



TRANSPORT RESEARCH CENTRE

# DRUGS AND DRIVING

## Detection and Deterrence







# **DRUGS AND DRIVING**

## **Detection and Deterrence**

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## FOREWORD

The overall purpose of this report is to provide a state of the art review of evidence on the role and impact of drugs in traffic.

It was prepared by an advisory group, chaired by Mr Horst Schulze (Germany). The full list of members can be found in the Appendix.

The main report was drafted by a team of consultants composed of

- Doug Beirness (Canada)
- Philip Swan (Australia)
- Barry Logan (United States)

The report is based on a search and review of the scientific literature, including journals and technical reports as well as to the responses to a questionnaire to which 16 OECD/ITF countries responded.

Members of the Advisory Group were consulted to develop and respond to the questionnaire and to provide a critical review of the draft report.





## ABSTRACT

### ITRD<sup>1</sup> NUMBER: E146855

Driving while impaired by drugs – whether licit or illicit – has emerged as an important road safety issue. This report provides a state-of-the-art review of the role and impact of drugs in road accident risk. It reviews the legislation, deterrence and roadside detection practices in member countries as well as preventative measures to combat drug use while driving.

The report first discusses the scientific evidence that provides the basis for understanding drug effects on driving performance, provides an assessment of the pharmacological effects in relation to driving skills and documents the relationship between blood toxicology findings and impairment. It then presents the evidence from studies that have examined the frequency of driving after drug use and the incidence of drugs among drivers involved in crashes and assesses the risks associated with driving after using drugs. It provides a review and discussion of legislative and enforcement policies and practices in OECD/ITF countries and of the prevention initiatives. Finally it draws conclusions about the role of drugs in traffic and identifies leading practices for controlling/preventing the behaviour based on the evidence presented.

Fields: Subject Category 83 accidents and the human factor

Keywords: alcohol, drugs, driving(veh), test, road user, accident, behaviour, legislation, enforcement(law)

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## EXECUTIVE SUMMARY

On the heels of several decades of successful efforts to understand and reduce the magnitude of the problems associated with driving after consuming alcohol, driving while impaired by other psychoactive substances has emerged as a road safety issue of its own. There are a wide variety of substances that have the potential to adversely affect the cognitive and behavioural skills required to operate a vehicle safely. The list of substances includes many illegal drugs (*e.g.* cannabis, ecstasy), psychotropic medications (*e.g.* benzodiazepines, opiates), and some over-the-counter preparations (*e.g.* antihistamines, cough and cold remedies). Despite the apparent similarity with the problem of alcohol use and driving, drug-driving<sup>1</sup> presents a whole new array of challenges for research, policy, and programmes.

Efforts to deal effectively with the use of drugs by drivers have been hindered by the incomplete and sometimes inconclusive evidence pertaining to the issue. Whereas drinking and driving countermeasures have been aided by the considerable evidence on the problem that has accumulated over the past fifty years, the state of knowledge on drug-driving pales in comparison. To a large extent, this is because drug-driving is a much more complex issue. Not only are there numerous substances that have the potential to impair driving abilities, detecting and measuring these substances cannot be done using breath samples but require more intrusive methods to gather samples of bodily fluids such as blood, urine, and/or oral fluid. This creates methodological and logistical obstacles to the study of drivers on the road and drivers involved in crashes. In addition, whereas alcohol use is common among most segments of the driving age population, different types of drugs tend to be used by subgroups within the population for a variety of purposes. Each substance presents a new set of challenges.

### The Evidence

A complete understanding of the role of drugs in motor vehicle crashes requires evidence from two complementary research approaches – experimental and epidemiological research. The role of experimentation is to document the nature and extent of impairment produced by specific dosages of particular drugs. The role of epidemiological studies is to determine the extent to which drugs contribute to motor vehicle collisions.

A wide variety of psychoactive drugs, whether ingested for legitimate medical reasons, misused, or taken for illicit recreational purposes, cause changes in the brain, which disrupt normal cognitive and psychomotor functioning. They do this through a number of different mechanisms depending on the type of substance. Some affect alertness and perception; others increase impulsiveness; still others slow the speed at which the brain receives processes and responds to environmental information. All of these mechanisms have the same net effect – a decrease in the quality of mental and physiological effort dedicated to the driving task, decreasing performance and increasing the risk of crash involvement.

The use of psychoactive substances for their mood-altering and/or euphoric properties is not uncommon. Recent surveys indicate that about 15% of the population report the use of a psychoactive

substance (excluding alcohol and prescription pharmaceuticals) at least once in the previous year. Given that the vast majority of people in Western countries drive a motor vehicle on a regular basis, it is not surprising that drug use and driving have occasion to occur in close temporal proximity.

Roadside surveys have been used to determine the extent to which drugs are used by drivers. Despite the logistical and technological challenges, roadside surveys of nighttime drivers in North America have determined that psychoactive drugs are found in 10 to 16% of drivers. Based on this evidence, the prevalence of drug use by drivers now rivals or exceeds that of drivers who have been drinking. In Europe, where roadside surveys of drug use among drivers are typically done at all times of day, drug use appears somewhat lower than in North America.

Drivers who have used drugs also tend to become involved in serious crashes. Numerous studies have examined the incidence of drugs among drivers injured or killed in motor vehicle crashes. The majority of studies report the overall incidence of drugs to be in the range of 14% to 17%. Cannabis is the most commonly found substance, followed by benzodiazepines. Estimates vary widely and depend on the type of crash and selection of cases. Nevertheless, the evidence clearly demonstrates that drugs other than alcohol are not uncommon among drivers involved in serious road crashes.

The key issue, however, is not how frequently drugs are detected among drivers, but the extent to which consumption of a particular psychoactive substance contributed to the crash. Analytic epidemiological studies seek to determine the extent to which drugs are disproportionately represented among drivers who become involved in road crashes and to quantify the crash risk associated with the use of various types of drugs. Three approaches have been used to estimate crash risk: case-control studies, crash responsibility/culpability studies, and pharmacoepidemiological studies. These studies face many methodological obstacles and the differences in findings may be attributable, in part, to a variety of factors – *e.g.* approach (case-control, responsibility analysis); severity of crash (*e.g.* injury, fatal); fluid tested (*e.g.* urine, blood); and sample size. Nevertheless, despite these challenges, the overall weight of the evidence reveals an increased risk of crash involvement among drivers who consume various types of substances. Two things are eminently clear. First, the magnitude of the crash risks associated with drug use is typically lower than those associated with alcohol use, particularly those at higher blood alcohol levels. Second, impairing substances pose greater risks when combined with even small amounts of alcohol.

Further studies employing large samples and rigorous methods will enhance our understanding of the extent of the risk posed by the use of drugs by drivers. Some of this research is currently being conducted as part of the DRUID<sup>2</sup> project in various centres across Europe. In addition, in the United States the National Highway Traffic Safety Administration is developing a plan to conduct a large-scale case-control study to examine the risks associated with driving after drug use. The results of these projects will provide valuable information that will be instrumental in furthering our understanding of the issue, establishing public policy, and developing enforcement and prevention programmes.

### **Legislation, Enforcement, and Prevention**

Efforts to deal effectively with drug-driving usually involve a combination of legislative initiatives, enforcement practices, and primary prevention activities. To date, the nature of these efforts have been modelled on the wealth of experience with measures introduced to control the drink-driving problem. A great deal has been learned over the past 30 years about effective ways to reduce drinking and driving and these lessons have guided the development and implementation of measures to control the drug-driving problem.

Despite the obvious parallels between drink- and drug-driving, there are numerous differences that must be taken into account in the adaptation of countermeasure programmes. For example, the term “drugs” encompasses a wide variety of substances. Some are illegal but are widely used for their euphoric effects (*e.g.* cannabis, cocaine); others are prescribed for legitimate medical purposes (*e.g.* benzodiazepines); still others can be purchased directly by consumers to treat minor ailments (*e.g.* antihistamines). In addition, some prescription medications are used inappropriately (*e.g.* wrong dose, with alcohol) or by those for whom they were not prescribed. Each of these situations involves different behaviours, motivations, and subgroups within the population. Any approach must take account of these various situations.

To a large extent, countries have used their drink-driving legislation as a model for their legal approach to drug-driving. Legislation falls into two general categories – behaviour-based (*i.e.* impairment) statutes and *per se* laws. Behaviour-based statutes focus on the degradation of driving skills as a consequence of consuming a psychoactive substance. These types of laws date back to the early part of the twentieth century and were introduced as a means to control “drunk driving” or “driving while intoxicated.” Over the years, a more objective standard of “impairment” was introduced and standardised protocols have been implemented to demonstrate the extent to which a driver’s ability had been compromised. These standards have been adapted and applied to deal with the drug-driving situation.

*Per se* laws also have their roots in efforts to deal with drink-driving. Based on the established relationships between blood alcohol concentration (BAC), impairment and crash risk, *per se* laws specify that drivers have committed an offence if their BAC exceeds a specified value. Such laws create a legal “short cut”, eliminating the requirement to demonstrate that the driver was adversely affected by the consumption of alcohol. Adapting *per se* laws to the drug-driving situation has proven somewhat more difficult. Whereas research over the past fifty years has clearly established the link between alcohol, impairment and crash risk, similar evidence is not available for every potentially impairing substance.

The alternative used by a number of jurisdictions is to set the *per se* limit for drugs at zero. So-called “zero tolerance” laws specify that any detectable amount of particular substances found in the body of a driver would be considered to constitute an offence. Several countries have zero tolerance laws for illegal drugs and/or specifically named substances. In the absence of definitive research evidence supporting an alternative *per se* limit, zero tolerance laws serve to reinforce existing laws against the possession and/or use of illegal substances.

Whereas zero tolerance laws for illegal substances might be politically acceptable and expeditious, such is not the case for medicinal substances. Establishing a zero tolerance standard for all medicinal psychoactive drugs would disqualify a large number of individuals from operating vehicles, a position that lacks unqualified scientific support. Nevertheless, any approach must acknowledge that many psychoactive pharmaceuticals can cause driver impairment, particularly upon initial use, following a change in dosage, when used inappropriately, or when combined with the use of other drugs and/or alcohol.

To a large extent, enforcement practices are determined by the type of drug-driving legislation in the jurisdiction. Behaviour-based statutes require police officers to collect and document evidence of impaired behaviour and to demonstrate that a psychoactive substance capable of producing the observed behaviour was present in the driver at the time. This often requires police officers to be specially trained to assess impairment and recognise the signs and symptoms of drug use (*e.g.* Drug Evaluation and Classification [DEC] Programme). The officer must also arrange for the collection of a biological specimen from the driver to determine the type of substance present. The enforcement of *per se* statutes

only requires the officer to collect a sample of bodily fluid that will be tested for the presence of psychoactive substances.

Checkpoints or controls have been used extensively in many countries to detect alcohol- and drug-impaired drivers. Although resource intensive, controls have been shown to be effective in identifying drinking drivers and reducing alcohol-impaired driving, most likely by providing a strong deterrent. The impact of controls on drug-driving has yet to be demonstrated.

Jurisdictions differ in terms of circumstances under which drivers may be tested for alcohol or drugs. Some jurisdictions require officers to have a suspicion of alcohol or drug use, or reasonable grounds to believe the driver is impaired, before demanding a specimen for testing. In several jurisdictions in Europe and Australia, however, random alcohol testing, and more recently random drug testing, is permitted. This allows police to demand a bodily fluid sample at any time without cause or suspicion. When implemented on a large scale, this approach increases both the perceived and actual probability of detection, thereby enhancing overall general deterrence.

Primary prevention efforts directed at drug-driving have been relatively superficial. Most programmes have relied heavily on public education/awareness and deterrence through media and enforcement. Admittedly, prevention of drug-driving can be a complex issue. There are numerous types of substances involved and a variety of groups within the population that use different types of substances, each of which most likely requires a distinct and separate approach.

## Conclusion

Whereas there may be similarities and parallels between drink-driving and drug-driving, it is important to appreciate the real and substantive differences between the two issues. In this context, it cannot simply be assumed that the same techniques, policies, procedures and countermeasures that were developed for the drink-driving problem can be readily adapted or transferred to deal with the drug-driving issue. Drug-driving is a more complex issue. Many questions remain. At the very least, the approach to drug-driving must acknowledge the variety of different situations in which the behaviour occurs; at the extreme, several different strategies may be required, each with a unique perspective on prevention, enforcement, sanctions, and rehabilitation. Further research is required to help unravel the intricacies of the drug-driving problem and to facilitate the development of new and effective approaches to deal with it.

## NOTES

1. In this report, the term “drug-driving” refers to driving after the use of a psychoactive drug, including, but not limited to, driving while one’s ability to do so is impaired by drug use, referred to as “drug-impaired driving”. Similarly, the terms “drink-driving” and “driving after drinking” refer to the operation of a vehicle following the consumption of alcohol. This includes, but is not limited to, “alcohol-impaired driving”, which refers to driving after consuming sufficient alcohol to impair one’s ability to drive safely.
2. DRUID is the acronym of the European research project “Driving under the Influence of Drugs, Alcohol and Medicines”.



## 1. INTRODUCTION

Following almost three decades of intensive efforts to reduce the magnitude of the alcohol-crash problem, safety advocates, policy makers, legislators, and enforcement agencies have begun to express greater concern about the use of drugs by drivers. Although the misuse of drugs has long been considered a major social problem, the acute and devastating consequences of driving while impaired by psychoactive substances other than, or in addition to, alcohol has only recently become a recognised road safety issue of its own.

At the outset, it is essential to define which types of substances pose a risk to road safety. In general, any psychoactive substance – *i.e.* one that acts on the central nervous system and alters brain function – has the potential to adversely affect the ability to operate a vehicle safely. This includes most illegal substances (*e.g.* cannabis, cocaine), a wide variety of prescription pharmaceuticals (*e.g.* benzodiazepines, opiates), as well as certain over-the-counter medicines (*e.g.* antihistamines, cough and cold remedies). For the purposes of this report, unless there is an explicit reason to distinguish among various types of substances, the term “drug” refers to any psychoactive substance that can impair the ability to operate a vehicle safely. The exception is alcohol, which although technically a psychoactive substance, is considered outside the scope of the term “drug” as defined in this report.

It is also essential to state that the focus of this report is not as much about the types of substances as it is about the extent to which these substances impair driving and their effect on crash risk. The magnitude and qualitative nature of the impairment may vary according to the type of substance and the manner of use. In this context, some substances may be viewed as being inherently more dangerous than others. These judgements need to be based on empirical evidence of impairment and risk rather than loosely defined classifications of “illegal” and “medicinal” substances.

Despite the increased interest in the role of drugs in traffic, efforts to deal effectively with the problem have been hindered by the sometimes incomplete and inconclusive evidence pertaining to the issue. It is well recognised that the state of knowledge about the effects and consequences of driving under the influence of psychoactive drugs, pales in comparison to that surrounding the issue of alcohol and driving. While a great deal can be gleaned from the successes in the area of alcohol and driving, it must be recognised that drug-driving presents a more complex issue. For one, there are numerous psychoactive substances that can adversely affect the ability to operate a vehicle safely. Some of these substances are illegal; others are therapeutic agents that have a legitimate medical purpose. The populations who use these various types of substances vary on many dimensions. Moreover, whereas alcohol can be readily and reliably measured in breath samples, other substances require samples of other bodily fluids such as urine, blood or oral fluid. These factors contribute to the information gaps that hinder the development and implementation of effective policies and programmes to deal effectively with the issue. Nevertheless, there is need to take immediate action.

Establishing effective policies concerning the role of drugs in traffic requires evidence from two distinct and separate approaches – experimentation and epidemiology (Simpson & Vingilis 1992). It was complementary and converging evidence from these two approaches that was used to establish the link between alcohol use and road crashes and to create programmes and policies to address the issues. Recently, a group of experts outlined a set of guidelines for experimental and epidemiological research on drug-driving that will help guide the accumulation of evidence (Walsh *et al.* 2008).

The role of experimentation is to document the nature and extent of the psychomotor and cognitive impairment produced by specific dosages of particular drugs. There exists a considerable literature on the effects of a multitude of drugs on various psychomotor tasks relevant to the safe operation of a motor vehicle. The evidence documents the type of performance deficits that may be experienced should one drive after using a particular substance.

The role of epidemiology is to determine the extent to which drugs actually contribute to motor vehicle crashes. Two types of epidemiological evidence are relevant. Descriptive epidemiological research documents the incidence of drug use in various populations of road users – *i.e.* the general population of drivers, drivers on the road not involved in crashes, and drivers killed or injured in crashes – provides an indication of the incidence of drug use by drivers, monitors trends over time, and helps direct the search for risk factors. Analytical epidemiological research compares the incidence of drugs among the population of drivers at risk to that among the population of drivers who crash to determine which drugs are associated with increased risk of crash involvement and to quantify the extent of that risk.

Complementary evidence from these two lines of research evidence establishes the nature and magnitude of the problem and provides the information from which effective policies and programmes can be developed.

### **1.1. Purpose and objective of the report**

The overall purpose of this report is to provide a state of the art review of evidence on the role and impact of drugs in traffic. The current project is designed to be complementary to the DRUID project, an ongoing standardised data collection and methodology refinement project in European countries. In particular, this report will provide:

- An assessment of the prevalence of overall drug use and drug use by drivers in OECD/ITF countries.
- A summary of the impact of various drugs on driving behaviour and crash risk.
- A review of legislation, detection and deterrence practices.
- A review of prevention activities to combat drug use in traffic.

### **1.2. Approach**

For the most part, a search and review of the scientific literature, including journals, technical reports, and other “grey” literature, provided the primary sources of the information contained in this paper. This was supplemented by informal discussions with other scientists and information gathered at conferences and meetings.

To facilitate the collection of information about the state of drug-driving and current practices, a questionnaire was sent to 16 OECD/ITF countries enquiring about the extent of alcohol and drug use, information on alcohol and drug testing among drivers involved in crashes, current legislation, enforcement practices, and prevention activities.<sup>1</sup> The findings from the questionnaire are presented at various places throughout the report as appropriate.

### 1.3. Scope of the report

The report is divided into the following sections.

- **The Effects of Drugs on Safe Driving Performance.** This section discusses the scientific evidence that provides the basis for our understanding of drug effects on driving performance. The evidence on the drug effects on driving skills will be assessed across three domains: strategic/analytic (*i.e.* higher-order cognitive functions such as planning, judgement); manoeuvring (*e.g.* lane-changing, merging, speed adjustments); and, vehicle control (*e.g.* tracking, reaction time). It also provides an assessment of the pharmacological effects in relation to driving skills and documents the relationship between blood toxicology findings and impairment.
- **Drug Use Among Drivers.** This section presents the evidence from studies that have examined the frequency of driving after drug use and the incidence of drugs among drivers involved in crashes. This includes population-level data on drug and alcohol use (including data from the survey conducted as part of this project), self-report surveys in which drivers are asked to describe their own practices of driving after using drugs, roadside surveys in which objective measures of drug use are usually obtained from drivers, and studies that seek to measure the type and extent of drugs among drivers who come to the attention of authorities as a result of arrest or crash involvement.
- **The Role of Drugs in Road Crashes.** The studies reviewed in this section attempt to establish the contributory role of drugs to crashes and/or the risks associated with driving after using drugs. Studies include case-control studies, in which the incidence of drug use is compared between drivers who are or are not involved in crashes, and crash responsibility/culpability studies, in which the incidence of drug use is compared between drivers who are and are not responsible/culpable for the crashes in which they are involved.
- **Legislation, Enforcement, and Prevention.** This section provides a review and discussion of legislative and enforcement policies and practices in OECD/ITF countries. In particular, it examines the two primary legislative approaches to controlling drug use by drivers – *per se* and behavioural/impairment – and provides practical examples of the implementation of these laws in Australia. In addition, this section will review approaches to enforcement (*e.g.* targeted, random), drug testing (*e.g.* oral fluid, urine, blood), and the distinction (if any) made between the use of illicit substances and prescription medications. A discussion of primary prevention initiatives is also provided.
- **Conclusions.** This section draws conclusions about the role of drugs in traffic and identifies leading practices for controlling/preventing the behaviour based on the evidence presented. The overall purpose is to identify evidence-informed practices to guide the development of effective policies to reduce drug-related traffic casualties.
- **References.** A complete list of references is provided.

**NOTES**

1. A copy of the questionnaire is provided in Appendix A.

## 2. THE EFFECTS OF DRUGS ON SAFE DRIVING PERFORMANCE

*This chapter discusses the scientific evidence that provides the basis for our understanding of drug effects on driving performance. The evidence on the drug effects on driving skills will be assessed across three domains: strategic/analytic (i.e. higher-order cognitive functions such as planning, judgement); manoeuvring (e.g. lane-changing, merging, speed adjustments); and, vehicle control (e.g. tracking, reaction time). It also provides an assessment of the pharmacological effects in relation to driving skills and documents the relationship between blood toxicology findings and impairment.*

Driving is often described as a complex task that requires the coordination of a variety of motor, perceptual and cognitive tasks. The skill and attention required for safe driving are acquired through years of practising the necessary actions and operations to guide a vehicle safely through traffic.

The application of the skills and abilities necessary for safe driving in the changing and dynamic environment on city streets and highways makes driving a complex task. It requires the appropriate division of attention among many cognitive and psychomotor tasks. It is possible to analyse the driving task in many ways; a relatively simple model of behavioural domains might be as described below, recognising the mixture of cognitive and psychomotor skills required for safe driving.

**Strategic and Analytical Abilities:** involving planning, route selection, traffic volume estimation, analysis of traffic patterns and the application of experience, vigilance, assessment of risk, critical judgment, risk assessment, dynamic evaluation of the environment, weather, and vehicle performance, and time and distance forecasting

**Manoeuvring Abilities:** required for complex action patterns, lane changes, maintaining headway, merging, adjusting speed to traffic flow, acceleration and deceleration

**Control Skills:** tracking, manipulating controls, automatic action patterns, reaction, and response, simple reaction and choice reaction.

For experienced drivers, these skills and behaviours seem routine and automatic. But even for the most skilful drivers, the use of drugs and alcohol can affect the efficient application of these skills.

If the alcohol- and drug-free driver represents a state of equilibrium, then any change in reaction time, impulse control, value judgment, anticipatory response, or other cognitive processes, results in a departure from that equilibrium and invariably a deterioration in driving performance. Cognitive skills are the most sensitive to substances that affect this equilibrium, and behavioural changes in driving performance reflecting the first two domains described above, are invariably the first to appear. These effects are also the most important considerations in routine, low-demand driving.

Psychomotor skills are related to vehicle control and manoeuvring but are relatively less sensitive to impairing effects of alcohol and drugs than cognitive skills. These skills become critically important in emergency or high demand driving situations, such as emergency response or crash avoidance.

Adopting the model of homeostasis or equilibrium as the baseline for an individual driver's performance is a useful reference point for assessing the significance of potentially impairing effects of any drug, irrespective of the direction of change.

Some drug effects are obvious in terms of their adverse effects on driving. Depressant drugs, which can cause slowed response time, slower neural processing, slower recall, greater error rates in complex tasks, balance and orientation changes, lowered alertness and sedation, can have a clear relationship to impairment. Likewise hallucinogens, and drugs with sedation as their main effect or side effect, have an obvious adverse effect on overall driving performance.

Stimulants, often thought of as performance-enhancing drugs, might increase reaction time but can also affect critical judgment, increase impulsiveness, increase error rate, and interrupt normal sleep patterns, leading to fatigued or sleep impaired driving.

The interrelation of skills involved in safe driving, and the inevitable occurrence of side effects means that any centrally-acting drug has at least the potential to negatively affect driving skill or to displace driving performance from its baseline level – *i.e.* they can interfere with the ability to operate a vehicle safely.

