from Research to Reality

Driver Safety
Night Shifts & Drowsy Driving

LIBERTY MUTUAL RESEARCH INSTITUTE FOR SAFETY

SCIENTIFIC UPDATE

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Drowsy Driving

The Dangers of a Sleep-Deprived Drive

We’ve all been there. Driving a stretch of road, struggling to stay awake and alert as fatigue begins to get the better of us. While many people admit to driving “under the influence” of fatigue from time to time, for night shift workers, drowsy driving is a recurring and potentially deadly risk.

Scientists from the Liberty Mutual Research Institute for Safety and Boston’s Brigham and Women’s Hospital examined the impact of night shift work on drowsiness and driving performance. Their findings, published in the Proceedings of the National Academy of Sciences, increase awareness and understanding of the dangers of drowsy driving and inform the development of appropriate countermeasures.

Drowsy Driving @ a Glance

Study:
Scientists studied the impact of night shift work on drowsiness and driving performance using real vehicles (versus a driving simulator) and actual night shift workers.

Methods:
Sixteen night shift workers each completed two driving sessions — one after 7.6 hours of sleep and no night shift work, and one after working a night shift. During each session, scientists collected objective and subjective measures of drowsiness and driving performance.

Findings:
More than a third of drivers who operated a vehicle on a closed test track after working the night shift were involved in near-crash events. The same drivers, with normal sleep the night before the test, had zero near-crashes. These and other findings from this study provide evidence of the dangers of driving following night shift work.

Implications:
The findings can be used to increase awareness about the risks associated with driving home after working a night shift and to inform the development of drowsy driving countermeasures.
Study Shows 40 Percent Risk of Near-Crash Event After Night Shift Work

Approximately one in five fatal car crashes (21 percent) involve a drowsy driver.¹ This statistic is sobering, especially for the 9.5 million Americans who work overnight or rotating shifts. These workers typically commute home from work during early morning hours, when their internal biological clocks are strongly signaling for sleep and the effects of insufficient nighttime sleep are palpable.

In a landmark study, scientists at the Liberty Mutual Research Institute for Safety (LMRIS) and Brigham and Women’s Hospital compared real-time driving performance and physiological changes in night shift workers both after a night of shift work and after a normal night of sleep. Unlike many drowsy driving studies, this one involved a real vehicle (closed track versus simulator driving) and actual night shift workers.

Fast Track to Real-Time Data

During two 2-hour driving sessions (one post night shift, one post sleep), scientists collected physiological measures of drowsiness using an EEG, eye-tracking equipment and self-report surveys. They evaluated driver performance by monitoring the number of near-crash events and terminated sessions, and by tracking lane departures.

“What made this study unique is that we were able to pull together different elements — a variety of physiological and performance measures and self-report data — using actual workers driving a real vehicle in the context of a morning commute,” says William J. Horrey, Ph.D., project co-investigator and principal research scientist at LMRIS. “This multifaceted approach adds a new dimension to our understanding of drowsy driving in general and to the particular risks in this working population.”

Crash Course in Drowsy Driving

According to the study findings, which were published in the Proceedings of the National Academy of Sciences,² nearly 40 percent of the drivers in the study experienced one or more near-crash events after working the night shift. The same drivers, after a normal night of sleep, had zero near-crash events. “While we expected differences between the two driving conditions, the sheer magnitude of that difference — 40 percent versus 0 percent — is striking,” says Horrey. “This finding underscores just how dangerous a homeward commute can be for this working population.”

In the Blink of an Eye

Further data analysis revealed significantly increased physiological and subjective measures of drowsiness after a night of shift work. Following the night shift, drivers experienced more episodes of prolonged blinking, more frequent slow eye movements and twice the number of lane departures — all of which are indicative of the transition from wakefulness to sleep. The data also showed increased risk of potentially dangerous microsleeps after 30 minutes of post night shift driving.

What Is a Microsleep?

Many people don’t realize that driving drowsy can lead to brief episodes of actual sleep, known as microsleeps. During these episodes, which can last from a fraction of a second up to several seconds, the driver’s brain literally falls asleep.

At 65 miles per hour, a three-second microsleep can result in 286 feet of road traveled — asleep. That’s nearly the length of an NFL regulation football field!

