Driving while hungover: the necessity of biomarkers of the alcohol hangover state

Joris C Verster[1,2], Aurora van de Loo[1], Luke A. Downey[2,3]

1. Utrecht Institute for Pharmaceutical Sciences, Division of Pharmacology, Utrecht University, Universiteitsweg 99, 3584 CG, Utrecht, The Netherlands.
2. Centre for Human Psychopharmacology, Swinburne University of Technology, Hawthorn, VIC, Australia.
3. Department of Psychology, Swansea University, Swansea, Wales, UK.

Driving is an example of complex yet skilled behavior that may be affected when under the influence of alcohol and drugs of abuse (Penning et al. 2010). A large body of evidence has shown dose-dependent driving impairment after consuming alcohol. This has been revealed using a variety of research methods, including cognitive and psychomotor tests examining driving-related skills and abilities, driving simulator experiments and on-road testing in normal traffic. In addition, many epidemiological studies have been conducted showing increased crash risks in intoxicated drivers. This has led to laws and regulations around the world, including enforcing cut-off levels of blood alcohol concentrations (BAC) above which driving is considered unsafe. Most countries have a legal limit for driving set at a BAC of 0.05%, although some countries including the United Kingdom and various states in the US use a higher BAC cut-off (0.08%). The corresponding laws can easily be reinforced, as breath alcohol analyzers have been developed that can be used along the road. These devices instantly and objectively provide the BAC of the driver. Given the regular prevention campaigns, the general public is aware of the risks of driving while intoxicated and the vast majority of drivers adhere to the legal limits for driving after consuming alcohol.

This is not the case for driving the day after a heavy drinking session; during the alcohol hangover. Until recently, research on driving during hangover was scarce (Törnros and Laurell 1991). Recently, however, a study among professional truck drivers revealed that driving while hungover is a common phenomenon (Verster et al. 2014a). In the interviews, drivers acknowledged that their driving ability

during alcohol hangover was worse when compared to other driving days which were not preceded by an evening of alcohol consumption. A driving simulator study provided confirmation of this decrement in driving performance whilst hungover, with performance on a 100-km simulated highway driving test being significantly worse during hangover when compared to the alcohol-free condition (Verster et al. 2014b). In this study, participants were instructed to drive with a steady lateral position within the right traffic lane while maintaining a constant speed of 95 km/h. The outcome measures were the Standard Deviation of Lateral Position (SDLP; the weaving of the car (Verster and Roth 2011), and the number of lapses. The study showed that during hangover both SDLP and the number of lapses were significantly increased. The magnitude of driving impairment during alcohol hangover was comparable to that observed while driving with a BAC exceeding 0.05%. The study confirmed previous findings that during hangover, performance impairment on a variety of cognitive and psychomotor tests was comparable to that seen with a BAC of 0.08% (McKinney et al. 2012).

These studies illustrate that driving during hangover is unsafe, and should be prevented. First of all, this requires creating awareness among drivers that driving is impaired the day after excessive drinking. Second, objective measures to quantify the presence and severity of the alcohol hangover state should be developed. This will be challenging. Currently, the only way to establish the presence of a hangover is by self-report of the drinker. As in general, people's blood alcohol concentration has returned to zero when hangover severity scores peak. Breath alcohol devices are also not useful in identifying drivers who are driving in a hungover state. Hence, it is clear that other objective biomarkers are needed.

Alcohol and its breakdown product acetaldehyde are generally absent during alcohol hangover. These compounds are therefore not useful as biomarkers. Previous research has shown that after alcohol ingestion the minor non-oxidative metabolites ethyl glucuronide (EtG) and ethyl sulfate (EtS) can be determined in urine (Helander et al. 2009). EtG (and EtS) may be potential candidates to reveal that people are in a hangover state; as the detection time of EtG in urine is 12-24 hours after alcohol consumption (Hegstad et al. 2009). These alcohol breakdown products can be identified in urine 10-20 hours after drinking. It would be ideal if their concentrations would actually relate to subjective hangover severity, AND driving performance impairment. The latter has to be verified by upcoming research. In this context, a study by Hoiset et al. (2014) revealed promising results. They examined blood samples from impaired Norwegian drivers. Eighteen percent of them were in the hangover state, as confirmed by positive EtG and EtS readings. By categorizing drivers into being either not impaired, mildly

impaired, moderately impaired, or considerably impaired, the magnitude of driving impairment could be related to EtG and EtS concentrations. A significant, albeit modest, correlation between driving impairment and blood EtG and EtS concentrations was found. Future studies should determine to what extent established driving test outcome measures such as SDLP relate to EtG and EtS concentrations. Finally, the biomarkers are currently assessed in urine. This is not very practical for quick screening of drivers along the road. Ideally, breath analyzer devices will be developed that can identify the presence and severity of alcohol hangover.

Declaration of interest

Joris Verster has received grants/research support from the Dutch Ministry of Infrastructure and the Environment, Janssen Research and Development, Takeda, and Red Bull and has acted as a consultant for the Canadian Beverage Association, Centraal Bureau Drogisterijbedrijven, Coleman Frost, Deenox, Eisai, Purdue, Red Bull, Sanofi-Aventis, Sepracor, Takeda, Transcept, and Trimbos Institute.

Dr Luke Downey is supported by a National Health and Medical Research Council (NH&MRC) biomedical fellowship (APP1054279).

References

Hegstad S, Johnsen L, Mørland J, Christophersen AS. Determination of ethylglucuronide in oral fluid by ultra-performance liquid chromatography-tandem mass spectometry. Journal of Analytical Toxicology 2009, 33: 204-207.

Helander A, Böttcher M, Fehr C, Dahmen N, Beck O. Assessment and detection: detection times for urinary ethyl glucuronide and ethyl sulfate in heavy drinkers during alcohol detoxification. Alcohol & Alcoholism 2009, 44: 55-61.

Høiseth G, Fosen JT, Liane V, Bogstrand ST, Mørland J. Alcohol Hangover as a Cause of Impairment in Apprehended Drivers, Traffic Injury Prevention 2014, DOI: 10.1080/15389588.2014.938324

McKinney A, Coyle K, Verster JC. Direct comparison of the cognitive effects of acute alcohol with the morning after a normal night's drinking. Human Psychopharmacology 2012, 27: 295-304.

Penning R, Veldstra J, Daamen AP, Olivier B, Verster JC. Drugs of abuse, driving and traffic safety. Current Drug Abuse Reviews 2010, 3: 23-32.

Törnros J, Laurell H. Acute and hangover effects of alcohol on simulated driving performance. Blut Alcohol 1991, 28:24–30.

Verster JC, Roth T. Standard Operation Procedures for conducting the on-the-road driving test, and measurement of the Standard Deviation of Lateral Position (SDLP). International Journal of General Medicine 2011, 4: 359-371.

Verster JC, van der Maarel M, McKinney A, Olivier B, de Haan L. Driving during alcohol hangover among Dutch professional truck drivers. Traffic Injury Prevention 2014a, 15:434-438.

Verster JC, Bervoets AC, de Klerk S, Vreman RA, Olivier B, Roth T, Brookhuis KA. Effects of alcohol hangover on simulated highway driving performance. Psychopharmacology 2014b, 231: 2999-3008.