## 2.1. Effects of Medicinal versus Illicit Drugs on Driving

It is important to consider the similarities and differences between illicit drugs such as heroin, over-the-counter preparations such as diphenhydramine, and therapeutic drugs such as methadone. The term “drug” is used interchangeably in most of the literature reviewed to include all three of the above categories, and is used that way here. In terms of their similarities, any substance that can interfere with the cognitive or physical abilities required to operate a vehicle can produce qualitatively the same effect on subjects irrespective of whether the substance was obtained legitimately by prescription or not. Abuse or misuse of therapeutic drugs or “medicines” can produce significant impairment and adverse effects. Recent studies show very poor rates of compliance with prescription directions in some patient populations such as those with chronic pain (Couto *et al.* 2009). Narcotic analgesic toxicity, whether caused by heroin injection or double-dosing with oxycodone, result in the same symptoms of sedation and sleepiness, slowed reactions and pinpoint pupils, resulting in qualitatively similar driver impairment. Adverse drug effects experienced by patients taking a drug for the first time, after a change in their dose, or through drug interactions can be just as impairing as effects from illicit drug use or abuse. For this reason, all types of drugs – prescription medications, over-the-counter preparations, and illicit substances – are discussed in this assessment.

It should be noted, however, that in some cases the use of the appropriate pharmaceutical under the supervision of a physician can actually serve to improve the ability of a patient to operate a vehicle safely by helping to alleviate the disease and re-establishing equilibrium. In other cases, the detrimental effects of some pharmaceuticals may wane with repeated administrations over time as a result of acquired tolerance.

## 2.2. Assessment of Pharmacological Effects and Relation to Driving Skills

A wide variety of substances can negatively affect the skills and abilities necessary to operate a vehicle safely. Identifying all such possible substances would be a daunting task. A prudent approach

would be to focus on those substances most likely to be encountered in present day driving populations. In a recent review of drug use among drivers, Farrell *et al.* (2007) identified a list of the substances most frequently encountered. Table 2.1 lists the drug classes considered as priority for investigators and policy makers in terms of the impact on road safety. Others have reported a similar range of most frequently encountered drugs (Jones *et al.* 2007; Walsh *et al.* 2008). Following the table, representative examples from the drug classes presented in the table are discussed.

Drugs can be discussed based on their pharmacological properties and the measurement of driving performance in a controlled environment, such as laboratory tests, driving simulators and/or on-road dual-control driving. The majority of the frequently encountered drugs described in Table 2.1 are discussed separately in the following sections in terms of the available research documenting their impact on skills and abilities related to driving performance.

Table 2.1. Priority drug classes identified as being detected in driving populations

<b>Cannabis</b>	<b>Depressants (cont.)</b>
<b>Stimulants</b>	Antihistamines
Cocaine	<i>Diphenhydramine</i>
Amphetamines	<i>Chlorpheniramine</i>
<i>Amphetamine</i>	<i>Doxylamine</i>
<i>Methamphetamine</i>	Muscle relaxants
<i>MDMA</i>	<i>Carisoprodol</i>
<b>Depressants</b>	<i>Meprobamate</i>
Benzodiazepines	<i>Butalbital</i>
<i>Alprazolam</i>	<b>Narcotic Analgesics</b>
<i>Diazepam</i>	Opiates
<i>Temazepam</i>	<i>Codeine</i>
<i>Flunitrazepam</i>	<i>Morphine</i>
<i>Lorazepam</i>	<i>Hydrocodone</i>
Sedative hypnotics	<i>Oxycodone</i>
<i>Zolpidem</i>	<i>Hydromorphone</i>
<i>Zopiclone</i>	Synthetic opioids
<i>Zaleplon</i>	<i>Methadone</i>
Second generation antidepressants	<i>Tramadol</i>
<i>Amitriptyline</i>	<b>Hallucinogens</b>
<i>Nortriptyline</i>	LSD
	Phencyclidine

Source: Compiled from: Farrell *et al.* 2007; Jones *et al.* 2007; Walsh *et al.* 2008

### 2.2.1. Cannabis

Cannabis (cannabis, hashish [hash], hash oil) is a unique drug, having both hallucinogenic and central nervous system depressant properties. Its effects are mediated through a distinct receptor system, different from those related to the effects of hallucinogens, opiates or central nervous system depressants. The cannabis user experiences feelings of relaxation, detachment, intoxication, and mild euphoria. Subtle visual hallucinations can occur such as objects changing shape or form. These distracting



perceptual changes create a distracting environment for the driver, and interfere with other tasks that require sustained and focused attention. Additional effects on driving are related to the user experiencing distorted perceptions, impaired coordination, difficulty in thinking and problem solving, and problems with learning and memory (Ramaekers *et al.*, 2006a).

In on-road driving experiments, difficulty in maintaining lane position (weaving), and headway between vehicles were noted with a trend towards increasing impairment with increasing dose (Ramaekers *et al.*, 2000). Other reported effects of cannabis on driving ability include inattention, poor coordination, and slowed reaction time, and increased error rates in complex tasks. Acute effects following cannabis use persist for two to six hours. THC has a rapid distribution half-life and concentrations in the blood decline rapidly after use. THC as measured at the common threshold of 1-2ng/mL may be undetectable a few hours following smoking if use is acute. Recent studies suggest that THC may be detectable in blood for several days after last use in heavy chronic users (Karshner *et al.*, 2008). THC is extensively metabolised and is typically not detected in the urine. When combined with alcohol, the effects appear to be synergistic (more than additive) and include a decrease in visual search activity, changes in reaction time, and increased driving out of lane (Lamers and Ramaekers, 2001; Ramaekers *et al.*, 2000).

After alcohol, cannabis is the most frequently encountered drug in European and North America driving populations. In surveys of fatally injured drivers, cannabis use as indicated by the detection of its active constituent tetrahydrocannabinol (THC) or its inactive major metabolite tetrahydrocannabinolic acid (THC-COOH) was the most prevalent finding (Scotland: Seymour *et al.* 1999; USA-WA: Schwilke *et al.*, 2006; Sweden: Ahlm *et al.*, 2009; Australia: Drummer *et al.*, 2004; France: Mura *et al.*, 2006). The significance of these findings is often hard to assess since the time between the crash and the time of death is not recorded. The rapid distribution of THC most likely means that the measured level does not reflect the level at the time of driving unless death is instantaneous. Other studies of drivers injured in motor vehicle crashes also found cannabinoids (either parent drug or metabolite) to be the most commonly encountered drug (USA-MD: Walsh *et al.*, 2005; Sweden: Ahlm, 2009; Denmark: Bernhoft *et al.* 2005; France: Mura *et al.* 2003). Finally, studies of drivers arrested for suspected impaired driving also show cannabis use as being the most commonly detected drug (USA-WI: Harding and Liddicoat, 2003; Scotland: Seymour *et al.*, 1999; Switzerland: Augsberger *et al.*, 2005; Netherlands: Smink *et al.*, 2001; Norway: Gjerde *et al.*, 2008; Germany: Toennes *et al.*, 2005). This international comparison shows the prevalence of cannabis in various driving populations across Europe and in North America, confirming its role as a major international public safety issue.

Attempts have been made to establish a threshold level for cannabis effects on drivers. As noted, this is made difficult by the rapid distribution kinetics of the drug. THC is a highly lipid soluble compound and disappears from the blood quickly. As a result, blood concentrations may be much lower when blood is collected an hour after the observed impaired driving took place. Meta-analysis of culpability and responsibility analysis research in fatal cannabis related crashes established a significant difference in driver culpability at serum THC concentrations greater than 10ng/mL, (*i.e.* whole blood concentrations greater than 5ng/mL) (Groetenhermen *et al.*, 2007); however, relating this to the concentration in a living driver some time after the arrest is very difficult if not impossible, because of the rapid change in concentrations during use. Evaluation of cannabis users by police physicians found an increased odds ratio for being deemed impaired at blood THC concentrations above 3 ng/mL (Khiabani *et al.*, 2006). Other workers have suggested that due to delays between the time of driving and sample collection, concentrations of 0.5 ng/mL (Mura *et al.*, 2006) would be more appropriate, and that efforts should be put into developing roadside testing technologies.



At this time it is well established that cannabis can produce effects inconsistent with safe driving, and that this is reflected in pharmacoepidemiological studies, responsibility analysis, laboratory assessment and on-road driving studies, and constitutes the major drug class involved in traffic crashes and arrests. There is general agreement that there is an increasing risk of crash involvement and driving impairment with increasing blood THC concentration, but the threshold for significant effects, and how to account for rapid changes in concentration are still unclear.

### 2.2.2. *Central Nervous System Stimulants*

This class of drugs includes predominantly cocaine, amphetamine, methamphetamine, and MDMA (ecstasy). It is typically the second most frequently detected drug class in driving populations. Stimulants act by increasing the concentrations of sympathomimetic amines in the brain. They do this by either promoting the synthesis and release (as in the case of the amphetamines) or blocking the reuptake (as in the case of cocaine) of the neurotransmitters norepinephrine, dopamine and serotonin (Logan, 2002).

Stimulants produce a range of effects on drivers that differ in the acute phase (shortly after drug consumption) from the post-acute phase, when drug withdrawal or abstinence syndrome can be an issue (Logan, 2002).

With amphetamine, methamphetamine and cocaine, the immediate effects of stimulant use produce intense excitement and euphoria, which can be distracting and disorienting, affecting the degree of attention and concentration on driving. The drugs also produce changes in reaction time, often resulting in faster but less reasoned, more impulsive responses, and increased risk taking. Higher doses or chronic use can produce agitation, hyper-vigilance, and irritability. Some of the motor effects of the drug result in motor restlessness, a need to be in constant motion, and problems with balance and coordination.

Following intense stimulant use (usually smoked or intravenous administration), susceptible users can develop paranoia, hallucinations and delusions, resulting in a drug-induced psychotic state (Blaho *et al.*, 2000). At low doses, stimulants can offset fatigue and delay the need for sleep (Caldwell *et al.*, 2000), but when abused, the chronic sleep loss resulting from binge use creates a rebound or withdrawal effect when drug use stops. Stimulant users in withdrawal suffer fatigue, extreme sleepiness, anxiety, exhaustion, drug craving, irritability and dysphoria (Logan, 2002). In some respects this withdrawal phase is similar to the effects caused by central nervous system depressant drugs, and can have profound effects on driving care and attention. As noted, the range of effects can vary dramatically in stimulant users depending on dose, route of administration, intensity of use and time since last use. Careful evaluation of the driver is essential in establishing the signs and symptoms of drug use, and behaviours that support an opinion as to the subject's level of intoxication (Gustavson *et al.*, 2006). There is no evidence that compliant physician-supervised therapeutic use of the amphetamines for attention deficit disorder, or narcolepsy produces any of these impairments (Jerome *et al.*, 2006).

MDMA, an amphetamine analog has a notably different effect and use pattern (Logan and Couper, 2001). Usually administered orally, the drug produces some of the same central stimulant effects, but generally causes less intense arousal and excitation at typical recreational doses. MDMA, however, produces a distinct pattern of effects on mood, sensorium, and perception, which may affect driving. The drug causes enhanced tactile and emotional response, and produces feelings of closeness and intimacy. Because of the less intensive patterns of use, impairment is more subtle affecting mood, mental state, memory, speed adaptation, and the ability to predict object movement (Lamers *et al.*, 2003; Ramaekers *et al.*, 2006b). Several cases of MDMA impaired driving have been reported and reviewed (Logan and Couper, 2001).

Cocaine produces the same constellation of acute excitatory effects as the amphetamines, although patterns of use tend to differ as the drug's half-life is significantly shorter. Cocaine using drivers report that their cocaine use frequently produced reckless or reduced driving ability (Macdonald *et al.*, 2008). There is a disappointing lack of laboratory-based studies of the effects of cocaine on driving performance because cocaine and its metabolite, benzoylecgonine, are among the most frequently detected drugs in driving populations.

MDMA is not uncommon in drivers in France (Mura *et al.*, 2003; Mura *et al.*, 2006), Switzerland (Augsberger *et al.*, 2005), the Netherlands (Smink *et al.*, 2001; Verschraagen *et al.*, 2007), Denmark (Bernhoft *et al.* 2005), and Australia (Drummer *et al.* 2004). In Sweden and Norway, amphetamine is the most commonly encountered stimulant in drivers, mainly as a result of diverted pharmaceuticals (Jones *et al.*, 2009; Gustavsen, 2006). Amphetamine's more potent analog, methamphetamine, and cocaine are more frequently encountered in the United States (Schwilke *et al.*, 2006; Walsh *et al.*, 2005; Harding and Liddicoat 2003; Farrell *et al.*, 2007).

Some work has been done to try and establish a threshold concentration for impairment by amphetamine (Gustavsen *et al.*, 2006). These workers found a positive concentration-dependent relationship in the odds ratio of being determined to be impaired with increasing blood amphetamine concentration, but did not establish a threshold for effect. This is most likely because of confounding by impairment occurring on the withdrawal phase when concentrations will be declining. Recreational use (as opposed to controlled medicinal use) of stimulant drugs produces a constellation of acute, and withdrawal symptoms that are not consistent with safe driving.

### 2.2.3 *Central Nervous System Depressants*

This category is the most challenging to discuss, because most of these compounds have legitimate therapeutic uses, and in many cases a driver appropriately treated with a drug which may have impairing side effects is often a better driver than an untreated driver (Wingen *et al.*, 2006). Many drivers mistakenly feel, however, that since the drug is prescribed by their doctor, that it is inherently safe. Even when drugs are prescribed by a doctor and dispensed by a pharmacist, they can still produce impairment and great care needs to be exercised by the patient, particularly when beginning use of a new drug, or changing doses.

Although the focus of this review is on drugs, their prevalence, their effects on driving, and strategies to control drug impaired driving, the archetypal compound for driving impairment is still alcohol. It is the most prevalent intoxicant found in arrested and fatally injured drivers; it is the most highly studied compound in laboratories, driving simulators and on-the-road, and it is the compound with which there has been the greatest success in relating blood concentrations to a level of effect. Not surprisingly, other drugs that act on the same systems in the brain produce a similar constellation of effects. Other drugs with CNS depressant effects most often act as agonists on the GABA receptor (benzodiazepines, barbiturates, muscle relaxants), or antagonists of the histamine H1 receptors (tricyclic antidepressants, antihistamines) producing a reduction in neural activity, and slowed neurotransmission. This translates to slower reaction times, poorer coordination, impaired executive function, and sedation or sleepiness. Consideration of these side effects, and balancing the treatment needs of the patient, dictates the choice of drug used therapeutically. The CNS depressant-impaired driver has difficulty maintaining lane position, drives too fast or too slow for conditions, fails to obey traffic signals, and is involved in crashes through lack of sustained attention, and slow reactions.

The major classes of CNS depressant drugs that are prevalent in the driving populations and associated with impairment are as follows:

### *Benzodiazepines and related substances*

The benzodiazepines are a major therapeutic drug class, comprising about thirty different compounds, with different pharmacokinetics and greater or lesser efficacy in treating anxiety, muscle tension, seizures, insomnia, and producing sedation. Shorter acting benzodiazepines such as midazolam (Versed®), temazepam (Restoril®), triazolam (Halcion®), and flunitrazepam (Rohypnol®), are used for sedation, while longer acting benzodiazepines alprazolam (Xanax®), diazepam (Valium®), chlordiazepoxide (Librium®), clonazepam (Klonopin®), are used to treat anxiety, produce muscle relaxation and control seizures.

Benzodiazepines are frequently encountered in driving populations. Prescribing practices differ between countries, but diazepam, nordiazepam, temazepam, lorazepam, clonazepam are widely cited as prominent impairing drugs, while in Europe and Australia, nitrazepam and flunitrazepam are also encountered, and in the United States alprazolam is common (Scotland: Wylie *et al.*, 2005; Seymour *et al.*, 1999; USA: Harding and Liddicoat, 2003; Schwilke *et al.*, 2006; Denmark: Bernhoft *et al.*, 2005; Norway: Christophersen and Morland, 2008; Australia: Drummer *et al.* 2003; Sweden: Jones *et al.* 2007).

Quantitative assessments of benzodiazepine effects on driving have been performed for alprazolam, showing serious driver impairment from both immediate release and extended release formulations on driving performance (Verster *et al.*, 2002; Verster *et al.*, 2004; Leufkens *et al.*, 2007), most notably weaving, and decreased alertness. Review of the combined performance effects of benzodiazepines with other antidepressants and vehicle operation (Ramaekers, 2003) concluded that the drug interaction could produce unacceptable levels of impairment. Assessment of the relationship between benzodiazepine concentrations in blood and the subject's performance in field tests for impairment showed a positive correlation between diminished performance and increasing concentration (Smink *et al.*, 2008; Boucart *et al.*, 2007; Bramness *et al.*, 2002).

The related group of drugs used for promoting sleep, the imidazopyridines, includes the compounds zolpidem (Ambien®), zopiclone (Imovane®), eszopiclone (Lunesta®) and zaleplon (Sonata®). These have similar effects on driving performance as would be expected from drugs effective at inducing sleep, and these effects have been confirmed in on-road driving studies (Logan and Couper, 2001; Verster *et al.*, 2002; Verster *et al.*, 2004; Verster *et al.*, 2006). A phenomenon, known as “sleep driving” is also associated with this class of drugs (Doane and Dalpiaz, 2008). This condition, characterised by unconscious driving, without intent, and with no recollection of the activity, is controversial and has only been reported anecdotally.

### *Antihistamines*

The ethanolamine antihistamines diphenhydramine and chlorpheniramine are well established as having the ability to cause impairment in driver ability. Specifically the sedating effects of the drugs, mediated through their H1 receptor antagonist effects, produce sleepiness and sedation, and loss of sustained attention (vigilance) (Verster and Volkerts, 2004b). Often these drugs are used in conjunction with other drugs that can produce impairment or drowsiness (*e.g.* dextromethorphan (Logan, 2009). Chlorpheniramine and diphenhydramine are both listed in epidemiological studies as being detected in impaired driver populations (Schwilke *et al.*, 2006; Wylie *et al.*, 2005; Harding and Liddicoat, 2003; Farrell *et al.*, 2007).

### *Muscle relaxants*

Muscular tension and pain is often treated with drugs which produce muscular relaxation. This includes the benzodiazepines (especially diazepam and lorazepam), and the barbiturate butalbital (Fiorinal®). The condition is also commonly treated with the GABA inhibitor carisoprodol (Soma®), which has been reported in many impaired driver arrests (Logan *et al.*, 2000; Bramness *et al.*, 2007). The drug produces CNS depression, intoxication, disorientation, sedation and sleepiness, and slowed reaction and response. Drivers under the influence of carisoprodol are often weaving wildly, driving too fast or slow for conditions, and hitting objects or other vehicles without stopping. Attempts have been made to correlate blood carisoprodol concentrations with impairment. One study has noted that when the combined concentration of carisoprodol and its active metabolite meprobamate exceeded 10mg/L, impairment was well established (Logan *et al.*, 2000). Bramness *et al.* (2004), suggested that there was a concentration-dependant increase in the likelihood of being considered impaired in an examination performed by a police surgeon with increasing blood carisoprodol concentration. Other research involving evaluation of records from a large driver database suggested that the risk of traffic accidents in drivers prescribed carisoprodol was almost four times that in other drivers (Bramness *et al.*, 2007).

### *Tricyclic antidepressants*

The tricyclic antidepressants amitriptyline, clomipramine, imipramine, desipramine, are less frequently prescribed today due to the availability of more selective antidepressants, such as fluoxetine, paroxetine, venlafaxine, citalopram. These latter drugs are generally agreed to have fewer side effects, in general, and on driving, in particular. The effects of amitriptyline were evaluated following chronic daily dosing (Veldhuijzen *et al.*, 2006), which found that on the first day of treatment, the effect on driving measures was equivalent to greater than a 0.05g/100mL blood alcohol concentrations, though by the tenth day of dosing, performance had returned to normal due to development of tolerance. This was confirmed in a Japanese simulator study, which found impaired road tracking, car following, vigilance and somnolence after use of amitriptyline (Iwamoto *et al.*, 2008). These and other studies have concluded that non-sedating antidepressants, such as fluoxetine and paroxetine, do not produce comparable levels of impairment and are generally considered low risk with respect to driving skills. They do, however, suggest that carefully supervised use of the drugs can minimise the risk of impaired driving.

### *In summary*

Drugs with central nervous system depressant effects – either as the main effect (sedatives) or as a side effect (antihistamines) – impair the critical cognitive and psychomotor effects necessary for safe driving. This includes the executive functions involving risk and information assessment, consciousness, divided and sustained attention, and reaction time. Although tolerance can offset some of the effects, care needs to be exercised when taking any of these drugs for the first time, after a change in dose, or in combination with other drugs or alcohol.

### **2.2.4. Narcotic Analgesics**

Narcotic analgesic drugs by their very nature promote sedation and sleep, and various other facets of central nervous system depression which make them high-risk drugs with respect to driving impairment. The class includes the naturally occurring opiates morphine and codeine, and semi-synthetic variants including oxycodone, oxymorphone, hydrocodone, hydromorphone, dihydrocodeine, buprenorphine, and diacetylmorphine (heroin), and synthetic opioids like methadone, propoxyphene, fentanyl, tramadol, tapentadol and meperidine/pethidine.

The opioids bind to opioid receptors in the brain producing analgesia and reduced sensitivity to pain, but also producing euphoria (especially following intravenous use), central nervous system and respiratory depression, sedation and sleep. This reduced level of consciousness which can accompany analgesia, particularly with excessive use or in non-tolerant individuals, can result in poorer performance in tasks demanding cognitive and psychomotor skill such as driving. Pupillary constriction, which is common with opiate abuse, may affect vision and light/dark accommodation.

Tolerance to the effects of opioids is well documented, and there is some evidence that patients stabilised on moderate doses of opioids have tolerance to some of the impairing effects of the drugs. It typically takes several days on a stable dose to acquire the tolerance necessary to counter the drug effects (Gringauz *et al.*, 2001). Changes in dose or frequency of dosing, breaks in dosing, or co-administration with other opioids, however, restores the risk of impairment. Patients being treated with opioids for chronic pain conditions often take other drugs in combination, such as muscle relaxants, sleep aids and anti-depressants, which can combine with the effects of the opioid to produce greater impairment. Recreational use or abuse of opiates generally involves the use of doses, which defeat any offset for tolerance. The euphoric intoxicating effect of opioid abuse is inherently inconsistent with safe driving.

The opioids most frequently encountered in driving populations are morphine and codeine, followed by methadone, oxycodone, hydrocodone and tramadol (Jones *et al.*, 2007; Smink *et al.*, 2001; Mura *et al.*, 2003; Schwilke *et al.*, 2006; Farrell *et al.*, 2007; Augsberger *et al.*, 2005; Drummer *et al.*, 2004). Prescribing patterns with respect to individual drugs differ by country and formulary; however, the general constellation of effects for drugs across the class of opiates is similar.

Relating blood concentrations of opioids to effect is difficult based on the development of tolerance. Careful assessment of the driver's appearance, behaviour, psychomotor skills and cognitive performance is critical to assessing his or her fitness to drive. A test of the subject's blood is critical in these cases to determine exactly which opiates are present, if the concentration is consistent with the patient's prescribed dose, and in the case of heroin, whether the specific heroin metabolite 6-monacetylmorphine is present. This specific marker can differentiate between use of prescription morphine, and heroin abuse. Often urine is the better marker for this rapidly eliminated metabolite.

In summary, therapeutic use of opioids by a naïve user, opioid abuse even in a tolerant user, or combining opioids with other central nervous system depressant drugs or alcohol create a significant risk of driving impairment.

