

EPIDEMIOLOGY – ILLICIT AND LICIT DRUGS

A Comparison of the Incidence of Drugs in Drink Drivers and Fatal Road Casualties

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Abstract

Results from a study of the incidence of alcohol and drugs in road accident fatalities carried out between 1996 and 2000 show a large increase in the incidence of illicit drugs (from 3% to 14%) since the last comparable study in Great Britain in the mid-1980s. For practical and ethical reasons, there are extreme difficulties in obtaining an un-biased control sample of the incidence of drugs in a population of non-accident involved road users. Whilst a fatal road accident population represents a well defined population for study it was considered desirable to study the incidence of drugs in alternative populations of road users, particularly those who were primarily non-accident involved.

One such population is the sample of drivers and riders who are required to give an evidential sample, under the 1988 Road Traffic Act, after suspicion of drink-driving above the legal limit. A subset of 2000 such cases where blood was given was selected anonymously from England and Wales and subsequently analysed for comparison with the fatally injured sample.

The results show that the incidence of drugs in a broadly representative sample of drink-drivers (26.7%) was similar to that in a population of fatally injured road users carried out over the same period (24.1%). When the fatally injured population who had also consumed alcohol was taken into account, there was shown to be no significant difference in drug usage between the two populations. The distribution of those who had consumed drugs and those who had not was not significantly different in the two populations. Drug usage was therefore found not to be associated with accident involvement and strongly suggests that drugs were not a major causative factor within the fatal road casualty population.

Drug Profiles of Apprehended Drivers in Victoria

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Background

In the laws of most Australian states there is a provision for taking blood samples from drivers suspected of driving under the influence of drugs. On 1 December 2000, the Road Safety Act of Victoria was amended to give Victoria Police the power to require a driver to undergo an assessment of impairment which includes the taking of a blood sample.

Objectives

To determine the prevalence of drugs in Victorian drivers suspected of driving while impaired by a drug.

Methods

100 specimens from motor vehicle drivers apprehended by police trained in drug recognition and who failed a standard roadside impairment test were submitted for analysis. Blood stored in Vacutainer® tubes containing preservative were screened for drugs of abuse using enzyme-linked immunosorbent assay (ELISA) and confirmed using standard chromatographic techniques.

Results

Ninety-six percent were positive for one or more drugs. The number of male drivers greatly exceeded the number of female drivers (85% vs 15%). The most prevalent drugs were benzodiazepines (64%), opioids (43%) and cannabis as THC (30%). Amphetamines were detected in 13% of drivers, however this figure is increasing as more specimens are being analysed. Methadone was detected in 10% of all drivers. The most frequent combination of drugs was benzodiazepines and opioids (25%). Alcohol was present in 3% of drivers.

Discussion

In most of the cases, drugs detected reflected a combination of illicit and other drugs. There were very few drivers who legitimately had prescriptions for many of the legal drugs – including benzodiazepines and opioids (codeine etc).

The use of the standard roadside impairment test as an initial method for detecting drug use has been confirmed in at least 96% of drivers using psychotropic drugs.

Introduction

In 1996 the Victorian Parliamentary Road Safety Committee Inquiry made 41 recommendations in relation to the effects of drugs (other than alcohol) on road safety in the state of Victoria, Australia [1].

The Road Safety Act (1986) prohibits the driving of motor vehicles while under the influence of drugs and gives Victoria Police authority to remove incapable drivers from the road. The Act has now been amended to give police authority to obtain blood or urine samples from drivers suspected of being drug impaired.

This paper provides a summary of the incidence of drugs found in the first 100 apprehended drivers in Victoria.

Method

100 specimens from motor vehicle drivers apprehended by police and who failed a standard impairment test were submitted for analysis. The assessment procedure consisted of the following stages: Drivers were apprehended by police on suspicion of impairment and required to undergo a preliminary breath test (for alcohol) and an initial roadside assessment. Drivers suspected of being drug affected were taken to a police station for further assessment by a specially trained police officer. This assessment included an evidentiary breath test, a structured interview and a standardized field sobriety test (horizontal gaze nystagmus - walk and turn, one leg stand) which was videotaped. A blood sample was also taken by a Forensic Physician. The primary reason for videotaping assessments was to demonstrate that the assessment procedure was followed properly. It was not intended to be a record of clinical signs. Each assessment was completed within 3 hours.

Blood sampled from the apprehended driver was stored in Vacutainer® tubes containing preservative and screened for drugs of abuse using enzyme-linked immunosorbent assay (ELISA) and confirmed using standard chromatographic techniques. Toxicology testing covered a large range of drugs and drug classes including the following: amphetamines and related stimulants, benzodiazepines and major tranquillizers, cannabis, cocaine, opioids, barbiturates, anticonvulsants and analgesics. Cannabis testing was based on the presence of Δ^9 -tetrahydrocannabinol (THC) in blood which was measured using gas chromatography with selected ion monitoring.

Results

The incidences of drugs in apprehended drivers are summarised in Table 1. 85% of all drivers apprehended were male. There were three cases where there were no drugs of abuse detected.

Table 1: Summary of the most common drugs detected from the first 100 drivers apprehended by Victoria Police

Drug	%	Median Concentration	Concentration range
A m p h e t a m i n e s			
Amphetamine	3	0.06	0.06 – 0.08
Methylamphetamine	11	0.2	0.1 – 0.9
MDMA	3	0.2	0.2 – 0.4
B e n z o d i a z e p i n e s			
Diazepam	42	0.4	0.05 – 2.6
Nordiazepam	39	0.2	0.05 – 1.7
Oxazepam	34	0.3	0.05 – 6
Temazepam	36	0.6	0.05 – 3.7
Clonazepam/7-amino-clonazepam	5	-	0.05 – 0.1
Alprazolam	3	-	0.05 – 0.8
7-amino-flunitrazepam	2	-	0.02
Lorazepam	1	-	0.05
C a n n a b i s			
Δ^9 – Tetrahydrocannabinol	30	6	2 – 20
O p i o i d s			
Morphine, free	31	0.03	0.02 – 0.8
Codeine, free	8	0.03	0.02 – 0.06
Methadone	10	0.2	0.1 – 0.6

All concentrations in mg/L (or ug/ml) except for cannabis which is in ng/mL.

There was one positive urine result for morphine, codeine and 6-acetylmorphine, where no blood was obtainable from the driver.

The most common amphetamine was methylamphetamine. Subsequent specimens received from more apprehended drivers show the incidence of amphetamines to be increasing. Benzodiazepines were the most common class of drug (64%) with diazepam, oxazepam and temazepam being frequently detected. Oxazepam and temazepam were often present as metabolic products of diazepam. There were some drivers which had above therapeutic concentrations of these drugs, for example a concentration of 6 mg/L oxazepam was detected in one driver while another had temazepam at 3.7 mg/L. Both these benzodiazepines were in combination with opioids (morphine) which suggest the profile of a typical heroin user combating heroin withdrawal with benzodiazepines. Alprazolam also appeared in one case at a very high concentration of 0.8mg/L.

Cannabis was detected in 30% of drivers. The median concentration for Δ^9 – Tetrahydrocannabinol (THC) positive drivers was 6ng/mL. When THC is present in blood concentrations of 5 ng/mL or higher, this reflected probable recent use of cannabis, and therefore likely impairment [2].

The number of drivers with methadone in their blood was 10%. Most of these drivers also had other drugs which would lead to some impairment of driving as a result of polydrug use.

A number of miscellaneous drugs were also detected including amitriptyline (0.1 mg/L), lithium, (0.1 mg/L), pheniramine (n=2), promethazine (0.1 mg/L), phentermine (0.3 mg/L) sertraline (0.1 mg/L) and venlafaxine (n=3, 0.1 – 0.5 mg/L).

The combination of benzodiazepines and opioids were most prevalent followed by benzodiazepines only (see figure 1).

