Drowsy Driving

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On the morning of June 26, 2002, a teenage driver fell asleep at the wheel after staying up all night playing video games. He collided with and killed Major Rob Raneri of Holliston, MA just a week before his wedding. This tragedy set in motion a chain of events which resulted in the recent passage in Massachusetts of legislation that restricts teen drivers with junior operator licenses from driving their vehicles between 12:30am and 5:00am, and initiated driver training in the consequences of sleep deprivation.(1)

How widespread is the problem of drowsy driving? What can be done to address it?

Epidemiology. Motor vehicle crashes (MVCs) result in approximately 43,000 deaths each year in the United States, making then the eighth leading cause of mortality at all ages; in individuals less than 35 years of age, they are far and away the leading cause of death.(2) While the role of alcohol and drugs in MVCs has long been appreciated, the importance of drowsiness has only recently begun to be fully recognized.

The scope of the drowsy driving problem is astounding. Fatigue is cited by police officers as the cause of the crash in approximately 56,000 crashes per year and 1,550 fatalities (~3% of fatal MVCs).(3) The true number is believed to be much higher as data on fatigue are not routinely collected by police officers in most states. Thirty seven per cent of drivers report having nodded off while driving, with 10% acknowledging having done so in the past month. One in three of these drivers woke up after drifting out of their lane or onto the shoulder of the road; 19% crossed the center line, and 10% ran off the road. The National Highway Traffic Safety Administration estimates that approximately 292,000 drivers were involved in a motor vehicle crash within the past six months due to nodding off at the wheel.(3) Among commercial truck drivers, the National Transportation Safety Board has cited fatigue as the most common probable cause of fatal-to-the-driver heavy truck crashes, exceeding the number due to alcohol and drugs combined.(4)

These estimates have been corroborated by recent research that has used intensive observational methods to collect prospective data on the causes of motor vehicle crashes. In the 100-Car Naturalistic Driving Study, investigators equipped 100 vehicles with multiple cameras directed at the roadways and drivers, gathering approximately 43,000 hours of data on drivers, motor vehicle crashes, and their causes under routine non-commercial driving conditions.(5) They found that the drivers experienced 82 crashes and 761 near-crashes over the course of a year. Fatigue was a contributing cause in 22% of all MVCs and 16% of all near-crashes, a number far in excess of that suggested by police reports. Extrapolating from this figure to the annual number of MVC fatalities, as many as 8,000 fatigue-related fatal crashes could occur each year in the U.S.

Mechanisms of Drowsy Driving. Sleepiness and consequent performance is determined principally by two neurobiological systems: the sleep homeostat and the circadian system. The *sleep homeostat* is the system responsible for increasing sleepiness with increasing time awake, regardless of time of day. The longer one has been awake without sleep, the greater the drive to sleep. Being awake for 24 consecutive hours impairs reaction time as much as a blood alcohol level of 0.10.(6) In addition, the drive to sleep can build up as a consequence of *chronic partial sleep deprivation*, that is, getting too little sleep for many days in a row. After 10-14 days with 6 hours of sleep per night, the average person's reaction time will deteriorates to a level equivalent to that induced by 24 hours of acute sleep deprivation.(7) The *circadian system* superimposes a near-24 hour cycle of performance on top of the effects due to the sleep homeostat, with the nadir of performance normally occurring a few hours prior to waking (i.e., between approximately 3 and 6am for most people). In addition to these two systems, *sleep inertia,* an impairment of performance in the first few minutes after awakening that can be quite severe, can also lead to performance decrements.(8) Each of these neurobiologic factors, alone or in isolation, can lead to lapses of attention that increase the risk of a drowsy driving crash *(note: further information on these factors can be obtained by reading the article on Sleep Loss, Drowsiness and Performance by Dr. Shantha Rajaratnam, published in the October 2006 Sleep HealthCenters Newsletter).* Drivers operating in the middle of the

night are at particularly high risk of reaction time slowing and a fatigue-related crash if they have been up for more than 16 hours and are operating near the circadian nadir. However, poor reaction time is only part of the problem. Drowsy drivers are also at risk of suddenly falling asleep at the wheel, thereby losing all ability to respond to dangerous situations.

Risk Factors. In many respects, the crash that killed Major Raneri was typical of drowsy driving crashes: the driver who fell asleep was young, acutely sleep deprived, and suddenly drifted across the center line when he fell asleep and crashed. Known risk factors for drowsy driving crashes include the following:

- **Acute or chronic sleep loss**, as described above.
- **Driving at night**
- **Shift work,** due both to circadian misalignment and often chronic partial sleep loss among shift workers
- **Use of sedating medications**
- **Young age.** Two out of three drowsy driving injuries are caused by drivers in their teens and twenties. Most young drivers, however, are completely unaware of the dangers of drowsy driving. Young men appear to be at particularly high risk.(9)
- **Untreated Sleep Disorders**. Obstructive Sleep Apnea Syndrome in particular is associated with a seven-fold increase in risk of road traffic accidents (10). Narcolepsy has also been shown to convey an increased risk of MVCs.(11)
- **Consumption of Alcohol** synergistically interacts with sleep deprivation to degrade driving performance and increase risk more than would be predicted by a given amount of alcohol or sleep deprivation alone.(12)

Beyond an assessment of these individual factors as risks for drowsy driving, clinicians should keep in mind that having multiple risk factors will tend to increase total risk.

