Maintaining Commercial Driver Alertness, Managing Fatigue, Fostering Driver Health and Wellness:

Assessment of the National Academies' Committee on National Statistics (CNSTAT)
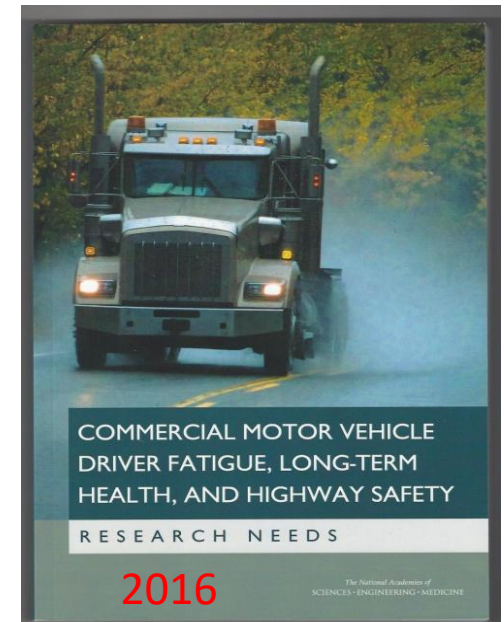
10th Int'l Conference: Managing Fatigue

By Gerald P. Krueger, Ph.D.
Panel Member
JerryKrueg@aol.com

3/21/2017

COMMERCIAL MOTOR VEHICLE DRIVER FATIGUE, LONG-TERM HEALTH, AND HIGHWAY SAFETY

R E S E A R C H   N E E D S

2016

The National Academies of SCIENCES · ENGINEERING · MEDICINE

1

CNSTAT Panel Members

Matthew Rizzo (co-chair): Dept. Neurological Science, Univ. Nebraska Med Ctr

Hal S. Stern (co-chair): Dept. of Statistics, Univ. of California, Irvine

Daniel Blower, Univ. of Michigan Transportation Research Institute (UMTRI)

Charles A. Czeisler, Brigham & Woman's Hospital Harvard Medical School

David F. Dinges, Dept. of Psychiatry, Univ. of Pennsylvania School of Medicine

Joel B. Greenhouse, Dept. of Statistics, Carnegie Mellon Univ.

Feng Guo, Dept. of Statistics, Virginia Tech University

Richard J. Hanowski, Virginia Tech Transportation Institute (VTTI)

Natalie P. Hartenbaum, Occumedix, Inc.

Gerald P. Krueger, Krueger Ergonomics Consultants

Melissa M. Mallis, M3Alertness Management, LLC

John R. Pearson, Canadian Council Deputy Ministers Transp. & Highway Safety

Dylan S. Small, Dept. of Statistics, Wharton School, Univ. Pennsylvania

Elizabeth A. Stuart, Mental Health & Biostatistics, Johns Hopkins - Public Health

David H. Wegman, School of Health & Environment, Univ. Massachusetts, Lowell

NAS Staff: Michael Cohen, Esha Sinha, Agnes Gaskin, & Rick Pain (consultant)

Chapter 1, Introduction: Importance of the Issues

FMCSA's **3 charges to the Panel**:

• Assess the <u>state of knowledge</u> about the <u>relationship</u> of such factors as **hours of driving, hours on duty, and periods of rest** to the <u>fatigue</u> experienced by <u>truck and bus drivers</u> while driving

• Assess the <u>relationship</u> of these factors to **<u>drivers' health</u>** over the longer term.

• Identify improvements in data & research methods that can lead to better understanding in both areas.

