurobiological basis of these deficits.

The mechanisms by which sleep loss impairs alertness and performance can be best understood in the context of the four major sleep-related determinants of alertness and performance (5). Specialized protocols, such as the forced desynchrony protocol in which subjects are scheduled to an irregular day length (e.g., 28-hour day) that desynchronizes the sleep/wake cycle from the circadian pacemaker, are used to evaluate the relative contribution of these factors to neurobehavioral performance. The first of these major factors is the duration of prior wakefulness. Increasing the duration of prior wakefulness will increase homeostatic sleep pressure or sleep drive. From the time of waking until the next sleep episode, homeostatic sleep pressure continues to mount. Saper and colleagues have described a switch mechanism in the hypothalamus, in which the ventrolateral preoptic nucleus plays a key role, responsible for alternating between the behavioral states of sleep and wakefulness (6). Microsleeps and lapses in cognitive attention, which occur after an extended period of wakefulness (i.e., sleep loss), may be behavioral manifestations of the switch between wakefulness and sleep, described by Dinges and colleagues as *state instability* (7). (continued on page 2)

Dear Colleague,

In this issue of the Sleep HealthCenters® Newsletter, Shantha M.W. Rajaratnam, PhD, addresses the impact of sleep loss and drowsiness on performance. He describes the four major sleep-related determinants of alertness – duration of prior wakefulness, duration of sleep, circadian system, and sleep inertia – and how they affect performance. Dr. Rajaratnam is highly qualified in this area, having performed studies on the effect of sleep deprivation on performance as part of the Harvard Medical School Work Hours, Health and Safety Group.

In the CEO Corner, we are pleased to announce our first out-of-state location in New York City. This new facility is affiliated with Beth Israel Medical Center and will open later this fall. Dr. Mangala Narasimhan will serve as the Medical Director.

Our two newest sites in Massachusetts are up and running in Framingham and Stoughton. Each site offers clinic and diagnostic services. We are especially excited to welcome Dr. Sandra Horowitz as the Medical Director of our Framingham site and Dr. Alex White as the Medical Director of our site in Stoughton, affiliated with New England Sinai Hospital and Rehabilitation Center.

As you can see, there is quite a bit of activity occurring at Sleep HealthCenters®. We look forward to sharing news as we continue to progress. If you have any questions about sleep disorders, our services, our affiliations, or our locations, please feel free to contact us.



Sincerely,

Lawrence J. Epstein, MD
Medical Director
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Sleep HealthCenters®
Better Sleep. Better Health.

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Sleep HealthCenters® is a network of sleep medicine centers staffed by experts in the field of sleep medicine. Our integrated care system provides all the services needed to diagnose and treat patients with the entire array of sleep disorders including obstructive sleep apnea, insomnia, narcolepsy and restless legs syndrome.

In this issue of the Sleep HealthCenters® Newsletter...

- ▶ Sleep Loss, Drowsiness and Performance by Shantha M.W. Rajaratnam, PhD
- ▶ CEO Corner:
 - Our Framingham site is now open with Dr. Sandra Horowitz as Medical Director
 - Our New England Sinai Hospital and Rehabilitation Center affiliated site in Stoughton is now open with Dr. Alex White as Medical Director
 - New site opening in Manhattan, New York, affiliated with Beth Israel Medical Center
 - New staff in our CPAP and Business Development teams
 - AASM accreditation at our Beverly and Faulkner labs
- ▶ Research Activities

Affiliations: Massachusetts – Beth Israel Deaconess Medical Center, Brigham and Women's Hospital, Faulkner Hospital, Hallmark Health, McLean Hospital, New England Sinai Hospital and Rehabilitation Center, UMass Memorial Medical Group
New York – Beth Israel Medical Center

Locations: Massachusetts – Bedford, Beverly, Boston, Brighton, Framingham, Jamaica Plain, Malden, Newton, Stoughton, Weymouth, Worcester
New York – Manhattan

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Requisition forms are available on our website.

Sleep HealthCenters® Newsletter

(continued from page 1) Duration of sleep is the second major factor, which is influenced by the amount of sleep not only on the preceding sleep episode, but also in the recent past. Curtailment of sleep over days is also known to increase sleep pressure. For example, 6 hours or less of sleep over 14 consecutive days results in an equivalent level of cognitive performance impairment as 2 days of total sleep deprivation (8). In view of the reported data on average amount of sleep in the American and British populations, the impact of chronic sleep loss on performance is likely to be substantial.

The third determinant is the time of day relative to the individual's internal timekeeping process, controlled by the circadian system. Laboratory and field studies have demonstrated significant impairment of alertness and performance during the biological night-time, when the circadian system is promoting sleep. The circadian system is responsible for generating and maintaining circadian (approximately 24 hour) rhythms, including the sleep-wake cycle. In a discovery over 25 years ago, the site of the primary circadian pacemaker in mammals was found to be the suprachiasmatic nuclei of the hypothalamus. Light has been shown to be the major synchronizing agent for circadian rhythms, achieving this action through daily resetting of the circadian pacemaker. Night-time exposure to light can also have an acute alerting effect in humans, with some evidence to suggest that this effect is achieved through suppression of the pineal hormone melatonin. The alerting and phase-resetting effects of light depend on intensity and wavelength of the exposure. Short-wavelength light, in the blue-ultraviolet range, is more effective than long-wavelength light in suppressing the night-time rise in sleepiness and also the production of melatonin. Light exposure is therefore a potential counter-measure for excessive sleepiness during night shift work.

