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Methodologies for Establishing the Relationship Between Alcohol/Drug Use and Driving Impairment — Differences Between Epidemiological, Experimental, and Real-Case Studies

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ABSTRACT: Experimental, epidemiological, and real-case studies have different advantages and limitations when used to study the effect of substance use on the risk for involvement in a road traffic crash. It is easier to perform well-controlled experimental studies than well-controlled epidemiological studies due to difficulties related to selection bias, information bias, and confounding. On the other hand, it is difficult or impossible to perform experimental studies using single and repeated substance doses similar to those used by drivers and problematic drugs users. Real-case studies indicate which substances may cause observed impairment and involvement in road traffic crashes and at which concentrations; however, those studies cannot be used to quantify crash risks or determine causality. All three types of studies are needed to obtain a broad and complete picture as they may complement each other when assessing the effects of substance use on road traffic safety.

KEYWORDS: Alcohol, drugs, impairment, research methods, road traffic crash, substance use, traffic safety.

INTRODUCTION

A large proportion of road traffic crashes are caused by driver impairment after using alcohol or other psychoactive substances [167]. Analysis of blood samples from those arrested for driving under the influence (DUI) of alcohol or drugs, or from crash-involved drivers, show variations in detected substances across countries related to regional differences in the use of alcohol, recreational drugs, and psychoactive medicines, including problematic use and addiction, as well as differences in attitudes toward driving after using alcohol or drugs [21,47,94,95]. Such differences make comparisons between studies difficult. In general, alcohol is the most commonly used psychoactive substance among drivers, followed by cannabis, central nervous stimulants such as amphetamines and cocaine, and central nervous depressants such as sedatives, hypnotics, and narcotic analgesics. Multiple substance use is also common among arrested DUI offenders [66,84,154].

Most countries have implemented statutory alcohol concentration limits in blood or breath for DUI of alcohol. Many countries also have laws on driving under the influence of drugs other than alcohol, which may either be based on documented impairment, zero tolerance for psychoactive drugs, or concentration per se limits in blood [21,162]. Zero-tolerance laws make it a criminal offense to have a drug or metabolite in the body while operating a motor vehicle, and is sometimes regarded as a type of per se legislation. This legal framework was constructed, at least in part, to simplify the evidence necessary for a successful prosecution [74].

Standardized research methods are needed in order to generate accurate and reproducible data when studying the effects of alcohol and drugs on the ability to drive safely. The first recommendations and guidelines were published in the 1980s and '90s [29,69,70,82]. In 2007, an expert meeting was held in Talloires (France) where guidelines on both experimental and epidemiological research were discussed [163]. As an outcome of that meeting, more detailed guidelines and recommendations were developed and published in 2008 [164]. US National Highway Traffic Safety Administration published a consensus protocol for assessing the potential of drugs to impair driving in 2011, although with less details [85], and a white paper on drugged-driving research was published by the Drugged Driving Committee of the Institute for Behavior and Health in the US, also in 2011 [33]. Finally, the Food and Drug Administration published Guidance for Industry on the evaluation of drug effects on the ability to operate a motor vehicle in 2017 [38], although less detailed than other guidelines.

The aim of this article is to describe the methodologies used to investigate the effect of alcohol and drugs on the ability to drive safely, present the main advantages and challenges, and discuss disagreements between findings for some substances.

I. EXPERIMENTAL STUDIES

Experimental studies on the acute effects of alcohol and/or drugs on a person's ability to drive safely are performed by giving a defined amount of substance to a number of test persons and measuring the effect on performance at predefined time points.

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Hallvard Gjerde obtained his M.Sc. degree in biochemistry from the University of Oslo (Oslo, Norway) in 1983 and a Ph.D. from the Faculty of Medicine of the same university in 1988. Dr. Gjerde is currently a senior researcher in the Department of Forensic Sciences, Oslo University Hospital (Oslo, Norway).

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Dr. Gjerde has published about 100 articles in peer-reviewed journals on drug analysis, forensic sciences, alcohol and drug use, and road traffic safety. He is currently a board member of the International Council of Alcohol, Drugs and Traffic Safety.

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Dr. Ramaekers's research focuses on effects of medicinal and illicit drugs on cognitive functions and driving. He has been organizing courses in the field of Human Psychopharmacology, Biological Psychology, and Traffic & Aviation Psychology and is the author or co-author of almost 200 peer-reviewed articles. He is currently president of the International Council of Alcohol, Drugs and Traffic Safety.

Jørg G. Mørland received an M.D. degree from the University of Oslo in 1967 and a Ph.D. degree in pharmacology from the same university in 1975. Dr. Mørland is now a senior scientist at the Division of Health Data and Digitalization of the Norwegian Institute of Public Health and a professor emeritus at the University of Oslo.

Throughout his professional career, Dr. Mørland has served as professor of pharmacology at the University of Oslo and the University of Tromsø (Tromsø, Norway), director of the former Norwegian National Institute of Forensic Toxicology, and director of the Division of Forensic Medicine and Drug Abuse Research of the Norwegian Institute of Public Health (Oslo, Norway) until 2012.

Dr. Mørland is a medical specialist in clinical pharmacology. His main research field is biomedical effects of alcohol and drugs of abuse, their metabolites and metabolism. He has been and is the principal supervisor for approximately 30 Ph.D. students, as well as being the scientific project manager for several projects supported by the Research Council of Norway.

Dr. Mørland has published more than 400 articles in peer-reviewed journals on pharmacology, toxicology, forensic sciences, neuroscience, alcoholism, epidemiology, drug analysis, and road traffic safety. He has also written more than 8,000 expert-witness statements for the police and courts in Norway, and has had several hundred court appearances as an expert witness in courts at all levels in Norway as well as in some courts in Sweden. He was the recipient of a Widmark Award from the International Council on Alcohol, Drugs and Traffic Saftety (ICADTS) in 2004.