U.S. Department of Transportation
Federal Motor Carrier Safety Administration

Overview of the National Academy of Sciences (NAS) Panel Study on Methodological Approaches to Understanding Driver Fatigue

2016 Transportation Research Board 95th Annual Meeting
Federal Motor Carrier Safety Administration
Analysis, Research, and Technology Forum
January 11, 2016



Office of Research and Information Technology

Overview

- Summary of National Academy of Sciences (NAS) panel report commissioned by the Federal Motor Carrier Safety Administration (FMCSA).
- Report still under review; still considered draft.
  - 13 anonymous external reviewers have provided comments.
  - Panel currently responding to those comments and finalizing final report.
- Today: General overview and some of the main conclusions.

BACKGROUND ON PANEL AND PROCESS

Background on Panel

- FMCSA charged the National Academies of Sciences, Engineering, and Medicine (NASEM) and the Committee on National Statistics (CNSTAT) to assemble a panel to investigate research methods and statistical approaches for understanding driver fatigue in motor carrier safety and driver health:
  - Strong support from FMCSA staff.
- NASEM assembled a panel of experts in a variety of fields:
  - Chairs: Matthew Rizzo, Hal Stern
  - CNSTAT Staff: Michael Cohen, Esha Sinha
- Panel met six times over a 2-year period:
  - Presentations from experts; internal discussion.

The National Academies of SCIENCES · ENGINEERING · MEDICINE

COMMITTEE ON NATIONAL STATISTICS
Division of Behavioral and Social Sciences and Education

Panel Charge

"…assess the state of knowledge about the relationship of such factors as hours of driving, hours on duty, and periods of rest to the fatigue experienced by truck and bus drivers while driving and the implications for the safe operation of their vehicles. The panel will also assess the relationship of these factors to drivers' health over the longer term. It will identify improvements in data and research methods that can lead to better understanding in both areas."

Panel Members

- **Matthew Rizzo (Co-Chair)**
  - University of Nebraska Medical Center
- **Hal Stern (Co-Chair)**
  - University of California at Irvine
- **Daniel Blower**
  - University of Michigan Transportation Research Institute
- **Charles Czeisler**
  - Harvard Medical School
- **David Dinges**
  - University of Pennsylvania School of Medicine
- **Joel Greenhouse**
  - Carnegie Mellon University

Panel Members (cont.)

- **Feng Guo**
  - Virginia Tech Transportation Institute
- **Richard Hanowski**
  - Virginia Tech Transportation Institute
- **Natalie Hartenbaum**
  - Occumedix, Inc.
- **Gerald Krueger**
  - Krueger Ergonomics Consultants
- **Melissa Mallis**
  - M3Alertness Management, LLC
- **John Pearson**
  - Council of Deputy Ministers Responsible for Transportation and Highway Safety

Panel Members (cont.)

- **Dylan Small**
  - University of Pennsylvania
- **Elizabeth Stuart**
  - Johns Hopkins Bloomberg School of Public Health
- **Michael Cohen**, Co-Study Director, CNSTAT
- **Esha Sinha**, Co-Study Director, CNSTAT
- **Agnes Gaskin**, Administrative Assistant, CNSTAT

OVERVIEW OF CONCLUSIONS

Statement of the Problem

- Approximately 4,000 fatalities in crashes involving large trucks and buses in the United States each year.
- 10–20 percent of these may involve fatigued drivers.
- Job stress and duties as well as lifestyle may put large truck and bus drivers at risk for insufficient sleep and short- and long-term health problems.
- FMCSA's mission is to "reduce crashes, injuries, and fatalities involving large trucks and buses."
- Research base regarding fatigue and its consequences not fully developed, and new technologies coming on board.

Complex System

- Many factors influence crash risk:
  - Driver factors, job factors, road factors, etc.
- Report focuses on data and statistical methods needed to better understand the links between:
  - Fatigue and crash risk.
  - Fatigue and driver health.

Image credit: Phil Konstantin

Report Summarizes What is Known with Respect to…

- What causes driver fatigue?
- Why do drivers continue to drive when at high risk of fatigue?
- Relationship between sleep deficits and decreased driver altertness.
- Practical ways of reducing or removing driver fatigue.
- What is the relationship between acute or chronic sleep loss and increased crash risk?
- What is the relationship between obstructive sleep apnea (OSA), continuous positive airway pressure (CPAP) use, and crash risk?