Analysis of the self-report data showed that post night shift drivers were, for the most part, aware of being much sleepier and of having increasing difficulty keeping their eyes open and maintaining their lane positions. Drivers were also aware that the differences between the post night shift and post sleep conditions became more pronounced after driving for more than 30 minutes (see chart, below).

The Road Ahead

Moving forward, Horrey and his colleagues are working with the data from this study to assess its potential use in predictive crash models. By examining critical events, such as sudden braking, lane drifting and near-crashes, and working backward along the different data streams, scientists will determine if physiological changes predict those events. Explains Yulan Liang, Ph.D., LMRIS research scientist and project co-investigator, “If you look at the seconds, tens of seconds and minutes leading up to a near-crash event, you can determine whether certain changes — for example decreased blink rate — indicate an increased risk of a crash. This use of the data holds great promise for the development of interventions such as in-vehicle systems that monitor a driver’s condition to warn someone of potentially dangerous levels of fatigue.”

“The more data-driven evidence we have to paint the picture, the better we can help build awareness and develop countermeasures to minimize drowsy driving risks for night shift workers and other high-risk populations,” concludes Horrey.

Comparison of Post Night Shift Drives and Post Sleep Drives

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>POST NIGHT SHIFT</th>
<th>POST SLEEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRIVING PERFORMANCE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drives with emergency brake applied</td>
<td>37.5%</td>
<td>0%</td>
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<tr>
<td>Drive ended early</td>
<td>43.8%</td>
<td>0%</td>
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<tr>
<td>Rate of lane crossing</td>
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<tr>
<td>OCULAR MEASURES</td>
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<tr>
<td>Slow eye movements</td>
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<td>10.6/h</td>
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<tr>
<td>Blink time duration (seconds)</td>
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<tr>
<td>Drowsiness*</td>
<td>1.71</td>
<td>0.97</td>
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<tr>
<td>EEG</td>
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<td></td>
</tr>
<tr>
<td>Microsleep episodes</td>
<td>1.00/h</td>
<td>0.47/h</td>
</tr>
</tbody>
</table>

The above table shows key findings from physiological and performance data collected from drivers who completed both post sleep and post night shift driving trials.

*According to the Johns Drowsiness Scale
People who routinely work the night shift, or who work a combination of night and day shifts, are battling their natural sleep cycles. As a result, they do not typically get the quality or quantity of sleep they need to function at their best. David Lombardi, Ph.D., Liberty Mutual Research Institute for Safety principal research scientist and expert in shift work fatigue, explains that night shift work can disrupt natural biological sleep-wake cycles as the timing varies from the body’s natural circadian rhythms. When a person commutes home in the early hours after working overnight, the need for recuperative rest is intensified by the fact that circadian rhythms are strongly signaling for sleep. But by the time the person gets home, his or her body may begin to prepare for waking up. “Once a person has been in this cycle for some time, getting back on track becomes extremely difficult,” notes Lombardi.

“Admittedly, some people adapt to night work better than others,” says Lombardi. “But most do not adapt well. As a result, they sleep for shorter durations during the day, and this sleep is often of lower quality.” Lombardi notes that the situation is further complicated by the fact that night shift workers often perform everyday tasks (such as food shopping, taking care of kids and going to doctor appointments) during daytime hours. “It’s vital for night shift workers to schedule uninterrupted sleep on workdays to allow for complete recuperative rest,” says Lombardi.

Lombardi also notes the importance of shift scheduling. “Our research has shown that for shift workers who work four consecutive nights, the risk of injury increases by 36 percent by the fourth night. That is a big risk increase that can be easily avoided with proper scheduling practices.”

“The more data-driven evidence we have ... the better we can help build awareness and develop countermeasures to minimize drowsy driving risks.”

Dr. William Horrey, Principal Research Scientist
Liberty Mutual Research Institute for Safety
What do medical professionals, police officers, news reporters and long-haul truckers have in common? These are among the nation’s 9.5 million shift workers — the types of workers who, according to research led by Liberty Mutual Research Institute for Safety and Brigham and Women’s Hospital, experienced 40 percent more near-crash events when they drove after working an overnight shift versus after a night of sleep. The study findings have implications for this population as well as for others who find themselves driving with a sleep deficit.

