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EDITORIALS

Industrial Regulation of Fatigue: Lessons Learned From Aviation

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In July of 2017, an Air Canada plane carrying 135 passengers came within 20 feet of another aircraft as the pilots inadvertently navigated the airplane to land on a taxiway at San Francisco International Airport.[1] This event occurred during the biological night of the pilots and after the captain had been awake for 19 consecutive hours.

Had the pilots been employed by a United States airline, they would not have been allowed to fly at such a vulnerable time due to Federal Aviation Administration (FAA) work-hour restrictions. Fatigue arising from sleep loss and circadian misalignment has long been recognized as a threat in safety-sensitive occupations that require 24-hour operations. Despite the clear science characterizing changes in human performance during extended-duty and night shifts, tension between economic concerns and duty-hour regulation often prevent proactive fatigue management in industry.[2] In the future when organizations such as the Federal Motor Carrier Safety Administration (FMCSA) reconsider their hours-of-service regulations, lessons learned from the regulation of fatigue in aviation may provide a useful model for rulemaking in other industries.

Fatigue risk is difficult to regulate due to inter-individual differences in response to sleep loss and the murky relationship between work-hour regulation and an individual's actual sleep practices. Regulating work hours does not always result in more sleep. For example, a worker with a night owl chronotype who is required to work from 9:00 AM to 5:00 PM could end up working during the sleepiest part of his or her circadian cycle in the morning, resulting in fatigue during the morning commute and while on the job, despite a work-hour requirement that on the surface appears unlikely to cause a fatigue state. In situations that require around-the-clock operations, the relationship between work hours and fatigue is more complicated, because a conscientious employee may genuinely try to sleep while being off-duty, but may be unable to achieve sleep if off-duty time coincides with an alert portion of the circadian cycle.[3] Similarly, an individual may obtain what he or she considers to be adequate sleep to support good performance, yet still be at elevated risk for fatigue-related error during work times when the circadian rhythm corresponds with low levels of alertness.[4]

These misunderstandings are fueled by lack of knowledge regarding how the circadian and homeostatic drives for sleep interact with work hours. Although duty-hour limitations are an important component in minimizing fatigue-related error, the complexity of the underlying causes of fatigue necessitate a nuanced approach to combating fatigue in the workplace. This has been addressed in the aviation sector through restricting work hours, requiring augmented crew on long-haul flights, and through the implementation of a fatigue risk management system (FRMS).[5] This approach has significant translational potential for other safety-sensitive occupations.

In general, limiting work hours alone is insufficient to combat fatigue. In 24-hour operations, however, sleep and circadian research indicates that limiting work hours mitigates the likelihood that work schedules alone will cause unacceptable levels of fatigue. In aviation, the FAA has embraced a time-of-day-based approach to duty hours, whereby a pilot is allowed to fly for a longer duration during the day compared to the night.[5] This approach is based on many years of research demonstrating that performance is degraded during the biological night due to the added influence of the circadian rhythm, in addition to duration of continuous time awake. The National Transportation Safety Board's findings from Air Canada's near-miss incident highlight how a less stringent approach to nighttime work hours undermines safety. Current FMCSA rules give no consideration for time-of-day influences on alertness and performance, despite studies demonstrating that falling-asleep-at-the-wheel accidents peak following extended wakefulness at the circadian nadir, and as the recent Air Canada incident clearly shows. Although there are likely strong economic and practical cases for allowing transportation workers to operate for long hours during the biological night (eg, driving during the night when there is less traffic), scientific evidence does not support such allowances.

Eliminating all night work would be one solution to combat workplace fatigue, but such a drastic approach would come at a significant economic cost. While it is difficult to reconcile the competing interests between economics and safety, the FAA has responded to concerns from the aviation industry about work hour limitations by requiring the implementation of an FRMS.[6] An FRMS is a program embedded within an organization that provides fatigue education to employees, researches fatigue in operations, and engages with the regulator to propose "alternative methods of compliance" (AMOC), which is an evidence-based request to relax duty-hour restrictions for specific operations.[7] In this way, work hours are tightly restricted to promote safety, but a company may identify situations in which modest extensions to work hours are likely to pose no additional risk to safety. In these cases, the company is able to conduct a research study to support an AMOC request, and then if the safety case is met, the FAA may allow the company to extend operations for that route. An additional benefit to having an in-house FRMS is that the data acquired from a given company's operations can inform educational campaigns and can be used to apply lessons learned that are specific to the nature of that company's operation. The FMCSA provides fatigue education through the North American Fatigue Management Program, but it is unclear whether this program is effective.[8] The adoption of an aviation-style FRMS in the motor carrier industry would have the potential to provide evidence-based fatigue mitigation strategies that improve safety while providing operational flexibility. Unlike the more consolidated airline industry with its greater resources, most trucking and bus companies lack the resources needed to develop and implement their own FRMS. Therefore, FMCSA, in collaboration with the motor carriers, should take the lead in conducting research and collecting much-needed data on how interventions, such as the implementation of flexible sleeper berths, might mitigate fatigue.

No perfect solution to managing fatigue in industry exists, but lessons learned from nearly 40 years of effort in the aviation sector suggest that a multi-pronged approach is prudent. Best practices include work-hour requirements that adhere to scientific principles, continuous education for workers, and review and revision of requirements through an FRMS. There are still areas of concern that must be addressed in aviation, such as the impact of commuting across time zones for work and minimal screening for sleep disorders for pilots. However, the way that the aviation industry has approached fatigue management using evidence-based work-hour restrictions, combined with providing companies the opportunity to continually research and revise their operations, is a solid foundation for combating fatigue that can serve as a model for other industries.

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