Report Summarizes What is Known with Respect to…

- What do health and wellness programs and fatigue management initiatives do to modify the behavior of CMV drivers?
- What are the likely safety effects that can be obtained with improvements and deployment of collision avoidance and associated fatigue alert technologies touted to ameliorate the impact of fatigue on crash risk?

Challenges Highlighted

- **Fatigue itself—no objective measure:**
  - Panel was concerned about the inability to define fatigue and is considering factors that can be more objectively measured, such as level of alertness or degree of sleep deficiency.
- **Crashes:**
  - Rare, so hard to study; instead use surrogate measures such as safety-critical events (SCEs).
  - Hard to definitively say which crashes are associated with fatigue.
- **Measurement of relevant factors:**
  - Driver, vehicle, carrier, external (environmental) characteristics.
- **Heterogeneity of truck and bus industries:**
  - Research needs to account for this heterogeneity in hours of work, compensation methods, etc.

Clear Need for More Information on…

- Driver loss of alertness in near-real time.
- Amount of quality sleep a driver received in past 24 hours.
- Number of sleep-related crashes in which a driver was involved, per vehicle miles driven over a long period of time (e.g., years).
- Driver's longitudinal development of various health conditions that can affect driver alertness.
- Changes in a driver's lifestyle components, especially diet and health.




Report Highlights Data Needs

- “Denominator” data on miles traveled, driving conditions.
- Population data on commercial motor vehicle (CMV) drivers, e.g., longitudinal survey of representative sample of drivers.
- Ongoing survey on health and wellness of CMV drivers.
- More data sharing from companies, which often have more detailed information:
  - Can utilize recent statistical methods for disclosure avoidance.

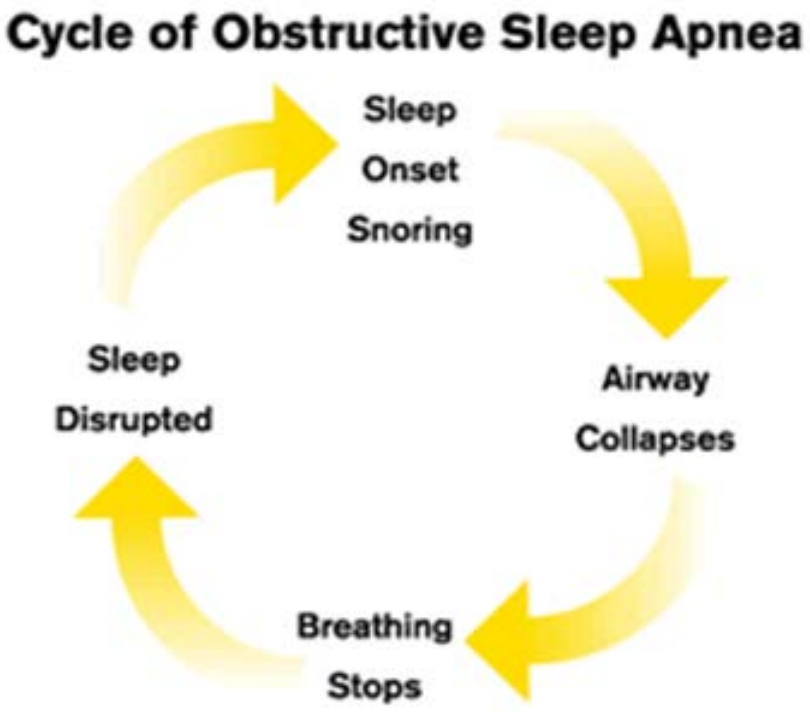
SPECIFIC CONCLUSIONS

Conclusions: CMV Drivers' Health & Wellness

- Insufficient sleep can increase risk of health problems, which can then impact alertness and crash risk.
- There are gaps in our understanding of factors that relate to health and wellness of CMV drivers.
- Many CMV drivers work/live with occupational pressures that adversely affect health.
- Insufficient data are available on sleep insufficiencies, economic pressures, diet, exercise habits of CMV drivers.
- Insufficient information is available on health and wellness programs and their use and effects.