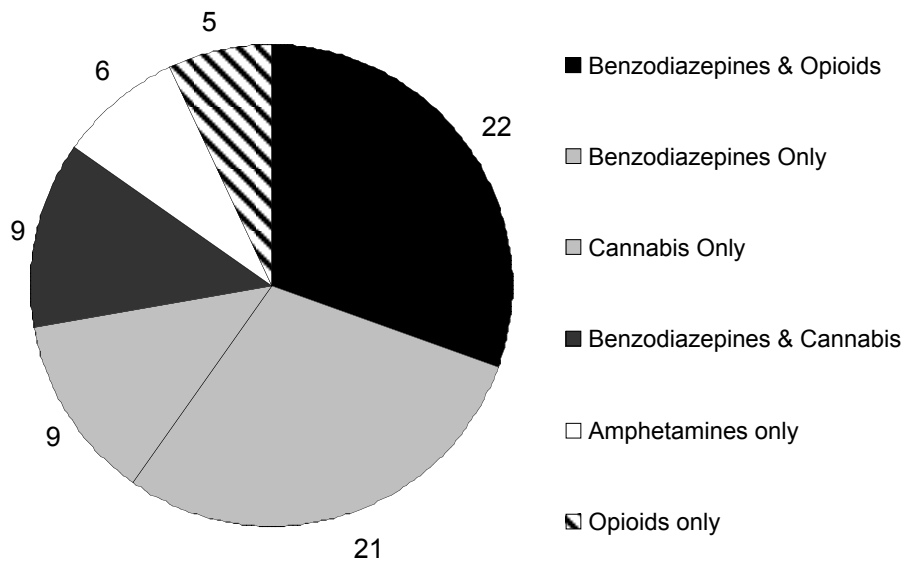


Figure 1: Drug use in 100 apprehended drivers

Discussion

The first 100 drivers apprehended by Victoria Police showed a high prevalence of drug intoxication. This is not surprising as these drivers were selected on the basis of observed impaired driving and a negative or low breath test. Under these circumstances the only possible explanations for the impaired driving are drug intoxication, fatigue or some medical condition.

The relative frequency of benzodiazepines, cannabis and opioids are broadly similar than that found in other studies [3]. Alcohol was conspicuous by its low incidence in this population but this is partly explicable by the selection process where drivers testing above 0.05% would have been charged under the per se Victorian law and would not have proceeded to impairment testing and blood sampling.

The high incidence of morphine is probably as a result of heroin use rather than legitimate use of morphine. The police procedures for identifying drug impaired drivers appear to be highly effective as shown by the high incidence (96%) of drivers with positive toxicology.

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Drug Prevalence in Road Trauma Victims in Victoria

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Background

Previous studies in Victoria have found drugs other than alcohol to be highly prevalent in drivers involved in fatal crashes [1, 2]. However there is scarce information on overall drug prevalence in the driving population where prevalence studies are not currently possible. One approach to studying drug use is to obtain information following hospital admission after crashes.

Objectives

To determine the prevalence of drugs in injured Victorians involved in a motor vehicle accident.

Methods

With Ethics Committee approval, a blood sample was obtained from all patients taken to a major trauma hospital in Melbourne following a motor vehicle collision. This was done at the same time and under the same law as the compulsory blood screening which is legal in Victoria. 358 specimens have been submitted for analysis so far. Blood stored in vacutainer tubes containing preservative were screened for drugs using enzyme-linked immunosorbent assay (ELISA) and confirmed using chromatographic techniques. Medically administered drugs were excluded from the results.

Results

Cannabis was the most commonly found drug (36%). The next most prevalent drugs were benzodiazepines (14%), amphetamines (12%) and opioids (10%). Cocaine was detected in 2% of cases.

Discussion

The prevalence of drugs from initial work suggests that the rate is much higher than previous studies involving fatal accidents [1, 2]. Further analysis is continuing to determine the contribution of drug use to culpability for the crash.

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Conclusion

There is a high rate of drug use in road users involved in non-fatal crashes in Melbourne. This has implications for preventative programs.

Introduction

There is increasing interest throughout the world concerning the incidence of drugs in driving and in their contribution to road trauma specifically. The most common drugs found in fatally injured drivers have been cannabis, benzodiazepines, amphetamine-like stimulants and opioids. A number of reports have detailed the incidence of drugs in fatally-injured drivers around the world. A number of jurisdictions have reported increases in the proportion of drivers using drugs [3-6]. Preliminary data has also suggested similar trends in Australia [7, 8].

Injured drivers also show a high prevalence of drugs. Cannabinoids were found in 13.9 % of French injured drivers, while opioids, cocaine and amphetamines were found in 10.5 %, 1.0 % and 1.4 %, respectively [9]. Impairing drugs were found in 32 % of injured drivers presented to an urban emergency center in Colorado. Cannabis was the most frequent detected drug (17 %) even over alcohol (14 %). [10]. A relatively high incidence was also found in South Australian injured drivers [11].

The purpose of this study was to determine the prevalence of drugs in injured Victorians involved in a motor vehicle crash.

Materials and Methods

With Ethics Committee approval, a blood sample was obtained from all patients taken to a major trauma hospital in Melbourne. This was done at the same time and under the same law which permits compulsory blood screening in Victoria. The study samples were subjected to a different analysis procedure than the compulsory procedure which is primarily intended to detect alcohol.

Blood stored in vacutainer tubes containing preservative were screened for drugs using enzyme-linked immunosorbent assay (ELISA) and confirmed using chromatographic techniques. Medically administered drugs were excluded from the results.

Results

Characteristics of Drivers

The total number of injured persons included in the study was 358.

Prevalence of drugs

Cannabis was the most commonly found drug (36%). The next most prevalent drugs were benzodiazepines (14%), amphetamines (12%) and opioids (10%). Cocaine was detected in 2% of cases.

While investigations and confirmations are continuing, a breakdown of all drugs identified will be released towards the end of 2002 (see www.vifp.monash.edu.au/publications for further updates).

Discussion

The prevalence of drugs in Australia fatal crashes is somewhat similar to previously published studies in other countries. The relative prevalence of different drugs broadly mirrors their incidences in the community. Cannabis, in line with most countries sampled, was the most frequent detected drug.

Benzodiazepines, amphetamine-like stimulants and opioids represented the next class of frequently detected drugs. However, one notable difference is the absence of any significant presence of cocaine in Australia. This is accord with the frequency of cocaine detections in Coroners cases and government surveys generally around Australia (OH Drummer, personal communication).

The high relative incidence of cannabis represents drivers with the inactive carboxy- form of THC as well as the active form. Quantification is under way and when this is complete is likely to show a smaller proportion of drivers with a significant level of the active drug. The next highest drug group represented was benzodiazepines which have been found to be the most prevalent impairing drug in drivers apprehended for impaired driving[12].

It will never be possible to obtain “accurate” data on the incidence of drugged driving because of the impossibility of screening the driving population. The nature of this study means that the population which was tested is biased because it includes people who were brought to hospital following a crash. Persons involved in a crash of lesser severity which did not require hospital admission would not have been tested. There is also an indeterminable effect which may be due to the location of the trauma centre in an area closer to inner city entertainment districts than other hospitals. Despite these limitations, the study is a worthwhile contribution to the epidemiology of drugged driving in Victoria.

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Use of Psychoactive Medicines and Drugs as a Cause of Road Trauma

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Keywords

Alcohol, drugs, injury, medicines, risk

Abstract

This article deals with the feasibility of a case-control design for determining the relative injury risk of motorists who have used alcohol, and/or illicit drugs, and/or medicines. Methods of data collection are presented, as well as analytical and statistical methods. Preliminary study results indicate that the use of illicit drugs by Dutch motorists is rapidly growing. Increased risk of road trauma ($p < 0.05$) was assessed for single use of benzodiazepines or of alcohol, when resulting in a BAC between 0.5 and 1.3 g/L. High relative risk factors were assessed for combinations of several drugs and for BACs over 1.3 g/L. An extremely high risk factor was assessed for combined use of drugs and alcohol (generally resulting in high BACs). No enhanced risk was (yet) assessed for single use of alcohol resulting in a BAC between 0.2 and 0.5 g/L, and for single use of cannabis, amphetamines, cocaine, tricyclic antidepressants or opiates. Only for single opiate use, an odds ratio of more than 1 was found; this result, however, was not statistically significant.

Introduction

The dose-related accident risk of alcohol use was determined in several well-designed case-control studies, especially the well-known Grand Rapids Study (1). A similar study on the accident risk of the use of other psychoactive substances, however, has not yet been conducted. Apart from methodological and analytical reasons, an obvious reason for that is the high cost of such a study. Previous studies aimed at assessing the risk of driving under the influence of psychoactive substances other than alcohol, had important limitations.

A lot of *experimental research* has been conducted in laboratory settings, using small numbers of volunteers. These studies measured the effects of controlled doses of psychoactive substances on psychomotor skills, supposedly relevant for driving. Most of these studies regarded prescription drugs. The results varied widely and provided only rough indications of the effects on accident or injury risk. Experiments in driving simulators, or even with instrumented cars in real traffic, made

it possible to assess the effects on one or more aspects of the driving task, e.g. course holding (2), but the translation of these results into risk factors is difficult.

