Brief Review: Sleep Health and Safety for Transportation Workers

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Abstract

Accidents related to sleepiness related fatigue are an important concern in transportation related industries. This brief review outlines the public safety concerns with sleepiness related fatigue in the railroad, aviation and motor vehicle transportation fields. In addition, the common causes of sleepiness related fatigue, and impact on operators and their families are highlighted. It is suggested that in addition to greater recognition and changes in duty hour regulations, there should be a greater emphasis on the education of operators on the importance of sleep and circadian factors in causing fatigue, as well as strategies to mitigate
their impact.

Reports from the Field

The following are two of many potential examples from the National Transportation Safety Board that highlight "The Problem".

Press Release: November 19, 2002
NTSB CITES CREW SLEEP APNEA IN 2001 MICHIGAN RAIL ACCIDENT (excerpt)
On November 15, 2001 Canadian National/Illinois Central Railway southbound train 533 and northbound train 243 collided near Clarkston, Michigan. The collision occurred at a switch at the south end of a siding designated as the Andersonville siding. Train 533 was traveling at 13 miles per hour when it struck train 243. The signal at the turnout for the siding displayed a stop indication, but train 533 did not stop before proceeding onto the mainline track. Train 243 was traveling about 25 miles per hour on a "proceed" signal on the single main track when the accident occurred. Both crewmembers on train 243 were fatally injured. The two crewmen on train 533 sustained serious injuries.
The Board found that both the conductor and the engineer of train 533 suffered from obstructive sleep apnea. Although the engineer was taking prescription medication for high blood pressure and diabetes and had been instructed by his private physician to seek further medical treatment for sleep apnea, his condition was not being treated at the time of the accident. The conductor's treatment was insufficient to successfully mitigate the affects of the condition, the Board found (1).

USA Today and National Transportation and Safety Board (AAR1402): September 9, 2014

NTSB: FATIGUE A FACTOR IN FATAL UPS CRASH
At approximately 4:47 am local time on August 14, 2013, UPS Flight 1354 crashed on approach to runway 18 at Birmingham-Shuttlesworth International Airport. The fuselage broke apart killing both the pilot and co-pilot. The accident was investigated by the National Transportation Safety Board and determined that the pilots failed to monitor their altitude and had descended below the minimum altitude resulting in the plane crashing into the ground below. The Board cited several procedural violations as factors causing the crash, but contributing to the accident were "the captain's performance deficiencies likely due to factors including, but not limited to, fatigue, …" and "the first officer's fatigue due to acute sleep loss resulting from her ineffective off-duty time management and circadian factors" (2,3). On the cockpit voice recorder, the pilots are heard to be complaining of being tired.

The Problem

Two fatal transportation industry accidents. One common root cause—***sleepiness induced fatigue***.

Although it is difficult to estimate the exact number of public transportation accidents that have fatigue as a causal or contributing factor, there is no doubt that operator fatigue is a critical issue. For rail accidents, this statement is supported by analyses from the Collision Avoidance Working Group determining that in 19 of 65 human factors-caused mainline track train collisions, 29.3% involved impaired alertness (4).Furthermore, in testimony before the Senate Subcommittee on Surface Transportation in 1998, the Administrator of the Federal Railroad Administration stated, "human factors account for about one-third of the rail equipment accidents/incidents as well as many personal injuries". She went on to testify that fatigue was an important underlying factor in many of them (5).

Similar concerns were voiced by the Vice Chairman of the NTSB at an aviation fatigue symposium in 2008. In that address, he stated that there had been over 250 commercial aviation fatalities the 15 years prior to his speech as well as numerous general aviation fatalities (6). Since that time, pilot and/or crew fatigue has been cited by the NTSB as a contributing cause of several commercial airline crashes including that of the well publicized Colgan Air Flight 3407 over Buffalo, New York in 2009 (7).

Fatigue related accidents also are widespread in other transportation sectors. The deadly crash of a bus carrying 32 passengers returning from a casino in Connecticut in which the NTSB found that the driver was speeding and was "impaired by fatigue at the time of the accident due to sleep deprivation, poor sleep quality and circadian factors" has been widely publicized" (8). In another event that received national attention, police alleged that the truck driver who critically injured comedian Tracy Morgan and killed another passenger had been awake for more than 24 hours at the time of the crash (9). In Newton, MA, a subway train crashed because the operator failed to brake and was killed. She had untreated sleep apnea (10).

