



United States Department of Transportation
FEDERAL MOTOR CARRIER SAFETY ADMINISTRATION

Meeting Summary

The U.S. Department of Transportation's (DOT) Federal Motor Carrier Safety Administration (FMCSA or the Agency) Medical Review Board (MRB) convened on February 13, 2013, in Alexandria, Virginia. The meeting was open to the public.

Attendees

Board Members:

Christine Cisneros, M.D.
Benjamin H. Hoffman, M.D.
Brian T. Morris, M.D.
Albert J. Osbahr III, M.D.
Gina C. Pervall, M.D., Committee Chairperson

FMCSA Staff:

Peter Chandler
Anne Ferro, Administrator
Theresa Hallquist
Valerie Height
Benisse Lester, M.D., Chief Medical Officer
Robert Miller
Larry W. Minor, Associate Administrator for Policy, Designated Federal Officer
Martin Walker
Angela Ward, R.N., Nurse Consultant
Shannon Watson, Senior Policy Advisor
Tom Yager, Chief of Driver and Carrier Operations Division

Expert Panel:¹

Gregory Belenky, M.D., FAPA, Professor and founding Director, Sleep and Performance Research Center at Washington State University, Spokane
Richard Hanowski, Ph.D., Director, Center for Truck and Bus Safety at Virginia Tech Transportation Institute
Paul Jovanis, Ph.D., Professor, Pennsylvania State University, University Park

FMCSA Contractors:

Meredith Calloway, M.S., Manila Consulting
Jennifer Ibekwe, Manila Consulting
Michelle Tregear, Ph.D., Manila Consulting
Stephen Tregear, Manila Consulting

¹Drs. Hanowski and Jovanis were not able to attend the meeting.

Members of the Public:

Megan Benfatti, National School Transportation Association
Kristin Butterfield, American Academy of Physician Assistants
Shaun Kildare, Advocates for Highway and Auto Safety
Norm Littler, American Bus Association
Jana Price, National Transportation Safety Board
Boyd Stephenson, American Trucking Associations
Alan Teaford, Verizon Environmental Health and Safety

Call to Order, Official Remarks, and Agenda Review

Gina C. Pervall, M.D., FMCSA MRB Committee Chairperson,² explained the meeting's purpose: to discuss fatigue and commercial motorcoach and bus driver safety and invited Board members and others to introduce themselves.³ Meeting attendees received an agenda, and Dr. Pervall introduced Meredith Calloway, M.S.

Evidence Report on Fatigue and Motorcoach/Bus Drivers

Ms. Calloway and Dr. Michelle Tregear of Manila Consulting Group (Manila) presented the findings from a literature search and analysis of evidence relevant to four key questions concerning driver fatigue that FMCSA developed. Manila compiled these findings in the *Fatigue and Motorcoach/Bus Driver Safety Evidence Report* (Evidence Report), the stated purpose of which is "to assess and characterize the relationship between crash and fatigue in generally healthy motorcoach drivers." As preface to presenting Manila's findings, Ms. Calloway explained the scope of the Evidence Report as an examination of "nonpathologic fatigue," or fatigue caused by factors other than sleep or medical disorders such as obstructive sleep apnea, or other health issues. Regarding commercial motor vehicle (CMV) operation, she said the causes of nonpathologic fatigue are insufficient sleep, disrupted circadian cycles, driving-related stress, and monotony.

Key Question 1A: What impact does nonpathologic fatigue have on crash incidence?

For Key Question 1, Ms. Calloway noted that there is no evidence correlating motorcoach crash incidence to driver health, and few studies of motorcoach driver performance. She said that because of this lack of evidence, Manila examined studies of other healthy drivers, focusing on studies of other healthy CMV drivers (primarily truck drivers). Ms. Calloway stated the evidence for the driver population studied suggests that crash incidence begins to increase after 5 or 6 hours of driving time and continues to increase until the end of driving time, typically from 8 to 11 hours. In response to a question from an MRB panel member, Ms. Calloway noted that although the total driving time across studies varied, the

²Dr. Pervall, Medical Director for Johns Hopkins University's Applied Physics Laboratory in Laurel, Maryland, also provides services for the Washington Metropolitan Area Transit Authority (WMATA) in Washington D.C. and serves on the Medical Advisory Board for the Maryland Motor Vehicle Administration.

³Other MRB members included Christine Cisneros, M.D., with U.S. Health Works in Indiana; Benjamin H. Hoffman, M.D., Medical Director at General Electric and professor at the University of Texas, School of Public Health; Brian T. Morris, M.D., physician and attorney for One Health; and Albert J. Osbahr III, M.D., occupational physician from Hickory, North Carolina. FMCSA staff present included Larry Minor, Associate Administrator for Policy and Designated Federal Officer; Benisse Lester, M.D., Chief Medical Officer; Angela Ward, R.N., MRB liaison; Shannon Watson, Senior Policy Advisor to the Associate Administrator for Policy; and Tom Yager, Chief of Driver and Carrier Operations Division. Meredith Calloway, M.S., and Michelle Tregear, Ph.D., of Manila Consulting are FMCSA contractors.

trends among studies were consistent: Crash incidence generally is highest during overnight and early morning hours, and between 2:00 p.m. and 4:00 p.m.