Conclusions: CMV Drivers' Health & Wellness (cont.)

- OSA increases crash risk among drivers in general; no reason to think this would not be true among CMV drivers.
- Need to better understand effects of treating OSA on sleep quality, cognition, and driver performance.
- Commercial driver medical examiners not consistent in how they identify drivers at risk for OSA.



Conclusions: Sleep Insufficiency & Safety

- Sleep insufficiency produces fatigue in drivers, as do lengthy and irregular work schedules.
- There is no biological substitute for insufficient sleep.
- Operator fatigue has negative safety implications for workers in many fields, leading to many projects on detecting, preventing, and managing fatigue.
- Real-time operator fatigue detection technologies are still in early phases of understanding and use.
- Bio-mathematical models can be useful for general work/rest schedule development.

Conclusions: Sleep Insufficiency & Safety (cont.)

- Roadway rumble strips help prevent fatigue-related accidents, but can lead drivers to postpone taking other fatigue countermeasures.
- There are insufficient numbers of publicly-available rest areas where drivers can safely take a lengthy rest.
- Additional research needed on devices to address reduced vigilance due to fatigue (such as fatigue detection systems, vehicle-based systems).
- Fatigue risk management plans and systems from other fields could serve as models for CMV driving.
- Impact of safety culture on driver decisionmaking should be studied.

STATISTICAL APPROACHES THAT MAY BE USEFUL

Potentially Useful Statistical Methods

- Panel identified a number of statistical methods common in other fields that may be useful in this context.
- Examples:
  - Surrogate outcomes (e.g., from medical fields).
  - Advances in multilevel and longitudinal models.
  - Video feature extraction methods.

Advances in Causal Inference Can Be Used

- Statistical literature offers advances in causal inference that can be used to estimate causal effects, such as to:
  - Disentangle crash risk factors and their effects.
  - Validate new technologies such as lane deviation tracking systems.
  - Assess effectiveness of education programs such as the North American Fatigue Management Program (NAFMP).
  - Understand how SCEs relate to crashes.
- Some methods (such as case control studies) used in this area; others underutilized.

Randomized Encouragement Designs

- Sometimes can randomize individuals to an encouragement to do something even when it is not possible randomize the treatment of actual interest.
- Related to “instrumental variables” approaches.
- For example, could randomize people to some encouragement to use CPAP machines to estimate the effect of CPAP machines on crash risk (e.g., free machines, or financial incentives to use them).

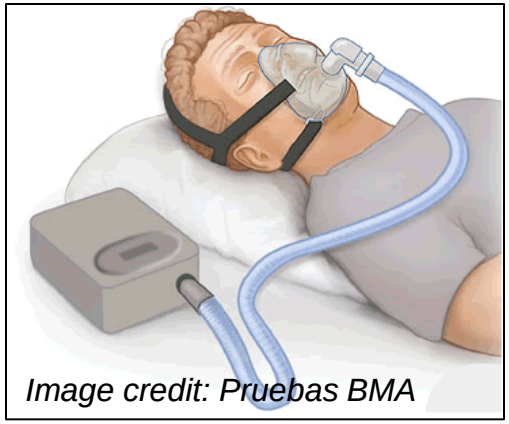


Image credit: Pruebas BMA

Propensity Score Methods

- Sometimes cannot randomize at all, in which case propensity score methods can help estimate causal effects.
- Main idea is to find treatment and comparison individuals who look as similar as possible on all confounding factors.
- For example, to estimate the effect of different compensation schemes on crash risk, find workers with different schemes but who are similar with respect to other factors, such as demographics, work schedules, and driving conditions.

Comparative Interrupted Time Series Methods

- When we have repeated measures of the outcome over time, we can use comparative interrupted time series methods to estimate the effect of some change that happens at a particular point in time.
- Commonly used to estimate effects of policy changes.
- Strongest if there is a comparison entity that did not have the policy change.
- For example, could look at the effects of a change in a company health program by comparing trends in crash rates for that company and those for another (similar) company that didn't make such a change.

Conclusions

- Panel summarized the state of research on fatigue, crash risk, and driver health.
- Identified existing resources that can be better utilized.
- Identified statistical methods and new data sources that could help move the field along.
- Final report should be available in the coming weeks.

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