### **2.2.5. *Hallucinogens, dissociatives and inhalants***

Hallucinogens are drugs that create an altered perception of reality. This can mean visual changes, such as objects losing definition or changing shape, frank illusions – seeing objects or individuals not present – hearing sounds or speech not present, tactile sensations of animals or insects under the skin, synesthesias – where stimulus in one sense triggers perception in another, such as sounds having colour. Hallucinations can be accompanied by delusions (false beliefs), disorganisation of thought, mania, and changes in behaviour, which together constitute a psychotic state. The drugs that produce this sort of change in reality are profoundly impairing, and include substances like LSD, psilocybin mushrooms, salvia, mescaline, and peyote. This class of drugs is perhaps the least studied, since the adverse effects can be so significant it is difficult to conduct ethical experiments. A recent study involving the administration of the hallucinogenic Mexican herb salvia, produced such a strong effect in the subjects that it was considered unsafe to collect blood samples (Pichini *et al.* 2005).



Dissociative drugs are a related class of compounds that produce a set of symptoms, including delusional beliefs, out-of-body or religious experiences, and separation from reality. Examples of drugs known to cause these effects include the dissociative anesthetics phencyclidine (PCP), ketamine, and other drugs that act on the same pathways, including very high doses of the antitussive medication, dextromethorphan (Kunsmann *et al.*, 1997; Cochems *et al.*, 2007; Logan, 2009).

Inhalants are common volatile chemicals or solvents that produce anesthesia or profound sedation, described as a “twilight state” of diminished consciousness (Capron and Logan, 2009). They include the solvents toluene and xylene, gasoline/petrol, butane, propane, and halogenated hydrocarbons, such as the propellant difluoroethane (DFE), or the cleaning solvent ethyl chloride.

These types of compounds are highly debilitating and interfere with a person’s normal daily activities to the extent that driving is not just impaired, but is impossible. Consequently, hallucinogens and dissociatives are less frequently encountered in arrested or deceased drivers. This is reflected in the epidemiological studies cited elsewhere in this report. Their impairing effects, however, are so profound that they must not be overlooked in any analytical protocol for testing suspected impaired drivers or in the investigation of traffic deaths. Some of the tests for low dose high potency compounds like LSD or Salvinorin A are highly specialised and cannot be done with routine methods or equipment. Because of their low frequency of use, decisions to test for these compounds should be based on history, behaviour or other evidence of hallucinogen use.

The concentrations of these hallucinogens and dissociatives in blood have not been related to a degree of impairment, and their detection, when considered together with driving behaviour and appearance and demeanour, is the most appropriate means of assessing their significance in an individual case. In the case of dextromethorphan, blood concentrations are helpful in distinguishing benign therapeutic use from abuse. A large part of the driving task is perception- reaction: filtering, assessing, weighing, and evaluating sensory input, so that any drug interfering with orientation, perception and executive function would be a grave risk to safe driver behaviour.

### 2.3. Drug Testing Procedures and Their Effects on Epidemiological Data.

One significant factor when considering epidemiological data for comparison in the assessment of prevalence of drug use in drivers is the laboratory procedures employed in the testing of biological samples. Many factors can come into play. The choice of specimen is the first consideration. Blood is a preferred sample over urine. Blood concentrations can be interpreted by comparisons with published data in the medical and scientific literature, which allows assessment of dose range, abuse or compliant use, and potential toxicity. Sometimes serum concentrations are reported. Blood and the corresponding serum concentrations can often be inter-converted but for some drugs no conversion factor has been reported. Urine is the least useful specimen and reflects only drug use or exposure rather than intoxication, as drugs can be excreted for hours or days after the effect has dissipated.

In postmortem studies of driving populations, blood drug concentrations can vary dramatically depending on the body location from where the blood is collected (Ferner *et al.*, 2009). Trauma and prolonged postmortem interval increases the likelihood of changes in postmortem drug concentrations for example in studies of fatally injured drivers, if blood is taken from the body cavity or from a non-peripheral site, such as the heart, aorta or subclavian vein (Pélissier-Alicot *et al.*, 2003).

The scope of analysis also impacts the results of any pharmaco-epidemiological assessment. A study that relies on immunoassay testing for priority drug abuse classes will likely miss muscle relaxants, some sedative hypnotics and narcotic analgesics, and other drug classes that may impact driver safety. Ideally, any analytical methodology will include a gas or liquid chromatography screen which will pick

up other drugs and their metabolites which can be included in any prevalence or relative risk assessment. Two recent articles have suggested an appropriate basic analytical scope for DUI demographic or epidemiological studies (Farrell *et al.*, 2007; Walsh *et al.*, 2008).

Finally, once scope is established, the threshold level for reporting drugs as present or not detected needs to be considered. Both Farrell *et al.* (2007) and Walsh *et al.* (2008), include recommendations regarding the appropriate cut-off concentrations for measurement of drugs in blood and urine.

Roadside testing methodologies for drug testing in oral fluid (saliva) have been evaluated (Walsh *et al.*, 2004; Crouch *et al.*, 2008) and are currently not considered to be robust for field deployment. Additionally they have other limitations, such as poor or excessive cross reactivity, uneven partition of drugs into oral fluid from plasma, and limited scope.

The optimum methodology for drug-driving research, as described by Farrell *et al.* (2007) and Walsh *et al.* (2008), is collection of whole blood in a grey top vial, followed by comprehensive immunoassay and gas or liquid chromatography analysis, with quantitative confirmation of any positive results.

## 2.4. Summary

Drugs – whether ingested for legitimate medical reasons, misused, or taken for illicit recreational purposes – cause changes in the brain which disrupt normal cognition and psychomotor skills. They do this through a variety of mechanisms. In the case of cannabis, it impairs, by affecting alertness, vigilance and perception, a driver's ability to maintain a safe operating distance, accurately judge the movement of other vehicles, and attend to a monotonous task over time. In the case of stimulants, they impair acutely by causing over-stimulation of the brain and create a distracting sensorium, where decisions are made impulsively, greater risk is taken, and normal sleep and rest periods are disrupted. During the post acute phase, fatigue and sleepiness caused by the acute effects cause inattention and carelessness. Central nervous system depressants slow the speed at which the brain receives, processes, and responds to environmental information, and the effectiveness and efficiency with which decisions are made, and impact motor control. Hallucinogens cause changes in perception and awareness, affect how we see and understand our environment and how we respond accordingly. All of these different mechanisms have the same net effect – a decrease in the quality of mental and physiological effort that goes into the driving task, raising the risk of crash involvement.

Route of administration can cause a difference in the intensity of effect, and tolerance to the drug effect can make it difficult to predict the specific level of effect in an individual drug-using driver. Prescription drugs when misused have the potential to cause as much impairment as an illicit recreational drug, and even responsible use of a medication in a non-tolerant user, or through interaction with other drugs and/or alcohol, can create a dangerous decline in driving performance.

Future assessment of drugs in driving populations and their effects, through laboratory-based behavioural studies, on-road driving studies, and epidemiological studies, can all benefit from careful toxicological analysis of specimens for a broad range of possible impairing substances.

Experimental research demonstrating the impairing effects of drugs is, however, only one piece of evidence implicating drugs as a risk factor for driving. It is also necessary to show that drivers use potentially impairing substances and that these substances contribute to crashes – *i.e.* epidemiological evidence. The following sections provide a summary of recent epidemiological studies in this area.





### 3. DRUG USE AMONG DRIVERS

*This chapter presents the evidence from studies that have examined the frequency of driving after drug use and the incidence of drugs among drivers involved in crashes. This includes population-level data on drug and alcohol use (including data from the survey conducted as part of this project), self-report surveys in which drivers are asked to describe their own practices of driving after using drugs, roadside surveys in which objective measures of drug use are usually obtained from drivers, and studies that seek to measure the type and extent of drugs among drivers who come to the attention of authorities as a result of arrest or crash involvement.*

#### 3.1. The Environmental Context of Drug-driving.

The drug-driving problem is the result of the overlap between two behaviours – the operation of a motor vehicle and the use of psychotropic substances. In OECD/ITF countries, motor vehicles have become the preferred means of personal travel. In fact, for some people, driving is a necessity of modern life. The consumption of alcohol is also widespread and is a regular part of everyday life for some people. The use of other psychoactive substances – for both medicinal and non-medicinal purposes – is also not uncommon. Some of the substances used are illegal; some are used illicitly; still others are used legitimately to treat a variety of ailments. The problem arises when the consumption of alcohol, other psychoactive substances, or a combination of alcohol and/or drugs impairs one's ability to operate a motor vehicle safely. As demonstrated in the previous section, many of these substances can impair the ability to operate a vehicle safely and the consequences can be tragic.

Table 3.1 presents information illustrating the extent of driving, as well as the use of alcohol and selected illegal drugs,<sup>1</sup> in countries that responded to the survey.<sup>2</sup> For example, in most countries, there is one motor vehicle for every 1.2 to 2.1 persons. Clearly, motor vehicles are a pervasive element in society. Moreover, all countries have developed an extensive roadway network to facilitate the movement of people and products.

In most of the countries surveyed, alcohol is consumed at least occasionally by more than three-quarters of the population age 15 and over. The amount of alcohol consumed per year varies, from a low of 2.4 litres of absolute alcohol per person in Israel, to 13.9 litres per person in Austria. To put this in perspective, 10 litres of absolute alcohol represents a total of 584 standard drinks<sup>3</sup> per year for each person age 15 and over.

Recreational drug use, the purpose of which is primarily to experience the euphoric or pleasurable effects, is not an uncommon activity in industrialised societies. Although the use of potentially impairing drugs is considerably lower than the 60% to 90% of the population who report consuming alcohol, there

is a substantial proportion of the population who report at least occasional use of psychoactive substances. By far the most commonly used illicit substance is cannabis. Use of cannabis varies considerably among countries. In general, about 22% of adults in Europe report having used cannabis at some point during their lifetime; in North America, the figure is closer to 40%. Cocaine and amphetamine-type substances are the next most commonly reported drugs, with lifetime use being reported by 3% to 5% of adults (Table 3.1).

Table 3.1 shows that cannabis is the most commonly reported substance used in the OECD/ITF countries that responded to the survey. Between 2.8% and 17% of the population in each country reported cannabis use in the past year. Younger people (*i.e.* age 15 to 24) typically have much higher rates of use. Other substances, such as cocaine, amphetamines and opiates, are reportedly used by less than 1% of the population in most cases. The common use of these substances in populations with extensive use of motor vehicles is a situation with a great deal of potential for both behaviours to occur in close temporal proximity. Subsequent sections document the extent to which people combine the use of impairing substances with motor vehicle use and the incidence of crashes that result.

### 3.2. Drug Use Among Road Users – Self-report Surveys

One approach for determining the extent of drug use among drivers is to conduct a random survey and ask drivers how often they operate a vehicle after using psychoactive substances. Telephone surveys of large samples can be conducted relatively quickly and easily. Such surveys, however, are often limited by relatively low response rates and by the fact that the information is based on self-reports of dangerous and illegal behaviours. Self-reported behaviours can be biased by social desirability and faulty recall. Nevertheless, survey data can provide valuable insights into the extent of driving after drug use and the characteristics of those who report doing so.

Table 3.2 presents the findings from a number of self-report surveys of drivers. Such surveys are more common in North America than in Europe. In the United States, a national household survey found that 5.3% of drivers reported operating a vehicle within two hours of drug use (Townsend *et al.*, 1998). This compares with 22.6% in the same survey who reported driving after drinking. Drug-driving was most common among males between 16 and 20 years of age (14.8%). This group was almost equally likely to report drug-driving as drink-driving (13.3%), making them a particularly high risk group. But whereas drug-driving after drug use was most prevalent among young males, the reported incidence of drink-driving was most common (32.4%) among males between 21 and 34 years of age. These figures indicate that alcohol remains the substance most commonly used by U.S. drivers, and that there appears to be a demographic distinction between those who drive after drinking and those who drive after using drugs.

Many surveys also indicate that it is not uncommon for drugs to be used in combination with alcohol before driving. The extent of this behaviour – the circumstances under which it occurs, and the characteristics of those who engage in the behaviour – have not been well-studied.

Table 3.1. The Environmental Context for Drugs and Driving

Country	Population (1000s)	Public Roadways (kms)	Motor Vehicles (1000s)	% Consume Alcohol* (M/F)	Per Capita Consumption (litres abs alc)	Minimum Alcohol Purchase Age	% Cannabis Use*	% Cocaine Use*	% Amphet Use*	% Opiate Use*
Australia	21 017	815 739	1 4775	n/a	9.2	18	11.4	2.9	2.0	0.5
Austria	8 360	106 855	5 796	69.2 (76.4 / 62.5)	13.9	16/18	7.5	0.8	0.9	0.5
Belgium	10 511	152 256	6 362	84.2 (88.9 / 79.9)	8.9	16/18	5	0.6	0.9	0.4
Canada	32 976	1 408 800	20 065	79.3 (82.0 / 76.8)	8.3	18/19	17	1.0	2.3	0.3
Denmark	5 474	73 487	2 767	93	12.1	16	5.2	0.7	1.0	0.5
France	61 647	1 037 647	37 926	84.8 (87.0 / 82.8)	12.8	18	8.6	0.6	0.2	0.1
Germany	82 599	64 480	5 511	92 (93 / 91)	10.1	16/18	6.9	1.0	0.9	0.2
Israel	7 244	1 870	283	66 (75 / 57)	2.5	18	8.5	0.6	0.4	0.1
Netherlands	16 418	117 430	8 863	81 (83 / 76)	7.9	16/18	5.4	0.3	0.6	0.3
New Zealand	4 228	93 576	3 189	83.7	9.4	18	13.7	0.4	2.5	0.4
Poland	38 125	382 615	18 035	53	8.7	18	2.8	0.7	0.2	0.1
Portugal	10 623	76 800	5 948	70.6 (81.9 / 59.6)	9.6	16	3.6	0.6	0.2	0.2
Slovenia	2 010	20 236	1 287	86.3 (>50 / <50)	10.3	18	8.8	0.2	0.3	0.5
Sweden	9 119	213 000	5 500	86 (90 / 82)	4.8	18/20	3.1	0.2	0.2	0.2
Spain	44 279	667 400	31 441	68.6 (80.2 / 57.5)	10.0	18	10.1	3.5	0.9	0.1
Switzerland	7 509	71 400	5 356	75.5 (85.8 / 69.6)	10.4	16/18	27.7 (age 15-39)	2.9	1.1	0.6
United Kingdom	60 769	394 500	34 327	65** (73/58)	11.7	18	7.4^	2.3^	1.0^	0.2^
United States	305 826	6 430 351	251 422	61 (68 / 55)	8.5	21	10.1	2.3	1.2	0.1

Note: \* use in the past 12 months; \*\* past week use; ^ England and Wales; n/a not available

Table 3.2. Drug Use Among Road Users: Self-Report Surveys

Study	Jurisdiction	Period	Sample (N)	Methodology	Findings
Adlaf <i>et al.</i> , 2003	Ontario, Canada	2001	n=508 high school students with driver's licence	Self-report survey	19.7% drove within an hour of using cannabis.
Alvarez <i>et al.</i> , 2004	Spain	January-July 2001	n=2 000 drivers age 14-69	Interviewed at driver test centres	91% believed meds did not affect ability to drive 4% of those on meds made an effort not to drive 1% stopped driving while taking meds.
Beirness <i>et al.</i> , 2003	Canada	2002	n=1 214 drivers	Telephone survey	17.7% drove after using drugs 1.5% drove after using cannabis 0.9% drove after using other illegal drugs 2.1 % drove after using cannabis (up from 1.5% two years previous).
Beirness <i>et al.</i> 2004	Canada	2004	n=1 209 drivers	Telephone survey	4.8% of drivers drove after cannabis 20.6% of 16-19 year olds did so.
Beirness & Davis, 2006	Canada	2004	n=4 639	Telephone survey	1.9% drove after cannabis use (1996-1997) 2.9% reported doing so in 2002 survey.
Centre for Addiction and Mental Health, 2003	Ontario	1996-1997 2002	n=5 497 (96-97) n=2 129 (2002) age 18+ with driver's licence	Telephone surveys	
Fergusson & Horwood, 2001	New Zealand	1998	Birth cohort during period of 18-21 years of age (n=907)	Interviewed at age 21	Frequency of cannabis use significantly related to rates of active accidents (not passive). OR=1.16 for those using cannabis more than 50 times per year. OR=0.97 when confounding variables (particularly risky driving behaviours) accounted for.
Ingram <i>et al.</i> , 2000	Scotland	2000	n=1 008 drivers age 17 to 39	Computer-assisted self inventory	9% had driven after using drugs 5% had done so in past year (4% had driven after cannabis)
Neale <i>et al.</i> , 2000	Scotland	2000	n=61 drug users n=88 night club attendees n=536 drivers n=10 focus groups n=11 847	Mostly self-report questionnaire and interviews	Driving after drugs common among night club attendees. Respondents considered cannabis less dangerous than other drugs when driving
Townsend <i>et al.</i> 1998	United States	1996	n=11 847	National household survey	5% reported driving within 2 hours of drug use.
Walsh & Mann 1999	Ontario, Canada	1996-1997	n=4 735	Random telephone survey	1.9% reported driving after using cannabis.

In Canada, a national telephone survey of drivers found that almost 18% of drivers reported operating a vehicle within two hours of using a psychoactive drug or medication in the past 12 months (Beirness *et al.*, 2003). Driving after using cannabis was reported by 1.5% of drivers; other illegal drugs were reported by less than 1% of drivers. A follow-up survey two years later found the incidence of driving after using cannabis had increased, from 1.5% to 2.1% (Beirness *et al.*, 2004).

A recent analysis of data collected as part of the Canadian Addiction Survey in 2004 found that 4.8% of drivers reported driving within two hours of using cannabis (Beirness and Davis, 2006). This was more than double the prevalence reported in a comparable survey (National Alcohol and Drug Survey 1989). Among drivers age 16 to 19, driving after cannabis use was reported by 20.6%, slightly higher than the 19.6% of drivers in this age group who reported driving after drinking.

Population surveys conducted in the province of Ontario report that the incidence of driving after using cannabis increased from 1.9% in 1996-97, to 2.9% in 2002 (CAMH 2003). Among high school students, 19.7% reported having driven after using cannabis (Adlaf *et al.*, 2003).

In Scotland, 9% of respondents reported having driven after drug use; 5% had done so in the past year. Cannabis was the most commonly reported substance used (Ingram *et al.*, 2000). Neale *et al.* (2000), found that driving after drugs was common among nightclub attendees in Scotland, and that many believed that cannabis was less dangerous than other drugs when driving.

In general, driving after drinking remains a more commonly reported behaviour than driving after drug use. This is perhaps not surprising given that alcohol use is considerably more common than drug use. Nevertheless, it is important to recognise that the population is aging and the use of medicines known to impair driving performance (particularly opioids and benzodiazepines) may become increasingly more common among drivers in this segment of the population. In addition, recent findings indicate that driving after cannabis use is at least as common as driving after alcohol among young drivers. This trend may reflect the fact that young people do not believe the effects of cannabis impair the ability to drive and/or that the police are unable to detect cannabis as readily as alcohol (Davey *et al.*, 2005; Patton *et al.*, 2005; Terry and Wright, 2005). Either way, merely substituting one substance (cannabis) for another (alcohol) is unlikely to have an overall beneficial effect on road safety.

### 3.3. Drug Use Among Road Users – Roadside Surveys

#### 3.3.1 Methodology Issues

Random surveys of drivers conducted at roadside have also been used to determine the extent of drug use by drivers. These surveys of drivers on the road potentially provide the most valid source of data, because the objective measurements from fluid samples provided by drivers can reveal the type(s) and level(s) of drugs detected. The roadside survey technique, commonly used to determine the prevalence of alcohol use among drivers, is considerably more challenging when used to study drug-driving. For example, drugs cannot be reliably measured from breath samples, but typically require more intrusive methods (*i.e.* blood, oral fluid or urine samples) to detect and measure their presence. Not only is the collection of bodily fluid samples at roadside logistically challenging, but low compliance among motorists raises issues about the validity of the resultant estimates of the prevalence of drug use among drivers. Even with compliance rates of 80% or more, the proportion of drivers who test positive for substance use is often lower than the proportion that refuse to provide a sample for analysis. To the extent that those who refuse to provide a sample for analysis are more likely to have been using drugs, the results will be biased and provide an underestimate of the extent of drug use among drivers.

In addition, because some drugs (most notably cannabis) can be detected in urine samples for several days after exposure, positive urine tests are of questionable relevance to driver impairment and road safety. In recent surveys, oral fluid has been used as the medium for drug testing. The collection of oral fluid involves a less intrusive procedure than the collection of either blood or urine and provides evidence of drug use that is more consistent with that derived from blood and hence, is more reflective of recent drug use than those derived from urine. However, oral fluid testing is usually limited to a relatively narrow range of substances. This is largely a consequence of the limited volume of oral fluid that can reasonably be collected in a brief period of time, and the fact that not all substances are easily detected or quantified in oral fluid.

All roadside surveys seek to collect alcohol and/or drug information from a random sample of drivers. However, the methods used can vary somewhat among surveys and this variation influences the comparability and interpretation of the results. For example, some surveys are restricted to nighttime hours on weekends. Others collect data at all times and on all days of the week. Nighttime weekend hours were initially established as the ideal time to conduct roadside surveys of driver alcohol use, so as to correspond with the most prominent times for drinking and alcohol-involved crashes. Although some types of drug use may also be more prominent during these hours, recent surveys of drug use by drivers have included daytime and weekday hours to collect information on the full extent and range of drug use.

The role of enforcement personnel is another methodological issue that should be considered in evaluating and comparing studies. Some surveys are conducted by police as part of an enforcement operation; others are conducted by civilians downstream from enforcement; some use enforcement to control traffic; still others are conducted independently of enforcement. The variations on the role of enforcement typically reflect differences in legal and ethical requirements for the conduct of such studies, as well as the nature of the agreement with enforcement agencies to ensure their participation. The more involved enforcement personnel are in operation of the survey, the greater the degree of driver compliance. However, high participation rates must often be balanced with ethical issues surrounding the perception of coercion.

The type of bodily fluid sample(s) collected and the laboratory procedures employed in the testing of biological samples are also important considerations. Whereas alcohol can be easily and reliably measured from breath samples, testing for other substances requires a sample of urine, blood or oral fluid. Blood is the “gold standard” in terms of drug testing, because drug levels measured in blood reflect the extent of the substance having an active effect on the individual. Urine is often used for drug testing, but the metabolites of many drugs (most notably cannabis) can be detected in urine for long periods after use. These drug levels do not reflect active drug levels or recent use and cannot be linked to driver impairment. Oral fluid is rapidly becoming a useful and viable medium for drug testing, not only because it is obtained readily and unobtrusively, but because for many substances drug levels measured in oral fluid are closely correlated with those found in blood. (See also Section 2.3.)

On-site oral fluid drug testing devices have undergone extensive evaluation and are currently not considered to be sufficiently reliable for field deployment (Crouch *et al.*, 2008; Verstraete and Raes, 2006; Walsh *et al.*, 2004). Additionally, they have other limitations, such as poor or excessive cross reactivity, uneven partition of drugs into oral fluid from plasma, and limited scope. Oral fluid samples collected at roadside should be sent to a laboratory for toxicological testing.

The optimum methodology for drug-driving research, as described by Farrell *et al.*, (2007) and Walsh *et al.*, (2008), is collection of whole blood in a grey top vial, followed by comprehensive immunoassay and gas or liquid chromatography analysis, with quantitative confirmation of any positives. The collection of blood samples from volunteers at roadside, even with monetary incentives for participation, remains a challenge (Lacey *et al.*, 2009).