Key Question 1B: What impact does nonpathologic fatigue have on driving ability?

Ms. Calloway said Manila analyzed studies of the effect of fatigue on driving ability for other CMV drivers (primarily commercial truck drivers) based on critical event rates, and for noncommercial passenger-vehicle drivers (including college students and other noncommercial passenger-vehicle drivers) based on simulator observations. She said that for the commercial truck driver population, the evidence suggests an increase in critical event rates “over 11-hour driving shifts.” For the noncommercial driver population, she said simulator performance evidence suggests that insufficient sleep leads to greater incidence of simulated crash and simulated unintentional lane departure.

Key Question 2: How much rest does a fatigued professional driver need to resume driving unimpaired?

Ms. Calloway said that the major driver population studied for this topic was truck drivers. In this context, she said “rest” included naps, time before shift, and restart. Ms. Calloway reported the following findings.

- Resting or napping for 30 minutes during a work break might reduce the incidences of crashes, near crashes, or other safety critical events, but evidence to determine the minimum effective rest or nap period is insufficient.
- Four studies collectively suggest that to reduce the incidence of driving-related functional impairment, drivers need a minimum of 4 to 6.7 hours of sleep in a 24-hour period before driving and a minimum of 8 to 12 hours in a 48-hour period before driving.
- In a study⁴ analyzing fatigue in a population of motorcoach drivers, researchers concluded that consecutive hours of sleep during the night is “more beneficial” than divided sleep (i.e., sleeping partly during the day and partly at night). This same study showed that divided sleep “is better than consolidated sleep in the daytime.”
- Two studies indicated that with less sleep comes greater sleepiness, especially among drivers sleeping less than 4 to 4.75 hours overnight. (In response to a question from an MRB panel member, Ms. Calloway said “rest periods” means actual sleep hours, rather than just the opportunity for sleep.)
- Regarding restart (i.e., the primary off-duty period), determining the number of hours off a driver needs to reduce fatigue and sleepiness and to improve or maintain function is impossible to conclude from the evidence.

Key Question 3a–d: How do motorcoach/bus drivers differ from truck drivers in terms of the following attributes: demographics, job function, work environment, and health-related behaviors and disease characteristics?

Regarding Key Questions 3 and 4, Dr. Michelle Tregear⁵ presented the findings of the literature research and analysis. She explained the relationship between these two questions, observing that Question 3 is aimed at assessing whether motorcoach drivers differ with respect to demographics, job function, work environment, and health-related behavior and characteristics; and Question 4 addresses whether those differences affect the risk of “acute nonpathologic fatigue.” Dr. Tregear said Manila searched literature

⁴Belenky et al. 2012. Motorcoach Driver Fatigue Study, 2011, <http://www.fmcsa.dot.gov/facts-research/research-technology/report/Motorcoach-Driver-Fatigue-Study-2011-508.pdf>. Unless otherwise noted, presenters did not provide the titles or authors of the studies referenced in their presentations before the MRB.

⁵Dr. Stephen Tregear made no statements in the record of the February 13, 2013 meeting.

for the preceding 10 years pertaining to truck drivers, motorcoach/bus drivers, and transit bus drivers in the United States. She said supporting data for Key Question 3 came from the U.S. Bureau of Labor Statistics, 39 moderate-to-large cross-sectional or cohort studies with truck drivers and motorcoach/bus drivers, and 2 new (2013) studies on motorcoach and bus drivers. Dr. Tregear presented the following information.

Demographics (i.e., gender, race/ethnicity, age, education, income, marital status,⁶ and job tenure)

- Most truck and motorcoach/bus drivers are male, and most truck drivers (approximately 82 percent) are white. There are more black motorcoach/bus drivers (27 percent) than there are black truck drivers (14 percent).
- Among female commercial drivers, more drive motorcoach/buses (22.2 percent) than drive trucks (4.5 percent).
- The mean age of truck drivers is 43.7 years. For motorcoach/bus drivers, the mean age is 48 years.
- The percentage of truck drivers who lack a high school diploma (17.8 percent) is greater than the percentage of motorcoach/bus drivers who lack a diploma (10.6 percent).
- Truck drivers earn more than motorcoach/bus drivers do (approximately \$1 more per hour and \$2,000 per year during the preceding 10 years).
- Job tenure for a truck driver is 10.6 years, and 16.6 years for a motorcoach/bus driver.

Job Function (e.g., roads travelled, distance travelled, driving time, total time worked, and opportunities for rest)

- Average trip lengths for truck drivers are longer (approximately 500–1000+ miles) than for bus drivers (approximately 300 miles), and truck drivers drive more miles per week on average (approximately 2,449 miles) than do bus drivers (approximately 1,200 miles).⁷
- Truck drivers spend about 60–66 percent of every shift driving. Of truck drivers in the studies, 60 percent reported driving less than 10 hours per day, and 40 percent reported driving between 10 and 11 hours per day. Most bus drivers drive approximately 8 to 10 hours per day (10 hours is the maximum permitted under current regulations), and 42 to 44 hours a week. Split-shift bus drivers drive about 4 more hours per week than straight-shift local bus drivers (47.65 hours versus 43.52 hours, respectively).⁸
- For motorcoach drivers, the mean duty hours per week was less than 43 hours for drivers who described themselves as engaged in one of the following passenger-carrier operations: charter, tour, regular route, and commuter express. The mean total duty time was approximately 9 hours for drivers in the four operations.⁹
- Breaks for split-shift truck drivers range from 3 to 4.5 hours.¹⁰

⁶We have no record of Dr. Tregear's comments on marital status as a demographic factor distinguishing motorcoach/bus drivers from truck drivers.

