Safety, Economic and Health Consequences of Sleep Loss and Fatigue in Shift Work

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Fatigue in Shift Work

A key problem in shift work operations is difficulty obtaining adequate sleep while off duty, especially during the daytime[1]. Indeed, it has been estimated that 75% of night shift workers experience fatigue every night, with 20% of them reporting they fall asleep on the job[2].

In a study of the aviation maintenance work environment, maintenance personnel were found to obtain an average of about 5 hours of sleep per day[3]. Laboratory research has revealed that this level of sleep restriction leads to cumulative declines in cognitive performance, equivalent to what is seen after *not sleeping at all* for a day or more[4, 5].

Performance and Safety

Fatigue increases the risk of errors, incidents and accidents[6]. The operational relevance has been illustrated in a sleep deprivation study of an airport bag screening task, which showed that threat detection accuracy decreased while false alarm rates increased following sleep loss[7]. In aviation maintenance operations, the circadian rhythm (i.e., 24-hour rhythm of the biological clock) in fatigue has been found to be associated with a nighttime peak in skill-based errors[8].

Risks from fatigue are not only encountered during work hours, but also when off duty, with time spent on the road (e.g., while commuting) being particularly risky. Fatigue is believed to be a contributing factor in many road accidents, for example, in 30%–40% of accidents involving heavy trucks[9]. In many cases, this is an issue of not getting enough sleep rather than how long the driver has been on duty. There is also a distinct effect of the circadian rhythm on the risk of road accidents[10]. In other words, time awake and time of day affect a person's fatigue risk.

These findings emphasize the importance of accounting for sleep loss in interaction with time of day when managing fatigue[10–13]. This has been recognized in time-of-day-dependent provisions in notices of proposed rulemaking (NPRMs) recently issued for commercial vehicle drivers and for flight crews[14, 15].

Economic Consequences

Sleep loss is causing U.S. employers approximately $136 billion per year or more in lost productivity due to do-overs, unproductive work time and absenteeism[16]. To get a sense of magnitude, compare this to the economic burden of drug abuse ($124 billion) or cancer ($69 billion)[17, 18]. Such numbers have a significant effect on the corporate bottom line.

The economic impact of fatigue-related *incidents and accidents* is not precisely known, but believed to be substantial. A large-scale study conducted by the Federal Railroad Administration[19] exposed that at least $46 million worth of property damage in railroad accidents, per year, is caused by human factor errors likely to be related to fatigue. No comparable statistic is currently available for aviation.

Health Hazards

Other than through accidents, fatigue also affects personal safety and health in more subtle ways. Repeatedly not getting enough sleep is believed to increase the risk of a variety of chronic medical problems[20, 21]. Sleep loss disrupts the balance between the hormone ghrelin, which stimulates appetite, and the hormone leptin, which dampens hunger [22]. This disruption leads to craving of unhealthy (fatty) foods when awake at night, and dysregulates glucose metabolism[20]. This can lead to obesity[23], which in turn increases the risk of sleep apnea[24], a sleep-related breathing disorder causing fragmented sleep and further sleep loss[25]. The result is a vicious circle of abnormal metabolic, hormonal, cardiovascular and nervous system functioning known as metabolic syndrome[26], which tends to produce various other negative health outcomes such as cardiovascular disease[27] and diabetes[28]. See Figure 1.

A variety of health issues are reported by personnel working shifts[29]. Symptoms include depression, gastrointestinal problems, compromised immune function, substance abuse, and cardiovascular disease[30]. Healthy lifestyles focusing on diet and exercise (without giving up sleep to make time for exercise) help to counteract the adverse health consequences of fatigue[31], as does transferring to daytime work[1].

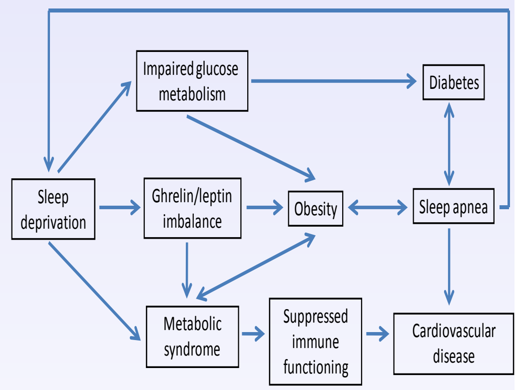

Figure 1: Simplified diagram displaying associations between chronic sleep loss and adverse health outcomes.

Take-Home Message

Fatigue has a critical impact on safety, productivity, health and well-being – and this comes with significant economic and societal costs. As a technician or an executive, the return on investment for implementing fatigue risk management strategies is expected to be high[32].

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