### 3.3.2 Results

These variations in the design and operation of roadside drug and alcohol surveys of drivers render it challenging to compare the results among studies and caution is warranted in attempts to do so. Notwithstanding these caveats, the findings from several roadside surveys can be examined to help determine the prevalence of drug use among drivers. Table 3.3 presents a summary of these studies. One of the earliest roadside surveys of drug use by drivers was conducted by Krueger and colleagues (1995) in Germany. From the 2 235 oral fluid samples collected from drivers in the region of Unterfranken, it was determined that 3.6% of the driving trips involved a driver positive for benzodiazepines; 0.6% of drivers tested positive for cannabis. Among the 0.7% of drivers who tested positive for opiates, approximately three-quarters were suspected to have been the result of the legitimate use of codeine. Of some note, about one-third of all drug-positive cases were also found to be positive for alcohol.

A roadside survey in Quebec collected breath, urine, and/or oral fluid samples from drivers (Brault *et al.*, 2004; Dussault *et al.*, 2000). The sample was distributed proportionately to the number of fatal crashes by time of day and day of week. Compliance with the request for urine yielded only a 49% response rate. Among those who refused to provide urine, about 85% agreed to provide a sample of oral fluid<sup>4</sup>. Overall, 11.8% of urine samples were positive for at least one psychoactive drug. Cannabis (6.7%) and benzodiazepines (3.6%) were the most commonly found substances.

As part of the IMMORTAL<sup>5</sup> Project in the EU, roadside surveys were conducted in three countries – the Netherlands, Norway and the United Kingdom (Assum *et al.*, 2005). These three studies were conducted at all times of day and on all days of the week. In the UK, Buttress, Sexton, Tunbridge and Oliver interviewed and collected oral fluid samples from 1 312 drivers in Glasgow. Overall, 10.8% of samples were found to be positive for at least one drug other than alcohol. Ecstasy was the most common substance found (4.6%), followed by cannabis (3.2%), cocaine (1.3%) and codeine (1.6%).

In the Netherlands, Mathijssen and Houwing collected urine samples from 2 873 drivers, and blood samples from another 501 drivers (total N=3 799) across all times of day and days of the week. All drivers were required to provide a breath sample. Toxicological tests on the urine and blood samples revealed 8.5% of drivers were positive for psychoactive substances other than alcohol; 2.1% tested positive for alcohol. The most common substances found were cannabis (4.5%) and benzodiazepines (2.1%). Cocaine (0.7%) and ecstasy (0.6%) were detected less frequently.

The Norwegian portion of the IMMORTAL project was conducted over a one-year period between May 2003 and June 2004. The police collected breath and oral fluid samples from 410 drivers at all times of day and all days of the week. Less than 1% of drivers tested positive for drugs. The only substances found were benzodiazepines, cannabis, and opiates. No drivers were found to have been drinking.

A subsequent roadside survey in Norway (Gjerde *et al.*, 2008) collected oral fluid from 10 816 drivers sampled from all days of the week and all times of day. Overall, 4.5% of drivers were found to be positive for alcohol or drugs or both. The most commonly detected substances were the sedative zopiclone (1.4%) and other benzodiazepines (1.4%). Cannabis was found in 0.6% of drivers and alcohol was present in only 0.4% of drivers.

In Denmark, oral fluid samples were collected from 961 drivers according to a sampling plan that was designed to reflect population and traffic volume over the day in primarily rural areas far from the metropolitan area of Copenhagen. Police stopped drivers at their convenience during regular patrols. Those without a valid licence, or who were suspected of having used alcohol or drugs, were not included. Hence, the sample does not represent a random selection of drivers. Nevertheless, among drivers who

participated, 1.3% tested positive for illegal drugs and 0.7% were confirmed positive for one or more benzodiazepines (Behrensdorff and Steentoft, 2003).

Roadside alcohol and drug surveys have also been conducted in North America. Lacey *et al.* (2007) reported on the results of a pilot study for a national roadside survey of drug and alcohol use among drivers in the United States. Among the 818 participating drivers, 13.3% tested positive for drugs alone; alcohol was present in 7.7% of drivers; and a combination of drugs and alcohol were found in 1.7%. Cannabis and cocaine were the most commonly detected substances.

Following the pilot test, the full U.S. National Roadside Survey was conducted in 2007 (Lacey *et al.*, 2009). Drivers were selected randomly at 300 locations across the contiguous United States and asked to provide breath, oral fluid and blood samples. Data collection occurred primarily on Friday and Saturday nights between 10 p.m. and midnight, and between 1 a.m. and 3 a.m. To gauge daytime alcohol and drug use, data were also collected on Fridays between 9:30 a.m. and 11:30 a.m., and between 1:30 p.m. and 3:30 p.m. In total, 9 413 drivers (86%) provided breath samples, 7 719 (71%) provided oral fluid samples, and 3 276 (39%) agreed to provide a blood sample. Based on oral fluid samples, 14.4% of nighttime drivers tested positive for psychoactive drugs. From the oral fluid samples collected during the daytime, 11.0% of drivers were found to have used drugs. The most commonly detected substances among nighttime drivers were cannabis (7.7%), cocaine (3.9%) and methamphetamine (1.2%). Among nighttime drivers, 2.2% had BACs in excess of 80 mg/dL.

In Canada, breath and oral fluid samples were collected from 1 197 randomly selected drivers on weekend nights in three cities in British Columbia in June 2008. Drugs were detected in 10.4% of drivers; alcohol was present in 8.1%. Cannabis (4.6%) and cocaine (4.6%) were the most commonly detected substances (Beirness and Beasley, 2009a).

In Australia, Davey and Freeman (2009) collected oral fluid samples from drivers who volunteered for the study at random breath testing locations in Brisbane. It was estimated that 71% of drivers complied with the police request to participate in the study. The locations were selected by the police and tended to be in high-risk areas (around licensed establishments) and sampling was restricted to the time period between 5 p.m. and 1 a.m. Overall, 3.7% of drivers tested positive for at least one of the four substances of interest – ecstasy (2.2%), cannabis (1.3%), amphetamines (1.1%), and cocaine (0.1%).

In summary, in the US and Canada, alcohol remains the single most commonly used substance among drivers. Recent evidence, however, indicates that psychoactive drugs other than alcohol are found in 10 to 16% of drivers, and overall drug use now rivals or exceeds the prevalence of drivers who have been drinking. In Europe, drug use by drivers appears somewhat lower than in North America. The exception is the U.K., where the Glasgow study reported the prevalence of drug use among drivers at levels similar to those in North America.



Table 3.3. Drug Use Among Road Users: Roadside Surveys

Study	Jurisdiction	Period	Sample (N)	Method	Findings
IMMORTAL Studies Assum <i>et al.</i> , 2005	Norway	May 2003-June 2004	n=410	Roadside survey all days/all times. Oral fluid samples collected by police	99.2% negative for alcohol and drugs Cannabis 0.5% Opiates 0.2% Benzodiazepines 0.2% Alcohol 0.0%
IMMORTAL Studies Buttress <i>et al.</i> , 2005	Glasgow, Scotland	July 2003-June 2004	n=1 312	Roadside survey all days/all times. Oral fluid samples. Police screened drivers for impairment	Cannabis 3.14% Amphetamines 0.49% Ecstasy 4.10% Cocaine 0.98% Opiates 0.02% (excludes codeine) Codeine 1.34%
IMMORTAL Studies Mathijssen & Housing, 2005	Netherlands (Tilburg region)	Jan 2002-March 2004	n=3 799	Roadside survey all days/all times. Urine samples (n=2 873) Blood samples (n=501)	Alcohol 2.3% Cannabis 4.5% Benzodiazepines 2.1% Amphetamines 0.03% Ecstasy 0.6% Cocaine 0.7% Opiates 6.6% (includes codeine)
Behrendorff & Steentoft, 2003	Denmark	Not mentioned	n=961 Car or small van drivers (drivers suspected of illegal driving not included)	Roadside survey (70% daytime). Mainly rural. Oral fluid sample requested by police	1.3% +ve for illegal drugs 0.7% +ve for 1 or more benzodiazepines. 4-9% admitted driving a few hours after having drugs and alcohol
Beirness & Beasley, 2009	British Columbia Canada (3 cities)	June 2008	n=1 533 78.1% provided oral fluid (n=1 197)	Roadside survey 9pm-3pm, Wed-Sat	Alcohol 8.1% Drugs 10.4% Cannabis 4.6% Cocaine 4.6% Opiates 0.9%
Davey & Freeman 2009	Brisbane, Australia	Not stated	n=1 587 63% male	Roadside survey (downstream from police random breath testing) 5 pm to 1 am oral fluid samples	Ecstasy 2.2% Cannabis 1.3% Amphetamines 1.1% Cocaine 0.1% Total Drugs 4.6%

Table 3.3 (contd). Drug Use Among Road Users: Roadside Surveys

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Dussault <i>et al.</i> , 2000	Quebec, Canada	1999	n=5 509 41.4% compliance	Roadside survey (urine tests). 24 hours/7 days (proportional to fatal crashes)	Cannabis 5.2% Benzodiazepines 3.7% Cocaine 1.1% Opiates 1.1% Barbiturates 0.4% Amphetamines < 0.1%
Cjerde <i>et al.</i> , 2008	SE Norway (except Oslo)	April 2005– April 2006	n=10 816	Roadside survey <i>all days, all times</i> Oral fluid	Alcohol or drug 4.5% <i>Alcohol 0.4%</i> Zopiclone 1.4% Benzodiazepines 1.4% Codeine 0.8% THC 0.6% Amphetamines 0.3% Cocaine 0.1%
Kruger <i>et al.</i> , 1995	Germany (Unterfranken)	1992	n=2 234 all times/days	Roadside survey (saliva samples)	3% of trips involve benzodiazepines 1% involve illicit drugs (mostly cannabis) 1/3 of drug cases also positive for alcohol
Lacey <i>et al.</i> , 2009	United States	2007	n=8 384 Nighttime	Roadside survey Fri/Sat 10 p.m.–12 a.m. 1 a.m.–3 a.m. Oral fluid 71% Blood 39%	Among nighttime drivers: Cannabis 7.7% Cocaine 3.9% Methamphetamine 1.2% Any drug 14.4%
			n=2 525 Daytime	Fri 9:30 a.m.–11:30 p.m. 1:30 p.m.–3:30 p.m. Oral fluid 73% Blood N/A	Cannabis 3.9% Cocaine 1.5% Methamphetamine 0.6% Any drug 11.0%

This disparity between North America and Europe may be attributable, in part, to methodological differences between studies. In particular, whereas European studies typically sample drivers from all times of day and all days of the week, the North American studies concentrate sampling on weekend nights. The focus on weekend nights originated in roadside surveys of alcohol use, which were designed to capitalise on the fact that alcohol use among drivers was more prevalent on weekend nights than during the week. This approach serves to maximise estimates of alcohol use as well as the use of certain recreational drugs, such as cannabis and cocaine. The concomitant use of alcohol with these substances is also not uncommon during these times. Distributing survey times throughout the week provides a more comprehensive and representative picture of the overall prevalence of alcohol and drug use by drivers. This approach shows alcohol use is not common during daytime hours, but serves to highlight the extent of medicinal drug use by drivers (*e.g.* benzodiazepines) during these times.

Recent roadside surveys also illustrate that the pattern of drug use by drivers does not necessarily mirror that of alcohol use. For the most part, alcohol use continues to be most common on weekend nights and increases during late night/early morning hours. Drug use among drivers is more evenly distributed across days and times, particularly medicinal drugs such as benzodiazepines and opiates. This pattern not only has implications for enforcement, but may be indicative of distinct and separate groups of users and reasons for use.

Moreover, the age of drivers using illicit drugs appears somewhat younger than the group that drives after drinking. Older drivers are also more likely to use medicinal drugs. Again, this would suggest distinct and separate groups of users and different motivations for drug use. Further research to delineate the characteristics of various subgroups of the population who drive after using drugs will facilitate efforts to develop appropriate and targeted enforcement and prevention initiatives.

### 3.4. Drug Use Among Drivers Injured in Crashes

Numerous studies from around the world have examined the incidence of drugs and alcohol among drivers injured in crashes. In reviewing these studies, it is important to recognise that they use a diversity of methods, procedures, populations, sample sizes, and case selection methods. Each of these factors can have an impact on the results. For example, low testing rates among drivers killed and injured in crashes continue to plague the search for a valid estimate of the prevalence of drug use among crash-involved drivers. In jurisdictions where such testing is not required, drivers who are injured or killed in crashes are rarely tested without at least suspicion of drug or alcohol use. This severely restricts the ability to determine the overall prevalence and contribution of substance use in crashes. Hence, attempts to estimate the overall prevalence of drug use among drivers involved in crashes from the existing studies should be made with considerable caution.

Table 3.4 presents a summary of findings from selected studies from various countries that have examined the prevalence of psychoactive drugs among drivers killed or injured in road crashes. Not surprisingly, the findings are quite varied. For example, only 7% of injured drivers in Denmark were found to have used drugs (Bernhoft *et al.*, 2004), but other studies report drug use among 30 to 50% of drivers injured, or killed, in crashes (*e.g.* Beirness and Beasley, 2009b; Jeffery *et al.*, 1996; Movig *et al.*, 2004; Smink *et al.*, 2005; Walsh *et al.*, 2005). To a large extent, the degree of variability in the results can be attributed to methodological and procedural diversity. As a general estimate of the extent to which drugs are detected among drivers injured, or killed, in crashes, a review of the extant literature finds the majority of studies report an overall incidence of drugs to be in the range of 14% to 25%. Cannabis is the most commonly found substance and is typically reported in about 10% to 11% of cases. Benzodiazepines are found in approximately 5% to 9% of cases. The concomitant use of alcohol is also not uncommon among drivers involved in serious crashes.

Table 3.4. Drug Use Among Crash Involved Drivers

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Ahlm <i>et al.</i> , 2009	Northern Sweden	December 2004–November 2006	n=102 hospitalised drivers n=56 fatalities	Fatals–blood & urine Injured–blood (up to 6 hours post crash)	<p><b>Fatal</b> Alcohol 38% Pharma 7% Illegal drugs 9% Combinations 5%</p> <p><b>Injured</b> 21% 13% 4% 7%</p>
Assum, 2004	Norway	May 2003–June 2004	Killed/injured drivers (n=11 at time of paper) General population roadside drivers (n=196 at time of paper)	Case-control study compares blood samples from injured/killed drivers with oral fluid samples from general population roadside drivers. No statistical analysis at this point	<p>Collection of blood samples from hospitals proved to be extremely difficult.</p> <p>Only 5 positive screenings in general population, 3 of those confirmed, with one for benzodiazepines, one for opiates, and one for cannabis.</p>
Barbone <i>et al.</i> , 1998	Tayside, UK	1 August, 1992– 30 June, 1995	18 and older drivers involved in road-traffic accident. Residents of Tayside registered with GP taking psychoactive drug during study period (n=1731)	Within-person Case-crossover study	<p>916 taking benzodiazepines OR=1.62 for benzodiazepines Risk greater for drivers 30 and younger, at fault, and with a +ve alcohol breath test</p>
Bernhoff <i>et al.</i> , 2004	Denmark	Not mentioned	n=300 injured drivers in ER	Oral fluid or blood samples (or both) Interview	<p>7% positive for drug use Cannabinoids and benzodiazepines (67%) 38% combined drugs with alcohol</p>
Braut <i>et al.</i> , 2004	Quebec	April 1999– December 2002	n=512 fatally injured drivers	Blood tests	<p>Cannabis 19.7% Benzodiazepines 10.4% Cocaine 7.8% Opiates 1.8% PCP 1.2% Amphetamines 0.8% Alcohol found in 47.5% of drug cases</p>
Crouch <i>et al.</i> , 1993	8 US States	October 1987– September 1988	n=168 truck driver fatalities (within 4 hours of crash)	Blood, vitreous humour or urine	<p>THC 12.5% Alcohol 12.5% Amphetamines 4.2% Cocaine 8.3% Methamphetamine 7.1%</p>

Table 3.4 (contd). Drug Use Among Crash Involved Drivers

Study	Jurisdiction	Period	Sample (N)	Method	Findings
del Rio <i>et al.</i> , 2002	Spain	January 1991 – December 2000	n=5 745 fatally injured drivers (9.7% of all cases)	Blood samples	Drugs &/or alcohol 50.1% Alcohol 43.8% Illegal drugs 8.8% Pharma 4.7% Cocaine 5.3% Opiates 3.2% THC 2.2% Amphetamines 1.2% Benzodiazepines 3.4%
del Rio & Alvarez, 2000	Spain	January 1994 – October 1996	Fatally injured drivers (n=285)	Blood samples	Illegal drugs 10% Cocaine (7%), opiates (5%), cannabis & amphetamine (1.4% each) 20% in combination with alcohol (cocaine most frequent (57%))
Drummer, 1995	Australia	January 1990 – December 1993	Fatally injured drivers (n=1052)	Responsibility analysis Blood samples	Drugs alone 13% Combined with alcohol 9% 36% with alcohol (OR=7.6) Cannabis 11%, & stimulants, opiates & benzodiazepines 3% each
Drummer <i>et al.</i> , 2004	Australia	1990–1999	Drivers killed in crash n=3398	Data from Coroner's office Blood samples	Alcohol 29% positive any drug type 27% Cannabinoids 14%
Dussault <i>et al.</i> , 2002	Quebec	1999–2001	n=354 fatally injured drivers	Blood tests	Cannabis 19.5% Benzodiazepines 8.5% Cocaine 6.8% Opiates 1.4% PCP 1.1% Alcohol found in 41% of drug cases
Gerostamoulos <i>et al.</i> , 2002	Melbourne, Australia	Not stated	n=358 crash victims at trauma centre	Blood samples	Cannabis 36% Benzodiazepines 14% Opiates 10% Barbiturates 2% Amphetamines 12%
Jeffery <i>et al.</i> , 1996	Canada	"through 1994"	n=391 fatalities	Incidence of drugs among cases submitted to forensic labs	cannabis 62.1% benzodiazepines 21.4% stimulants 14.5% opiates 8.2% barbiturates 3.1%

Table 3.4 (contd). Drug Use Among Crash Involved Drivers

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Johansen, 2002	Denmark	1995–2001	n= 201 to 235 cases annually	Cases referred by police for testing for amphetamines	Incidence increased by 10 to 15% from 1995 to 1998 2000 10% 2001 18%
Lillis, Good, Kwong, Gajary & States, 1999	Rochester?	Not mentioned	Drivers brought to ER (n=888)	Blood samples	33% +ve for at least one substance (23% with only one substance) Ethanol 13%, cannabis 6%, Cocaine 3–4%, Benzodiazepines 4%
Logan & Schwilke, 1996	Washington State	September 1992–August 1993	n=318 Fatally injured drivers	Blood and urine samples	46% had BAC >.01 g/100ml 11% +ve for cannabinoids with 63% of these also positive for alcohol 25% +ve for stimulants 3% cocaine 2% methamphetamine 9% depressants with 27% of these also +ve for alcohol
Logan & Schwilke, 2004	Washington State	February 2001–January 2002	Fatally injured drivers n=370	Blood and serum samples	41% +ve for alcohol, 39% CNS active drugs, 14% depressants, 13% cannabinoids, 10% stimulants, 3% narcotic analgesics (excluding morphine). Methamphetamine use increased from 2 to 5% between 1992 and 2002
Longo <i>et al.</i> , 2000a	South Australia	April–Aug 1995 Dec–Aug 1996	n=2 500 injured drivers	Incidence of drugs among injured drivers	32.6% positive for alcohol or drugs Cannabis 10.8% Benzodiazepines 2.7% Stimulants 1.3%
Maio, Guthrie, Hill, Gregor, Waller, & Blow, 2000	Michigan	Not mentioned	Motor vehicle crash victims (n=708)	Frozen serum samples from a previous study Tested specifically for benzodiazepines	Benzodiazepines 3% Seabert usage lower for those +ve 13% more +ve cases were culpable than those negative –60% also +ve for alcohol
Marquet <i>et al.</i> , 1998	France	Not mentioned	Injured drivers (n=296) Patients with non-traumatic injuries (n=278)	Case-control study Recruited in ER of hospitals Urine samples	14% of drivers +ve for cannabis versus 8% in patients (p=0.054) Higher cannabis prevalence in males (16%) than females (8%). More females drivers (8%) than patients (2%) positive for cannabis

Table 3.4 (contd). Drug Use Among Crash Involved Drivers

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Mercer & Jeffery, 1995	British Columbia	1 October, 1990 31 September, 1991	Fatally injured drivers (n=227)	Blood samples	Alcohol 48% Cannabis 13% Diazepam 5% Cocaine 4% Alcohol and drugs 11% Drugs only 9%
Movig <i>et al.</i> , 2004	Netherlands	May 2000– August 2001	Injured drivers n=110 Controls n=816	Blood and/or urine samples case-control designs	40% of cases positive for one or more substances. 14% of controls positive.
Papadodima <i>et al.</i> , 2008	Southern Greece	1998–2004	n=3 167 crash-involved drivers	Blood samples for alcohol Urine samples for drugs	1998-2000 alcohol 36-38% 2001-2004 alcohol 29% Drugs 9% THC 4% Opiates 4% Benzodiazepines 4% Cocaine 1%
Ricci <i>et al.</i> , 2008	Italy	January–April 2006	n=100 crash victims 56 drivers 15 passengers 12 bicyclists 17 pedestrians	Blood for alcohol Urine for drugs	Alcohol &/or drugs 43% Drivers 16% alcohol 12.5% drugs Alcohol 31% THC 9% Cocaine 9% Opiates 6% Benzodiazepines 18%
Schepens <i>et al.</i> , 1998	Belgium	1 July, 1994– 30 June, 1995	Drivers injured in weekend car crash (n=211)	Blood sample for alcohol Urine samples for drugs	Alcohol or drugs 48% Drugs alone 7% -RR for drivers with +ve BAC involved in weekend crash and hospitalised was 1.7
Smink <i>et al.</i> , 2005	Netherlands	October 1998– September 1999	n=993 crash involved drivers.	Blood samples (74% test rate) Link to crash severity	Alcohol &/or drugs 73% Alcohol 64.5% Drugs 41% Opiates 4.2% THC 16.9% Cocaine 6.5% Benzodiazepines 10.3%

Table 3.4 (contd). Drug Use Among Crash Involved Drivers

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Sjögren, Björnstig, Eriksson, Öhman, & Solarz, 1997	Sweden	May 1991–December 1993	Injured drivers (n=130) Fatally injured drivers (n=111)	Blood samples in ER or at autopsy	19% injured and ~23% fatalities +ve for drugs and/or alcohol Drugs alone in 10% injured and ~7% fatalities Alcohol alone in 13% injured and ~21% fatalities Opiates and benzodiazepines 3-8% Cannabinoids 4% Amphetamines 3%
Soderstrom <i>et al.</i> , 2002	Maryland	1996–2000	n=9 947 vehicle occupants reporting to trauma centres	Incidence of drugs from urine samples	Alcohol 20% Cannabis 15% Opiates 18% Cocaine 9%
Stoduto, Vingilis, Kapur, Sheu, McLellan, & Liban, 1993	Toronto, Canada	August 1, 1986–August 31, 1989	Injured victims in motor vehicle collisions n=854	Blood and urine samples	35% of drivers (n=339 tested) +ve for alcohol and 41% +ve for at least one drug other than alcohol Cannabinoids 14% Benzodiazepines 12% Cocaine & morphine 5% each
Tunbridge <i>et al.</i> , 2002	England and Wales	1997	n=2 000 suspected drinking drivers n=1 184 fatalities	Comparison of drug use in two populations	Cannabis 17.8% Single drug 22.7% Multiple drugs 4.1% <i>Fatalities</i> Cannabis 8.2% Single drug 17.7% Multiple drugs 6.3%
Walsh <i>et al.</i> , (2005)	Maryland, USA		n=108 injured drivers at trauma centre	Urine	Drugs 50.9% Alcohol 30.6% THC 26.9% Cocaine 10.2% Amphetamines 0.9% Methamphetamine 5.6% Opiates 10.2% Barbiturates 3.7%



Among the studies reviewed, benzodiazepines appear to be more commonly found in Europe than in either North America or Australia. At this point, it is uncertain as to whether this reflects differences in drug use patterns or testing protocols. Whereas many countries have well-developed systems for the routine collection of bodily fluid samples from drivers killed in road crashes to test for alcohol, testing for other substances is less consistent. In addition, the testing of drivers involved in non-fatal crashes is often sporadic. Ethical and privacy concerns often supersede the needs of research and enforcement. Nevertheless, such testing is critical for routine surveillance, monitoring trends, and identifying emerging patterns in the substances involved in traffic deaths and injuries.