⁷Dr. Tregear noted that limited data are available regarding distance travelled by motorcoach/bus drivers. (Note that the limited data sources focused on trucks and long-distance drivers. According to the Bureau of Labor Statistics Commodity Flow Survey, however, 94 percent of all truck shipments and 87 percent of for-hire shipments move less than 500 miles. See http://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/commodity_flow_survey/index.html).

⁸Dr. Tregear noted only one study with data on driving time for motorcoach and bus drivers.

⁹The source for this information is the Belenky et al. (2012) study referenced in Footnote 3.

¹⁰The sources for this information were two studies. Dr. Tregear said no data are available for motorcoach drivers.

Work Environment (e.g., control over trips, interactions with passengers, scheduling/shift cycles, access to health care, opportunities for exercise and sleep)

- In focus groups, commercial passenger-carrying vehicle drivers said interactions with passengers lead to driver stress and fatigue.¹¹
- “On average,” bus drivers get between 6 and 7.5 hours of sleep each day.¹² The percentage of truck drivers that reported obtaining 8 or more hours of sleep was 62 percent; 38 percent reported obtaining less than 8 hours.¹³
- For motorcoach operators in the Belenky study, the average total sleep time was between 7.5 and 8 hours, and was less on on-duty days than on off-duty days.
- Regarding scheduling and shift cycles, 63 percent of motorcoach/bus drivers reported starting and stopping their shifts at the same time every day (compared with 46 percent of truck drivers).¹⁴
- Motorcoach/bus drivers who reported driving split shifts ranged from 35 to 71 percent.¹⁵

Health Characteristics¹⁶ (e.g., sleep-disordered breathing, obesity, sleep apnea)

- The mean body mass index for truck drivers and motorcoach drivers was slightly above 32 kg/m².

Key Question 4: Do identified differences between motorcoach/bus and truck drivers increase (or decrease) the risks for nonpathologic fatigue?

Dr. Tregear said that Manila used the analysis findings from Key Question 3 to identify factors that increased the risk of “acute fatigue.” She said these factors were as follows: older age combined with shift work, female gender combined with shift work, female gender, long driving hours, shift work, long work hours, and obesity.

Following Dr. Tregear’s presentation, the Board members discussed the Evidence Report and asked questions of the presenters.

Evidence Report Discussion

Board members questioned the Manila presenters on evidence and study findings. After receiving confirmation that the demographic evidence did not include populations already susceptible to fatigue, Dr. Osbahr asked Dr. Tregear whether evidence showed factors other than gender that might contribute to female drivers’ having a higher risk of fatigue than male drivers. Dr. Osbahr also asked for an explanation of the term “long driving hours.” Regarding the first question, Dr. Tregear replied that the literature reported only a “slightly increased risk for acute fatigue” in females, but revealed nothing more. Regarding the second question, Dr. Tregear said the value for “long driving hours” varied by study but all studies showed that the more time spent driving the higher the risk of fatigue.

Regarding Dr. Osbahr’s follow-up question on defining “long work hours,” Dr. Tregear replied that data on the subject are few, especially regarding Key Question 3, but that an inference might be drawn concerning shift work and hours from truck driver self-reports on time spent driving between 4:00 a.m.

¹¹The sources for this information were two qualitative assessments of coach drivers.

¹²The sources for this information were two studies of transit bus drivers.

¹³The sources for this information were two studies

¹⁴The source for this information was one study of approximately 266 transit drivers.

¹⁵The sources for this information were three studies of 1,119 transit workers.

¹⁶Regarding health characteristics, Dr. Tregear reported a lack of data for all but body mass index, and that the sources for this characteristic were “[d]ata retrieved from the 10 included studies,” including the Belenky et al. study.

and 6:00 a.m. for Question 1. She said a large percentage of the self-reports indicate driving some number of hours from 12:00 a.m. to 4:00–6:00 a.m., and transit driver self-reports indicate driving during peak transit periods. For motorcoach operators, Dr. Tregear said no data are available on schedules other than drivers' reporting of "inverted shifts."

Remarking that Key Question 1 is the most important question, Dr. Morris acknowledged a lack of data showing a relationship between fatigue and crash incidence in motorcoach drivers, and that the relationship between fatigue and driving ability might be an acceptable surrogate for a relationship between fatigue and crash risk. He questioned the value for commercial drivers of a study used to address Question 1B, however, in which the study population was college students whose demographic characteristics were not the same as those for motorcoach drivers. Ms. Calloway responded that for Question 1, Manila used data from separate studies and analyzed results with college students and commercial truck drivers as separate populations. She repeated an earlier assertion that Manila used studies of driver populations other than commercial motorcoach/bus drivers because of the lack of data on motorcoach drivers. Dr. Morris concluded fatigue leads to deterioration in driving ability for professional drivers, which can be assumed to increase crash risk. Ms. Calloway stated that the studies reporting "sleep before shift" did include "sleep before shift."