The CNSTAT Report (June 2016)

Part I – Background

Chapter 2: The Truck and Bus Industries

- characterization of each transportation sector

Chap 3: Consequences of Fatigue from **Insufficient Sleep**

- the main culprit contributing to driver fatigue

Chap 4: Review of **Hours of Service** Regulations

- historical perspective, U.S., Canada, Mexico

Part II – Data & Methodology

Chap 5: Data Sources & limitations of crash databases

Chap 6: Res. Methods/Principles – Assessing Causality

Topics addressed at length include:

Part III – **Current Research Findings**

  Chap 7: Fatigue, Hours of Service, Highway Safety

  Chap 8: **Fatigue and Health and Wellness**

  Chap 9: Technological Countermeasures for
        and Corporate Management of Fatigue

Part IV – **Research Directions**

  Chap 10: Res. Directions for Fatigue & Highway Safety

  Chap 11: Res. on Impact of Fatigue on Health & Wellness

- **The Report contains 18 <u>conclusions</u> and**
  13 <u>recommendations</u>

Chapter 7: Fatigue, Hours of Service, & Highway Safety

Assessing Role of Fatigue in <u>Increasing the Risk</u> of Truck/Bus Crashes

Research on Fatigue, Hours of Service, and Risk of CMV Crashes - <u>Numerous studies</u> are reviewed in the report.

Research Needs:

Greater experimental <u>control</u> / confounding factors

More research is needed on <u>bus/motorcoach</u> HOS, driver fatigue, and crash risk

<u>Disentangle different causes</u> & effects of operator fatigue

Discern <u>how drivers decide</u> <u>to</u> <u>continue driving</u> when tired

More research needed on the <u>benefits of CPAP </u>as treatment for **sleep apnea (OSA)**

Chapter 8 (a): Fatigue and **Health and Wellness**

Linkages between Fatigue and Health

Conclusion 1: **Insufficient sleep** can **increase the risk** of developing various **health problems** … each can impact alertness while driving and potentially increase crash risk.

Medical certification of health of CMV drivers

Obstructive Sleep Apnea (OSA)

Increased risk of crashes for CMV drivers with OSA

Conclusion 2: **Evidence from non-CMV drivers suggests OSA increases crash risk. There is no evidence nor compelling reason for thinking the same would not also be true for CMV drivers.**

Chap. 8(b): Treatment for Obstructive Sleep Apnea (OSA)

Conclusion 3: **Need better understanding of <u>effects of treating OSA</u> <u>in CMV drivers</u> with <u>positive airway pressure</u> (PAP) therapy (e.g., CPAP) with respect to amount and quality of sleep obtained, and <u>driver cognition</u> and <u>driving performance</u> following PAP treatment sessions.**

Medical examination <u>policy</u> regarding OSA (extensive coverage)

Conclusion 4: **<u>Medical examiners</u> who certify CMV drivers are <u>not consistent</u> in understanding and applying <u>current best practice</u> to identify drivers at risk of moderate to severe OSA.**

<u>Examiners are inconsistent</u> deciding when a driver should be referred for additional sleep testing.

Chap. 8(c): Lifestyle Factors and CMV Drivers' Health

Conclusion 5: Substantial <u>data gaps</u> limit understanding the factors that impact <u>health and wellness</u> of CMV drivers. Need better understanding of <u>drivers' current status</u> and long-term prospects with respect to health and wellness.

Conclusion 6: Many CMV drivers <u>work/live with occupational pressures</u> that adversely <u>affect health</u>.

Conclusion 7: <u>Insufficient data</u> on prevalence of sleep insufficiency, diet and exercise habits, and economic pressures for the population of CMV drivers.

Chap. 8(d): Current **Fatigue Mgmt & Health/Wellness Programs** for CMV Drivers

- They are mostly <u>large truck carrier</u> and <u>bus industry</u> initiatives

- FMCSA's Fatigue Outreach & Health/Wellness Initiatives (reviewed)

Conclusion 8: Insufficient information as to:

(1) **how the variety of current fatigue management and health & wellness <u>programs</u> <u>are designed</u>**

(2) **whether drivers/employers <u>actually adhere to these programs</u>**

(3) **whether these programs are <u>effective</u> in achieving their goals.**

Chap. 9: Countermeasures & Management of Fatigue

Conclusion 9: **Acute and chronic sleep insufficiency produces fatigue in drivers, as do <u>lengthy and irregular work schedules</u>.**

       (this is almost stating the obvious !)