Raising Awareness

The tangible, quantifiable risk observed in this study adds a new and important dimension to ongoing efforts by Liberty Mutual Insurance (LMI) to increase drivers’ awareness of the dangers of drowsy driving. “It’s one thing to say driving drowsy is dangerous based on anecdotal information, surveys or intuition. It’s another thing to be able to have hard numbers to point to,” says Peter VanDyne, technical director, Risk Control, LMI Commercial Insurance. VanDyne sees the findings as a “wake up” call for those who work night shifts to remain alert to the signs of fatigue and to take measures to reduce their effects.

Rick Bagby, VP, Bodily Injury Claims Analytics and Product, LMI U.S. Consumer Markets, agrees with VanDyne. “Having fact-based research that shows the impact of drowsy driving can increase awareness of risks for our customers and may help reduce bodily injury claims, benefiting our customers as well as other drivers on the road.”

Beyond the Night Shift

As manager of the Next Generation Vehicle Program, LMI U.S. Consumer Markets, Ted Kwartler sees the implications of this research as extending beyond just night shift workers. “In today’s hyperproductive society, many people are convinced that they can operate effectively on just four or five hours of sleep. But we now have evidence to show that driving performance really suffers when sleep is lacking,” he says, noting that the near crashes observed in the controlled experimental environment could be actual crashes on the roadways.

Kwartler is optimistic that further scientific analysis of the data from this study will inform future driving technologies and innovations. “As cars become more advanced and data more rich, this type of research is foundational in shaping our business thinking. The clear link between drowsiness and driving performance found here supports a belief that next-generation vehicles may and should incorporate driver-sensing...”

Ted Kwartler, Manager
Next Generation Vehicle Program
LMI U.S. Consumer Markets

“As cars become more advanced and data more rich, this type of research is foundational in shaping our business thinking.”
technologies that can detect signs of sleepiness and alert the driver. This will help promote safer roads and driving habits as we think about the car’s evolution in the coming years.”

From Research to Reality

Building upon a research legacy that includes contributions to now-standard safety features such as seat belts and air bags, Liberty Mutual Research Institute for Safety remains at the forefront of automotive and driving safety. As new driving technologies continue to emerge, the application of science to driving safety is more important today than ever before.

“The better we understand the mechanisms of risk, the more opportunities we have to intervene effectively and help reduce vehicle crashes,” says Research Institute Director Ian Noy, Ph.D. “It is this kind of informed, evidence-based approach to assessing risk that can make roadways safer.”

The Night Shift Worker’s Dilemma

Clearly, night shift workers face a dilemma: Hampered by the natural biological drive for sleep while fighting fatigue and often sleep-deprived, they are at significant risk — but they need to work, and they need to get home after work. So what is a night shift worker to do?

“First and foremost, the night shift worker needs to adapt to a lifestyle that prioritizes recuperative rest,” explains Peter VanDyne, LMI CI Risk Control Services technical director. “With so many factors that compete with daytime rest — child care responsibilities, daytime errands, social pressures and life events — it is critical that night shift workers adhere to a structured daytime schedule that prioritizes sleep.”

Second, spouses, families and friends need to understand and support the night shift worker’s physiological need to get rest during the daytime hours. “No matter how much others want to get things done or how much they want the shift worker to participate in activities during the day, people need to adjust their expectations for the well-being of the shift worker,” says VanDyne, adding that those who live with shift workers also need to support and help maintain sleeping conditions that promote good daytime rest.

VanDyne also recommends that night shift workers have a “backup” plan in place, especially for those times when daytime sleep has been disrupted and they feel fatigued. “If someone is nodding off at the end of the shift, that person probably isn’t ready to handle early morning rush hour traffic after working all night. It’s a good idea for overnight shift workers to line up a family member or friend to be a designated driver, or use public transport.”

Top 10 Tips for Shift Workers to Combat Sleepiness and Drowsy Driving

1. Make your bedroom dark— like nighttime — and sleep at the same time every day.
2. Block or mask outside sounds.
3. Lower your thermostat before going to bed.
4. Maintain your overall health.
5. Avoid caffeine for several hours before bedtime.
6. Avoid alcohol for several hours before bedtime.
7. Know the side effects of your medications.
8. Close your bedroom door, and hang a “Do not disturb” sign on it.
9. Unplug the telephone in your bedroom.
10. Develop a relaxing sleep ritual.