Board members shifted the discussion to what value they might bring to FMCSA policy deliberation concerning driver fatigue. Dr. Benjamin Hoffman asked how a medical review team might help FMCSA address nonpathologic fatigue, noting in his inquiry, however, that if motorcoach drivers have a body mass index of 33 or more, there is pathologic fatigue. He observed that even if drivers in diverse studies reported no medical disorder, there is likely a high incidence of the medical condition obstructive sleep apnea in a population with a mean body mass index of 33 or greater. He said that FMCSA's promulgation of a sleep apnea regulation is "essential." Mr. Larry Minor responded that the Agency intends to issue guidance on sleep apnea (now under review with the Office of Management and Budget), followed by notice-and-comment rulemaking addressing the issue. Resuming his inquiry, Dr. Hoffman asked what input FMCSA expected from the Board concerning nonpathologic fatigue. Administrator Ferro said the Agency was eager to hear perspective on whether fatigue is a matter for the Board; whether tools or processes are available for fatigue detection, treatment, and enforcement; and how the Agency can facilitate its ultimate goal of changing behavior to eliminate fatigued driving. Ms. Ferro said the Board also might address any medical evidence indicating a connection between drowsiness and sleepiness as markers of pathologic fatigue.

Dr. Morris said that lacking a clear definition of fatigue, the Board would have difficulty creating medical guidelines and recommendations. He said that unlike obstructive sleep apnea and other disorders the medical community defines by objective measures, objective agreement on what physical or cognitive impairments constitute fatigue is absent; he added that he finds the definition of nonpathologic fatigue troubling. Dr. Cisneros spoke of the "intuitive idea" that fatigue manifests itself in cognitive and psychomotor performance degradation, that studies showing a relationship between fatigue and degraded performance were relevant irrespective of demographic populations involved, and that the Board could structure useful recommendations for FMCSA based on recognizing the relationship between fatigue and circadian cycles. Dr. Pervall said the Board's role was to provide information to FMCSA's Motor Carrier Safety Advisory Committee (MCSAC) that would support the Committee in recommending "tools" in the future, and to present guidance for identifying fatigue in the field.

Returning to a discussion of the Evidence Report, Dr. Lester referenced physical activity as among the health-related risk factors for fatigue, and asked whether studies reveal a connection between fatigue and physical activity. Dr. Lester asked further about what conclusions Manila drew from its finding that shift work increased the risk of fatigue. Regarding the first question, Dr. Tregear responded that the literature supports a finding that fatigue arises largely from sleep-related factors such as working split shifts, working overnight shifts, or working counter to the circadian clock. Commenting that strenuous physical activity likely would increase fatigue, Dr. Tregear said another perspective was that a moderate level of

physical activity should reduce the risk of fatigue. On the other hand, Dr. Tregear said Manila “repeatedly” found in the literature that shift work—working overnight and sleeping during the day—put individuals at risk of fatigue. (She noted, however, that Manila did not do a “systematic review on the risk factors for fatigue,” because that was not the task assigned. Rather, to address Key Question 4, understanding the risk factors for fatigue was necessary.)

Acknowledging that shift work and fitness for duty are issues that health professionals like medical examiners (MEs) must evaluate, a Board member commented that—irrespective of Manila’s assignment—the Board needs information to help objectively determine the fatigue effects of shift work and other sleep disorders. Dr. Morris asked whether FMCSA intended to use the Board’s findings to support a requirement for a minimum number of sleep hours to reduce crash risk, and if so, how such a requirement would account for individual differences in drivers’ needs for sleep. Administrator Ferro replied that before the Agency gets to rulemaking on fatigue, FMCSA would benefit from Board members’ refining the issues the Agency should examine; and from the Board’s perspectives on strategies and guidance the Agency could provide for MEs who would assess driver fatigue, protocols for fatigue detection and treatment, and whether the problem has a medical dimension. Noting that fatigue affects CMV driver ability to drive safely, the Administrator expressed the Agency’s ultimate goal of changing behavior so that commercial drivers are in the best state of health and alertness to operate safely. Responding further to a follow-up question concerning raising fatigue awareness issues among drivers and MEs to reduce crash risk, the Administrator acknowledged the value of insight from the Board about educating these populations, and underscored the value of having the Board explore important questions.¹⁷

Concluding the discussion, Dr. Hoffman observed that commercial property carriers increasingly are installing drive-cams to detect anomalies in driver behavior, and that if the camera suggests fatigue, neither the carrier nor its front-line medical staff know what to do with the information. Dr. Pervall noted that the drive-cams installed in all Washington Metropolitan Transit Authority buses have revealed several bus drivers falling asleep. She said that although these drivers present at the medical office with a nonpathologic condition, health care staff are finding that 70 percent of these drivers have some pathology. Drs. Hoffman and Pervall agreed that the Board could focus on providing fatigue-related guidance for the medical community.