Epidemiological research is more sparse and was often directed to the prevalence of drugs in either non-injured (3,4) or injured drivers (5), which made it impossible to determine risk factors. Case-control studies often included a very limited number of psychoactive substances, either of a licit or an illicit nature. Furthermore, in none of these studies did the control group consist of drivers who were not involved in an accident. As a substitute for a proper control group, for instance, the whole population of a geographical area (6,7) or non-trauma hospital in-patients (8) were used.

Some researchers tried to overcome the control group problem by using a case-crossover design, as in the so-called culpability studies of (fatally) injured drivers (9,10,11). Important limitations of this type of study are the generally small numbers of subjects, and subjective elements which are involved in evaluating culpability.

In May 2000, SWOV and the Utrecht Institute for Pharmaceutical Sciences started a feasibility study, preceding a large-scale case-control study in the framework of the EU-project IMMORTAL (Impaired Motorists, Methods Of Roadside Testing and Assessment for Licensing), which started in January 2002.

Methods

A prospective case-control study was conducted to determine the relationship between the use of psychoactive substances and road trauma. Cases and controls were selected over a 15-month period, from May 2000 until August 2001. The study was conducted in the town of Tilburg and surroundings, covering a population of approximately 350,000 inhabitants. The Medical Ethics Committee of the St. Elisabeth Hospital approved the study protocol.

Body fluids of both cases and controls were tested for the presence of alcohol, cannabis, opiates, amphetamines, benzodiazepines, tricyclic antidepressants, and barbiturates. The relative risk of the use of these psychoactive substances was estimated by comparing the prevalence of these substances in cases and controls.

Cases

Potential cases were seriously injured motorists who were admitted to the emergency department of the St. Elisabeth Hospital. An index date was defined for each case as the calendar date at which the accident had happened. Urine and/or blood samples were taken on admission. Patients were defined as exposed to a drug when the laboratory test for a substance was positive. Medical and ambulance records were examined to control for drugs administered during transport and at the emergency department. When urine or blood samples were positive for drugs administered during transport or in the emergency department before taking the matrix, the samples were considered negative for these drugs.

Information on injuries of the case patients was obtained from medical records and records from the ambulance personnel. The doctors at the emergency department were trained to fill in a detailed questionnaire about the crash circumstances. The severity of injuries was graded according to the Injury Severity Scale (ISS).

All case patients, or their legal relatives, were asked for informed consent to participate in the study. If informed consent was not obtained during hospital admission, patients or their legal representatives were approached afterwards by mail. All data were processed anonymously.

Controls

During 20 roadside survey sessions, motorists were taken at random from moving traffic in the Tilburg police district, which covers the catchment area of the St. Elisabeth Hospital. In order to be able to construct a representative control sample, the week was systematically divided into 28 consecutive six-hour periods. Each of the 20 roadside survey sessions that were conducted, covered such a six-hour period. For the sake of statistical analysis, the original 28 six-hour periods were next aggregated into eight day/time categories, which were supposed to be more or less homogeneous with respect to traffic volume and substance use. These eight categories were:

1. the five weekday mornings (Monday to Friday), from 4 am till 10 am;
2. the five weekday 'afternoons' (Monday to Friday), from 10 am till 4 pm;
3. the four weekday 'evenings' (Monday to Thursday), from 4 pm till 10 pm;
4. the four weekday nights (Monday to Thursday), from 10 pm till 4 am;
5. the two weekend mornings (Saturday and Sunday), from 4 am till 10 am;
6. the two weekend 'afternoons' (Saturday and Sunday), from 10 am till 4 pm;
7. the three weekend 'evenings' (Friday to Sunday), from 4 pm till 10 pm; and
8. the three weekend nights (Friday to Sunday), from 10 pm till 4 am.

Motorists were stopped by the police and asked by researchers to participate in the study on a voluntary basis. The survey sessions were combined with normal police enforcement activities regarding drink-driving. During each survey session, four different research locations along main roads in the Tilburg police district were visited. The frequent change of location was intended to minimize the predictability of the alcohol controls with respect to place and time.

If the selected motorists agreed to cooperate, they were interviewed on their drug and medicine use and subsequently requested to produce a urine specimen. If they were not able or willing to do so, they were requested to deliver a blood specimen. A trained research nurse performed the venapuncture. Subjects who delivered a urine or blood specimen, received a small reward of 5 Euro.

Interviewing and sampling of body fluids took place in a specially equipped mobile research unit with private toilet. After the interview and the urine or blood sampling, all subjects were breath-tested for alcohol by a police officer, using a Dräger Alcotest 7410 Plus screening device. The breath test was compulsory for all motorists who were stopped by the police. Data collection also comprised date and time of selection, gender and age of the subject, and signs of intoxication.

Analysis of body fluids

Urine samples were screened at the Dutch Laboratory for Drugs Doping, Tilburg, by Enzyme Multiplied Immunoassay Technique (EMIT[®] II Plus). This technique is based on competition for drug antibody binding sites. For benzodiazepines a special high sensitivity protocol was used with on-line deglucuronidation. EMIT[®] II Plus ethanol assay is based on oxidation of ethanol in presence of alcoholdehydrogenase (ADH) with NAD to acetaldehyde. Samples were considered

positive when the screening result was higher than the cut-off value mentioned in the SAMHSA guidelines for drug of abuse testing. Positive screening results for amphetamines and opiates were confirmed with appropriate gas chromatography/mass spectrometry (GC/MS) techniques. Using these techniques allowed to distinguish between amphetamine, methamphetamine, MDA, MDEA and MDMA. For opiates, GC/MS-confirmation allowed to distinguish between codeine, morphine and 6-monoacetylmorphine (heroin). Furthermore, confirmation by GC/MS excluded the risk of false-positive results.

Drug screening in serum was performed by the Dutch Forensic Institute (NFI), Rijswijk. Screening for opiates and cannabis was performed by Cozart[®] Enzyme ImmunoAssay (EIA), which is based on competition for drug antibody binding sites. Confirmation of opiates (codeine, morphine, 6-monoacetylmorphine (6-MAM) and normorfine) and cannabis (delta-9-tetrahydrocannabinol, 11-hydroxy-delta-9-tetrahydrocannabinol and 9-carboxy-11-nor-delta-9-tetrahydrocannabinol) was performed with GC/MS after solid phase extraction. Screening for the other drugs and pharmaceuticals was performed with high-performance liquid chromatography (HPLC) after solid phase extraction.

Statistical analysis

The relative risk of psychoactive substances was determined by comparing their prevalence in the experimental group with their prevalence in the weighted control sample, using a univariate logistic regression model in SPSS. Odds ratios were computed by relating subjects who had been tested positive for a substance or a combination of different substances, to subjects who had been tested negative for all substances. A 5% probability level ($p < 0.05$) was used for significance. Odds ratios may also be computed by relating subjects who had been tested positive for a substance, regardless of the combination with other substances, to subjects who had been tested negative for that particular substance, regardless of their use of other substances. In that case, the effect of the substance on a population is determined, rather than the effect on a subject. The latter, however, is the goal of the IMMORTAL project.

Results

During the study period, a total of 112 evaluable cases of injured motorists were admitted to the emergency department of the St. Elisabeth Hospital. The relatives of two deceased patients refused consent; these two cases were excluded from the analysis. For 39.1% of the valid cases, a urine sample was available for analysis; for the other 60.9%, a blood sample.

During the same period, a random sample of 1,029 motorists were stopped by the police and asked to participate in the study. Of these motorists, 20,7% did not deliver a specimen of a body fluid. Of 816 specimens, 84.8% consisted of urine and 15.2% of blood.

When compared to the non-response group, women aged 25-34 years were slightly under-represented in the response group, whereas men and woman of 50 years and older were slightly over-represented. With respect to alcohol use and self-reported use of other psychoactive substances, the response group was not significantly different from the non-response group. Based on these findings, there is no reason to suppose that the response group was selective with regard to the use of alcohol or illicit drugs. Users of prescription drugs, however, might be slightly over-represented in the response group, given the slight over-representation of older

drivers. Furthermore, the unweighted control sample cannot be considered to be representative of all motorists who participated in road traffic in the Tilburg police district at all days of the week and all times of the day, since the sample distribution over different times and days was not equal to the distribution of traffic volumes. The reason for this is the more or less constant sampling capacity of the research team, regardless of the strongly varying traffic volumes, combined with a quite understandable preference of the police for enforcement activities during high-risk hours, i.e. the nighttime hours with low traffic volumes. In order to make the control sample representative, it was weighted on the basis of trip data that was collected over 1999 and 2000 by the Dutch Central Bureau of Statistics (CBS). Since no survey sessions were conducted during day/time categories 1 (weekday mornings) and 5 (weekend mornings), these categories were combined with categories 3 (weekday evenings) and 8 (weekend nights), respectively (Table 1).