The final sleep-related factor that influences alertness and performance is the recency of transition from sleep to wakefulness. The impairment in alertness and performance that occurs upon awakening is referred to as sleep inertia. The impairment is reflected in a range of tasks including short-term memory, cognitive function, reaction time, ability to resist sleep, and grip strength. Several factors have been reported to affect the severity of sleep inertia including the circadian phase at which the sleep opportunity and wake time occurred, previous sleep loss, sleep stage at awakening, and exogenous influences. Jewett and colleagues

reported that sleep inertia dissipates in an asymptotic manner and takes 2-4 hours to near the asymptote (9). The impact of sleep inertia on alertness and performance can be particularly detrimental in situations where individuals are required to perform effectively immediately upon waking, such as emergency personnel, medical staff and other extended duty workers, and in individuals who operate a motor vehicle within a short time after awakening.

Each of these factors, alone or in combination, can reduce alertness and performance. Chronic sleep loss or sleep disruption due to sleep disorders can influence any combination of these factors, and thereby further impair alertness and performance. Such impairment gives rise to substantially increased risk of accidents and injuries. In view of these increased risks, a significant challenge for sleep researchers is to educate the general public and the healthcare community about these risks and advocate for the development of policies, in areas such as working time and drowsy driving, that reflect what we have learned.

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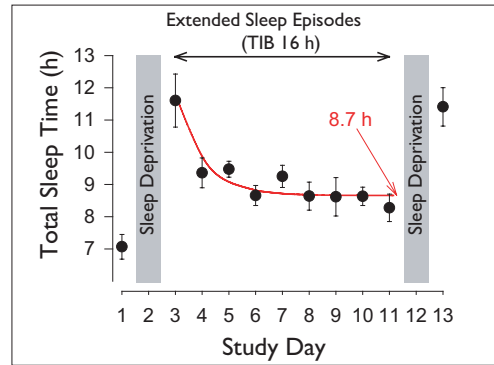


Figure 1: Mean nightly sleep duration in subjects who have 16-hours time in bed.

Time course of mean total sleep time (hours, ± SEM) in 8 healthy male subjects who participated in a 13-day laboratory-controlled trial involving ~8-hours baseline (study day 1), 32.75 hours sleep deprivation (study day 2), extended sleep opportunities (16-hour time in bed, study days 3 to 11), 32.75 hours sleep deprivation (study day 12), and 16-hour recovery sleep (study day 13). The time course has been estimated with an exponential decaying function (red) using a non-linear regression procedure. The asymptote value of the function is 8.7 hours. From (2), with permission from Blackwell Publishing.

Research Activities

Sleep HealthCenters® is proud to work with some of the premier sleep researchers in the country. The following research studies are currently underway in conjunction with our partners:

Apnea Positive Pressure Long-Term Efficacy Study (APPLES) The Sleep HealthCenter® associated with Brigham and Women's Hospital is conducting a NIH-funded study that examines the long-term effects on quality of life, neurocognitive function, sleepiness and mood by using Continuous Positive Airway Pressure (CPAP) to treat sleep apnea.

Positive Airway Pressure Device As part of Sleep HealthCenters® commitment to long term success of therapies to treat sleep disorders, we are currently investigating a standardized clinical program to help patients adjust to their initial experience with CPAP therapy to treat obstructive sleep apnea.

Restless Legs Syndrome The Sleep HealthCenter® associated with Brigham and Women's Hospital is conducting two new research studies on treatments for Restless Legs Syndrome (uncomfortable sensations in the legs accompanied by the urge to move, which generally start during periods of rest and are worse at night).

Operation Healthy Sleep This innovative research project is funded by the National Institute of Justice and is designed to examine and evaluate the impact of sleep disorders and treatment of sleep disorders on the safety, health, and performance of Massachusetts State Police and the City of Philadelphia Police.

Sleep and Menopause This unique study concentrates on understanding the role that hot flashes and sleep disruption play in the effect of estrogen replacement therapy on mood in perimenopausal and postmenopausal women.



CEO Corner

Paul S. Valentine

President and Chief Executive Officer

Sleep HealthCenters® continues to expand to provide quality sleep medicine services in your community. We are excited to announce that as of early September we officially opened our two newest sites in Massachusetts.