Expert Panel Report

Describing the panel’s objectives of reviewing key findings in the Evidence Report and providing FMCSA with consensus opinion on fatigue, Dr. Belenky began his substantive presentation by discussing the critical necessity of developing an “operational definition” of fatigue to provide a framework for objective discussion of fatigue, and for understanding what exists and what needs to be done. Rather than distinguishing between nonpathologic¹⁸ and pathologic fatigue as in the Evidence Report, he presented the panel’s observations and its recommendation for an operational definition of fatigue.

¹⁷The Administrator offered the following examples as questions the Board Members could refine: What is a fatigue detection model? Is there such a model? Is there a fatigue detection expert, as there is a drug detection expert, who could be available at roadside to assist law enforcement? Is facial recognition technology a means of fatigue detection? What is a fatigue management system (e.g., the Federal Aviation Administration system for air carriers), and is mandating such a system possible without defining “fatigue”?

¹⁸Dr. Belenky observed that some sleep disorders are nonpathologic, although these are named as pathologies. One is “insufficient sleep syndrome” (or insufficient sleep), and another is “shift-work disorder” arising from a work-sleep cycle that is out of synch with an individual’s circadian phase.

Operational Definition of Fatigue

- Fatigue is measurable subjectively (by self-reporting) and objectively (by degradation in performance based on a psychomotor vigilance task test or “PVT test”¹⁹).
- Fatigue is an outcome of sleep loss (whether the cause is medical or nonmedical), adverse circadian rhythm phase, and high workload (time-on-task, task intensity, and task complexity). Fatigue, irrespective of its cause, manifests itself as degraded performance. An individual who sleeps 7–8 hours in 24 hours is likely to perform a task acceptably.
- Fatigue might vary “to some degree” based on individual differences. Although 1 person in 20 can tolerate major sleep loss without performance degradation, individual differences at this scale do not support broad policy decisions.

Dr. Belenky said that the dearth of evidence showing a relationship between fatigue and the incidence of CMV crashes is because a crash is a rare event. Using an operational definition of fatigue, he said, “contribute[s] to a *base* operational model of fatigue and its impact,” where one can assume that performance degradation resulting from fatigue increases crash risk. He presented several graphs plotting the findings of various studies linking fatigue and performance, including results from a Washington State University study under Department of Transportation sponsorship describing the work, sleep (measured by a wrist-worn Actigraph²⁰), and performance of 84 commercial motorcoach drivers.²¹ Based on these studies, Dr. Belenky reported the following findings.

Sleep Loss

- In a test of 49 healthy, young volunteers who were not commercial motor vehicle drivers (the N = 49 study), researchers administered a PVT test to participants who were awake for 40 hours and took the test every 2 hours for 10 minutes. Tests results showed a relatively high level of performance through the first 16 hours of wakefulness, and a significant performance decline by hour 22. (The test assessed performance as a function of time of day, time on task, and sleep deprivation.)
- A 2003 sleep-dose response study by Belenky et al. examined the performance effects of restricted sleep on 16 to 18 CDL drivers in good health and with an average age of 38. Following a 3-day baseline period of 8 hours in bed, study subjects received 3, 5, 7, or 9 hours of time in bed per day over a 7-day “sleep restriction” period. The study showed degraded performance for drivers with just 40 minutes of sleep deprivation; that drivers with 4 hours in bed displayed stable, but lower level of performance than did drivers with 7 or 8 hours in bed; and that drivers with 3 hours in bed displayed steady performance degradation throughout the entire day. Although the study protocol included a 3-day recovery period, drivers in the 3-hour sleep group needed more than the protocol period to recover from lack of sleep.
- During the “sleep restriction” period in the 2003 study, researchers tested CDL driver performance on a simulator by recording simulator lane departures. As the time allowed in bed decreased, simulated lane departures increased.

¹⁹Dr. Belenky stated that a PVT test is a good test for measuring performance because it is “IQ-independent,” requires little learning, and the subjects’ performances do not improve with practice.

²⁰A device containing an accelerometer, central processing unit, and memory that continuously records the number of arm movements per minute, and that stores the number of movements at 1-minute intervals.

²¹The title of the Washington State University report is, *Motorcoach Driver Fatigue Study, 2011*, performed by the Sleep and Performance Research Center at the University. The U.S. Government assumes no liability for the content or use of the study. The contents of the report reflect the views of the contractor, who is responsible for the accuracy of the data presented.

Circadian Phase

- Circadian rhythm helps consolidate wakefulness during the day and sleepiness at night. Because of circadian influences, most healthy people cannot sleep during the day for more than a consolidated 5 hours, which is not enough sleep to restore performance. When an individual is out of circadian rhythm, sleep spreads out in small sleep bouts called polyphasic sleep. Caffeinated beverages, short naps lasting 20–30 minutes, and forced breaks help to counteract daytime sleepiness.
- A 2012 Belenky et al. study of rest and sleep patterns in motorcoach drivers showed that consolidated sleep at night is most restorative and that consolidated daytime sleep often is truncated by the circadian drive for wakefulness (and therefore, is not as restful as consolidated nighttime sleep). This study also showed that splitting sleep between night (when the circadian cycle is low) and day is more restorative than consolidated daytime sleep. The study suggests that if drivers must split sleep, facilities should be made available for sleep between shifts.
- Starting work very early in the morning can interfere with sleep. The circadian drive for wakefulness decreases at about 10:00 p.m., making sleep in the early evening impossible for most people. Consequently, early starts generally result in a negative impact on driver performance. On average, night shift workers get 5 hours of sleep per day. Either an on-duty sanctioned nap or a late afternoon break could help.