At one extreme, the incidence of drugs among serious and/or fatally injured drivers can appear to rival that of alcohol. On the other hand, drug use can be shown to be but a small fraction of alcohol use among crash populations. While such information provides valuable evidence of the extent to which drugs are involved in property road crashes, the key issue is not only how frequently drugs are detected among drivers, but the extent to which consumption of psychoactive substances contributed to the crash. The evidence pertaining to this issue is examined in the next section.

### NOTES

1. The prevalence of use of many substances (*e.g.*, methamphetamine, MDMA) is either not reported or is so low as to have little confidence in the numbers.
2. Some information (*e.g.*, population, km of public roadways, number of motor vehicles) was derived from the International Traffic Safety Data and Analysis Group (2007). Information missing from survey responses on drug use was obtained from the United Nations World Drug Report 2008.
3. The definition of a “standard” drink varies somewhat according to country. For the current report, a “standard” drink is assumed to contain 13.5 grams of absolute alcohol.
4. Results from oral fluid samples were not reported.
5. Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing (IMMORTAL).



## 4. THE ROLE OF DRUGS IN ROAD CRASHES

*The studies reviewed in this chapter attempt to establish the contributory role of drugs to crashes and/or the risks associated with driving after using drugs. Studies include case-control studies, in which the incidence of drug use is compared between drivers who are or are not involved in crashes, and crash responsibility/culpability studies, in which the incidence of drug use is compared between drivers who are and are not responsible/culpable for the crashes in which they are involved.*

Analytic epidemiological studies in this area examine the extent to which drugs are disproportionately represented in road crashes and quantify the crash risk associated with the use of various types of drugs. Two primary approaches have been used: case-control studies and crash responsibility/culpability studies. A third approach – referred to as pharmacoepidemiology – has also been used to estimate the risk of crash involvement associated with the use of certain pharmaceuticals. All three approaches provide valuable information pertinent to the issue. This section examines the strengths and limitations of the various approaches and summarises the evidence from studies that have used these methods.

### 4.1. Methodological Issues

The case-control methodology used in the study of drug-driving is a direct extension of the method used to determine the relative risk of crash among drinking drivers, which in turn is an adaptation of the design from classic medical epidemiology. Cases are defined as drivers involved, injured, or killed in road crashes. The frequency of alcohol or other drugs detected in the cases is compared to the frequency of drugs and/or alcohol detected in a comparable group of drivers who have not been involved in crashes. To the extent that alcohol and/or drugs are more frequently detected in crash populations is an indication of the degree to which the use of psychoactive substances presents an elevated risk for drivers. This method has been instrumental in understanding the risks associated with alcohol use by drivers. In addition, by comparing the quantity of alcohol used among cases and controls, it was possible to determine the relative likelihood of crash at different blood alcohol concentrations (BACs) (Bloomberg *et al.* 2009; Borkenstein *et al.*, 1964). This information contributed substantially in the setting of *per se* alcohol limits for drivers in many countries.

The application of the case-control method to studying the risk of crash for drivers using drugs is somewhat more complex than for alcohol. First, unlike the situation involving alcohol, the testing for drugs, both among the cases and the controls, is more difficult. Ideally, blood should be obtained from both cases and controls but, as noted previously, obtaining the needed compliance from controls can be difficult and, as a consequence, testing rates are often low and estimates unreliable. Among cases, similar problems are experienced but are often minimised in the case of fatalities. The net result is that the estimates derived from the comparison group often suffer as a result of missing data. Indeed, the

proportion of non-respondents in the comparison or control group can exceed the proportion of those with positive drug test results. Assumptions made about the distribution of drugs in the untested portion of the sample can have profound effects on the resultant estimates of risk.

In addition, the sample medium used to test for drugs has a strong bearing on the certainty that a substance poses a risk for crash involvement. Ideally, if a substance is detected, it should signify that it could reasonably be expected to have had an adverse effect on the driver at or around the time of the crash. This requires an indication of the level of active drug in the driver's blood because the amount of a substance in blood corresponds best with recent use and the extent of the influence on driver behaviour. In this context, the study of the role of alcohol in crashes has been greatly facilitated by the fact that blood alcohol levels can be easily and reliably established from breath samples. This is not the case with other types of psychoactive substances, which typically require that toxicological testing be conducted on other bodily fluids. Because of the inherent difficulties in obtaining blood samples, many studies have used urine as the medium for drug testing. Unfortunately, some drugs can be detected in urine for long periods of time following drug use, so detection does not necessarily imply an active drug level (*i.e.* impairment) at the time of the crash.

In recent years, oral fluid has been gaining prominence as a medium for drug testing. It is readily available and can be collected conveniently and unobtrusively. The encouraging degree of correspondence between drug levels detected in oral fluid and those in blood, combined with the convenience and ease with which oral fluid can be obtained, has tremendous potential to enhance research efforts.

A third methodological problem that complicates case-control studies is the elapsed time between the crash and the drawing of the specimen for drug analysis. Unlike alcohol where the rate of elimination from the blood is relatively slow and fixed, this is not true of other substances. Of particular interest in this regard is cannabis, most of which is metabolised and removed from the blood within the first hour or two after use. The longer the period of time between the crash and the drawing of the sample, the greater the risk of underestimating the incidence and level of the drug.

The case-control method requires the sample of crash-involved cases to be compared to a sample of drivers who have not been involved in crashes, matched on variables known to be differentially associated with crash involvement – *e.g.* time of day, day of week, location, and type of vehicle. Drivers selected for inclusion are usually volunteers and have the option of refusing to participate. Not surprisingly, some studies show that a substantial proportion of drivers elect not to participate with invasive procedures such as the collection of blood or urine samples. For example, in the recent Quebec study, 97% of drivers provided a breath sample, but only half (49.6%) agreed to provide a urine sample to test for the presence of drugs (Brault *et al.*, 2004). Some drivers may refuse because of fear of detection and prosecution; others may simply object to the invasiveness of the procedures or the amount of time required. It should be noted; however, that in several European studies (*e.g.* Assum *et al.*, 2005), high response rates have been found. Undoubtedly, random testing laws and the use of police to conduct the survey served to enhance compliance. In any event, refusal rates that exceed the incidence of drug detection can compromise the validity of the comparisons.

The wide range of psychoactive drugs that can be studied mean that case-control studies require an extremely large number of crash-involved and crash-free drivers. Even when they number in the thousands, the relatively low incidence of drugs means that comparisons are often relegated to a simple comparison of the presence or absence of the drug under investigation. Rarely is it possible to make comparisons across different levels of a particular drug.

Furthermore, should a substance be found to be over-represented in crashes, it is often assumed that the mere presence of the substance was sufficient to have contributed to the crash. In fact, the case-control approach simply provides evidence of an association between drugs (or alcohol) and crashes and does not directly provide evidence that the substance induced a degree of impairment sufficient to have contributed to the crash. Other factors associated with drug use – *e.g.* characteristics of the person, their driving style – could also explain the observed association (Terhune, 1986). For example, people who consume illegal drugs have been shown to exhibit a variety of “deviant” characteristics, including a greater tendency toward risk-taking, which may predispose them to higher rates of crash even in the absence of drug or alcohol use (Jessor *et al.*, 1991). This is also the situation for case-control studies concerning the role of alcohol in crashes; however, in the case of alcohol, the repeated demonstration of a dose-dependent increase in risk combined with a corresponding dose-response relationship in experimental studies provides convincing evidence of the contributory role of alcohol in crashes. To date, most epidemiological studies of the role of drugs in crashes have simply determined the presence or absence of particular drugs and few studies have attempted to determine the extent of increased risk according to the quantity of drug found (Drummer, 2004; Laumon *et al.*, 2005).

An alternative approach, referred to as responsibility/culpability analysis, has also been employed as a means to study the role of drugs (and/or alcohol) in motor vehicle crashes (Robertson and Drummer, 1994; Terhune, 1983; 1986). The distinguishing features of this approach are the absence of a noncrash-involved control group of drivers and the inclusion of information concerning the attribution of drivers’ responsibility for the crash. Judgements about responsibility for causing the crash are made by examining the circumstances and events leading up to the crash. A comparison can then be made between the proportion of drivers who were positive for drugs, and judged responsible for the crash, with the proportion who tested positive for drugs, but were deemed not responsible for the crash; as well as a comparison of the proportion of drivers who were drug-free, and judged responsible for the crash, with the proportion of drug-free drivers not responsible for the crash. The contribution of drugs is determined by the extent to which a greater proportion of drug-positive drivers are deemed responsible for the crashes in which they were involved.

This approach alleviates the problems associated with obtaining fluid samples from an appropriate sample of drivers not involved in crashes. At the same time, however, it loses valuable exposure information concerning the use of drugs and/or alcohol by drivers who are exposed to risk but have not been involved in a crash. Moreover, the design does not eliminate the challenges associated with obtaining a valid sample of crash-involved cases that have appropriate toxicological data derived from fluid samples obtained in close temporal proximity to the crash. As well, the procedure is somewhat subjective and highly dependent upon the method of rating the crash responsibility, so it is critical that judgements about responsibility are made in the absence of knowledge about drivers’ use of alcohol or drugs and that responsibility be assessed through the application of a strict set of scoring criteria with demonstrated evidence of inter-rater reliability. Some studies, however, rely on judgements of responsibility made by the investigating police officer. Police judgements of crash responsibility are not necessarily reliable and may be biased by knowledge or suspicion of alcohol and/or drug use among the drivers involved.

Another problematic issue for responsibility analysis is the overall high proportion of drivers deemed responsible for their crashes, even among drivers free of alcohol or drugs. To some extent, this situation is exacerbated by the relatively high proportion of single vehicle crashes among those selected for inclusion in the analysis – *i.e.* typically drivers involved in serious injury or fatal crashes. Drivers involved in single-vehicle crashes are overwhelmingly deemed responsible. In addition, drivers who have been drinking or using cannabis are more likely to die in a crash even when they are not at fault (Laumon *et al.* 2005). Hence, some studies elect to include only drivers involved in crashes in which two or more

vehicles are involved. Excluding these drivers, however, only allows the results to be interpreted in terms of the risks associated with collisions involving two or more vehicles.

The responsibility/culpability approach has been used successfully in the study of alcohol and driving and such studies have consistently found alcohol to be associated with higher risk of crash involvement. Its application to the analysis of the role of drugs in crashes provides another valid source of evidence.

A variation on the case-control and responsibility methods that has recently emerged involves a comparison of the road crash involvement between reported drug users and non-users (*e.g.* Asbridge *et al.*, 2005; Blows *et al.*, 2005). These studies do not include objective measures of drug use but rely entirely on self-reported drug use. They may ask drivers to indicate whether or not they used drugs in the period immediately preceding the crash or ask about general drug use patterns. In either case, the validity of attributions of a causal connection between drug use and crash involvement is suspect. At best, such studies provide information that can associate the characteristics of reported drug use with an increased frequency of crash involvement.

Pharmacoepidemiological studies are a variation of the classic case-control approach that have been used to study the role of medicinal drugs in road crashes. These studies compare the incidence of crashes among drivers who have (cases) or have not (controls) been prescribed a specific pharmaceutical for the treatment of some disorder. Information from toxicological tests on drivers involved in crashes is not typically obtained or used in the analysis. Hence, it is not possible to verify that cases were actually taking the prescribed medication at the time of the crash, taking it as directed, and/or taking the medication in the absence of alcohol or other drugs. Nevertheless, the large sample sizes typically involved in these studies reduces the possibility of these factors having a significant influence on the overall results and can provide valuable insights into the relationship between prescription drug use and crash involvement.

In summary, the methods used to examine the contribution of drugs to crashes face challenges that must be considered when the findings from them are examined. The following section examines the evidence from analytical epidemiological studies to determine the contributory role of drugs in road crashes.

## 4.2. The Evidence

The experimental literature provides a long list of psychoactive substances that can impair psychomotor and cognitive skills and, hence, have the potential to affect driver behaviour and contribute to road crashes. Many of these substances have been found in drivers injured or killed in crashes. However, relatively few of these substances have been examined in terms of their contribution to crashes. This section discusses the evidence pertaining to the commonly used substances for which the literature provides evidence of the risk associated with crash involvement – *i.e.* cannabis, benzodiazepines, and stimulants.

Table 4.1 provides a summary of the analytic epidemiological studies in this area, listed in alphabetical order by author. The major findings are presented in terms of the odds ratio (OR) or relative risk (RR) of crash involvement associated with the major types of drugs or drug combinations. In addition, odds ratios for alcohol as well as drugs combined with alcohol are also shown. Where available, the 95% confidence intervals are also presented.<sup>1</sup>



## *Cannabis*

A quick overview of the findings of these studies reveals that about half report cannabis use by drivers to be associated with an increased risk of crash involvement. The other studies find no significant increase in risk associated with cannabis use. Indeed, in several of these studies, cannabis was associated with an odds ratio less than 1.0, suggesting a lower risk of crash involvement than for drivers who have not used cannabis (Drummer, 1995; Longo *et al.*, 2000b; Mathijssen *et al.*, 2005; Terhune *et al.*, 1992; Williams *et al.*, 1985). Other studies report non-significant increases in the risk of crash involvement associated with cannabis use (Lowenstein and Koziol-McLain, 2001; Marquet *et al.*, 1998; Mathijssen and Houwing, 2005; Movig *et al.*, 2004; Terhune, 1982). In addition, the two reports on the Quebec study (Brault *et al.*, 2004; Dussault *et al.*, 2002) found increased risk associated with cannabis use, but the increase was only significant using the case-control approach; responsibility analysis found no significant increase in risk.

Among the studies that have examined the role of cannabis in crashes listed in Table 4.1, there are several recent studies (Drummer *et al.*, 2004; Laumon *et al.*, 2005; Longo *et al.*, 2000b; Mura *et al.*, 2003)<sup>2</sup> that are methodologically stronger than the others because they all used blood samples to specifically test for the presence of the active ingredient in cannabis (THC) rather than its inactive metabolite (carboxy-THC). This is important, because individuals found to have a positive level of THC in blood are most likely to be under the influence of cannabis. Three of these studies reported a significant increase in risk associated with cannabis use. Mura *et al.* (2003) employed a case-control approach, comparing a sample of injured drivers with a sample of other patients attending hospital in France and found drivers with cannabis levels greater than 1 ng/ml were 2.5 times more likely to have been injured in a crash. The significant increase in risk associated with cannabis use, however, was restricted to those under 27 years of age.

Other studies, using large sample sizes and rigorous methods, provide strong evidence of increased risk of crash associated with THC. Using responsibility analysis with samples of fatally injured drivers in Australia, Drummer *et al.* (2004) reported drivers with THC levels greater than 5 ng/ml were 6.6 times more likely to be responsible for the crash than drivers who had not used drugs or alcohol. Laumon *et al.* (2005) reported an increase in the risk of crash responsibility of 1.78 associated with any cannabis use. Higher THC levels were associated with greater risk. In an analysis of data from 21 087 drivers between the ages of 20 and 49 involved in fatal crashes in the United States who were tested for cannabis, Bédard *et al.* (2007) found drivers deemed responsible for the crash (as determined by having one or more potentially unsafe driver actions attributed to them) were significantly more likely to be positive for cannabis than drivers deemed not responsible. However, in contrast to these findings, Longo *et al.* (2000b) reported that injured drivers who tested positive for active THC in blood were no more likely than drug-free drivers to be responsible for the crash in which they were involved.

Among the limited number of recent epidemiological studies that have measured active THC in blood samples, there remains a degree of inconsistency in the evidence. However, the weight of the evidence shows that cannabis use is associated with increased risk of crash involvement. In addition, studies that show a dose-related increase in risk provide strong evidence implicating cannabis as a causal factor in crashes (*e.g.* Drummer *et al.*, 2004; Laumon *et al.*, 2005).

The apparent inconsistency of the available epidemiological results may be attributable, in part, to the variability of the studies in terms of the approach (case-control, responsibility analysis), severity of crash (injury, fatal), fluid tested (urine, oral fluid, blood), component of cannabis tested (THC, carboxy-THC), and sample size. Although the total number of drivers included in any study may appear large, the actual number who test positive for THC is typically small. The relatively low incidence of cannabis detection among drivers renders the results sensitive to even small variations in sampling and case



selection. Large-scale studies, using rigorous and consistent methods, are necessary to provide clear and unambiguous evidence of the increased risk of crashes associated with cannabis use by drivers.

Even if the data were consistent, it would still only provide evidence of an association between cannabis use and crash involvement and would not be sufficient to establish that the effect of the drug contributed to crash involvement. This is because it is not possible to determine the extent to which the observed association is a function of the effect of the drug or a result of the characteristics of those who use the drug. Evidence of a dose-dependent increase in risk contributes to the case for cannabis as a risk factor. To date, few analytic epidemiological studies have quantified the extent of cannabis use and have relied almost exclusively on a simple dichotomy of its presence or absence. The studies by Drummer (2004) and Laumon *et al.* (2005) found higher risks associated with THC levels of 5 ng/ml or greater. Further studies, distinguishing among various levels of THC among large numbers of road users, would enhance the strength of the evidence concerning the extent of the increased risks of cannabis use by drivers.

Although the evidence pertaining to the use of cannabis alone can appear somewhat equivocal, the available evidence is very clear that the use of cannabis in combination with alcohol is associated with higher risk of crash involvement. Among the small number of studies listed in Table 6 that separate cases positive for both cannabis and alcohol, significantly increased risks are reported, relative to drivers who are drug-free (Brault *et al.* 2004; Laumon *et al.* 2005; Longo *et al.* 2000b; Williams *et al.* 1985), or relative to those who are positive for alcohol alone (Drummer *et al.* 2004).

### ***Benzodiazepines***

Benzodiazepines are among the most commonly prescribed medications and it is, therefore, not surprising that they are found among drivers on the road as well as among those involved in crashes. Among the twelve studies in the table that examined benzodiazepines, the evidence is mixed concerning the extent to which benzodiazepines are over-represented among drivers involved in crashes. For example, two case-control studies conducted in the Netherlands reported an increased risk of driver injury associated with benzodiazepines (Mathijssen and Houwing 2005; Movig *et al.*, 2004). The Quebec study (Brault *et al.*, 2004; Dussault *et al.*, 2002) reported significantly higher risk associated with benzodiazepines among fatally injured drivers using the case-control approach, but not using responsibility analysis. Dubois *et al.* (2008) found significantly increased risk among drivers who tested positive for intermediate and long-acting benzodiazepines, but not short-acting ones.

Among the studies that used blood samples to determine the presence of benzodiazepines in both the case samples and the control samples, two older studies (Benzodiazepine/Driving Collaborative Group, 1993; Drummer, 1995) reported no significant increase in risk associated with benzodiazepine use. Of the more recent studies, two reported a significant increase in risk associated with benzodiazepines (Longo *et al.*, 2000b; Mura *et al.*, 2003); one found no significant increase in risk (Drummer *et al.*, 2004).

Table 4.1. Studies Assessing the Risks Associated with Drugs in Crashes

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Barbone <i>et al.</i> , 1998	Tayside UK	August 1, 1992–June 30, 1995	18 and older drivers involved in road-traffic accident taking psychoactive drug during study period (n=1731)	Case-crossover study	OR= 1.62 (p<.05) benzodiazepine use (risk greater for drivers 30 and younger, at fault, and with a positive alcohol breath test)
Bédard <i>et al.</i> , 2007	United States	1993–2003	Drivers aged 20 to 49 involved in a fatal crash confirmed BAC=0 tested for cannabis (n=21 087)	Modified responsibility analysis	OR=1.39 (1.21 - 1.59) OR=1.29 (1.11 - 1.50) adjusted for age, sex, prior driving record
Benzodiazepine/Driving Collaborative Group, 1993	France	May 1989–1 July 1990	n=2 852 injured drivers	Responsibility analysis Blood samples	OR=0.96 (0.8 - 1.2) BZD + alcohol < .02 OR=7.2 (3.4 - 15.2) BZD + alcohol > .02 (BZD=benzodiazepines)
Blows <i>et al.</i> , 2005	Auckland NZ	March 1998–1 July 1999	Cases n=571 car occupants killed or injured Controls n=588 random sample of cars	Case -control Self-reported cannabis use (acute and chronic use)	OR=11.9 (3.6 - 35.4) acute use OR=3.9 (1.2-12.9) acute use adjusted OR=0.8 (0.2 -3.3) acute use adjusted for risk factors. OR=9.5 (2.8 - 32.3) chronic use adjusted
Brault <i>et al.</i> , 2004	Quebec	April 1999–December 2002	n=512 fatally injured drivers n=5 931 drivers tested at roadside	Case-control responsibility analysis. Urine samples	<b>Substance</b> Alcohol > .08 69.9 32.6 Cannabis alone 1.6 1.2 n.s. Cannabis+alc>.08 203.8 8.5 Cocaine 4.5 – Benzodiazepines 3.9 2.5 n.s. Opiates 3.1 3.2 n.s. Any drug, no alc. 2.5 2.1 Any drug, alc. >.08 185.4 10.5

Notes: OR = Odds ratio; RR = Relative risk; ns = Not significant.