Table 1: Comparison between day/time-distribution of the control sample of motorists and the CBS-sample of trips

Day/time categories	Distribution of control sample	Distribution of CBS-sample
1+3	14.9%	34.3%
2	18.4%	25.6%
4	16.5%	3.2%
5+8	24.3%	7.5%
6	11.2%	12.8%
7	14.7%	16.6%

The comparison shows that especially the nighttime hours were overrepresented in the control sample. Drink-driving is strongly concentrated in these hours. As a consequence, drink-driving was overrepresented in the unweighted control sample. This problem was solved by weighting.

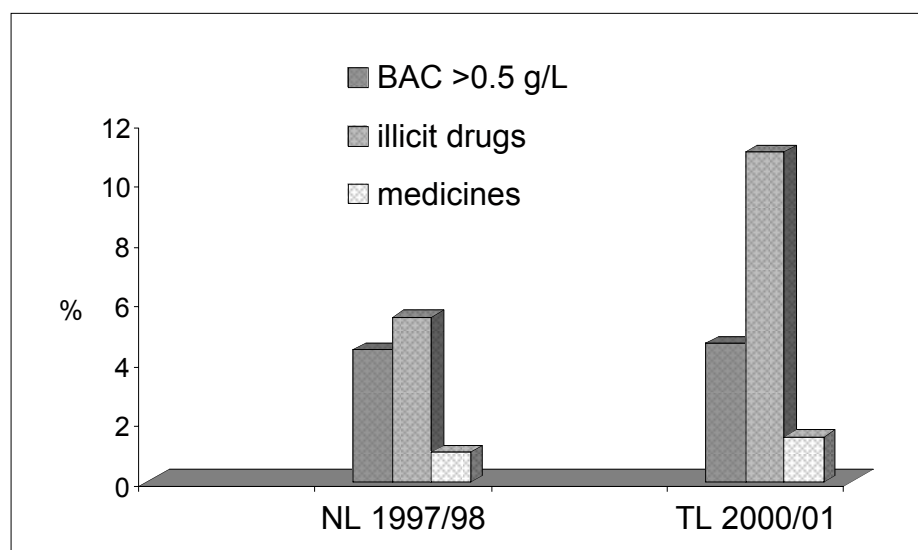
Table 2 shows the distribution of psychoactive substances for cases and for the weighted control sample, together with the results of logistic regression analysis.

Table 2: Relative injury risk associated with the use of various psychoactive substances by motorists

Psychoactive substances	Cases (n=110)	Controls (n=816)	Odds ratios	Significance
No substance	56.4%	85.7%	1.0	
Cannabis	0.9%	4.8%	0.3	n.s.
Amphetamines	0.0%	1.0%	--	--
Cocaine	0.0%	0.3%	--	--
Opiates	3.6%	2.1%	2.6	$p < 0.10$
Benzodiazepines	2.7%	0.9%	4.4	$p < 0.05$
Tricyclic antidepressants	0.0%	0.5%	--	--
Drug combinations	10.0%	1.7%	8.8	$p < 0.01$
BAC 0.2-0.5 g/L	0.9%	1.5%	0.9	n.s.
BAC 0.5-0.8 g/L	1.8%	0.5%	6.1	$p < 0.05$
BAC 0.8-1.3 g/L	1.8%	0.6%	4.5	$p < 0.10$
BAC > 1.3 g/L	10.0%	0.3%	48.0	$p < 0.01$
Alcohol+drugs	11.8%	<0.1%	458.2	$p < 0.01$

Increased risk of road trauma ($p < 0.05$) was associated with single use of benzodiazepines or alcohol, when resulting in a BAC between 0.5 and 1.3 g/L. High relative risk factors were associated with combinations of several drugs and with BACs over 1.3 g/L. An extremely high risk factor was associated with (generally) high BACs in combination with illicit drug use. No enhanced risk was determined for single use of alcohol, resulting in a BAC between 0.2 and 0.5 g/L, and for single use of cannabis, amphetamines, cocaine, tricyclic antidepressants, or opiates. Only for single opiate use, an odds ratio of more than 1 was found; this result, however, was not statistically significant ($p < 0.10$). It should be noted that 76% of all motorists in the control group who had been tested positive for cannabis, had used no other psychoactive substances. For cocaine and amphetamine users, however, it was the other way around; 69% and 62% of them, respectively, had also used one or more other illicit drugs.

Figure 1: Psychoactive substance use by motorists in weekend nights, in the Netherlands (1997/98) and the Tilburg police district (2000/01)



When comparing the Tilburg control group data for weekend nights only, with similar nationwide data of 1997/1998 (4,12), it is obvious that illicit drug use in the Tilburg control group is much higher (Figure 1). This may indicate that the use of illicit drugs by Dutch motorists is rapidly growing. Although it is not certain that illicit drug use in the Tilburg police district is representative of the Netherlands, in 1997/98 there was no difference between the Netherlands and the southern region that the Tilburg district is part of.

Discussion

An important source of potential bias was non-response, especially in the control sample. Although no indications of a strong bias have been found, future data collection should aim at a further reduction of non-response. In the first 12 roadside sessions following the feasibility study (until mid-April 2002), non-response was indeed reduced: only 72 out of the 739 motorists who were selected for interviewing and sampling of a body fluid, did not deliver a specimen. A major factor in this reduction was the increased experience of the roadside research team.

Another source of potential bias was the fact that, for psychoactive substances other than alcohol, the detection window in urine is wider than in blood. This is especially the case for cannabis. In the control sample, 85% of specimens consisted of urine, against no more than 39% in the case group. Further analysis of the control sample, however, suggests that the actual bias is limited: 4.8% of the urine specimens were found to be positive for cannabis, against 4.0% of the blood specimens.

Between the early 1970s and 2000, drink-driving in the Netherlands decreased considerably. In weekend nights, the share of motorists with a BAC over 0.5 g/L, dropped from 16% to 4.5%. But despite this, and the probable increase of drug-driving in recent years, alcohol still seems to be the predominant risk factor in road traffic. This might be due to a disproportionate small decrease of hardcore drinking drivers, part of whom are now combining high BACs with illicit drug use.

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Licit and Illicit Drugs among Danish Car Drivers

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Keywords

Impaired driving, licit drugs, illicit drugs

Abstract

This study illustrates the prevalence of licit and illicit drugs among 1000 randomly stopped Danish car drivers whom the police did not suspect to be under the influence of drugs. About 98% of the stopped drivers anonymously delivered a saliva sample and 66% returned a handed-out questionnaire. Confirming analyses revealed that 0.7% of the investigated saliva samples were positive for benzodiazepines and 1.3% for amphetamine, cannabis, cocaine or opiates. Questionnaire statements confirmed that some of the drivers indicate occasionally to drive despite a suspicion to be under the influence of illicit drugs (2.8%), illicit drugs including alcohol (4%), alcohol alone (24.5%) or potentially hazardous prescription drugs including alcohol (8.5%).

Introduction

A national review of international and Danish literature (1) demonstrated that both in Denmark and abroad only sparse or inadequate knowledge is available of the prevalence of drugged driving, and national statistics only inadequately report accidents involving drugged drivers. Two studies (2, 3) based on saliva samples have found that about one percent of the investigated German and Australian car drivers were positive for illicit drugs and three to four percent were positive for a licit drug. A Canadian roadside survey based on urine samples (4) found that 9.5% of the drivers were positive for a licit or illicit drug.

According to the Danish Road Traffic Act a person is not allowed to drive a motor vehicle if, due to illness, debility, strain, too little sleep or influence of drugs, he or she is incapable of driving properly. However, in Denmark the annual number of blood samples analysed for drugs other than alcohol has been very limited over the years (5). So the objective of this survey (6) was to provide some baseline data on the prevalence of licit and illicit drugs in the normal car driver population. The survey was conducted in 2000 in a mainly rural district far from the metropolitan area, with about 100,000 inhabitants.

Methods

Sample selection and procedure

The survey is based on collection of saliva samples from about 1000 randomly stopped drivers of cars and small vans to get a measure of the prevalence of benzodiazepines, amphetamine, cannabis, cocaine and opiates in the stopped drivers.