Workload

- Because no well-established way to quantify workload as a factor in fatigue exists, panel members invoked the Yerkes-Dodson law, which states that performance will improve with increasing stimulation until it reaches an optimum level. Beyond the optimum level of stimulation, performance degrades. With insufficient stimulation, drivers can fall asleep. Whether some optimum level of stimulation will sustain performance remains an open question.
- Time-on-task is another key factor that contributes to performance degradation. Taking a mental break helps increase performance levels. According to German studies cited by the Federal Aviation Administration, after 8–9 hours of work, performance begins to degrade exponentially. Whether time-on-task effects actually occur, or whether these effects mask sleep loss, is unknown. For example, factors such as commuting time, work stress, or personal matters might extend the time awake, irrespective of the number of work hours. More research on such effects is needed.

Dr. Belenky concluded his presentation with the following expert panel recommendations.

- To avoid constantly shifting drivers' circadian phases, FMCSA should consider restricting the hours of service (HOS) rules for motorcoach and truck drivers to a fixed, 24-hour period. Any model of regulation should be based on a 24-hour clock in synch with circadian phases.
- FMCSA should consider restricting work start times to a particular period so that drivers have relatively consistent day-to-day schedules, with an opportunity for sleeping at least 8 hours in every 24 hours. The sleep opportunity should occur during circadian low points whenever possible. Early starts should be avoided, and drivers should be assured that they can take advantage of the sleep opportunity.
- FMCSA should permit motorcoach companies to implement fatigue risk-management programs "as an alternative means of demonstrating compliance."
- FMCSA should identify technologies to measure fatigue and driving performance in real time. Real-time performance measurement enables collecting the data to set schedules based on predictive models of performance arising from sleep loss and circadian phase, or to detect indications of fatigue (e.g., land departure) during driving.

- Preliminary research should be conducted to understand better the current driver and industry strategies for coping with fatigue, and research should also be conducted to follow drivers through full 24-hour cycles to collect more data on “real-world driving hours and patterns.”

Expert Panel Report Discussion

Noting that much of the research has evaluated drivers' performance of very simple tasks, and that driving is more complex than the tasks in the research protocols, Dr. Morris asked whether real-time, fatigued driving performance might degrade earlier in a shift than the research indicated. Dr. Belenky responded that real-time driving, which is a more complex and interesting task than is a PVT test, might show less performance degradation. Exploring the relationship between PVTs and driving performance (perhaps with a simulator) would be valuable.

Dr. Osbahr asked about tools MEs might use to measure sleepiness and fatigue; and whether an Actigraph is an affordable, accessible, and accurate measurement tool. Dr. Belenky responded that the panel members used the Karolinska Sleepiness Scale and the Samn-Perelli Fatigue Scale, which take little time to complete and accurately measure fatigue. Dr. Belenky said the cost of an Actigraph is from \$200 to \$1500, and that with computer-based sleep-scoring algorithms that analyze the Actigraph data, the tool is reliable for measuring sleep in individuals engaged in the level of activity required for driving a bus.

Dr. Osbahr observed that for the N = 49 study, the study subjects performed as one might expect commercial drivers to perform at those same times of day and hour intervals, and Dr. Lester expressed surprise that the low performance point was between 7:00 and 9:00 a.m. of the second day. Dr. Belenky replied that the low point of circadian temperature is between 4:00 and 6:00 a.m., and the low performance point is behind the low point in that temperature by 1 to 2 hours. Dr. Ben Hoffman asked whether PVT tests could be used on a smartphone as a screening tool for sleep apnea. Dr. Belenky replied that the PVT test could be used to measure daytime sleepiness, which is a “cardinal symptom” of sleep apnea.

MRB Deliberation on Fatigue and Motorcoach/Bus Driver Safety

Following the presentations and discussion of the Evidence Report and Expert Panel Report, Board members discussed fatigue and set recommendations.

Fatigue Education, Outreach, and Field Detection

Dr. Morris stated that learning what industry leaders are doing to prevent fatigue would be helpful, and noted that some trucking companies screen for fatigue by placing cameras in the truck cab. Dr. Morris stated Schneider National is currently performing research on sleep apnea and evaluating its data would be helpful. He said it would be particularly helpful if Schneider has materials that an ME could use, such as a questionnaire on fatigue.

Dr. Pervall stated the Board's support for educating drivers about fatigue and encouraging carrier fatigue management programs as a top priority. She said further that the Board supports a fatigue monitoring system in truck cabs and motorcoaches, that it has yet to identify fatigue-screening tools for MEs, and that Board members hoped Dr. Belenky could help with this endeavor. She said the Board should develop guidance suggesting what should happen after an ME determines a commercial driver is at risk of fatigue. Dr. Morris suggested that the guidance permit MEs to exercise discretion in deciding whether a driver is fit for work, and that MEs evaluate each driver for fatigue. Dr. Cisneros said that any guidance should address incorporating circadian rhythm into commercial driver hours of operation, and Dr. Pervall expressed support for the suggestion.