Table 4.1 (contd). Studies Assessing the Risks Associated with Drugs in Crashes

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Drummer <i>et al.</i> , 2004	Australia	1990–1999	Drivers killed in crash (n=3 398)	Responsibility analysis Blood samples	OR=2.7 any THC OR=6.6 THC >5 ng/ml OR=1.27 BZD n.s. OR=2.3 stimulants n.s. OR=3.8 other drugs OR=2.9 THC + alcohol >.05 vs alcohol alone
Drummer, 1995	Australia	January 1990– December 1993	Fatally injured drivers (n=1 052)	Responsibility analysis Blood samples	OR=7.6 alcohol OR=0.6 cannabis n.s. OR=2.0 stimulants n.s. OR=2.0 benzodiazepines n.s. OR=2.0 opiates n.s.
Dubois <i>et al.</i> , 2008	United States	1993–2006	n=72 026 drivers involved in fatal crashes BAC=0 3% positive for Benzo	Responsibility Analysis (Unsafe driving actions leading to fatal crash)	OR=1.02 (0.73 - 1.42) short acting BZD OR=1.53 (1.20 - 1.96) intermediate OR=1.44 (1.25 - 1.66) long acting
Dussault <i>et al.</i> , 2002	Quebec	1999–2001	n=354 fatally injured drivers n=5 931 drivers at roadside	Case control Responsibility analysis Urine tests for controls Blood + urine tests for cases	<b>Substance</b> <b>Case-Control</b> <b>Resp</b> Cannabis            2.2            1.2 n.s. Cannabis + Alcohol    8.5            2.5 n.s. Cocaine                4.9            – Benzodiazepines    2.5            3.6 n.s.
Gustavsen <i>et al.</i> , 2006	Norway	January 2004– September 2006	n=3.9 million persons prescribed medications n=129 crashes	Pharmacoepidemiological Standardised incident ratios exposed person years	SIR=2.3 (2.0 - 2.8) Zopiclone SIR=2.2 (1.4 - 3.4) Solpidem SIR=2.7 (1.8 - 3.9) Nitrazepam SIR=4.0 (2.4 - 6.4) Flunitrazepam
Hemmelgarn <i>et al.</i> , 1997	Quebec	June 1, 1990– May 31, 1993	67-84 year old drivers involved in a crash where at least 1 person was injured (n=5 579). Controls (n=18 490)	Nested case-control design prescription information obtained from the provincial agency responsible for administering health care services)	OR=1.28 use of long-life BDZ p<.05 OR=1.45 for first 7 days of use p<.05 OR=1.26 61-365 days BDZ n.s. OR=0.96 short-life BDZ n.s.
Laumon <i>et al.</i> , 2005	France	October 2001 – September 2003	n=10 748 drivers in fatal crashes n=6 766 at fault n=3 982 others	Responsibility Analysis Blood tests for alcohol and THC	OR=3.32 (2.63 - 4.18) THC OR=2.18 (1.22 - 3.89) THC < 1ng/ml OR=4.72 (3.04 - 7.33) THC ≥ 5ng/ml OR=14.0 (8.0 - 24.7) THC + alcohol

Table 4.1 (contd). Studies Assessing the Risks Associated with Drugs in Crashes

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Longo <i>et al.</i> , 2000b	South Australia	April–Aug 1995 Dec–Aug 1996	n=2 279 injured drivers	Responsibility analysis (blood samples)	OR=8.0 Alcohol only OR=0.82 cannabis only n.s. OR=5.4 cannabis + alcohol OR=2.0 Benzodiazepines only OR= 13.4 alcohol + benzodiazepines OR=2.0 stimulants only n.s.
Lowenstein & Koziol-McLain 2001	Denver	1 June 1995	n=414 injured drivers	Responsibility analysis (urine samples)	OR=3.2 (1.1 - 9.4) alcohol OR=3.5 (1.2 - 11.4) alcohol + drugs OR=1.1 (0.5 - 2.4) cannabis
Marquet <i>et al.</i> , 1998	France	Not mentioned	Injured drivers (n=296) patients with non-traumatic injuries (n=278)	Case-control study (urine samples)	14% of drivers +ve for cannabis versus 8% in patients (p=0.054) OR=1.87 (0.85 - 2.89) n.s. (calculated from report)
Mathijssen and Houwing, 2005	Netherlands	May 2000– March 2004	n=121 injured drivers n=3 374 control drivers	Case-control study Cases: 66% blood; 34% urine Control: 85% urine; 15% blood	OR=1.45 cannabis n.s. OR=2.98 BDZ OR=3.04 codeine n.s. OR=32.4 morphine OR=12.9 alc<.08 + drugs OR=179 alc >.08 + drugs OR=24.0 drug combinations
Movig <i>et al.</i> , 2004	Netherlands	May 2000– August 2001	Injured drivers (n=110) controls randomly stopped on public roads (n=816)	Case-control design Blood and/or urine samples	OR=1.22 cannabis n.s. OR=5.1 benzodiazepines OR=5.5 alcohol >05% OR=16 alcohol >.08% OR=6.1 more than one substance OR ns for amphet, cocaine, opiates
Mura <i>et al.</i> , 2003	France	2000–2001	n=900 injured drivers n=900 ER patients	Case-control Blood samples	*OR=2.5 cannabis > 1ng/ml *OR=3.8 alcohol >.05 *OR=4.6 alcohol + cannabis OR=8.2 morphine > 20 ng/ml OR=1.7 BDZ * includes those < 27 years old

Table 4.1 (contd). Studies Assessing the Risks Associated with Drugs in Crashes

Study	Jurisdiction	Period	Sample (N)	Method	Findings
Neutel, 1995	Saskatchewan	1979–1986	n=147 726 drivers with prescription for BDZ. n=97 862 controls	Case-control (no toxicology)	OR=3.9 short-acting BDZ within 4 weeks OR=6.5 short-acting BDZ within 2 weeks OR=2.5 long-acting BDZ within 4 weeks OR=5.6 long-acting BDZ within 2 weeks OR=2.2 other sedatives OR=1.7 anticonvulsants n.s. OR=0.6 antipsychotics n.s.
Soderstrom <i>et al.</i> , 2005	Maryland USA	1997–2001	N=2 537 drivers admitted for treatment (with complete toxicology)	Culpability Analysis Alcohol - blood Drugs - urine	OR=7.45 (5.12 - 10.84) Alcohol OR=2.33 (1.36 - 3.99) Cocaine OR=1.18 (0.84 - 1.64) THC
Swann, 2000	New South Wales	1995–1999	n=544 fatally injured drivers	Responsibility analysis Blood samples	OR=7.5 (3.2-21.9) alcohol only OR=3.8 (1.7-10.1) drugs only OR=9.2 (1.9-165.0) drugs + alcohol OR=3.4 (1.3-11.6) drugs but not THC OR=6.4 (1.3-115.7) delta-9-THC
Terhune, 1982	Rochester, NY		n=497 injured drivers	Responsibility analysis Blood samples	OR= 5.4 alcohol OR=2.1 cannabis n.s. (calculated from report)
Terhune <i>et al.</i> , 1992	7 states	1990–1991	n=1 882 fatally injured drivers	Responsibility analysis blood samples	OR= 4.82 alcohol OR= 0.66 cannabis n.s. (calculated from report)
Williams <i>et al.</i> , 1985	California	1982–1983	n=440 fatally injured drivers	Responsibility analysis Blood samples	OR= 5.0 alcohol OR= 0.5 cannabis n.s. OR= 8.6 alcohol and cannabis (calculated from report)

Four studies have used a pharmacoepidemiological approach to examine the risk of crash involvement among patients with a prescription for benzodiazepines (Barbone *et al.*, 1998; Engeland *et al.*, 2007; Hemmelgarn *et al.*, 1997; Neutel, 1995). In these studies, crash involvement among drivers with a prescription for benzodiazepines was compared with that among a comparison group of drivers who were not taking benzodiazepines. Toxicological tests for the presence of benzodiazepines (or any other substance) were not conducted among crash-involved drivers. All three studies report an over-representation of crashes among drivers given a prescription for benzodiazepines, but the risk depended on the type of benzodiazepine and the duration of its use. For example, long-acting benzodiazepines were associated with higher crash risk than short-acting benzodiazepines. The risks were also higher within the first couple of weeks following the prescription (and presumably the start of drug use), but the magnitude of the risk decreased with longer-term use (*i.e.* 61 to 365 days). This finding suggests that patients quickly develop a tolerance to the impairing effects of the medication, or are learning to adapt their behaviour so as not to be as susceptible to the adverse effects.

Overall, evidence pertaining to the contribution of benzodiazepines to road crashes is mixed and inconsistent. The more recent studies, combined with the evidence from pharmacoepidemiological studies, suggests that there may be a modest increase in the risk of crash associated with benzodiazepines; and that the risk may be specific to the use of long-acting benzodiazepines and for use within the first few weeks following the start of drug use. The actual magnitude of the increase in risk, however, is relatively small (ORs typically  $\leq 2.0$ ) but increases substantially when used in combination with alcohol (Benzodiazepine/Driving Collaborative Group, 1993; Brault *et al.*, 2004; Longo *et al.*, 2000b).

### ***Stimulants***

Few studies have examined the crash risk associated with stimulant drugs, including amphetamines and cocaine. Three studies reported a non-significant increase in risk associated with the use of stimulants (Drummer, 1995; Drummer *et al.*, 2004; Movig *et al.*, 2004). The Quebec study (Brault *et al.*, 2004; Dussault *et al.*, 2002) found cocaine to be associated with an increased risk of fatal crash involvement. The increased risk associated with amphetamines reported by Brault *et al.* (2004) was limited to the case-control study and included all amphetamine-positive cases, including those also found to be positive for alcohol and/or the use of other substances.

### ***Other drugs***

Few other substances have been examined (or at least reported) in the studies listed in Table 4.1. Studies that have examined the use of opiates (morphine/heroin/codeine) report significantly increased risks (Brault *et al.*, 2004; Mathijssen *et al.*, 2004) but the actual number of cases is extremely small. Other drugs, such as sedatives, anticonvulsants, antipsychotics, and antidepressants, are mentioned in some studies, but it would appear that the number of drivers found with positive levels of these substances is sufficiently small to preclude their being examined separately. Hence, there is insufficient evidence to determine the extent to which these other psychoactive substances are associated with increased crash risk.

### ***Drug combinations***

Several of the studies cited in previous sections and listed in Table 4.1 were able to assess the increased risk of crash associated with driving after using more than one substance. The findings almost invariably show that drivers who combine the use of alcohol with cannabis (*e.g.* Brault *et al.*, 2004; Drummer *et al.*, 2004; Longo *et al.*, 2000; Mura, 2003; Williams *et al.*, 1985), benzodiazepines (*e.g.* Barbone *et al.*, 1998; Benzodiazepine/Driving Collaborative Group, 1993; Brault *et al.*, 2004; Longo,

2000; Lowenstein and Koziol-McLean, 2001) or any other psychoactive substance (Brault *et al.* 2004; Mathijssen and Houwing 2005; Movig *et al.* 2004; Swann 2000) are at significantly increased risk of crash involvement. The use of more than one substance (not including alcohol) has also been shown to increase the risk of crash involvement (*e.g.* Mathijssen and Houwing 2005; Moving *et al.* 2004). Importantly, the risks associated with the use of more than one substance are higher than those associated with the use of a single substance alone. Clearly, drivers who combine more than one psychoactive substance and/or alcohol pose a serious threat to themselves and other road users.

### 4.3. Summary

Despite the many methodological challenges, the available analytic epidemiological studies provide evidence of the increased risk of crash involvement among drivers who consume various types of substances. Although the evidence at times appears equivocal, the more recent studies utilising blood samples to test for the presence of drugs provide a clearer picture of the increased risks associated with a variety of substances. Two things, however, are eminently clear. First, the magnitude of the risks is typically lower than those associated with alcohol use, particularly those at higher blood alcohol levels. Second, impairing substances pose greater risks when combined with even small amounts of alcohol. Further studies, employing large samples and rigorous methods, will enhance our understanding of the extent of the risk posed by the use of drugs by drivers. Some of this research is currently being conducted as part of the DRUID project in various centres across Europe. In addition, in the United States, the National Highway Traffic Safety Administration is conducting a large-scale case-control study to examine the risks associated with driving after drug use. The results of these projects will provide valuable information that will be instrumental in furthering our understanding of the issue, establishing public policy, and developing enforcement and prevention programmes.

### NOTES

1. Confidence intervals that include the value 1.0 are not considered to be statistically significant.
2. A fifth study (Swann 2000) was not included among this group, because it was based on a subset of cases included in the study reported by Drummer *et al.* (2004).



## 5. LEGISLATION, ENFORCEMENT AND PREVENTION

*This section provides a review and discussion of legislative and enforcement policies and practices in OECD/ITF countries. In particular, it examines the two primary legislative approaches to controlling drug use by drivers – per se and behavioural/impairment – and provides practical examples of the implementation of these laws in Australia. In addition, this section will review approaches to enforcement (e.g. targeted, random), drug testing (e.g. oral fluid, urine, blood), and the distinction (if any) made between the use of illicit substances and prescription medications. A discussion of primary prevention initiatives is also provided.*

Efforts to deal effectively with drug-driving usually involve a combination of legislative initiatives, enforcement practices, and primary prevention activities. To a large extent, the nature of these efforts to date has been modelled on the wealth of experience with measures introduced to control the drink-driving problem. A great deal has been learned over the past 30 years about effective ways to reduce drink-driving, and these lessons have guided the development and implementation of measures to control the drug-driving problem.

Despite the obvious parallels between alcohol- and drug-driving, there are numerous differences that must be taken into account in the adaptation of countermeasure programmes. For example, the term “drugs” encompasses a wide variety of substances. Some are illegal, but are widely used for their euphoric effects (e.g. cannabis, cocaine); others are prescribed for legitimate medical purposes (e.g. benzodiazepines); still others can be purchased directly by consumers to treat minor ailments (e.g. antihistamines). In addition, some prescription medications are used inappropriately (e.g. wrong dose, with alcohol) or by those for whom they were not prescribed. Each of these situations involves different behaviours, motivations, and subgroups within the population. A somewhat different approach may be necessary to deal effectively with each situation. This section outlines some of the measures various countries have taken to deal with the drug-driving problem.

### 5.1. Legislation

In general, impaired driving legislation aims to authorise, regulate, and provide sanctions. The legislative sanctions can be considered in terms of:

**Retribution.** Theoretically, punishment is deemed an appropriate and necessary consequence of an offence. Its severity should be proportional to the severity of the transgression and the extent of the risk posed. The purpose of punishment is to discourage the individual from future similar acts by instilling an understanding of the consequences.

**Deterrence:** of both the driver who experiences the punishment (specific deterrence), and other drivers who do not wish to be punished (general deterrence). There are many theoretical models of deterrence applied to military conflicts, crime and impairment (drink drive) legislation. Deterrence is particularly useful in situations where the offence is committed after the offender considers the risks and benefits of committing the offence. However, for the many dependent drug and alcohol drivers the motivation for the substance often compromises rational cost-benefit decision making and the deterrence value of the legislation is reduced.

**Rehabilitation** of those who engage in the sanctioned behaviour. Sanctions can initiate an opportunity for addressing the underlying reasons why the person is committing the offence. High-risk repeat drug offenders can be sanctioned by an intensive correction order, which requires the offender to undergo a treatment programme either outside or inside a prison, as prisons can provide a range of rehabilitative programmes.

**Incapacitation** involves preventing repeat occurrences of the behaviour by restricting, or completely removing, the person's capacity to drive (for example, by impounding his or her car or by putting the person in prison) for at least a period of time. This is potentially the most powerful tool, and it can achieve punishment, denunciation and deterrence; however, the scope of use is limited by the proportionality principle and by the economic and social costs of incapacitation.

Table 5.1 lists some key elements of drink- and drug-driving legislation in the countries that responded to the survey conducted as part of this project. The strong influence of science in the development of legislation in this area is evident in the establishment of *per se* laws<sup>1</sup> for alcohol in each of the countries listed in the table. The variation in the *per se* alcohol limits, as well as the authority and circumstances under which alcohol testing can occur, illustrates that even the strongest science is subject to the influence of legal traditions and politics in determining the specifics of drink-driving legislation and policies. In the areas of drug-driving, the science has lagged behind the need for legislation, policy and programmes, leaving legislation largely to the discretion of legal traditions and politics.

To a large extent, it would appear that countries have used their drink-driving legislation as a model for initiatives in the drug-driving area. For example, countries that allow random alcohol testing often permit random testing for drugs as well; those that require an alcohol test following a crash often require tests for drugs as well. *Per se* limits for drugs are commonplace as well, although these limits are typically set at zero and are restricted to specific types of drugs.

The greatest degree of variation in legislation among countries is in the evidential standard used to define drug-driving offences. For the most part, legislative initiatives in this area fall into two general categories – behaviour-based statutes and *per se* laws. Whereas *per se* laws have become the standard for alcohol and driving offences, behaviour-based statutes are still relatively common for drug-driving offences among the countries surveyed. The distinction between the two types of laws is an important one that has implications for enforcement and prevention. Hence, each of these approaches is discussed separately below

Table 5.1. Key Features of Alcohol and Drug-Impaired Driving Legislation

Country	Per Se Alcohol Limit*	Random Testing		Mandatory test after Collision		Evidential Standard Drugs Driving		Drug Testing Medium		
		Alcohol	Drugs	Alcohol	Drugs	Per se	Impairment	Blood	Urine	Oral Fluid
Australia	50	√	√	√	√	Zero tolerance (specific drugs)	√	√	√	√
Austria	50	√	x	Injury	x	x	√	√	√	√
Belgium	50	√	√	x	x	Zero tolerance (illegal drugs)	√	√	√	√
Canada	80/50	x	x	x	x	x	√	√	√	√
Denmark	50	√	√	x	x	Zero tolerance (illegal drugs)	√	√	√	√
France	50	√	√	√	√	Zero tolerance (illegal drugs)	√	√	√	√
Germany	50	x	x	x	x	Zero tolerance (illegal drugs)	√	√	√	√
Israel	50	√	√	x	x	Zero tolerance (illegal drugs)	√	√	√	√
Netherlands	50	√	x	√	Rare	x	√	√	√	√
New Zealand	80	√	x	√	x	x	√	√	√	√
Poland	20	x	x	√	√	Zero tolerance	√	√	√	√
Portugal	50	x	x	√	x	Zero tolerance (illegal drugs)	√	√	√	√
Slovenia	50	√	√	√	√	Zero tolerance (illegal drugs)	√	√	√	√
Sweden	20	√	√	√	√	Zero tolerance	√	√	√	√
Spain	80	x	x	√	√	Zero tolerance	√	√	√	√
Switzerland	50	√	x	√	If suspected	x	√	√	√	√
United Kingdom	80	x	x	x	x	Zero tolerance (illegal drugs)	√	√	√	√
United States	80	x	x	x	(unless requested)	x	Varies by state	Varies by state	√	√

Notes: \* = mg/100 ml blood; √ = Yes; x = No

### 5.1.1. Behaviour-based statutes

Driving while impaired by alcohol and/or drugs is the act of operating a motor vehicle after having consumed alcohol, or other drugs, to the degree that cognitive and motor skills necessary to operate a vehicle safely are sufficiently compromised so as to endanger the vehicle occupant(s) and other road users. The first impaired driving laws implemented in the early part of the twentieth century were behaviour-based statutes. Over the years, as the courts began to experience difficulty in securing convictions, the language in many of these laws changed from “driving while intoxicated” or “drunk” to “driving under the influence” or “driving while impaired.” The latter terms were seen to demand a more objective standard in defining the targeted behaviour. These types of laws are still in force in many countries around the world.

To be convicted of an alcohol or drug-driving offence under behaviour-based statutes, evidence must be presented demonstrating that the driver was exhibiting behaviour inconsistent with the safe operation of a vehicle, and that the impairment was the result of the consumption of alcohol and/or drugs. In many cases, this amounts to evidence of improper and/or unsafe driving behaviour observed by a police officer. A variety of other approaches have been adopted to instill a degree of commonality and standardisation to the types of evidence that can be used to demonstrate the degree of impairment. One of the most widely recognised protocols is the Standardised Field Sobriety Test (SFST) which is used throughout the United States and other countries (Burns and Moskowitz, 1977; Tharp *et al.*, 1981). The SFST involves three standardised tests – *i.e.* horizontal gaze nystagmus, walk and turn, and one-leg stand. Performance on these three tests has been shown to be highly correlated with blood alcohol concentration and provide a valid indicator of impairment (Anderson *et al.*, 1983; Burns and Anderson, 1995). Elements of the SFST have been incorporated into the standard behavioural impairment testing procedures used in other countries as well – *e.g.* the Field Impairment Test (FIT) in the United Kingdom, and the Roadside Impairment Assessment (RIA) and the Standard Impairment Assessment (SIA) used in Australia. To a certain extent, this approach takes into account the variability in the effects on different people that result from equivalent concentrations of alcohol or a drug in the blood. Behavioural evidence from these types of tests, combined with evidence of alcohol and/or drug use, provides a reasonable basis on which to pursue impaired driving charges.

In Table 5.1, it is apparent that the legislative standard for drug-impaired driving offences in many countries is a behaviour-based statute. These laws are often an extension of alcohol-impaired driving laws and require similar types of behavioural evidence to demonstrate impairment of the ability to drive safely. The systematic and standardised tests of impairment used to determine impairment by alcohol (*e.g.* SFST) are often used to determine impairment by other substances as well. In the United States and Canada, as well as in selected areas in other countries, the Drug Evaluation and Classification (DEC) programme is used to identify and document the signs and symptoms associated with various classes of drugs (International Association of Chiefs of Police, 1999.) The DEC evaluation is a twelve-step, systematic and standardised procedure, which involves a series of psychomotor and clinical tests concluding with the toxicological examination of a bodily fluid sample. The purpose of the procedure is to provide the necessary evidence to determine whether or not the suspect is impaired, whether the impairment is due to drugs, and which category (or categories) of drugs might be responsible for the observed impairment.

The strength of behaviour-based statutes lies in the fact that they target the impaired behaviours that compromise road safety, regardless of the specific type or amount of substance consumed. This approach takes into account the variability in effects of the same dose of drugs on different people, avoiding the perceived arbitrariness sometimes associated with *per se* laws. Behavioural statutes are not necessarily restricted to illegal substances, but can apply to any type of medication (prescription or over-the-counter)

as well as to drugs used in combination with alcohol. The issue is impairment, not whether the person has used (or possibly misused) a specific substance – the law targets drivers who display impaired driving behaviour, not drug users who happen to be driving. The public can comprehend the concept of “impaired ability”, although they may lack sufficient knowledge to be able to apply the standard to their own behaviour to determine when their ability to drive may be sufficiently compromised to put them, and other road users, at risk.

The limitations of behavioural-based statutes involve the nature and extent of evidence required to prove the offence, the time required to gather the evidence, and the low risk of detection and conviction. Police officers must be specially trained in the procedures necessary to gather behavioural evidence. In the case of the DEC programme, the training is intensive and time-consuming. Trained officers require continued involvement in the programme to practice their skills and maintain certification. Finally, in the absence of special enforcement campaigns, only those drivers who are severely and obviously impaired are ever charged and convicted.

### 5.1.2. *Per se laws*

*Per se* laws specify that drivers are considered to have committed an offence if the concentration of alcohol, or a specific drug in their blood, is found to be above a certain level. Based on the work of Widmark (1932; cited in Watson *et al.*, 1981), which demonstrated that the concentration of alcohol in the blood was related to the extent of alcohol consumption, *per se* laws for drink-driving offences were first introduced in Norway in 1936 and Sweden in 1941. Since then, *per se* laws have become the standard in terms of drink-driving statutes, establishing a threshold concentration of alcohol in the body above which it is an offence to operate a vehicle. Such laws are predicated on scientifically verified relationships between BAC, impaired performance, and the risk of crash involvement. The threshold value presumably equates the concentration of alcohol with a degree of driving impairment that is deemed inconsistent with the safe operation of a vehicle. Such laws created a legal “short cut”, eliminating the requirement for the police officer to collect extensive and detailed evidence necessary to prove in court that the driver was impaired or incapable of the safe operation of a motor vehicle. Theoretically, all that is necessary to prove a *per se* offence is evidence of a Blood Alcohol Concentration (BAC) in excess of the specified limit.

Although *per se* laws may operate this way in some jurisdictions, others (most notably many American states) require the officer to establish reasonable and probable grounds that the driver is impaired prior to demanding a breath or blood sample. In this case, the law operates as a *per se* statute with a behaviour-based component.

So called “zero tolerance” laws are a special case of *per se* laws, whereby the threshold values are set at zero (or effectively zero when analysis and administrative tolerance is taken into account). These types of laws prohibit drivers from having any measurable quantity of alcohol or specific drugs in their system. This type of legislation has been implemented for alcohol in many jurisdictions for high-risk groups, such as novice and/or young drivers (Lacey *et al.*, 2000).

Although many lessons can be gleaned from experience with *per se* laws to deal with drink-driving, it must be recognised that many of the issues for drug-driving are not only different, but more complex, as well, and cannot necessarily be dealt with in the same manner. Drugs present a series of special challenges for *per se* laws. For example, whereas research has clearly established a link between alcohol, impairment and crash risk, the same type of evidence is only beginning to emerge for the most commonly used substances (see Section 4.2). For a variety of reasons (see Section 4.), research on the

role of drugs is more difficult than with alcohol. Compounding the situation is the large number of substances that would have to be studied to establish a *per se* level for each.