The survey included a questionnaire to get information from the stopped drivers on their use of medicinal drugs (prescription or non-prescription) and/or illicit drugs, partly within the last 24 hours, partly generally before driving. Besides drug consumption prior to driving, the questionnaire included questions on attitudes to police control of drivers' use of potentially hazardous prescription and illicit drugs.

The police was in charge of collection of the saliva samples and currently sent them to the Department of Forensic Chemistry, University of Copenhagen, for analysis. The police had to follow an area-wise data collection plan adjusted for number of inhabitants and traffic volume in the study area. Otherwise, they had free hands to stop random drivers at convenient places during their daily patrols. All drivers participated voluntarily and anonymously, both in delivery of a saliva sample and filling-in of the questionnaire. Only drivers with a valid driving license, whom the police did not suspect to drive under the influence of drugs or alcohol, participated in the study.

The study design allowed matching of background data, saliva and questionnaire data by identical numbers on police registrations, saliva samples and questionnaire forms.

Technical equipment and analytical methods

The police used a RapiScan kit for saliva sample collection. At the Department of Forensic Chemistry, University of Copenhagen all collected samples were screened for benzodiazepines, amphetamine, cannabis, cocaine and opiates, i.e. those drugs included in the RapiScan screening system. After screening of some hundreds of the saliva samples by means of the RapiScan screening system it was obvious that the test was not reliable and reproducible. Therefore, the system was replaced by the Cozart "Drugs of Abuse Microplate EIA" screening system that offered the same screening facility and range of drugs. It was assessed that neither of the two screening systems was able to detect all of the frequently used benzodiazepines on the Danish market.

Only samples that tested positive by the screening were subjected to further confirming analyses, such as gas chromatography-mass spectrometry (GC-MS) etc. The saliva samples were neither screened nor analysed for alcohol.

Results

Of the 980 stopped car drivers, 961 agreed to deliver a saliva sample, i.e. very few (1.9%) refusals/dropouts and a result very close to the target of 1000 samples.

Screening and confirmed results

Of the collected 961 samples, 896 had enough material for screening and, if positive, for subsequent GC-MS analysis. Screenings showed that 7.1% (64) of the 896 samples were positive for benzodiazepines, amphetamine, cannabis, cocaine or opiates. The 64 samples gave 69

findings: four were positive for both amphetamine and opiate, and one was positive for amphetamine, cannabis and opiate.

The confirming analyses showed that 2% (18) of the investigated samples were positive for licit or illicit drugs. Of these, 0.7% (6) were positive for benzodiazepines within the group of benzodiazepines that the screening instrument could test for. 1.3% (12) of the samples were positive for an illicit drug, such as amphetamine, cannabis, cocaine or opiates. Of these, the majority 0.8% (7) concerned cannabis. The screening and confirmed analysis results are illustrated in table 1.

Table 1: Screening and confirmed analysis findings of saliva samples (n=896)

Methods	Amphetamine/ Metamphetamine	Cannabis (THC)	Cocaine	Opiates	Benzodia- zepines	Total Number %
Positive/ Screening	14	21	2	24	8	69 7.1
Positive/ GC- MS etc.	1(1*)	7(1*)	1	3 (5*) 7?(**)	6	18 2.0

* Not sufficient saliva for confirming analysis

** ? = Trace of opiate, but below limit of quantification

Questionnaire results

The questionnaire results are based on statements from 636 (66%) of the drivers, who returned the questionnaire form. A total of about 6% (38) of the respondents have stated use of a licit or illicit drug within the last 24 hours, before they were stopped. 3% (19) stated use of a hypnotic, tranquilliser or analgesic drug, i.e. licit prescription drugs, which in Denmark are labelled with a red triangle or have a package insert that inform of a potentially “hazardous drug” in relation to road safety or machine handling. Most of these drivers (13) have stated daily use of their prescription drug.

2.8% (18) of the respondents have stated use of other types of prescription or non-prescription drugs, such as drugs against high blood pressure, stomach ulcer, etc., i.e. drugs that are not considered a hazard to road safety and not labelled with a red triangle. One driver stated use of cannabis within the last 24 hours. Table 2 illustrates respondents’ use of prescription drugs that may include benzodiazepines or other psychotropic substances, which may constitute a hazard to road safety, or prescription/non-prescription drugs, which are considered not to constitute a hazard to road safety within the last 24 hours.

Table 2 Respondents’ use of prescription “hazardous” or prescription/non-prescription “non-hazardous” or illicit drugs within the last 24 hours before they were stopped by the police for saliva collection (n=636)

Type of drug	Number of statements	
Prescription, hazardous	19	3%
Prescription/non-prescription, non hazardous	18	2.8%
Illicit	1	0.2%
Total	38	6%

About half of the respondents have filled in four general questions concerning use of illicit drugs, illicit drugs including alcohol, potentially hazardous drugs including alcohol, or alcohol alone prior to motor vehicle driving. The following statements include answers from those drivers, who have

ticked “yes” or “occasionally” to drive a motor vehicle despite a suspicion to be under the influence of licit or illicit drugs and/or alcohol. Some drivers have ticked affirmatively to more than one question:

- 2.8 % have stated occasionally to drive despite a suspicion to be under the influence of an illicit drug.
- 4 % have stated occasionally to drive despite a suspicion to be under the influence of an illicit drug as well as alcohol.
- 8.5 % have stated to drive a few hours after taking a potentially hazardous drug as well as alcohol
- 24.5 % have stated occasionally to drive despite a suspicion to be above the legal BAC limit of 0.5 percent.

Police control of licit and illicit drugs

The attitude among the respondents is clear: The vast majority strongly supports control of drugged driving. On average 96% of the respondents are of the opinion that the police should control drivers for use of potentially hazardous drugs, and 98% favour controls of illicit drugs. Among respondents, who have *not* taken prescription or illicit drugs within the last 24 hours, there is a stronger support to future police control of potentially hazardous drugs (93%) than among respondents, who *have* taken such drugs within the last 24 hours (85%) ($p < 0.05$). Both groups seem to support illicit drug controls almost to the same degree (94% and 90%, respectively). However, the number of respondents in the two groups is very uneven, as the “drug user group” is very small. Therefore, a comparison of the two groups is not reliable or meaningful.

Generally, the drivers who have filled in the questionnaire are of the opinion that the police should control for drugged driving, and saliva testing is a method that the police could use in future controls of licit as well as illicit drugs. This opinion is shared by 96% of the respondents. The result should be considered on the fact that all these respondents have had the experience of delivering a saliva sample at the roadside and apparently do not consider this method too embarrassing. The respondents’ attitudes to controls of drugged driving are illustrated in figure 1.

Erreur ! Liaison incorrecte.

Ici (voir Joanne Bouchard pour le document Proceedings no. 303)

Figure 1. Respondents’ attitudes to future police controls of drugged driving, i.e. control of drivers for potentially hazardous prescription drugs and illicit drugs by use of saliva testing.

Characteristics of drivers who drive after use of a prescription or illicit drug

Matching of police registrations, forensic and questionnaire results has made it possible to throw light upon sex and age of those drivers whose saliva sample proved positive, or who have stated to drive despite a suspicion to be under the influence of a potentially hazardous (prescription drug) or illicit drug.

Taking all data into account, driving under the influence of an illicit drug or an illicit drug including alcohol seems in this study to be associated to especially men, aged 22-44 years. It should be born in mind that the forensic analyses did not include testing for alcohol. Driving under the influence of a potentially hazardous prescription drug seems in this study to be associated to middle aged or elderly drivers, both men and women.

Discussion

The prevalence of benzodiazepines, amphetamine, cannabis, cocaine and opiates has been investigated in a Danish rural area with a population of 100,000 inhabitants by collection of saliva samples from about 1000 randomly stopped anonymous drivers of cars and small vans. Only drivers, whom the police did not suspect to be under the influence of drugs (licit, illicit or alcohol) were included in the study.

Confirmed analyses revealed that 0.7% of investigated saliva samples were positive for benzodiazepines and 1.3% for amphetamine, cannabis, cocaine or opiates. Of this cannabis accounted for 0.8%. Internationally, only little research is available on the effect of a certain amount of drug found in saliva. Therefore, it is difficult to assess the significance of the analysis results in relation to practical vehicle handling and to the ability of the drug positives to safely drive a vehicle at the time, when the police collected the sample. A conservative estimate is that half of these drivers were impaired to a degree that might have been of importance in relation to road safety.