Conclusion 10: **There is <u>no biological substitute for sufficient sleep</u>**

    <u>Technological Approaches</u> for Detecting/Managing Operator Fatigue
      -- Online Operator Fatigue Detection Technologies (while driving)
      -- **Fitness-for-Duty** Devices (before driving & while on duty)
      -- Biomathematical Models used for scheduling (best for big ops)

Conclusion 11: **Operator fatigue has negative safety implications for <u>numerous classes of workers</u>, including commercial drivers.**

    Such concerns motivated a variety of applied research projects
    on detecting, preventing, and/or managing operator fatigue.

Chap. 10 Collection of Survey Data on CMV Drivers

Recommendation 1: **NIOSH should be enlisted to conduct a regularly scheduled survey (~ every 5 to 10 years) to understand demographics and employment circumstances of all CMV drivers in various industry segments.**

In **mid-2016** FMCSA & NIOSH discussed plans to address this recommendation

Recommendation 10: **The Dept. of Health and Human Services (NIOSH) and/or U.S. DOT should fund, design, conduct ongoing surveys permitting longitudinal comparisons of CMV drivers to track changes in their health status, and factors associated with changes, over time.**

It would be highly desirable to link survey data to relevant electronic health records, with a focus on conditions that threaten drivers' health and safety.

Chap. 11 Regarding - Obstructive Sleep Apnea

Screening CMV Drivers for OSA

Recommendation 11: **FMCSA should continue to <u>encourage</u> all Certified Medical Examiners (CMEs) in the National Registry to <u>use current best practices</u> to identify drivers who should be <u>referred for additional sleep malady testing</u>, and in making determinations about commercial driver's license renewal extensions.**

This contentious issue is headed toward **Public Rule Making**

As soon as possible, DOT should **supply medical examiners** with <u>clear criteria or guidance</u> on when it is appropriate to refer presenting drivers for sleep malady testing.

Chap. 11: more on Obstructive Sleep Apnea

Recommendation 12: FMSCA should support <u>peer-review process</u> in all stages of research on OSA and CMV drivers.

Research **focus** to <u>understand the incidence of OSA</u> in CMV drivers; **its impact on driver fatigue, safety, & health**; benefits of treatments. **<u>Topics</u>** include:

• **determine percent of drivers whose quantity/quality of sleep & driving performance are affected at <u>various levels</u> of apnea-hypopnea (mild, moderate, severe OSA);**

• **determine effective <u>guidance</u> for sleep-screening referrals to discriminate CMV drivers with and without OSA;**

• **delineate causal chain from diagnosis of OSA (as a function of severity) to increased likelihood of crash frequency among CMV drivers;**

• **determine <u>impact</u> of PAP treatment on long-term health & crash rates for CMV drivers with varying degrees of <u>apnea severity</u>; and**

• **identify recommended <u>duration</u> of PAP treatment (e.g., suggested # of hours of treatment per day/week) before a driver can return to driving.**

Chap. 11 - more on fatigue & H&W

-- Utility of commercial driver
    medical examination data

-- Needed research on **psychoactive drug use**
    and driving performance

-- Research directions for evaluation of
    health and wellness **programs**

Chap. 11 - more recommendations on fatigue & H&W

Recommendation 13: FMCSA should carry out a research program on "driver fatigue management and training," including:

- **Evaluate effectiveness** of North American Fatigue Management Program (**NAFMP**) on educating **truck & bus drivers** in **how** to modify their behavior to counter fatigue

- Determine **how effective NAFMP training modules are** in meeting needs of drivers' **employers**, fleet managers, safety/risk managers, dispatchers, driver trainers and those conducting **carrier-sponsored employee health and wellness programs**

- Evaluate any **new education programs** regarding sleep apnea that FMCSA currently has, or plans to develop;   and