In addition, whereas alcohol is a legal and regulated substance, many of the drugs of concern are illegal. Implicit in *per se* laws is the message that it is not illegal to drive after using a substance unless they have consumed “too much”. Hence, messages telling drivers not to drive if they have had too much of a particular substance may be seen as promoting “responsible” drug use practices. Although such messages could be rationalised as a form of “harm reduction”, they would most likely prove to be extremely controversial.

One of the limitations of *per se* alcohol legislation is the fact that no consideration is taken of individual differences in the ability to perform tasks at higher alcohol levels as a consequence of variation in sensitivity and tolerance to alcohol (*e.g.* Mitchell, 1985; Moskowitz, Daily & Henderson, 1977; Vogel-Sprott, 1992). With drugs, the issue is more pronounced as individual differences in sensitivity and tolerance can be considerably more variable.

A persistent criticism of alcohol *per se* laws is that drivers are unable to know easily, and with accuracy, their specific alcohol level at any particular point in time (*e.g.* Beirness, 1984). Although small, accurate and reliable breath testing instruments to measure alcohol concentration are available for use by individuals or in licensed establishments, their use has yet to become commonplace. In light of the extremely limited use of personal breath testing devices, it seems there would be little demand for a comparable device to test drug levels.

The alternative is to set the *per se* limit for drugs at zero. Any detectable amount of particular substances found in the body of a driver would be considered to constitute an offence. Such “zero tolerance” laws are easy for the public to comprehend and compliance would appear simple and straightforward. However, although one is generally able to determine whether or not they have ingested a drug, it may be considerably more difficult to determine when the drug effects have fully dissipated and the active substance has been completely removed from their system. The message “Don’t drive if you have been using drugs” might oversimplify the situation. Nevertheless, in the absence of definitive research evidence supporting alternative *per se* standards, zero tolerance may be the most prudent approach.

A note of caution is warranted. It is important to ensure that zero tolerance laws are implemented and enforced in the interests of road safety and not implemented as a drug control strategy used to identify drug users who happen to be driving. This has the potential to be a particular problem in jurisdictions that allow random drug testing of drivers. Random testing of drivers for drugs and prosecuting those who are found to be positive for a prohibited substance, regardless of evidence of impairment or risk to road safety, can easily be perceived as a mechanism by which to conduct random drug tests in the population. Being subjected to random testing as a means to enhance road safety is acceptable to the public in many jurisdictions; citizens might not be quite so tolerant of random drug testing for other purposes. Hence, using traffic law as a means to test and sanction drug users is a legal and political quagmire that is best avoided.

The issue of driving after using medicinal substances is also a contentious one for zero tolerance laws. Whereas it may be prudent and politically acceptable to implement zero tolerance for illegal substances, such is not necessarily the case for all medicinal substances. Among jurisdictions that have implemented zero tolerance legislation, the laws are typically restricted to illegal substances or specifically named medicinal substances. This approach, however, fails to acknowledge that many medicinal substances can impair the ability to drive safely. Compounding the issue is the fact that many



medicinal substances can be used illicitly, inappropriately and/or for purposes other than those for which they were intended. A comprehensive approach for dealing with drugs in traffic must acknowledge the potential of medicinal substances to impair critical cognitive and motor functions and establish fair and effective measures. Establishing a zero tolerance standard for all psychoactive medicinal substances would disqualify a large number of individuals from operating vehicles, a position that lacks unqualified scientific support. As noted previously, some medications can actually help alleviate the impairment associated with certain medical conditions. Alternative approaches need to be considered, including the possibility of using behaviour-based statutes that target impaired behaviour for those who fail to adhere to medical advice and/or combine medications with alcohol or other substances.

## 5.2. Enforcement

To a large extent, enforcement practices are determined by the type of impaired driving legislation in force in the jurisdiction. Detection tactics can include targeted efforts, random testing, and spot checks/controls. Some countries allow for drivers to be tested randomly; others require at least a suspicion of drug use; still others provide for mandatory testing of drivers involved in crashes. The type of bodily fluid collected for testing can also have an influence on approaches to enforcement. For example, testing oral fluid at roadside is considerably more efficient than having to obtain a warrant and then take a driver to a medical facility to have blood drawn. The various approaches, along with the benefits and limitations, are outlined below.

### 5.2.1. Behaviour-based statutes enforcement.

Enforcement of behaviour-based statutes targets those whose driving behaviour is adversely affected by alcohol and/or drugs. Typically, suspected impaired drivers are identified by routine police patrols through observations of traffic. Drivers whose behaviour is distinguished from that of other road users are targeted for investigation for suspected drug and/or alcohol use. Concentrated enforcement activities, known as saturation patrols, have been deployed in areas known to have a large number of impaired drivers in an attempt to increase the number of impaired drivers arrested. Saturation patrols are mobile and specifically target drivers who display classic signs of impaired driving behaviour. Where permitted, these patrols can also target a specific area in which to conduct random alcohol and/or drug tests (Stuster, 2000).

Impaired driving checkpoints or controls are DWI enforcement operations that involve the stopping of all vehicles, or a specific sequence of vehicles, at predetermined locations to check for impaired drivers. Drivers are not stopped based on suspicion of impaired driving or for any other cause, but rather to allow the police to determine whether or not the driver may be impaired. Police officers typically ask drivers a few questions and may request to see driver or vehicle documentation, all the while evaluating the driver's behaviour for signs of impairment. The purpose of checkpoints is two-fold. First, it is an enforcement operation to detect impaired drivers and remove them from the road. More importantly, checkpoints serve to increase the perceived risk of detection among the general population of drivers – a critical element in effective general deterrence. Checkpoints are often highly visible operations conducted in locations where large numbers of drivers will at least see them even if they are not actually stopped. Checkpoints accompanied by extensive media coverage helps to enhance the general deterrent effect of checkpoints by ensuring that the driving public is aware that the police are conducting checkpoints. Elder *et al.* (2002) provide a comprehensive review of the effectiveness of this type of enforcement and found average decreases of 20% for fatal and injury crashes and 24% for property damage crashes following the implementation of checkpoints.



Checkpoints are typically conducted on weekend nights when driving after drinking is most common. However, roadside surveys of drug use among drivers would suggest that weekend nights would not necessarily be the most efficient time for checkpoints as a means to detect drug-impaired drivers (*e.g.* Beirness and Beasley, 2009a). Whereas drinking is a legally sanctioned social activity that often takes place in licensed establishments, drug use does not adhere to the same pattern. Drug impaired drivers can be found at all times of day and on all days of the week. The strategy for controls or checkpoints will need to be revised to enhance the effectiveness of the practice in identifying drivers who are impaired by drugs.

In general, successful prosecution of impaired drivers under behaviour-based statutes requires enforcement personnel to provide evidence to establish that:

- alcohol or a drug was present in the driver at the time of driving;
- the alcohol or drug present affected the driver at the time of driving; and,
- the effect of the alcohol or drug present rendered the driver incapable of operating the vehicle safely.

Under behaviour-based statutes, the presentation of evidence to establish a drug-impaired driving offence typically relies on expert testimony. Experts are required to establish a nexus between the observed behaviour, the appearance of the suspect, and the effect of the drug found present in the suspect. In some jurisdictions, an expert must also establish that the suspect had indeed used a substance known to produce the observed effects, and that the effect of the drug present was sufficiently profound so as to render the suspect incapable of operating the vehicle safely.

To provide such evidence, police officers must be specifically trained to assess impairment and recognise the signs and symptoms of drug use. The DEC, RIA, and SIA described previously are examples of systematic and standardised drug assessment procedures that are currently being used by enforcement personnel to provide behavioural evidence to support drug-impaired driving charges. The training is intensive, time-consuming and expensive. In addition, the time required to conduct an assessment can take an hour or more. Some jurisdictions (*e.g.* United Kingdom) require that an assessment be conducted by a physician, further increasing the cost and often introducing a time delay awaiting the arrival of the physician.

In many cases, the behavioural evidence must be supported by toxicological evidence of drug use. With the exception of several American states (*e.g.* Arizona, Utah), where select police officers are trained as phlebotomists (Hedlund and Beirness, 2007), blood samples must be obtained by a qualified health professional. This can involve transporting the suspect to a medical facility and finding a health professional willing to draw the sample. The alternative is for urine and/or oral fluid samples to be collected by police officers and sent to the lab for toxicological analysis.

A key component in these procedures is ensuring that suspects cooperate with enforcement (and medical) personnel to provide the evidence required. This means that it must be mandatory for suspects to participate in behavioural tests and to provide bodily fluid samples for analysis as required. In addition, refusal to participate must carry sanctions equivalent to (or greater than) those for the impaired driving offence. Without the ability to compel suspects to participate in tests and to provide samples as required, there is often little or no evidence on which to base charges or support a conviction.

Enforcement of behaviour-based statutes is time consuming, complex and resource-intensive in terms of police time both for training and deployment. It requires a systematic and complex process of

progressive evidence gathering to determine the presence of impairment and the cause of that impairment. The process has many pitfalls that suspects can exploit to their advantage in court. In the end, enforcement efforts yield a relatively small number of arrests and relatively few convictions compared to the number of people who report driving while impaired. In the absence of a strong and real threat of detection and conviction, the deterrent value is minimal and far from ideal.

To some extent, behavioural-based enforcement has been undermined by an increasing reliance on technology. The widespread use of accurate, reliable, hand-held breath testers over the past two or three decades has simplified the process of gathering evidence of alcohol use, but at the expense of gathering evidence of the signs and symptoms of impairment. Police officers need to be trained to recognise key indicators of alcohol and drug use to enhance their ability to detect those who are adversely affected by alcohol and drugs. This knowledge can be applied not only as part of driver alcohol and drug controls/checkpoints, but as part of their everyday interactions with drivers. Technological approaches – including alcohol screening devices as well as oral fluid tests for psychoactive substances – can be a valuable addition to routine enforcement activities but should not be relied on exclusively as a means of identifying impaired drivers.

### 5.2.2. *Per se law enforcement*

The development of effective low cost enforcement technology, such as the breathalyser, has greatly assisted the worldwide establishment and enforcement of *per se* alcohol legislation. Fuel cells that enable the use of hand-held breath testing devices, have allowed individual police officers to efficiently and effectively enforce alcohol *per se* laws. The ability to screen drivers and/or measure BAC at the side of the road using these portable devices allows police officers a quick and easy means to determine which drivers should be immediately removed from the road and possibly detained for further testing. Drivers with moderate BACs who may not necessarily display the full range of classic symptoms of alcohol impairment are more likely to be identified and arrested. Those drivers who believe they are not affected by low to moderate doses of alcohol and who may be able to sufficiently disguise the alcohol effects to escape detection will not be able to disavow the breath test reading. There is little doubt that portable breath test devices have served to enhance the probability of detection.

However, a device to screen for drugs similar to portable breath testers does not exist. Although several devices are available to collect and test oral fluid samples at roadside, none has been deemed acceptable for use (Verstraete and Pudder, 2000). Oral fluid can be collected at the side of the road, but reliable results depend on toxicological testing in a qualified laboratory. Blood samples must be collected by medical personnel and tested in a lab, as well. Clearly, enforcement of *per se* drug laws is somewhat more difficult than *per se* alcohol laws.

Checkpoints or controls have been used extensively throughout many countries to detect alcohol-impaired drivers.<sup>2</sup> Although checkpoints/controls are resource intensive, they are an effective means to identify impaired drivers and provide a strong deterrent (*e.g.* Elder *et al.*, 2002). Portable breath testing devices are undoubtedly a critical component in successful checkpoint operations. Jurisdictions differ, however, in terms of the circumstances under which these devices can be used. For example, some jurisdictions allow vehicles to be stopped randomly at checkpoints, but do not allow the officer to demand a breath test in the absence of suspicion of alcohol use or reasonable grounds to believe the driver is impaired. In some European countries and Australia, however, so-called random breath testing allows the police to demand a breath test from any driver at any time without suspicion or cause.

Random breath testing (RBT) has been shown to have a profound influence on rates of drink-driving and alcohol-related crashes (*e.g.* Homel, 1993; McCaul and McLean, 1990; Moloney, 1995). The

keys to effective implementation of RBT are publicity to inform the driving public about the possibility of being tested and extensive enforcement through checkpoints. In Australia, most states conduct millions of breath tests every year. For example, in Victoria, there are approximately 3.7 million breath tests conducted for 3.5 million drivers, so on average every driver can be expected to be tested about once per year. This creates a very real threat of detection and a strong general deterrent.

Australia has recently adapted the RBT model for drug-driving enforcement – at least for selected illegal drugs (Boorman and Owens, 2009; Drummer *et al.*, 2007). Random drug testing (RDT) relies on the use of oral fluid screening devices that can be deployed at roadside. Although several such devices are available, a recent review concluded that current roadside oral fluid tests are not sufficiently sensitive and/or specific to give reliable results for all major drugs of interest (Verstraete and Pudder, 2000). The methods for the detection and quantification for drugs in oral fluid continue to be refined and improved and hold promise for the future (Teixeira *et al.*, 2004; Toennes *et al.*, 2005). Nevertheless, the state of Victoria has determined that devices which have high specificity – *i.e.* the ability to confirm that the drug is not present – but relatively low sensitivity – *i.e.* the ability to detect the drug when it is indeed present – were sufficient to allow the introduction of general deterrence drug-driving enforcement programmes based on “zero tolerance” legislation. This approach is especially relevant for illicit drugs that have a high prevalence in specific road user groups – *i.e.* cannabis, amphetamines, and MDMA (ecstasy). Approximately 30 000 drivers per year have been subjected to random oral fluid testing – impressive, but a far cry from the millions of drivers tested for alcohol. Evaluations of the effectiveness of RDT await more extensive implementation – *e.g.* as is being done within the DRUID project.

There is little doubt that *per se* laws have facilitated the enforcement and prosecution of alcohol impaired driving offences. *Per se* laws provide a convenient “short cut” by reducing or eliminating the necessity to provide extensive behavioural evidence of impairment, which is sometimes interpreted as being highly subjective. Objective measures of BAC are generally sufficient to secure a conviction. The use of zero tolerance *per se* laws for drug offences may provide the same benefits.

One of the limitations of *per se* enforcement of drug-driving statutes is the necessity to obtain a bodily fluid sample for testing. Whereas breath testing for alcohol has become commonplace, the public has only recently been confronted with the prospect of having to provide a sample of urine, blood, and/or oral fluid. Enforcement personnel must be trained in the safe and respectful collection and storage of these types of fluids. Unlike alcohol, where breath testing for alcohol is relatively straightforward and provides immediate results, bodily fluids are generally sent to the lab for analysis. The distribution and elimination of alcohol are also relatively simple and predictable. However, the time lag between detection, obtaining a bodily fluid, and toxicological testing can result in drug concentrations considerably lower than those at the time of driving. Hence, a breath test provides a good indication of the BAC at the time of the incident (*i.e.* arrest or crash involvement) even if taken an hour or two afterwards. In contrast, drug testing may require a blood test that must be obtained by a qualified individual, usually a medical practitioner. This can take considerable time during which the drug level can change dramatically. Urine samples can generally be obtained more efficiently, but the procedure is often viewed as intrusive and samples can be adulterated. Also, urine tests do not always provide evidence of active or recent drug use. Oral fluid can be easily obtained and provides a better indication of active drug effects than urine, but not all substances of interest are readily detected (or reliably quantified) in oral fluid samples (Verstraete, 2005).

**A word of caution.** Comparing legislation and enforcement practices among jurisdictions is fraught with a variety of limitations and pitfalls. An important consideration is whether impaired driving is considered as a traffic violation or a criminal offence. For example, some jurisdictions deal with low BAC *per se* offences as a traffic violation, similar to a speeding infraction. Violations are dealt with

simply and easily without the necessity for the offender to appear in court. Sanctions may include a fine and an immediate short-term licence suspension. Other jurisdictions deal with impaired driving offences in a manner similar to other criminal offences such as theft and murder. The offender must appear in court, the evidence must be evaluated by the court, and the sanctions include the possibility of incarceration. In some cases, impaired driving violations fall under both categories, first offences being treated as a relatively minor transgression (*e.g.* a civil or traffic violation) and repeat offences or egregious violations being treated as a more serious (*e.g.* criminal) offence.

One of the major differences between criminal and traffic law is the procedures and the standards for evidence presented to prove the offence. Criminal law is typically more strict in the types and quality of the evidence that are deemed acceptable. The degree of scrutiny to which the evidence is subjected is also more rigorous. The implications for enforcement are not trivial. Police officers must adhere to strict rules concerning the collection of evidence. It can be a tedious and time-consuming process that necessitates meticulous attention to detail. Legal traditions and precedents play an important role in determining which types of evidence are necessary, how they can be collected, and under what circumstances. Traffic law is more lenient in this regard and thus can generally deal with offenders much more expediently.

The bottom line is that it is difficult and often inappropriate to make direct comparisons of the legislation and enforcement practices among jurisdictions without consideration of the underlying legal principles. Although the overall goal in every jurisdiction is to reduce or eliminate impaired driving, the ways and means to achieve the goal may be very different and not necessarily comparable. Importing legislation and enforcement practices from one jurisdiction to another requires careful consideration of the existing social and legal environment. Measures that are effective in one jurisdiction may fail miserably in another.

### 5.3. Prevention

Primary prevention efforts directed at drug-driving have to this point been relatively superficial. Although many of the countries that responded to the survey indicated that they engage in prevention efforts, most were classified as educational programmes. There was no indication that any of these efforts had been evaluated.

A wide variety of measures have been demonstrated effective in the prevention of alcohol-impaired driving (*e.g.* Shults *et al.*, 2001). The experience gained in planning and implementing prevention programmes for alcohol-impaired driving provides a solid basis on which to proceed with efforts directed at drug-impaired driving. However, caution is warranted in efforts to translate and apply effective alcohol programmes to drugs. For example, raising the legal drinking age has been hailed as an effective means of preventing alcohol-impaired driving among youth. Such a measure makes little sense when applied to drugs. However, designated driver programmes could be applicable to both alcohol and drug-impaired driving. Each measure must be examined individually and possibly adapted where appropriate.

Primary prevention of drug-impaired driving is a challenging issue. As noted previously, drug-impaired driving is more complex than alcohol-impaired driving. It involves a variety of different substances some of which are illegal; others are restricted for medical purposes; still others are available to the public in pharmacies to treat minor ailments. Each represents a unique situation and a different group of users. Most likely, each requires a distinct and separate approach to prevention.

For the most part, drug-impaired driving prevention efforts appear to have relied heavily on public education/awareness and deterrence through enforcement. Although there is scant evidence to indicate that public education and awareness have any substantive impact on drug-driving behaviour, such

initiatives may play a role in enhancing the general deterrent value of enforcement activities by increasing the perceived probability of detection among the general population.

Creating a real and credible threat of detection and apprehension is a key element in effective deterrence. This involves a high level of enforcement activity (usually involving checkpoints or controls) combined with a media campaign to ensure the population of drivers is aware of the police activity and enhance the perception of being caught should they engage in the behaviour (*e.g.* Lacey *et al.*, 1999; Mercer, 1985; Shinar and McKnight, 1986).

The Australians have taken the deterrence approach to the next step by applying the RBT model to drug-driving. Random drug testing, when employed in checkpoints, seeks to test large numbers of drivers not only to detect those who have been using drugs, but also to increase the perceived threat of detection. There has not yet been an evaluation of the impact of random drug testing.

General public education and messages to prevent drug-impaired driving require considerable care and forethought to avoid unintended effects. For example, a message that tells the public not to drive after using drugs fails to take into consideration the fact that many pharmaceutical substances are not known to have an impact on driving. Specifying particular drugs in the message becomes confusing and leaves the impression that if the drug isn't on the list then it must be safe. Messages that tell the public not to drive after taking too much of a drug imply that moderate drug use is acceptable. Great care needs to be taken in developing such messages. A variety of messages targeting specific populations and specific types of substances may be required.

Prescription medicines present a special challenge and, at the same time, a tremendous opportunity for prevention. First, many medicines are known to cause cognitive and psychomotor impairment. In some cases, patients should not drive while taking these medicines; in others, the effects become less intense as the patient develops a tolerance to the impairing effects of the drug. In still other cases, the condition being treated might well pose a greater risk to road safety than the drug used to treat it. Telling all individuals who use medicines not to drive would be overly restrictive, especially with an aging population. Clearly, people taking medications need greater information to facilitate their decision whether or not the medicine affects their ability to drive safely.

The opportunity for prevention arises from the fact that prescription medicines are highly controlled and therefore have built-in points for prevention efforts – *i.e.* physicians, pharmacists, and other health care providers. Several European countries have proposed a graded level warning system for medicinal drugs. On the basis of the drug actions, the reported adverse drug reactions and/or known impairment of skills and abilities related to driving, three levels are proposed: (1) presumed to be safe or unlikely to produce an effect; (2) likely to produce minor or moderate adverse effects; or (3) likely to produce severe effects or presumed to be potentially dangerous. In France, a labelling system for medicines has become mandatory. The three levels are represented by coloured warning symbols. Yellow indicates “Be careful. Do not drive without having read the leaflet.” Orange means “Be very careful. Do not drive without the advice of a medical professional”. Red means “Attention: danger. Do not drive.” (de Gier *et al.*, 2009).

The system of labelling of pharmaceutical products in France is an example of an approach to prevention that provides information to consumers in the form of simple graphics displayed on product labels. It is not clear, however, as to whether there is an onus on manufacturers to determine the potential impact of their products on driving or whether this is left to governmental or other agencies. In fact, it is not known the extent to which these ratings are based on empirical evidence or what the criteria for the various ratings are, raising the possibility for manufacturers to put an “orange” label on all products merely as a means to reduce their liability. Clearly, labelling of pharmaceutical products is a step in the



right direction, but there needs to be scientifically established criteria for determining which warning label should be applied to each product.

Illegal substances, as well as the inappropriate use of medicinal substances, present their own unique challenges for the prevention of drug-impaired driving. The fact that those who engage in this type of drug use have already violated established social rules against such behaviour renders it unlikely that they would comply with laws against driving after using drugs. In this situation, a harm reduction approach may be one means of helping to limit the adverse consequences associated with drug-impaired driving. For example, designated driver programmes may be one option that can be used to encourage drug users to identify a person who has not consumed drugs (or alcohol) to take responsibility for the transportation of the group.

Chronic drug users may present a situation similar to that of hard-core drinking drivers. In such cases, drug use behaviour overrides rational consideration of the dangers involved in driving while under the influence. Even previous arrests and/or convictions for impaired driving offences are often not sufficient to prevent further offences. Such cases need to be dealt with firmly, with a strong emphasis on providing the appropriate supports and services required for successful rehabilitation.

### NOTES

1. *Per se laws* make it an offence to operate a vehicle with a concentration of alcohol or drug in the body above a specified threshold value. *Per se* limits provide a legal “shortcut” in that it is usually not necessary to prove that the driver was impaired, merely that the concentration of alcohol or drug was in excess of the established threshold.
2. Checkpoints involve stopping vehicles without suspicion or cause. Some jurisdictions – notably some American states – do not allow vehicles to be stopped without cause.





## 6. CONCLUSIONS AND RECOMMENDATIONS

*This chapter draws conclusions about the role of drugs in traffic and identifies leading practices for controlling/preventing the behaviour based on the evidence presented. The overall purpose is to identify evidence-informed practices to guide the development of effective policies to reduce drug-related traffic casualties.*

The contribution of drugs to motor vehicle crashes, injuries, and deaths continues to be a subject of considerable interest and debate. Although there is a growing volume of scientific literature on the topic, current methodological difficulties limit the pace at which knowledge and understanding in this area accumulates. There remain a great number of challenges to overcome and questions to be answered.