The results suggest that the prevalence of illicit drugs among Danish car drivers be of the same amount as in similar studies in Australia and Germany. Benzodiazepines seem of a lower amount, which may be attributed to the used screening methods, which did not include all the frequently used benzodiazepines in Denmark.

In addition to delivery of a saliva sample, 66% of the drivers participated in a questionnaire. The response rate suggests a wide support to the survey and great interest in the issue: licit and illicit drugs in traffic. Among others this is reflected in the questionnaire results, where 96% of the respondents state that in future the police should control drivers for potentially hazardous prescription and illicit drugs, and saliva testing is an acceptable method.

It is not possible to assess a potential effect of the dropouts on the overall result. Although the number of refusals/dropouts were very small (1.9% of the stopped drivers), even a few more drug-positives among those drivers, who did not deliver a saliva sample, might have influenced the final forensic result.

The participating drivers are considered representative as regards age, sex and amount of traffic compared with available data from national travel surveys. Therefore, the results are considered reliable and valid for the study area. The study area is a mainly rural district far from the metropolitan area, and as international studies have shown larger drug consumption in major cities than in provincial or rural areas, the results may not reflect national conditions. Questionnaire statements from some of the drivers confirm that occasionally some of these drive despite a suspicion to be under the influence of an illicit drug (2.8 %), an illicit drug including alcohol (4%), or a potentially hazardous prescription drug including alcohol (8.5%), or alcohol alone above the legal limit (24.5%).

This indicates that alcohol is still the major drug among the driving population. However, it may be concluded that potentially hazardous prescription and illicit drugs - just like alcohol - may be found among randomly stopped Danish drivers. This points at the need of various initiatives to prevent driving under the influence of prescription and illicit drugs, and at the same time keep up prevention efforts against drinking and driving.

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An Epidemiological Study on Alcohol/drugs related Fatal Traffic Accident Cases of Deceased Drivers in Hong Kong

YUK Ki, C.

Abstract

This study was designed to evaluate the correlation between fatal traffic accidents (FTA) and consumption of alcohol and/or drugs among drivers. Between 1996 and 2000 in Hong Kong, a total of 202 FTA cases of deceased drivers were investigated. The blood and/or urine samples of the victims were examined for the presence of alcohol and drugs. The 202 cases were classified into 2 groups: single vehicle crashes and multiple vehicle crashes. Out of the 118 cases for the latter group, alcohol and/or drugs were detected in 32 cases (27%) while the remaining cases (73%) were regarded as negative. As for the 84 cases in single vehicle crash group, 47 cases (54%) were positive for alcohol and/or drugs. The findings indicate that drivers consuming alcohol and/or drugs had a higher risk of being involved in fatal traffic accidents. The number of cases with ketamine, methamphetamine and MDMA detected has increased in recent years as these party drugs have gained popularity in Hong Kong.

Driving under the influence of prescribed drugs in Poland – questionnaire studies

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Keywords

Driving under the influence of drugs, epidemiology.

Abstract

The earliest information about the influence of drugs on driving performance appeared in the forties.

Although the effects of alcohol and narcotics (illicit drugs) on driving performance have been widely studied and are well-known, the potential risk of patients causing traffic crashes under the influence of prescribed drugs is ignored by patients and also by pharmacists and physicians.

The purpose of this study was to assess the frequency of medicinal drugs taking by Polish drivers and to evaluate drivers' knowledge on the impairment properties of various drugs on driving performance.

The study was performed on the basis of a specially constructed questionnaire, which was sent to 4000 drivers.

1161 drivers (29%) responded to the questionnaire. In this group were 894 men and 267 women. Most of them were experienced drivers, driving longer than 5 years; the frequencies of driving were a few times a week or every day. Analysis of the answers showed that the prescribed drugs most frequently taken by drivers are pain relievers (35.6 % of drivers) and benzodiazepines (11.1% of drivers). The most popular benzodiazepine was diazepam, taken by 40% of drivers taking benzodiazepines.

Only 28% of those questioned knew that law does not allow driving under the influence of the drugs mentioned in the questionnaire (psychotropic, benzodiazepines etc.).

From the study it can be concluded that one third of Polish drivers drive under the influence of prescribed drugs that are forbidden by law when driving.

Introduction

The earliest information about the influence of drugs on driving performance appeared in the forties.

Although the effects of alcohol and narcotics (illicit drugs) on driving performance have been widely studied and are well known, the potential risk of patients causing traffic crashes under the influence of prescribed drugs is ignored by patients and also by pharmacists and physicians [1-6].

Materials and Methods

The questionnaire was sent to 4 000 drivers living in the south-eastern part of Poland. The first part of the questionnaire concerned demographic data (sex, age, level of education, driving experiences etc.)**. In the second part were questions about medication-taking and driving under the influence of medicine. In this part of the questionnaire seven groups of medications were listed: sedative, hypnotic, psychotropic, pain relief, antiasthmatic, benzodiazepines and others. On the basis of the answer to this question, two variables were created: the first variable had a qualitative character – the answer “yes” was assigned if the driver was driving under even one questioned drug and “no” in the opposite situation. The second variable was quantitative and had values from 1 to 7 depending on the number of groups from which drivers took medicines and drove.

In the last part of the questionnaire, knowledge of road traffic regulations relating to driving under drug influence was tested. Respondents had to answer whether in Poland driving under drug influence is prohibited and how often other drivers drive under the influence of drugs.

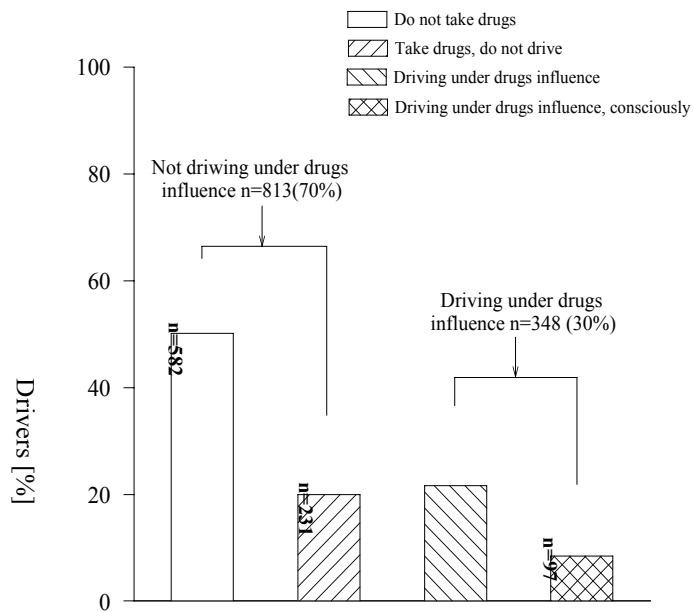
For statistical analysis, in order to identify variables, which might influence the probability of driving after consumption of drugs a loglinear analysis was applied [7]. To check if sexes differ in the average number of various kinds of drugs ingested by drivers we used the randomization test which algorithm is described by Manly[8]. The G test was used to test the connections between opinion of the inquired person about commonness of using drugs by drivers and his/her own experience in driving after ingestion a drug.

Results and discussion.

Correctly filled-in forms were received from 1161 respondents (894 men and 267 women). The mean age of drivers was 42.1 ± 12.9 years, ranging from 17 to 84 years. The level of education among drivers (respondents) did not reflect that of the general population in Poland. 39% and 29% of respondents had university and college education respectively. 28% of responding drivers had vocational education and 4 % of the studied population had basic education. 75 % of drivers lived outside Krakow City. The majority of drivers (83%) could be considered experienced drivers, as they had driven at least a few times a week over the last five years.

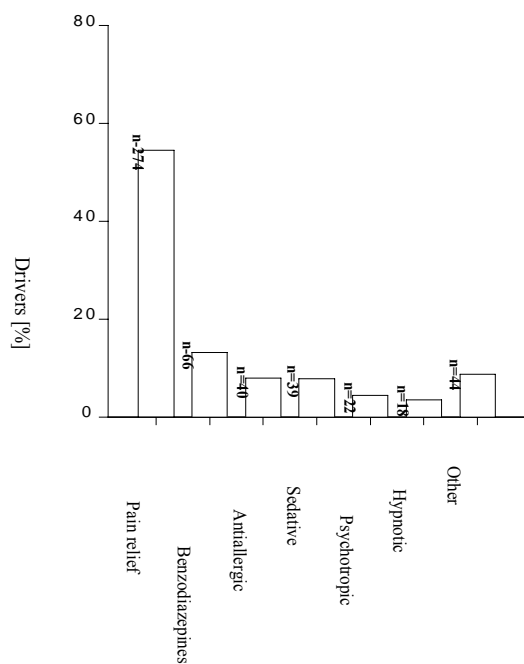
Among the questioned group were persons who took drugs from the list attached to the questionnaire but did not drive after this, and 251 (~30%) drivers who drove under the influence of drugs (Figure 1).