- Examine possibilities for developing and evaluating **incentive-based programs** for **improving health and fitness**, including regular coaching, assessment, and support.
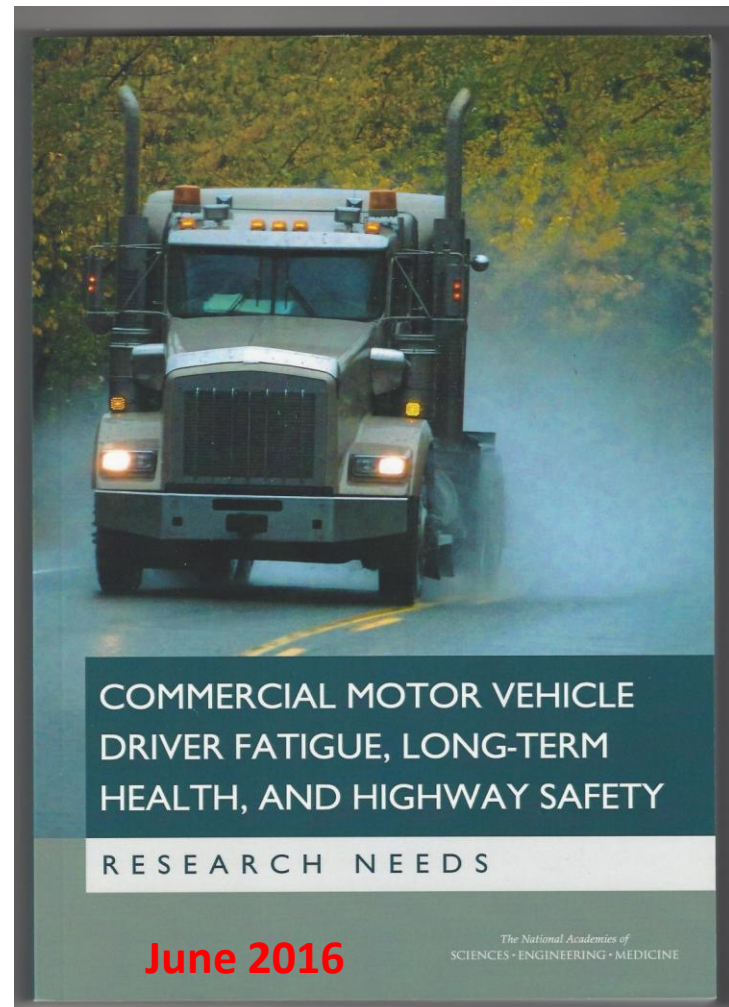
Gerald P. Krueger, Ph.D., CPE
Alexandria, VA

JerryKrueg@aol.com

Report Published in **June 2016**
by the: National Academies Press,
 www.nap.edu

Report available in pdf on various web sites
https://www.nap.edu/download/21921

COMMERCIAL MOTOR VEHICLE
DRIVER FATIGUE, LONG-TERM
HEALTH, AND HIGHWAY SAFETY

R E S E A R C H   N E E D S

June 2016

The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Extra: Additional Backup Slides

Part II: Chapters 5 & 6: Data & Methodology

Chap. 5(a): Data Sources – a statistical committee's take on data

Publicly available <u>crash databases</u>

       Fatality Analysis Reporting System (FARS)
       Trucks & Buses involved in Fatal Accidents (TIFA & BIFA)
       National Automotive Sampling System (NASS)
       Motor Carrier Management Information System (MCMIS)

<u>Limitations</u> of CMV Crash Data Bases –discussed at length

FMCSA's Large Truck Crash Causation Study (LTCCS) Database

Data on Vehicle Miles Traveled (needed as baseline for most statistics)

Research or Study-Based Data Sets, e.g.:

       Naturalistic Driving Study (NDS) data sets
       Driving Simulator studies

Chapter 5 (b): Data Sources cont'd

Proprietary Data,   e.g. data being collected by:

American Transportation Research Institute (ATRI)

Data collected by large truck carriers (mainly for internal use only)

Other Data Sources: Paper logs, inspection reports, surveys

Needed Information

Exposure: hour of day, miles driven etc.

