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Applied Fatigue Risk Management for Transit: Biomathematical Modeling in the Analysis of Recorded Events

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Problem
Despite a number of serious accidents attributed to fatigue-related impairment, there are currently no federal regulations specifically governing fatigue management in U.S. public transit operations [1]. Pending the development of national regulations, the Washington Metropolitan Area Transit Authority has put in place an organizational Fatigue Risk Management System (FRMS) to address the risk of fatigue-related impairment in operations. The program includes a number of individual initiatives each intended to reduce the risk of fatigue-related impairment throughout the organization. Biomathematical modeling is employed within the FRMS, including as a part of work scheduling practices and in retrospective incident analyses.

Method
Video event recorders installed throughout the bus fleet are triggered by unusual driving events including speeding, hard braking and collision near misses. While these events do not typically constitute reportable incidents, they are routinely used within operations to coach drivers on safe behaviors. The scope of this preliminary analysis included a set of 882 events captured in 2015. Operator work schedules in the 30 days prior to recorded events were input to the Sleep, Activity, Fatigue, and Task Effectiveness Fatigue Avoidance Scheduling Tool (SAFTE-FAST) biomathematical model and application to: (1) estimate the performance effectiveness (expressed as a percentage relative to an optimal performance) at the time of the recorded event and (2) to estimate a profile of performance effectiveness in the weeks leading up to the event [2]. The SAFTE-FAST auto sleep function was used to estimate daily sleep timing and duration throughout the modeled schedules [3].

Results
The events in this subset make up about 10% of all video recorder events captured in 2015. When work schedules were modeled using auto sleep assumptions, estimated effectiveness at the time of event ranged from 63.4% to 100% effectiveness, where 93.6% of the events in the subset occurred at times where performance effectiveness was estimated to be $\geq$ 90%.
Published reports on rail human factor accidents indicate an elevated risk where personnel effectiveness is estimated below 70% [4]. Analysis of the 30-day work schedules leading up to recorded events revealed 74 schedules with any time below 70% effectiveness, accounting for about 8% of schedules analyzed.

Discussion
Analyses are ongoing to establish the relationship between work scheduling factors and the likelihood of recorded driving events of different types. The outcome of these analyses will serve to inform the larger FRMS, including how sleep hygiene education can be incorporated with the driver coaching that typically follows recorded video events. Updated investigation procedures now employ biomathematical modelling to assist investigators in establishing the potential role of fatigue-related impairment in reportable incidents. The present analyses also underscore the value of sleep data collected from operational groups to both inform auto sleep settings used and further improve model-based estimates.

Summary

Preliminary results of an ongoing analysis are presented here. Work schedules for operators captured by on-board event recorders were modeled to estimate performance effectiveness at the time of, and in the weeks leading up to, a captured event. The results of these analyses are intended to further inform customized development of the transit FRMS.

Ongoing analyses will establish what specific relationships exist between fatigue risk as driven by the work schedule and specific driving event types, to better coach drivers on fatigue risk management within the FRMS. The proportion of events that were not associated with an estimated performance impairment suggests the importance of personal sleep hygiene coaching as a part of the overall FMRS.

References

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