Figure 1: Frequency of drug taking by drivers



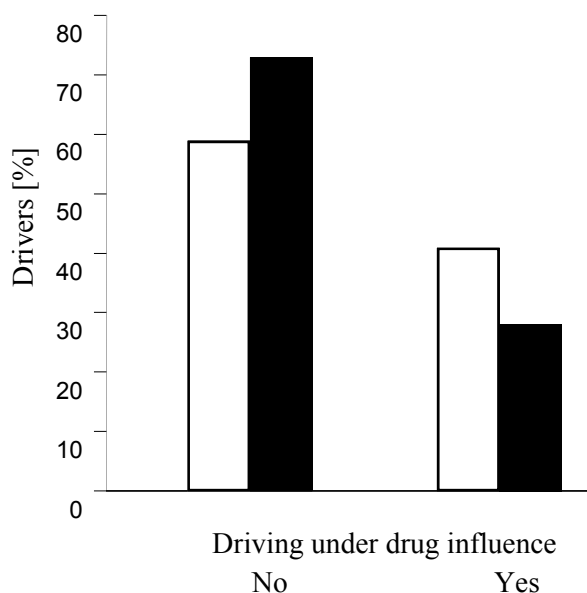
Most frequently drivers took pain relievers (274 cases), benzodiazepines (66 cases), and around 40 drivers took sedatives and antiallergics. Over 20 of them took psychotropic and hypnotic drugs (Figure 2).

Figure 2: The type of drug taking by drivers



As a result of log-linear analysis only sex has statistical importance ($p \ll 0.001$) when taking a decision about driving after medication taking (Figure 3). Other demographic parameters were not characteristic for people driving under drug influence.

Figure 3: Sex related driving under drug influence (white – women, black – men)



From the third part of the questionnaire it could be concluded that knowledge of traffic regulations among Polish drivers is low. Almost 18 % of them think that the law does not forbid driving after taking drugs, and only 27% of drivers know that this kind of regulation exists. Interestingly, ignorance of traffic regulations was not correlated with frequency of driving under the influence of drugs ($G=0.57$, $p < 0.75$).

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Clinical Impairment of Benzodiazepines – Relation between Benzodiazepine Concentrations and Impairment in Apprehended Drivers

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Keywords

Benzodiazepines, psychomotor impairment

Abstract

Acute intake of benzodiazepines has shown to be followed by concentration dependent deterioration of psychomotor performance and cognition in controlled experimental studies with volunteers. Whether similar concentration-effect relationships exist in a more diverse population of benzodiazepine users is uncertain. We wanted to address this question by studying a population of apprehended impaired drivers.

Our data indicated highly different benzodiazepine intake patterns amongst the drivers during the period prior to apprehension. Impaired subjects had significantly higher blood levels of diazepam and oxazepam than those not impaired. The risk of being assessed as impaired did rise with increasing benzodiazepine blood level. This corresponded to a similar rise in such risk in a reference group where alcohol was detected.

Of the various characteristics studied for the studied subjects the blood concentration of benzodiazepines was the only, which was related to clinically assessed impairment. The results open for further studies and discussion on legal limits for benzodiazepines in relation to driving.

Introduction

Benzodiazepines are drugs widely used as anxiolytics and hypnotics that also have additional medical indications. They are commonly abused drugs. In drivers apprehended for suspected impaired driving, 10-15% will have benzodiazepines in their blood upon testing (1, 2).

Most research on the concentration effect relationship of benzodiazepines has been performed with healthy volunteers given acute moderate doses of the drugs. In such studies benzodiazepines have shown a deteriorating effect on psychomotor performance and cognitive function (3, 4). An almost linear relationship between drug blood concentration and effects has been found for almost all benzodiazepines (5).

Less research exists concerning the concentration effect relationship amongst experienced benzodiazepine users. Tolerance is known to develop more rapidly for hypnotic sedative effects than for anticonvulsant and anxiolytic effects (6). Also for motor effects there appears to be a development of tolerance in animal models (7). Some authors have studied psychomotor impairment after acute intake of benzodiazepines in chronic benzodiazepine users (1, 8-10).

The aim of the present study was to see whether blood benzodiazepine concentration levels detected in a population having taken the drug at diverging times and in varying doses were related to a physician's conclusion of "not impaired" or "impaired" as assessed by a clinical test for drunkenness (CTD). A group of drunken drivers with only alcohol in their blood was used as reference group.

Methods

Of approximately 90 000 blood samples from cases of suspected driving under the influence from the period 1987 to 1998 approximately 9 500 samples contained benzodiazepines. 1201 samples containing only one benzodiazepine were drawn for further study. In these cases no other drugs or alcohol was detected. The detection and quantification of benzodiazepines, as well as the exclusion of alcohol and other drugs in these samples, was based on a battery of analytical methods used according to forensic toxicological principles. 383 samples were excluded due to various non-analytical reasons. The remaining 818 cases constituted the material for this study.

10 759 blood samples containing only alcohol from suspected drivers in 1987 were used as reference group. In the reference group no background variables were available, only the physician's conclusion and blood alcohol concentrations (BAC).

A physician performs the CTD shortly after apprehension of drivers suspected of driving under the influence of non-alcoholic drugs. The test consists of 27 observations and simple psychomotor tests designed to evaluate driving fitness (11). This reports main dependent variable was the physician's conclusion to CTD. The main independent variables were the results of the drug analysis. For more advanced analysis the different benzodiazepines were grouped together in four groups with drug levels designated "therapeutic" or "mildly -", "moderately -" or "highly elevated". The background variables were partly related to the suspected driver, partly to the incident resulting in an examination, and partly to the test situation itself.

Results

The study of the background characteristics of our material revealed few interrelations, except for an expected gender differences with respect to BMI, and an age difference between male and female drivers where the female drivers were older than the male drivers ($P < 0.01$).

Generally the type of benzodiazepine found in the blood samples did not relate to the background variables, nor did the blood concentration of the benzodiazepine found. The blood drug concentrations of benzodiazepines were high, with average concentrations highly above what would be considered a therapeutic level. The average BAC that was found in our reference sample was also relatively high. When combining all the different benzodiazepines and grouping them in four groups according to drug blood concentration the different levels did not relate to the background variables.

159 suspected drivers (19%) were determined to be “not impaired”, while 659 (81%) were determined to be “impaired”. The background variables were not found to predict the physician’s conclusion to CTD. In the reference group where only alcohol was detected, 1002 suspected drivers (9%) were determined to be “not impaired”, while 9757 (91%) were determined to be “impaired”.

The type of benzodiazepine detected did not differ significantly between the “not impaired” and “impaired” groups. The impaired drivers had significantly higher levels of diazepam ($P < 0.01$) and oxazepam ($P < 0.05$) compared to not impaired drivers, and a similar trend was present for flunitrazepam, nitrazepam and alprazolam.

When the different benzodiazepines were combined in groups according to blood drug concentration level, the odds ratio for being determined impaired rose significantly from one group to the next. There appeared to be no increase in OR moving from the moderately to the highly elevated drug level. The OR differences persisted when adjusting for the background variables (tab. 1). The relation was also checked for interactions between the background variables and drug level. No interactions were found.

In the reference group in which alcohol was detected the average BAC (SD) for drivers determined to be “not impaired” was 0.102% (0.055%) and drivers determined to be “impaired” 0.161% (0.071%) ($P < 0.001$).