Countermeasures. Several countermeasures have been demonstrated effective in reducing the risk of a drowsy driving crash. These are as follows:

- **Avoiding driving (when possible) between midnight and 6am**, near the time of the circadian nadir
- **Napping.** Taking a nap prior to a long drive can decrease the risk of a crash.(13) In addition, pulling over to take a nap when a driver becomes drowsy has been shown to improve performance, though care must be taken to avoid sleep inertia (described above) immediately upon awakening. Even a 15-20 minute nap can be helpful, but ideally, drivers should wait an additional 15-30 minutes after awakening before driving again, to allow the worst effects of sleep inertia to dissipate.
- **Avoiding alcohol when drowsy.**(12)
- **Drinking caffeine.**(13) Caffeine has been found to be most effective as a countermeasure when small doses are taken frequently throughout the waking period,(14) or throughout a long drive.
- **Treatment of Narcolepsy and Sleep Apnea Syndrome.** Successful treatment of OSAS with continuous positive airway pressure (CPAP) therapy has resulted in a six- to seven-fold decrease in driving accident rates (15-17).
- **Reduction of sleep deprivation through reducing the intensity / misalignment of work schedules and employee sleep hygiene**

The following countermeasures have ***not*** been found to be effective:

- Listening to the radio
- Opening the window
- Talking to another passenger or on a mobile phone (in fact, speaking on a mobile phone has been found to increase crash risk in several studies)
- Chewing gum or eating

Altogether, compelling data have emerged demonstrating that drowsy driving is a major public health problem, and one amenable to correction through a combination of safer policies, driver education, and clinician treatment of sleep disorders. Adequately addressing the problem has the potential to substantially reduce the burden of motor vehicle crashes in the United States.

Reference List

(1) Landrigan CP, Czeisler CA. Drowsy Driving in Massachusetts: From Science to Policy. 2007. Accessed April 11, 2008 at http://www.sleepresearchsociety.org/LegislativeProcess.aspx.

(2) Centers for Disease Control and Prevention. Ten Leading Causes of Death by Age Group. 2004. Accessed April 8, 2008 at http://www.cdc.gov/ncipc/osp/charts.htm

(3) National Highway Traffic Safety Administration (NHT). The NHTSA & NCSDR program to combat drowsy driving: Report to the House and Senate Appropriations Committees describing collaboration between National Highway Traffic Safety Administration and National Center on Sleep Disorders Research, National Heart, Lung and Blood Institute, National Institutes of Health. 1999.

(4) National Transportation Safety Board. Safety Study: Fatigue, Alcohol, Other Drugs, and Medical Factors in Fatal-to-the-Driver Heavy Truck Crashes (Volume 1). NTSB/SS-90/01, 1-181. 1990. Washington, DC, National Transportation Safety Board.

(5) Neale VL, Dingus TA, Klauer SG, Sudweeks J. An Overview of the 100-Car Naturalistic Study and Findings. 2006. Accessed April 8, 2008 at http://www.vtti.vt.edu/PDF/100-Car_Fact-Sheet.pdf

(6) Dawson D, Reid K. Fatigue, alcohol and performance impairment. Nature 1997; 388:235.

(7) Van Dongen HPA, Maislin G, Mullington JM, Dinges DF. The cumulative cost of additional wakefulness: Dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. Sleep 2003; 26(2):117-126.

(8) Wertz AT, Ronda JM, Czeisler CA, Wright Jr. KP. Effects of sleep inertia on cognition. JAMA 2006; 295(2):163-164.

(9) Pack AI, Pack AM, Rodgman E, Cucchiara A, Dinges DF, Schwab CW. Characteristics of crashes attributed to the driver having fallen asleep. Accid Anal Prev 1995; 27(6):769-775.

(10) Findley LJ, Unverzagt ME, Suratt PM. Automobile accidents involving patients with obstructive sleep apnea. Am Rev Respir Dis 1988; 138:337-340.

(11) Findley L, Unverzagt M, Guchu R, Fabrizio M, Buckner J, Suratt P. Vigilance and automobile accidents in patients with sleep apnea or narcolepsy. Chest 1995; 108(3):619-624.

(12) Roehrs T, Beare D, Zorick F, Roth T. Sleepiness and ethanol effects on simulated driving. Alcohol Clin Exp Res 1994; 18(1):154-158.

(13) Philip P, Taillard J, Moore N, Delord S, Valtat C, Sagaspe P et al. The effects of coffee and napping on nighttime highway driving: a randomized trial. Ann Intern Med 2006; 144(11):785-791.

(14) Wyatt JK, Cajochen C, Ritz-De Cecco A, Czeisler CA, Dijk DJ. Low-dose, repeated caffeine administration for circadian-phase-dependent performance degradation during extended wakefulness. Sleep 2004; 27(3):374-381.

(15) Engleman HM, Asgari-Jirhandeh N, McLeod AL, Ramsay CF, Deary IJ, Douglas NJ. Self-reported use of CPAP and benefits of CPAP therapy: a patient survey. Chest 1996; 109(6):1470-1476.

(16) Cassel W, Ploch T, Becker C, Dugnus D, Peter JH, von Wichert P. Risk of traffic accidents in patients with sleep-disordered breathing: reduction with nasal CPAP. Eur Respir J 1996; 9(12):2606-2611.

(17) Krieger J, Meslier N, Lebrun T, Levy P, Phillip-Joet F, Sailly JC et al. Accidents in obstructive sleep apnea patients treated with nasal continuous positive airway pressure: a prospective study. The Working Group ANTADIR, Paris and CRESGE, Lille, France. Association Nationale de Traitement a Domicile des Insuffisants Respiratoires. Chest 1997; 112(6):1561-1566.