What We Know About the Problem

Why do transportation workers experience increased rates of fatigue? For some transportation industries, work hour regulations allow for prolonged and irregular schedules and schedules that create circadian misalignment. According to The Rail Safety Improvement Act of 2008, railroad personnel may work no longer than 12 continuous hours and all shifts must be followed by a minimum of 10 hours off for undisturbed rest. In addition, they cannot exceed 276 hours of duty in one month and after 6 consecutive days of service they must be given a minimum of 48 hours off duty at their home terminal (11). Consequently, as an extreme example, an engineer could be assigned to work a schedule of 12 hours on and 10 hours off for 6 consecutive days. Although this is a significant improvement in comparison to work hours rules specified in previous regulations (no longer than 12 continuous hours followed by a minimum of 10 hours off duty, and that they be given at least 8 consecutive hours off duty in every 24-hour period), they nonetheless still allow very irregular working hours, unpredictability of scheduling and promote circadian misalignment. In comparison, a commercial airline pilot's flight time is limited to 100 hours per month. However, depending on the number of flight segments and start time, their maximum duty period may be as long as 14 hours (12). Recently, new regulations incorporate variability in duty hours and rest periods to account for the impact of circadian factors on fatigue and sleepiness. Although the FAA encourages cargo airlines to voluntarily follow the new 2014 rule for flight, duty and rest requirements, it does not apply to cargo pilots, many of whom fly exclusively at night (13). A bus driver cannot drive more than 10 hours and not after having been on duty for 15 hours. Resumption of driving can only occur after 8 consecutive hours off duty. Furthermore, no driving is permitted after accumulating 60 hours on duty in 7 consecutive days (14). Truck drivers are limited to an 11 hour driving limit after 10 consecutive hours off duty, and cannot drive after the 14th consecutive hour on duty (14). Even these regulations for transportation workers allow for extended periods of continuous duty, much longer than that the traditional 8-hour work day. Furthermore, although all of these regulations specify rest periods, it is unclear whether operators actually obtain sufficient amounts of sleep.

In a survey of long haul (i.e., single long flight) and short haul (i.e., multiple flight segments per duty period) pilots, sleep deprivation was cited as a significant cause of fatigue and reduction in performance (15). In another study, the amount of sleep obtained by captains and first officers in the 24 hours prior to flight duty ranged from 3 to 13 hours with a mean of approximately 7 hours indicating that a significant proportion obtained insufficient sleep (16). Several studies have demonstrated that under current regulations, rail personnel also obtain inadequate amounts of sleep. In one study analyzing work/rest diary surveys of 200 locomotive engineers, although the average engineer obtained only slightly less sleep than a non railroader, those who started work late at night or in the very early morning slept only about five hours (17). In another study using simulated work schedules allowed by the current hours of service rules, subjects accumulated progressive sleep debt over time (18). Several older studies have documented that long haul truck drivers sleep inadequate amounts as well, with one study documenting less than 5 hours per 24 hour period (19-21). After implementation

of new duty hour rules, there was some increase in the amount of sleep obtained, but it still averaged only approximately 6 hours per 24 hour period (22).

Apart from work hour rules, there are many other factors that contribute to sleep deficiency in the transportation sector. Often transportation workers are required to sleep away from home; accommodations might be in a hotel room or in the cab of a truck. Even sleeping at home may be challenging if that sleep occurs during daytime hours when noise, light and family obligations make it difficult. Additionally, the allotted rest time between shifts might be insufficient to accommodate long commutes and other tasks of daily living as well as sleep.

The health impact of sleepiness induced fatigue extends well beyond the obvious increase in human factors accidents. Accumulating data now implicate inadequate or short sleep duration as a risk factor for cardiovascular disease, hypertension, diabetes and obesity (23-25). Moreover, shift work is now considered by the World Health Organization as a probable risk factor for cancer (26). Thus, given their higher probability of experiencing chronically insufficient sleep, it is likely that transportation workers are at greater risk for these adverse health consequences of inadequate or short sleep duration than members of the general non-shift-working population.

There is also a link between insufficient sleep and behavioral health problems. Sleep deprivation is associated with acute worsening of mood, with complaints of irritability, depression, and decreased motivation (27-29). In the setting of a pre-existing mental illness, sleep deprivation may trigger a change in condition (30). There is no reason to suspect that transportation workers would be less susceptible to the behavioral consequences of sleep deprivation. Insufficient sleep is also known to adversely affect judgment (31). This can lead the person who has had insufficient sleep to underestimate its effect on his/her performance.

Fatigue is not the only issue adversely impacting the performance of transportation workers. Long hours and irregular schedules leading to chronic sleep deprivation can impact their personal lives which in turn can result in performance degradation. For example, the impact of fatigue on the family lives of train operators was extensively explored in study by Holland in 2004 (32). He found three general themes:

1. Emotional issues impacting the family such as mood swings and irritability, and the need to compensate in some way for these;
2. The need for family support and awareness;
3. Social implications of the erratic schedules leading to isolation and frustration because of the inability to have a normal social life.