In reply to a question from Dr. Hoffman asking whether FMCSA has regulations addressing fatigue prevention programs, Mr. Minor said although no Agency regulations on the subject exist, FMCSA is

working on the North American Fatigue Management Pilot Program²² to educate carriers about fatigue and promote the voluntary use of fatigue management programs. Dr. Hoffman stated that most large carriers have fatigue management programs, that the Occupational Safety and Health Administration has performance standards regarding such programs, and that FMCSA should ask carriers to set fatigue management standards. Dr. Hoffman stated that technology to help monitor fatigue exists and is relatively inexpensive.

Regarding technologies for fatigue detection, Dr. Pervall stated that systems in some foreign cars measure speed, steering, and lane changes and flash a dashboard warning when driving anomalies are registered. Dr. Hoffman said such technologies could be useful and likely are inexpensive. He added that signaling a dispatcher when feeling fatigued should be within a driver's discretion, and that an evaluation should follow. He also supported an in-cab drive-cam as an option for fatigue detection. In reply to a question concerning whether fatigue management systems are available for use in a medical exam, Dr. Hoffman said that most fatigue management programs are educational, not medical. Mr. Tom Yager stated that enforcement authorities also have difficulty detecting fatigue in the field, and using findings in enforcement actions.

After expressing concern about how MEs and carriers would coordinate the use of fatigue technologies to evaluate commercial driver, Dr. Osbahr suggested using the Karolinska Sleepiness Scale and the Samn-Perelli Fatigue Scale as tools to interpret fatigue data. Dr. Belenky replied that the Samn-Perelli Fatigue Scale would be unsuitable for that purpose, however, and suggested using the Pittsburgh Sleep Quality Index to assess a patient's long-term sleep quality. He added that no predictive tools for determining fatigue are available, and that the Pittsburgh Sleep Quality Index does not measure fatigue. In reply to Dr. Morris's question of how an ME might screen for fatigue, Dr. Belenky suggested having the MEs simply ask a driver whether he or she is tired enough to fall asleep during the day. Dr. Belenky said he would look further into screening tools, and Dr. Morris said MEs should further test drivers who report feeling fatigued.

Dr. Morris said that educating drivers about fatigue is an inexpensive way to reduce crash risk, and that FMCSA should provide drivers with information on the advantages of power naps and on the minimum number of sleep-hours needed per day, adding that the Board must agree on this number. (Dr. Belenky reminded the Board of evidence showing that a loss of just 40 minutes of sleep degrades performance.) Dr. Morris suggested the Board recommend the installation of in-cab and in-coach monitoring systems to record lane changes, educating drivers about "sleep hygiene," and giving MEs screening tools to determine whether a driver is fatigued. He also suggested that the Board develop guidance for MEs who determine a driver is at risk for fatigue.

Hours of Service Implications

Dr. Osbahr asked why motorcoach and truck drivers have different HOS requirements. Drs. Belenky and Osbahr agreed that a single HOS rule should apply for all CMV drivers, and that data support that approach. Dr. Osbahr answered affirmatively when Mr. Minor asked whether both motorcoach and truck drivers should have a fixed driving window. Dr. Cisneros said the HOS rules for motorcoach drivers, however, should be more restrictive than for truck drivers, with total duty time not to exceed 9 hours, a break every 5 hours, and consistent sleep schedules. Mr. Minor summarized the HOS rules for commercial passenger-carrying drivers.²³

²²The North American Fatigue Management Program is an initiative jointly sponsored by FMCSA and Transport Canada to develop a comprehensive, integrated, fatigue management program for motor carriers, including guidelines and materials for implementation. See <http://www.fmcsa.dot.gov/facts-research/art-research-assessment-north-american-fatigue-management-program.htm>.

²³After 8 consecutive hours of off-duty time, commercial passenger-carrying drivers may drive up to 10 hours

Mr. Yager informed the Board that the HOS regulations for motorcoach drivers do not follow a 24-hour clock and that time on duty excludes driver-commuting time. He noted further that motorcoach drivers are "off duty" during the interval between driving passengers to and from a destination, although a driver might not have an opportunity to rest during these intervals. Consequently, said Mr. Yager, extending the on-duty period for a motorcoach driver beyond 24 hours is possible.

Dr. Belenky said that to ensure adequate rest for commercial drivers, the Board should consider whether drivers have an opportunity in every 24-hour period to get adequate, restorative sleep; whether this opportunity factors in circadian phases; whether drivers use the opportunity for actual sleep; and whether drivers are measurably performing well in real time. Following Dr. Morris's assertion that drivers need 10–12 hours off-duty time in every 24-hour period, Dr. Pervall said his assertion supports setting a fixed duty period for motorcoach drivers. Dr. Belenky reiterated the panel recommendation for a sleep performance prediction model study to support an HOS rule for motorcoach drivers, and for providing some sleep time at night during the circadian low. For motorcoach drivers, he suggested an HOS rule with 14 hours on duty and 10 hours off duty.