The Sleep HealthCenter® at Framingham is located at 125 Newbury Street and offers full clinic services, including treatment, and an eight-bed sleep lab. We are pleased to welcome Sandra Horowitz, MD, FRCP(C), as the Medical Director of the Framingham facility. Dr. Horowitz has built a very strong reputation for clinical expertise and service in the MetroWest area. She is Board Certified in Sleep Medicine, Neurology, and Neurophysiology and is an Associate Professor of Neurology at the University of Massachusetts. In the past, she served as the Medical Director of the Sleep Center at UMASS and at the Sleep Disorders Center of Central New England. She most recently served as the Medical Director of the Sleep Disorders Center at MetroWest Medical Center. We are quite pleased to have her as part of our team.

Case Study

The National Highway Transportation Safety Administration reports that drowsy driving accounts for more than 250,000 motor vehicle accidents each year, and the 2005 Institute of Medicine report on sleep disorders and sleep deprivation estimated that 20 percent of injuries in motor vehicle accidents are accounted for by drowsy driving. These alarming statistics clearly make the case for a comprehensive legislative plan informed by current scientific knowledge to address the problem of drowsy driving. The following legal case study illustrates the potentially disastrous consequences of drowsy driving. The case was heard on appeal in the Court of Appeals of Texas on June 8, 2006.

On March 17, 1998, Robert Ambriz was driving home on Highway 490 after completing a 12-hour night shift. Ambriz was employed on an oil and gas drilling site, and according to evidence presented at trial, the work performed on that shift was particularly exhausting as the workers were in a rush to complete repairs to the rig. The employer required its workers to work 12-hour night shifts for one-week straight, followed by a

week off. On this particular day Ambriz's vehicle crossed the highway median and collided head-on with another vehicle driven by Martin Rodriguez and occupied by three passengers. All five individuals in both vehicles died as a result of the collision. Law suits were brought against Ambriz's estate and his employer asserting gross negligence and wrongful death.

At trial, the jury returned a verdict in favor of the parties bringing the suit. However, the trial court granted a judgment notwithstanding the verdict in the employer's favor. On appeal, it was held that the trial court erred in granting this judgment, and the jury's verdict was reinstated. Importantly, in making this decision, the appeals court held that:

1) the employer had a duty of care to the motorists in the vehicle that collided with Ambriz's vehicle, because "it was aware of the dangers of fatigue and knew of the driver's fatigue prior to the accident"; and 2) since the employer nonetheless permitted Ambriz to drive, it had breached its duty. In their review of the applicable law, the appeals court referred to a previous case involving a fatal car accident caused by an

employee who left the job site intoxicated. In that case, the Texas Supreme Court found that an employer who had knowledge of an employee's incapacity (i.e., by intoxication) and also exercised control over the incapacitated employee, owes a duty to prevent the employee from causing an unreasonable risk of harm to others. The same principle was applied in the present case involving fatigue.

The appeals court considered evidence that the employer had formulated various safety policies, which included a fit-for-duty policy and training to recognize unsafe conditions. However, the company apparently never held meetings to inform workers of the dangers of fatigue. The company also required the designation of a safety captain on shift. However, on the shift in question, it was unclear if anyone was assigned this role.

This case illustrates the dire consequences of drowsy driving, and emphasizes the need for employers to implement effective fatigue management policies as a part of their overall duty to adequately train and supervise employees who work extended hours.

The Sleep HealthCenter® affiliated with New England Sinai Hospital and Rehabilitation Center (NESH) is located on the NESH campus. Diagnostic, clinical, and treatment services are also available at this center. As mentioned in our last edition, Dr. Alex White serves as the Medical Director in Stoughton.

We are very excited to announce our first location outside of Massachusetts in Manhattan, New York. This four-to-six bed center, affiliated with Beth Israel Medical Center (BIMC), will be located at First Avenue and 16th Street. We gladly welcome Mangala Narasimhan, DO, as the Medical Director of the Sleep HealthCenter® at Beth Israel Medical Center. Dr. Narasimhan is Board Certified in Internal Medicine and Pulmonary Disease and Board Eligible in Sleep Medicine and Critical Care Medicine. She currently serves as the Attending in the Division of Pulmonary and Critical Care Medicine and the Director of Sleep Medicine at BIMC.

We also welcome Jennifer Matthews, CRT, as our newest CPAP Counselor. Jennifer has worked as an in-hospital therapist and as a therapist for several homecare companies. She has experience in both CPAP and BiPAP and is also trained as a polysomnographer.

As our business development opportunities are increasing, we are pleased to welcome aboard Kristen Sternat as our Regional Business

Development Manager. Kristen has over 12 years of experience in provider relations, network management and contracting, and most recently built a provider network in the states of Connecticut and Vermont. She will report directly to Rosellen Sullivan, Director of Business Development, to build and maintain strong relationships with hospitals, hospital systems, academic medical institutions, large physician groups, and payors.

Finally, we are pleased to announce that our Beverly and Faulkner labs were granted AASM accreditation in August. We believe that AASM accreditation confirms the efforts we make to provide the best quality of care for our patients. In addition, more and more payors are requiring AASM accreditation for reimbursement. Our Worcester facility was also granted provisional AASM accreditation; we will be pursuing full accreditation in the next few months.

Thank you for allowing us to play a role in the care of your patients. Please contact us if there is anything we can do for you.