The importance of social well-being (leisure time and marital relationships) was further emphasized in another study of 276 railroad engineers and conductors at a North American railroad. In this study, the investigators found that social-well being was a significant mediating factor in the causal pathway between organizational factors (i.e., scheduling) and fatigue (33). Such findings are not unique to railroad workers. In a

study of airline pilots, mental health was associated with fatigue and lack of family social support (34). In a study of truck drivers, almost half of the drivers felt that their work interfered with their family responsibilities and those who drove more endorsed more issues with their family life (35).

Further exacerbating the impacts of chronic sleep deprivation and shift work is the specter of primary sleep disorders themselves. Obstructive sleep apnea syndrome is conservatively estimated to have a prevalence of 2 to 4% in middle-aged women and men respectively, but rates of polysomnographically defined obstructive sleep apnea may be as high as 9 and 24% in women and men from this same study (36). A more recent study conducted in Australia found the prevalence of OSA in middle-aged men to be 53% (37). It is generally accepted that obstructive sleep apnea is underdiagnosed and most afflicted individuals are either undiagnosed or inadequately treated (38). If one excludes the pervasiveness of chronic sleep deprivation, insomnia is one of the most common sleep disorders with a point prevalence rate of approximately 30% (39). Chronic insomnia is present in 10% of the general population, and tends to be an unremitting condition (40,41). Common complaints associated with insomnia are fatigue and sleepiness. Shift work as experienced by transportation workers is a cause of insomnia. Other sleep disorders such as restless legs syndrome, periodic limb movement disorder and narcolepsy also express themselves as causes of fatigue and/or sleepiness.

In general, workers in most transportation industries are hesitant to seek medical evaluation and treatment for sleep problems. Perceived or real concern about loss of employment tends to discourage those afflicted from seeking medical care. This results in large numbers of persons with untreated conditions working in potentially dangerous environments. For example, it is estimated that using a moderately conservative definition of obstructive sleep apnea, 46% of long-haul truck drivers have this condition (42). One can surmise that there are significant numbers of undiagnosed and hence untreated individuals with obstructive sleep apnea in other transportation industries as well.

What to do About the Problem

There are three components to addressing the issue of sleepiness related fatigue in the transportation industry. The first, admission that a problem exists, has been increasingly recognized by policy makers, the industry and workers as reflected by statements and presentations by these parties. The second is appropriate revision of duty hour regulations to make them consistent with scientific evidence related to the effects of sleep deprivation, circadian misalignment and their impact on performance. To some extent, this has resulted in revision of duty hour regulations in the railroad and the aviation industries. However, as evidenced by the exception given to cargo airlines, not all workers are covered. Moreover, a portion of the hours of service regulation for trucking that was enacted in 2011 has been recently rescinded, eliminating mandated rest. Additional changes are needed, but are difficult to implement because of the financial impacts they might have on employers. One of the reasons that cargo airlines

were exempted from the new duty and rest regulations was that the calculated financial cost exceeded any benefit irrespective of the impact on the personal lives of the employees (13). The third component is focused on operator education. The importance of this was recognized in the Rail Safety Improvement Act of 2008 (43). In the statute, each railroad was mandated to develop a "fatigue management plan" that needed to incorporate "Employee education and training on the physiological and human factors that affect fatigue, as well as strategies to reduce or mitigate the effects of fatigue, based on the most current scientific and medical research and literature", as well as "Opportunities for identification, diagnosis, and treatment of any medical condition that may affect alertness or fatigue, including sleep disorders." Studies have demonstrated that operator educational programs decrease fatigue related accidents. For example, in a recent study of Australian truck drivers, crash rates were higher among those who had not completed a fatigue management program (44).

Although individual industries and employers are at liberty to develop their own fatigue management educational programs, such efforts are not necessarily comprehensive or viewed by employees as containing unbiased information. Thus, there is a need to provide a source of information pertaining to sleep and circadian science, sleep disorders, fatigue/sleep deprivation mitigation strategies, self-evaluation assessment and pathways to seek treatment that is both scientifically accurate and unbiased to assist transportation workers, their families as well as other interested parties. To achieve the most impact, education should be customized to the industry, using the specific industry "language" and fatigue-driven scenarios that apply to the workers in that industry. Consequently, there is an opportunity for disinterested third parties to develop educational fatigue management resources. An example is the educational website, http://www.railroadersleep.org, developed by Division of Sleep Medicine at Harvard Medical School under contract from the Volpe National Transportation Center and the Federal Rail Administration. Other resources can be found at websites sponsored by the American Academy of Sleep Medicine http://www.sleepeducation.com and the National Sleep Foundation (http://sleepfoundation.org).

Fatigue related to sleep deprivation remains commonplace in the transportation industries. Crashes caused by fatigue can have catastrophic consequences on both societal and personal levels. There needs to be greater action to eliminate these events including appropriate revision of duty hour regulations using the best available scientific evidence as well as individual operator education on ways to recognize and mitigate fatigue related to sleep deprivation.

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