Trip length and driving hours

Diversity of routes and loads

Regular vs. irregular schedules

Driver loading and unloading activities

Operations at night

Sleep quality indicators

Method of driver compensation

Potential New Data Sources (advantages / disadvantages)

Electronic on-board recorders/logging devices

Telematics, on-board safety systems

Chapter 6: Research Methodology and Principles: Assessing Causality

The report details numerous related statistical topics:

Definition of <u>causal effect</u>

Drawing inferences and <u>standardizing crash counts</u>

Randomized Controlled Trials vs. Observational Studies

<u>Regression adjustment</u> isn't state-of-the-art

<u>Design methods</u>: cohort study, case-control, case-crossover

<u>Analysis methods</u>: propensity score methods, marginal structural models, multiple control groups, instrumental variables, regression discontinuity, interrupted time series

A.B. Hill's (1965)criteria on dose-response relationship

Chapter 9 (b) Fatigue Management Programs

Conclusion 12: **Despite 3 decades of research "technological innovations" for <u>detecting driver fatigue in near real-time</u> and operational strategies for their use are <u>still in the early phases</u> of understanding and application.**

Conclusion 13: **Biomathematical models can be useful for developing <u>general work-rest schedules</u>.   However, existing models <u>do not account for individual variation</u>. In applying them, care must be taken to address likely impacts of <u>irregular work schedules</u>.**

- Systems Designed to <u>Mitigate</u> the Effects of Fatigue (discussed in detail):

  Roadway rumble strips
  Rest areas (public and private)
  Vehicle-to Infrastructure (V2I) Systems
  Vehicle-based systems (e.g., Lane Departure Warning Systems)
  Partially autonomous vehicles
  NHTSA research & outreach initiatives on drowsy driving

Chapter 9 (c)

Conclusion 14: **Roadway <u>rumble strips</u> help prevent fatigue-related crashes .**

> However, drivers may treat rumble strips as if they provide repeated emergency alerts (alarms). Drivers may use rumble strips to postpone taking other countermeasures, e.g., stopping to rest.

Conclusion 15: **Repeated surveys indicate there are still <u>insufficient numbers</u> of publically available <u>rest areas</u> where CMV drivers can rest.**

Conclusion 16: **Additional research is needed on <u>effectiveness</u> of all technology <u>devices</u> that address reduced driver vigilance and fatigue.**

Chapter 9 (d)

Conclusion 17: **Fatigue risk management plans and <u>fatigue risk management systems</u> (FRMS) used in aviation, rail and pipeline industries <u>should be studied further</u>.**

They may provide models to apply to CMV driving.

Importance of Safety Culture

Conclusion 18: **Further research is needed on the impact of <u>corporate safety culture</u> on <u>driver decision-making</u> for countering fatigued driving, and on crash frequency.**

Part IV: Chapters 10 & 11

Chap.10-Research Directions for Fatigue & Highway Safety

Any approach to assessing the role played by operator fatigue and changing crash risk <u>needs to incorporate</u> classical fatigue factors as well as any confounding factors.

A large <u>matrix</u> in the report, **Table 10-1: Attempts to identify causal factors and their potential for serving in statistical models predicting crash rate and degree of fatigue.**

– FMCSA could attempt to fill out Table 10-1 as it offers helpful <u>foundations for planning</u> their research program(s).

Chapter 10(b) Research Directions

Commercial Driver License Info Sys Database
       -- Commercial Driver Surveys
       -- Need <u>Continuing Survey</u> of Truck & Bus Drivers

Data from vehicles should be available to researchers
                e.g., from on-board logging devices

Recommendation 2: FMCSA should evaluate whether <u>CMV drivers' use of electronic on-board recorders</u> correlates with reduced frequency of violations of hours-of-service rules, and reduced frequency of crashes.