The experimental literature provides a substantive body of evidence on the impairing effects of a wide variety of psychoactive substances. Complementary evidence from epidemiological research indicates that drug use by drivers is not uncommon. Some American studies suggest that drugs may rival alcohol in terms of the frequency with which they are found among drivers involved in crashes, whereas this does not seem to be the case in Europe. A key issue, however, concerns the extent to which impairment from these drugs contributes to crashes. The available literature implicates a number of substances as increasing the risk of crash. The various methodological limitations of the research in this area to date, however, warrant that caution be used in making definitive statements about the magnitude of the risks involved. Further research following the guidelines produced by Walsh *et al.* (2008) will help provide the quality of evidence required to further our understanding of this complex issue. Some of this research is currently being conducted as part of the DRUID project in various centres across Europe. In addition, in the United States the National Highway Traffic Safety Administration is conducting a large-scale case-control study to examine the risks associated with driving after drug use. The results of all these studies are anticipated with considerable enthusiasm.

A word of caution is warranted. There is tremendous tendency for public and political attention to be drawn towards new issues and away from old ones, particularly those that have a long legacy without an end in sight. In this context, the recent level of concern and interest in the issue of drug-driving may overshadow efforts to reduce drink-driving. This would be a most unfortunate situation. Despite the tremendous progress that has been made over the past 30 years on the issue of drink-driving, a problem of significant magnitude remains. Alcohol continues to be the single most prominent factor in serious road crashes. The issue of drug-driving should not detract from the ongoing battle to reduce or eliminate alcohol-related crashes. Nor should drug-driving be viewed as simply another facet of the drink-driving problem. It is a distinct and separate issue that requires a societal response of a magnitude at least comparable to that directed at drink-driving. Resources to address drug-driving should not be siphoned away from those allocated to drink-driving; there needs to be new resources dedicated to the drug-driving issue. It is a unique and complex issue that must be tackled on many fronts.

In the context of broader social concerns about drug use, much of the focus on the issue of drug-driving has been directed at ways to control the problem. Some might argue that many of these efforts are premature and misdirected because the evidence regarding the contributory role of drugs to motor vehicle crashes and injuries is incomplete and inconclusive. Nevertheless, most jurisdictions have recognised the need to take action on the issue and have responded to the challenge and introduced legislation, policies and procedures in an attempt to deal with the problem.

To a large extent, the types of measures that have been introduced have been modelled on those that have proven successful in dealing with alcohol-impaired driving. But whereas there may be similarities and parallels between drink-driving and drug-driving, it is important to appreciate that the differences are substantial. In this context, it cannot simply be assumed that the same techniques, policies, procedures and countermeasures that were developed for the drink-driving problem can be readily adapted or transferred to deal with the drug-driving issue. In many respects, drug-driving is a more complex issue. For example, whereas alcohol is a legal substance the use of which permeates many aspects of society, most of the drugs of concern are either illegal to possess or restricted to those who require them for therapeutic purposes. The exception is over-the-counter medications – such as antihistamines – which are widely available to treat a variety of common ailments. Each of these three types of drugs represents a distinct issue, each of which is associated with different patterns of use and somewhat different populations of users. Hence, several different strategies may be required, each with a unique perspective on prevention, enforcement, sanctions, and rehabilitation.

Among the countries surveyed for this report, the current legislative and enforcement environment was a mix of behaviour-based statutes and *per se* laws. There are strengths and limitations associated with each. Behaviour-based statutes target impaired driving, regardless of the type of substance or the amount consumed. Such an approach provides a means of dealing with drivers impaired by prescription and over-the-counter medications as well as drugs used in combination with alcohol. The major limitation for this is the intensive training and the amount of time required to gather the evidence required to support a drug-impaired driving charge. *Per se* laws provide a convenient short-cut in terms of training and evidence collection, but the scientific evidence required to support setting limits for the wide variety of drugs is not yet available. An alternative approach used in many jurisdictions is to set the *per se* limit at zero. So-called “zero tolerance” laws provide a clear message to drivers – *i.e.* driving after any drug use is not tolerated – and a relatively straightforward approach to enforcement. However, most zero tolerance laws are restricted to illegal substances. Drivers impaired by pharmaceuticals are not included.

Drug-driving prevention initiatives have been very limited. For the most part, prevention has been restricted to education/awareness campaigns with a heavy reliance of the deterrence inherent in enforcement activities. The Australians have pioneered wide-scale random drug testing to enhance the perceived likelihood of being detected, thereby creating a strong deterrent. The use of roadside oral fluid drug tests with high specificity, but relatively low sensitivity, has facilitated the widespread implementation of this technique. The results of evaluation studies will be viewed with considerable interest.

The use of pharmaceuticals by drivers presents special challenges for legislation and enforcement. At the same time, however, the controls on the distribution of these substances provide unique opportunities for prevention. Health professionals can play a critical role in providing consumers with vital information on the relative safety of these products for drivers. In addition, product labels, such as those used in France, provide consumers with guidance about the risks associated with the use of these products by drivers.

In conclusion, the drug-driving problem requires a comprehensive societal response consistent with its overall contribution to serious road crashes. At the same time, however, it is important to acknowledge the persistence of alcohol as the single most prominent factor in road safety. Hence, it would be unwise to introduce drug-driving countermeasures at the expense of existing measures to deal with drink-driving. Although drug-driving shares many commonalities with drink-driving, it must be treated as an additional issue, one that requires a separate response specific to the unique issues it presents.

The search for information to enhance our understanding of the drug-driving issue needs to continue. Ensuring that the knowledge is transferred to stakeholders and policy-makers in a format that is straightforward and acceptable will facilitate its uptake and its translation into effective policies and programmes to make the roads safer for all.

### Recommendations

- Recognise that, although there is overlap between drink-driving and drug-driving, there are substantive differences between the two issues so as to warrant a distinct and separate stream of funding for research, policy, enforcement, and prevention.
- Acknowledge that drug-driving is a complex issue of sufficient magnitude to warrant a societal response comparable to that afforded the problem of drink-driving.
- Encourage and solicit research activities to enhance surveillance, monitor trends and further the collective understanding of the risks of crash involvement and the factors that contribute to the problem.
- Make every effort to ensure that research adheres to international guidelines to enhance validity and facilitate comparisons among studies.
- Establish international consensus on a list of key substances that pose a risk to road safety and for which toxicological testing should take place.
- Work towards establishing international standards on toxicological testing protocols.
- Continue to encourage the development and refinement of oral fluid testing devices for use at roadside.
- Conduct a systematic review of existing legislation, policy and programmes to make certain they meet existing needs and address the problems of drug-driving.
- Ensure new programmes and policies are evidence-informed and based on the best available knowledge.
- Encourage and support the passing of legislation that addresses the increased risks associated with the use of all types of psychoactive substances by drivers.
- Ensure that drug-driving legislation focuses on enhancing road safety and is not used to identify and prosecute drug drivers.
- Enhance training programmes for enforcement personnel to develop and improve their ability to identify the signs and symptoms of impairment caused by drug use.
- Engage in awareness and education programmes to help reduce the prevalence of driving after drug use. Such efforts should be targeted to specific audiences and focused on the key substances used by particular groups.

- Encourage healthcare practitioners to discuss the potential for certain medications to interfere with the cognitive and motor skills required to operate a vehicle safely.
- Facilitate the safe use of pharmaceutical products by establishing a list of potentially impairing substances and labelling them with the appropriate warning.
- Work with health care providers and the appropriate regulatory bodies to establish prescribing and dispensing guidelines for psychoactive pharmaceutical that reflect the potential risk to road safety.

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## Appendix A

### QUESTIONNAIRE FOR SURVEY OF OECD/ITF COUNTRIES



## Questionnaire on Drugs in Traffic

Country: \_\_\_\_\_ Completed by: \_\_\_\_\_

E-mail: \_\_\_\_\_

### PART 1: Alcohol and Drugs

*This section seeks information on the overall prevalence of alcohol and drug use among the general population for the most recent year available.*

#### A. Alcohol

1. What percentage of the population reports using alcohol in the past 12 months? \_\_\_\_\_ %

Year reported: \_\_\_\_\_

2. What percentage of males and females report using alcohol in the past 12 months?

Males \_\_\_\_\_ %

Females \_\_\_\_\_ %

3. What percentage of each age group report using alcohol in the past 12 months?

15-19 \_\_\_\_\_ %

20-24 \_\_\_\_\_ %

25-34 \_\_\_\_\_ %

35-44 \_\_\_\_\_ %

45-54 \_\_\_\_\_ %

55-64 \_\_\_\_\_ %

65+ \_\_\_\_\_ %

*Use this space for alternative age groups.*

Age

Percent

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. Per capita consumption of alcohol:

\_\_\_\_\_ litres absolute alcohol per person age 15+ (Year: \_\_\_\_\_)

- 4(a) Is per capita consumption based on sales data?  YES  NO

If NO, what is the basis of the estimate? \_\_\_\_\_

**B. Drugs**

1. What percentage of the population reports having used using illegal substances:

- (a) in their lifetime? \_\_\_\_\_%
- (b) in the past 12 months? \_\_\_\_\_%
- (c) in the past month? \_\_\_\_\_%

2. What percentage of males and females report using illegal drugs in the past 12 months?

Males \_\_\_\_\_%      Females \_\_\_\_\_%

3. What percentage of each age group report using illegal drugs in the past 12 months?

- 15-19 \_\_\_\_\_%
- 20-24 \_\_\_\_\_%
- 25-34 \_\_\_\_\_%
- 35-44 \_\_\_\_\_%
- 45-54 \_\_\_\_\_%
- 55-64 \_\_\_\_\_%
- 65+ \_\_\_\_\_%

*Use this space for alternative age groups.*

<u>Age</u>	<u>Percent</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

4. What percentage of the population reports having used each of the following substances in the past 12 months?

- |                            |                            |
|----------------------------|----------------------------|
| Cannabis _____%            | Amphetamines _____%        |
| Cocaine _____%             | Methamphetamine _____%     |
| Ecstasy (MDMA) _____%      | Opiates _____%             |
| Phencyclidine (PCP) _____% | Barbiturates _____%        |
| Benzodiazepines _____%     | GHB _____%                 |
| Anti-depressants _____%    | Multiple substances _____% |

**Other substances (please list):**

- \_\_\_\_\_ %
- \_\_\_\_\_ %
- \_\_\_\_\_ %

**Part II: Driving After Using Alcohol and/or Drugs**

**A. Self-report data**

1. What percentage of drivers report driving after consuming alcohol? \_\_\_\_\_%

2. What percentage of males and females report driving after drinking?

Males \_\_\_\_\_% Females \_\_\_\_\_%

3. What percentage of each age group report driving after drinking?:

15-19 \_\_\_\_\_%

20-24 \_\_\_\_\_%

25-34 \_\_\_\_\_%

35-44 \_\_\_\_\_%

45-54 \_\_\_\_\_%

55-64 \_\_\_\_\_%

65+ \_\_\_\_\_%

*Use this space for alternative age groups.*

<u>Age</u>	<u>Percent</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

4. What percentage of drivers report driving after using a potentially impairing substance other than, or in combination with alcohol? \_\_\_\_\_%

5. What percentage of males and females report driving after drug use?

Males \_\_\_\_\_% Females \_\_\_\_\_%

6. What percentage of each age group report driving after drug use?:

15-19 \_\_\_\_\_%

20-24 \_\_\_\_\_%

25-34 \_\_\_\_\_%

35-44 \_\_\_\_\_%

45-54 \_\_\_\_\_%

55-64 \_\_\_\_\_%

65+ \_\_\_\_\_%

*Use this space for alternative age groups.*

<u>Age</u>	<u>Percent</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

**B. Roadside Surveys**

1. Have there been recent roadside surveys of driver alcohol and drug use?
  - YES       NO → (Skip to C: Enforcement Statistics)
  
2. What was the scope of these surveys?
  - National
  - Regional
  - Local/Municipal
  
3. Were these surveys conducted:
  - by police as part of enforcement operation where breath and/or other bodily fluid samples are required;
  - by non-police personnel, where breath and/or other bodily fluid samples are provided voluntarily;
  - by police for traffic control, with non-police personnel collecting voluntary breath and/or bodily fluid samples; or
  - by some other method (*please describe*):

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4. Please indicate the months, days of the week, and times of the surveys.
 

**Months:**     Jan       Feb       Mar  
                   Apr       May       June  
                   July       Aug       Sept  
                   Oct       Nov       Dec

**Days:**       Sunday       Monday       Tuesday  
                   Wednesday       Thursday       Friday  
                   Saturday

**Survey Hours:** \_\_\_\_\_ to \_\_\_\_\_
  
5. What samples were collected to test for alcohol and/or drugs?
  - Blood               Urine
  - Oral Fluid         Sweat
  - Other** (*Please specify*) \_\_\_\_\_

6. How were the survey sites selected?:

- Random
- By police
- History of collisions/charges
- Other** (Please specify)

\_\_\_\_\_

7. What percentage of drivers tested positive for alcohol? \_\_\_\_\_%

8. What percentage of males and females tested positive for alcohol?

Males \_\_\_\_\_% Females \_\_\_\_\_%

9. What percentage of each age group tested positive for alcohol?

15-19 \_\_\_\_\_%  
 20-24 \_\_\_\_\_%  
 25-34 \_\_\_\_\_%  
 35-44 \_\_\_\_\_%  
 45-54 \_\_\_\_\_%  
 55-64 \_\_\_\_\_%  
 65+ \_\_\_\_\_%

*Use this space for alternative age groups.*

<u>Age</u>	<u>Percent</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

10. Please provide a distribution of driver alcohol levels.

Zero \_\_\_\_\_%  
 <20 mg% \_\_\_\_\_%  
 21 – 49 mg% \_\_\_\_\_%  
 50 – 80 mg% \_\_\_\_\_%  
 81 – 149 mg % \_\_\_\_\_%  
 150+ mg% \_\_\_\_\_%

*At a minimum, please indicate the percent of drivers with a BAC over the per se threshold.*

\_\_\_\_\_ % were over \_\_\_\_\_mg%

11. What percentage of drivers tested positive for drugs (other than alcohol)? \_\_\_\_\_%

12. What percentage of males and females tested positive for drugs other than alcohol?

Males \_\_\_\_\_% Females \_\_\_\_\_%

13. What percentage of each age group tested positive for alcohol?:

- 15-19 \_\_\_\_\_%
- 20-24 \_\_\_\_\_%
- 25-34 \_\_\_\_\_%
- 35-44 \_\_\_\_\_%
- 45-54 \_\_\_\_\_%
- 55-64 \_\_\_\_\_%
- 65+ \_\_\_\_\_%

*Use this space for alternative age groups.*

<u>Age</u>	<u>Percent</u>
_____	_____
_____	_____
_____	_____
_____	_____

14. What percentage of drivers tested positive for each of the following drug categories?

Substance Positive	Percentage Tested	Fluid Threshold	Detection
Cannabis			
Amphetamines			
Cocaine			
Methamphetamine			
Ecstasy (MDMA)			
Opiates			
Phencyclidine (PCP)			
Barbiturates			
Benzodiazepines			
GHB			
Anti-depressants			
Multiple drugs			
<i>Other (Please specify)</i>			

**C. Police Enforcement Statistics**

1. Please indicate the criteria for alcohol-impaired driving offences in your country. If more than one type of offence, please list all: (use additional sheet if necessary)

- i. \_\_\_\_\_
- ii. \_\_\_\_\_
- iii. \_\_\_\_\_
- iv. \_\_\_\_\_

2. For each type of offence listed above, please indicate the number of drivers charged and/or convicted for the most recent year available. (Year : \_\_\_\_\_)

	<b>Charged</b>	<b>Convicted</b>
i.	_____	_____
ii.	_____	_____
iii.	_____	_____
iv.	_____	_____

3. Please indicate the criteria for drug-impaired driving offences in your country. If more than one type of offence, please list all: (use additional sheet if necessary)

- i. \_\_\_\_\_
- ii. \_\_\_\_\_
- iii. \_\_\_\_\_
- iv. \_\_\_\_\_

4. For each type of offence listed above, please indicate the number of drivers charged and/or convicted for the most recent year available. (Year: \_\_\_\_\_)

	<b>Charged</b>	<b>Convicted</b>
i.	_____	_____
ii.	_____	_____
iii.	_____	_____
iv.	_____	_____

5. What are the 3 most commonly found substances among those charged with a drug-impaired driving offence?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

6. Among drivers charged with a drug-impaired driving offence, what percentage also tested positive for alcohol? \_\_\_\_\_%

7. Among drivers charged with a drug-impaired driving offence, what percentage tested positive for more than one substance? \_\_\_\_\_%



**D. Hospital Statistics**

1. Please mark the statement that best describes the situation in your country for testing for alcohol and drugs among drivers presenting at hospital for treatment of injuries sustained in motor vehicle collisions.
  - Required by law. All injured drivers are tested.
  - Drivers are routinely tested for medical purposes.
  - Only drivers suspected of alcohol or drug use are tested.
  - Testing is only performed as part of special studies in specific locations.
  - No drivers are tested.
  
2. Among drivers who are tested, what percentage tested positive for alcohol and/or drugs?
  - Alcohol only \_\_\_\_\_%
  - Drugs only \_\_\_\_\_%
  - Alcohol & drugs \_\_\_\_\_%
  - Multiple drugs \_\_\_\_\_%
  
3. What are the 4 most commonly found substances among injured drivers?
  1. \_\_\_\_\_
  2. \_\_\_\_\_
  3. \_\_\_\_\_
  4. \_\_\_\_\_

**E: Coroner Statistics**

1. Please mark the statement that best describes the situation in your country for testing for alcohol and drugs among drivers killed in motor vehicle collisions.
  - Required by law. All fatally injured drivers are tested.
  - Drivers are routinely tested for medical purposes.
  - Only drivers suspected of alcohol or drug use are tested.
  - Testing is only performed as part of special studies in specific locations.
  - There is no specific policy on alcohol and drug testing.

2. For the most recent year available, what percentage of fatally injured drivers tested positive for alcohol and/or drugs?

Year \_\_\_\_\_

Alcohol only \_\_\_\_\_%

Drugs only \_\_\_\_\_%

Alcohol & drugs \_\_\_\_\_%

Multiple drugs \_\_\_\_\_%

3. What are the 4 most commonly found substances among fatally injured drivers?

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

### Part III: Legislation

1. What is the minimum age for purchase and/or consumption of alcohol beverages? \_\_\_\_\_

2. What is the maximum per se alcohol level for driving? \_\_\_\_\_

- 2(a) What type of specimen is collected and tested? (*Check all that apply.*)

Blood

Breath

Oral Fluid

Urine

**Other** (*Please specify:* \_\_\_\_\_)

3. How would you classify your country's alcohol and driving legislation?:

Zero tolerance (*i.e.* any measurable quantity of alcohol prohibited)

*Per se* (*i.e.* driving with a specific concentration of alcohol defines the offence)

Behavioural (*i.e.* evidence of behavioural impairment required)

Combination (*i.e.* more than one of the above may apply)

4. How would you classify your country's drugs and driving legislation?:

Zero tolerance (*i.e.* any measurable quantity of drug prohibited)

*Per se* (*i.e.* driving with a specific concentration of drug defines the offence)

Behavioural (*i.e.* evidence of behavioural impairment required)

Combination (*i.e.* more than one of the above may apply)

5. If your country has Zero tolerance legislation for drugs and driving, does it apply to:

- All drugs (both illegal and legal)
- Only illegal drugs
- Specific classes or types of drugs (*Please list*):

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

6. If there is *per se* legislation, what are the specified levels for each drug?

<b>Substance</b>	<b><i>Per Se</i> Level</b>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

7. On what basis can drivers be tested for alcohol?

- Suspicion of alcohol use
- Evidence of improper driving/impairment
- Crash involvement
- Probable cause that driver is impaired
- Random (without suspicion or cause)

8. On what basis can drivers be tested for drugs?

- Suspicion of drug use
- Evidence of improper driving/impairment
- Crash involvement
- Probable cause that driver is impaired
- Random (without suspicion or cause)

9. How do the sanctions for an alcohol-impaired driving conviction compare with those for a drug-impaired driving conviction?

- The sanctions are about the same for both offences.
- Sanctions for alcohol-driving offences are more severe than those for drug-driving offences.
- Sanctions for drug-driving offences are more severe than those for alcohol-driving offences.

10. Is driving while impaired by prescription medications treated in the same manner as driving while impaired by illegal substances?

- YES
- NO

10(b) If NO, what are the differences?

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11. Have there been legal/constitutional challenges of the drugs and driving legislation?

*Please describe the general nature of the challenge and/or the citation to significant cases or judgments. (Attach additional pages if necessary.)*

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**Part IV: Enforcement**

1. Can the police conduct random alcohol and/or drug tests (*i.e.* without suspicion or cause)?

Alcohol  Yes  No

Drugs  Yes  No

2. Is random drug testing restricted to testing for specific drugs?

Yes  No

2(a) If yes, which drugs?

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3. Can the police test drivers for alcohol and/or drugs following a collision?

Alcohol  Yes  No

Drugs  Yes  No

3(a) Which types of collisions can trigger alcohol or drug tests?

Fatal

Personal Injury

Property damage only

4. Do the police conduct physical tests of impairment such as the Standardised Field Sobriety Test or the Drug Evaluation and Classification program to assess the degree of alcohol or drug impairment?

YES  NO

If YES, please identify (*e.g.* SFST, DEC, FIT ) or describe the test procedures:

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5. Approximately what percentage of police officers are trained in these procedures? \_\_\_\_\_%
6. Are drivers required to participate in these test is requested by a police officer – *i.e.* are there sanctions for refusal?

YES       NO

- 6(a) If YES, are the sanctions for refusal...

- Less than those for conviction of impaired driving?  
 Greater than those for conviction of impaired driving?  
 The same as those for conviction of impaired driving?

7. Compared to the levels of enforcement of drink-driving, how would you rate your country's level of enforcement of drug-driving?

*(Please indicate your rating using the following 7 point scale, where 1 represents considerably less enforcement, 4 is about the same level, and 7 represents considerably more enforcement.)*

----- ----- ----- ----- ----- -----		
1                      2                      3                      4                      5                      6                      7		
<b>Considerably less than for Alcohol</b>	<b>About the Same</b>	<b>Considerably more than for Alcohol</b>

### Part V: Prevention

1. Please indicate which of the following approaches have been used to help prevent the use of drugs by drivers.

- Brochures                       Print ads (*e.g.* newspapers)                       Radio ads
- Television ads                       Internet based messages                       School programs
- Physician programs                       Pharmacist programs                       Drug labeling
- Other** (*Please describe*):

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2. Who have been the primary target groups for the prevention campaigns?

- |  |   |
|--|---|
| <input type="checkbox"/> Young drivers       | <input type="checkbox"/> Passengers               |
| <input type="checkbox"/> Young adult drivers | <input type="checkbox"/> Middle aged drivers      |
| <input type="checkbox"/> Older drivers       | <input type="checkbox"/> Parents of young drivers |

3. What approaches or messages have been used in the prevention campaigns?

- Information about the law and/or sanctions
- Awareness of enforcement activities
- Personal testimonials of tragedy
- Outlining the risk/danger of crash and/or arrest
- Other (Please describe):*

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4. Who has been responsible for these prevention campaigns?

- Government
- Non-profit organisations
- Victim groups
- Industry
- Media outlets

5. Using a scale from 1 to 7, where 1 represents no impact and 7 represents a strong impact, how would you rate the extent of the impact of these campaigns in preventing drug-impaired driving?

----- ----- ----- ----- ----- -----						
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>No impact</b>	<b>Modest impact</b>				<b>Strong impact</b>	



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This report provides a state-of-the-art review of the role and impact of drugs in road accident risk.

It reviews the legislation, deterrence and roadside detection practices in member countries as well as preventative measures to combat drug use while driving.

It provides recommendations on strategies to adopt in addressing this issue, with a view to contributing to a safe system approach and saving further lives on the roads.



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