The discussion turned to whether FMCSA should require mandatory duty-day breaks for motorcoach drivers. Dr. Cisneros asked how often drivers should take a break. Dr. Belenky responded the research suggests a break is needed after 5 to 6 hours of driving. FMCSA staff informed the Board that a new HOS rule provision (effective July 1, 2012) requires truck drivers to break for at least 30 minutes during every 8 hours of on-duty time, and that the break must be within the 14-hour fixed duty day. Dr. Morris said that adopting Dr. Belenky's proposed approach would increase the compliance burden for the motorcoach industry, because drivers would be unable to drive through the night. Dr. Osbahr replied that the rule should require drivers to sleep 8 hours in every 24 hours, irrespective of time of day.

MRB Recommendations

Following Board deliberations, Dr. Pervall presented summaries of the Board's recommendations concerning fatigue and driver safety for commercial motorcoach and bus drivers.

HOS Rules for Commercial Drivers

Dr. Osbahr moved to have the Board recommend applying the truck driver HOS rules to motorcoach drivers, and Dr. Cisneros supported the motion. Mr. Minor said that the Board should state which parts of the HOS rules should apply to motorcoach drivers. Mr. Minor said these recommendations could become best practices for the motorcoach industry. Dr. Osbahr said he did not see large differences in demographics between motorcoach and truck drivers, but suggested consulting MCSAC before making recommendations concerning HOS rules. Dr. Pervall said MRB does not have the expertise to make HOS recommendations without first consulting MCSAC.

The Board recommended structuring the HOS for motorcoach/bus drivers to a fixed window of 14 hours on duty, with no more than 10 hours driving, and a minimum of 10 hours off-duty for the opportunity to achieve 8 hours of sleep per 24-hour window. The Board further recommended adding a restriction on driving a vehicle unless at least 8 hours have passed since the driver's last off-duty period of 30 minutes or more.

The Board agreed that this hours configuration would give drivers adequate opportunity to have 8 hours of sleep in a 24-hour window. (The Board did not endorse Dr. Belenky's suggestion to eliminate driving restrictions within the on-duty window, provided drivers take "timely breaks.")

during a 15-hour on-duty window that is extendable by off-duty breaks. (For truck drivers, the on-duty period is a fixed, nonexpendable 14 hours.)

Fatigue Management Program

The Board recommended that FMCSA require carriers to establish a comprehensive fatigue management program that includes training for executives, safety managers, and drivers in fatigue management. She said the Board agreed to address a recommendation on program content (including general principles and elements) after it reviews the North American Fatigue Management Program and consults MCSAC.

Tools for MEs

The Board recommended that FMCSA obtain information from researchers and specialists regarding tools available for MEs to use for a fitness-for-duty evaluation. Dr. Pervall said the Board will review relevant information and provide a recommendation to the Agency for guiding commercial driver MEs in the evaluation of fatigue.

Shift Work Literature

The Board recommended that FMCSA provide the Board with literature regarding shift-work disorders and the effects on fatigue. The Board's recommendation was unanimous.

Fatigue Detection Technologies

The Board recommended that FMCSA consider requiring devices in the vehicle (e.g., cameras or lane deviation sensors) to monitor driver performance in real time. She said the Board agreed to consider recommending that carriers identify drivers at risk of fatigue during fitness-for-duty evaluations and to consider revising ME guidance on fatigue when more information becomes available. The Board's recommendation was unanimous.

Dr. Pervall concluded the deliberation on fatigue and motorcoach/bus driver safety.

Public Comment Period

Jana Price²⁴ said that the National Transportation Safety Board made the following recommendations to FMCSA concerning fatigue and commercial motor vehicle operations, and that these recommendations were relevant to the Board's deliberations on fatigue.

- “Develop and implement a plan to deploy technologies in commercial vehicles to reduce the occurrence of fatigue-related accidents.” (2008)
- “Require all motor carriers to adopt a fatigue management program based on the North American Fatigue Management Program guidelines for the management of fatigue in a motor carrier environment.” (2012)
- “Incorporate science-based fatigue mitigation strategies into the HOS regulations for passenger-carrying drivers who drive during the window of circadian low.” (2012)
- “Develop and disseminate guidance for motor carriers on how to most efficiently use currently available onboard monitoring systems and develop a plan to periodically update guidance. Upon completion of the field operational tests for onboard monitoring systems, determine whether test results indicate that such systems would reduce accidents or injuries, and, if so, require commercial motor carriers to use these systems to improve driver safety.” (2012)

Call to Adjourn

Dr. Pervall adjourned the meeting.

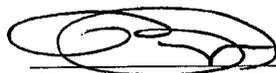
²⁴Ms. Price is a Senior Human Performance Investigator for the National Transportation Safety Board.



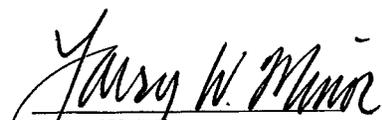
Certification

The minutes were approved by the Medical Review Board on + 16 / 13 .
(Date)

We hereby certify that, to the best of our knowledge, the foregoing minutes are accurate and complete.



Gina C. Pervall, M.D.
Chairperson
Medical Review Board



Larry W. Minor
Designated Federal Officer
Medical Review Board