Recommendation 3: FMCSA proposes to mandate use of electronic on-board recorders. Access to such recorded data could offer <u>substantial research benefits</u>.

The proposed rule should allow for "research use" of such e-recorded data; but captured in a manner that protects individualized confidential data from disclosure.

Chapter 10 (c): Research Directions

•Data are already being collected by electronic data recorders, telematics, and collision avoidance and fatigue detection systems.

•Could/should <u>focus research</u> on data **of all serious crashes,** collected automatically in the timeframe just prior to onset

Recommendation 4: When trucks and buses become involved in serious crashes, any electronic records, (data) regarding functioning of the driver <u>should be made available</u> to safety researchers (in a qualified confidential way).

Chapter 10 (d) Other Data Sources

-- Vehicle Inspection Reports (e.g., MCMIS, CVSA)

-- Data from Large Carriers

-- American Transportation Research Ins. (ATRI) Data

Recommendation 5: FMCSA should <u>incentivize those who capture driver performance data</u> ... to increase <u>availability of those data</u> relevant to research issues of operator fatigue, hours of service and highway safety.

Must ensure **data confidentiality** is maintained

— perhaps through restricted access arrangements or use of statistical techniques for disclosure protection.

Chapter 10 (e) Some Key Research Questions

-- Driving exposure data
-- Driver decision-making

Recommendation 6: FMCSA should improve <u>collection of baseline data on "driving exposure"</u> by including in its data collection efforts greater detail on the driving environment.

Then <u>provide access to these data</u> at low levels of geographic aggregation—even for individual highway segments.

Comparisons enabled by the availability of these baseline data would benefit several proposed lines of new <u>research</u>.

Recommendation 7: FMCSA should support research to <u>understand driver behavior</u> related to fatigue and sleep deficiency, including <u>what motivates "driver-decisions"</u> about continuing to drive when they feel fatigued.

Chapter 10 (f) Methodological Issues

- Study designs and associated data sets (improvements)

- Improve Naturalistic Driving Studies (NDS)

  – e.g., clarify definition & utility of Safety Critical Events

- Improving crash reports and observational data studies

- Use of encouragement designs, propensity scoring, etc.

Assessing new technologies to reduce fatigued driving

Recommendation 8: Using a human-systems integration (HSI) framework, FMCSA and NHTSA, in consultation with CDC and NIH, should develop evaluation guidelines and protocols for third-party testing, including field testing, to evaluate new technologies purporting to reduce impact of fatigue on driver safety.

Chapter 10 (h) Statistical Issues

Complex Correlation Structures (discussed)

Power of Studies (discussed)

Recommendation 9: FMCSA should make <u>greater use of independent peer review</u> in crafting requests for proposals, making decisions regarding research awards, and monitoring the progress of projects **(including statistical peer review in study design and analysis stages).**

Peer review should include expertise from <u>all relevant fields</u>, including epidemiology and statistics—especially causal inference—to address appropriate design and analysis methods.

Chapter 11 (a): Research Directions:
Impact of Fatigue on CMV **Health and Wellness**

A **framework** for assessing factors related to driver health/wellness

Table 11-1. – is similar to Table 10.1 – to help FMCSA

identify research directions

Need for an <u>ongoing survey</u> of CMV drivers

Goal: to understand driver health dynamics

– i.e. study what happens to driver health over time.

Maintaining Commercial Driver Alertness, Managing Fatigue, Fostering Driver Health and Wellness:

Assessment of the National Academies' Committee on National Statistics (CNSTAT)

10th Int'l Conference: Managing Fatigue

By Gerald P. Krueger, Ph.D.
Panel Member
JerryKrueg@aol.com

3/21/2017

COMMERCIAL MOTOR VEHICLE DRIVER FATIGUE, LONG-TERM HEALTH, AND HIGHWAY SAFETY

RESEARCH NEEDS

2016

The National Academies of SCIENCES · ENGINEERING · MEDICINE