Table 1: Odds ratios (95% CI) for being determined “impaired” on different elevated levels of drug concentration compared to the therapeutic drug level and odds ratios for being determined “impaired” on different BAC compared to the 0.025-0.050 % BAC

Binary regression analysis for drug concentration	<i>Blood benzodiazepine concentration</i>			
	Therapeutic ^a	Mildly elevated	Moderately elevated	Highly elevated
Drug concentration alone	1	1.61 (1.05-2.46)*	3.65 (1.88-7.08)***	4.11 (2.22-7.60)***
Adjusted for all background variables	1	1.60 (0.84-3.05)	3.71 (1.34-10.27)*	3.75 (1.46-9.63)**
Binary regression analysis for BAC	<i>BAC (%)</i>			
	0,025-0,050 ^a	0.051-0.100	0.101-0.150	>0.150
BAC alone	1	1.49 (1.22-1.83)***	2.94 (2.38-3.63)***	10.49 (8.36-13.16)***

^areference category, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Discussion

In this study we have used the physicians conclusion on the CTD as our dependant variable suggesting that this conclusion is a “gold standard” for the determination of impairment in the context of this paper. The CTD may have a low sensitivity for detecting roadside traffic relevant impairment (12-17). When subjects were given lower doses of benzodiazepines in controlled

laboratory settings more sophisticated psychomotor were needed to demonstrate drug impairment. Some studies indicate that the CTD may be a reliable tool in revealing impairment in a clinical setting when higher doses of benzodiazepines or combination of drugs are given (16, 18, 19).

Our use of the CTD as dependant variable implies some knowledge of the reliability of the test. In fact we only have a theoretically idea of this tests reliability and a reliability problem would obscure the concentration effect relationship in a study like the present.

There is a well-established concentration effect relationship between blood drug concentration of a certain benzodiazepine and the psychomotor effects (5). At the individual level, however, considerable intra- and inter-individual differences in the response to a certain dose have been demonstrated (3). Constitutional differences, acute or chronic tolerance to drug effects can partially explain these phenomena.

In the present study we obtained very limited background information about the subjects intake of drugs. In most instances, neither the dose nor the time of intake was known. A pharmacodynamic phenomenon like acute tolerance would greatly vary depending on time since last drug intake and dose ingested. The discussion of acute tolerance is beyond the scope of this article, but if it were to exist, it would obscure a concentration effect relationship in the present study.

A pharmacodynamic or functional mode of action can cause tolerance after repeated dosing. Pharmacodynamic tolerance for benzodiazepine effects is well-established (20) as for alcohol (21). There are probably also differences in degree of tolerance development when considering specific drug effects (22). In any case chronic tolerance would have had the capability to obscure a concentration effect relationship in the present study.

Some of the subjects in the present paper would have taken benzodiazepines as part of a therapeutic scheme for the treatment of epilepsy, anxiety or insomnia. Others might have ingested the drug for non-medicinal purposes and as part of drug abuse. Different indications could theoretically produce different response (23) and also obscure a concentration effect relationship.

Despite all these possible uncertainties and limitations we still found a clear concentration effect relationship measured as benzodiazepine drug concentrations and clinically assessed impairment. This relationship was maintained when adjustment is made for the background variables. The relationship is of a similar magnitude to that found in the reference group of drunken drivers, at least for mildly and moderately elevated BAC.

A lack of relationship between blood drug concentration and impairment has been one of the arguments against setting legal limits for benzodiazepine concentrations and driving (24). When comparing the present results on benzodiazepines and alcohol it seems that some arguments against the establishment of legal limits for benzodiazepines will have reduced value.

Future studies, e.g. in which more sensitive tests relevant to traffic safety can be applied in stead of CTD on a population of individuals with different patterns of benzodiazepine use, would further contribute to the knowledge background for setting such limits.

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Ecstasy & Designer Amphetamines Findings in Drivers and Post-Mortem Cases in Denmark

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Keywords

Designer amphetamines, ecstasy, blood, drivers

Abstract

Recently there has been a strong public interest as well as politically on the abuse of ecstasy in Denmark. The Department of Forensic Chemistry performs the toxicological analysis on the driving and criminal cases in Denmark and the post-mortem cases of East Denmark requested by the police. Screening for amphetamines and ecstasy is performed by RIA (amphetamine double antibody DPC) and confirmation and quantification by GC/MS analysis.

In recent years there has been a change in the number of samples tested positive for designer amphetamines including MDMA (ecstasy), MDA, MDEA etc. The first two positive cases of designer amphetamines among 213 traffic cases requested for analysis by the police were detected in 1997 (2/213 ~ 0,9%). In 1999 4 cases were found (4/223 ~ 1,8%), in 2000 were 9 cases observed (10/235 ~ 3,8%) and in 2001 were 6 positive cases among 201 analysed traffic cases (6/201 ~ 3,0%). In these cases the dominating compound was MDMA followed by MDA. A few positive cases of MDEA were also observed and always in mixture with MDA and/or MDMA. The whole blood concentration ranged from 0,03 to 1,1 mg/kg (fatal level) with a mean value of 0,35 mg/kg and a median of 0,23 mg/kg. The high incidence of MDA in MDMA positive cases and the fact that the concentration of MDA was about 1/10 of the concentration of MDMA in these cases indicate MDA's nature as a metabolite in MDMA consumption. Additional drugs were found in the blood in many of the cases such as THC, cocaine metabolite and benzodiazepines.

In the last 7 years the number of traffic cases for forensic investigations was about 200 per year and the percent of amphetamine positive cases was between 10-15%. This indicates an increase in the total number of phenylamine positive cases in Denmark due to ecstasy.

A similar increase has been observed among the post-mortem cases in Denmark. By now there are registered a total of 6 fatal cases of designer amphetamines involving MDMA and/or PMA/PMMA (paramethoxyamphetamine / paramethoxymetamphetamine). One fatal case of MDMA was found in 1998 and five fatal cases of MDMA and/or PMA/PMMA in 2000.

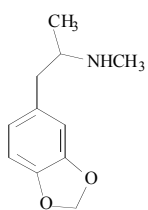
Introduction

MDMA or 3,4-methylenedioxymethamphetamine (ecstasy) is a ring substituted derivative of methamphetamine that is abused as a psychedelic substance. Metabolic demethylation of MDMA produces MDA or 3,4-methylenedioxyamphetamine, which is also pharmacological active. MDMA and related drugs such as MDA and MDEA (3,4-methylenedioxyethylamphetamine) are listed in schedule I of the controlled substance classification (prohibited drugs) (1). These drugs are referred to as designer drugs or designer amphetamines being methylenedioxy analogues of the amphetamines and are illustrated in Figure 1.

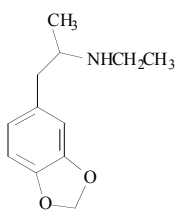
They can cause hallucination, paranoid delirium, seizures, psychosis, coma or even death (1-3). Studies have shown that MDMA use is not consistent with safe driving and that impairment of various types may persist for a considerable time after last use (3). The negative effects include muscle tension, pain, increased sweating, blurred vision, pupillary dilation, ataxia, anxiety, a nervous desire to be in motion, panic attacks etc. (1,3). All properties indicate that following the consumption of MDMA, a user would suffer effects that would impact the ability to safely operate a motor vehicle. Their detection in biological fluids is therefore of major concern in toxicology but also in occupational medicine, law enforcement administration, and other fields.

Analytical methods and some statistics on designer amphetamines are presented in the paper together with a discussion of the development in recent years and consequent expectations for the future.

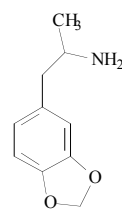
Figure 1: Structure of amphetamine and designer amphetamines such as MDMA (ecstasy)



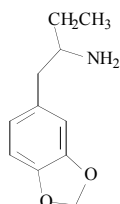
MDMA
3,4-methylenedioxyamphetamine



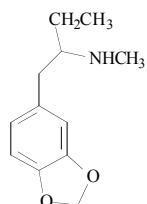
MDE=MDEA
3,4-methylenedioxyethylamphetamine



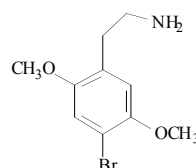
MDA
3,4-methylenedioxyamphetamine



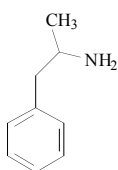
BDB
1-(1,3-benzodioxol-5-yl)-2-butanamine



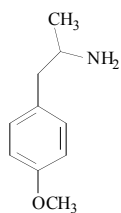
MBDB
N-methyl-1-(1,3-benzodioxol-5-yl)-2-butanamine



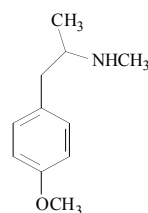
2-CB=BDMPEA
4-bromo-2,5-dimethoxyphenylethylamine



Amphetamine



PMA
paramethoxyamphetamine



PMMA
paramethoxyamphetamine

Table 1: Characteristics of designer amphetamines positive traffic cases in Denmark since 1995

Case	Year	Sex	Age	BAC per mille	Amphetamines concentration in [mg/kg]					Ratio of MDMA/ MDA	Other drugs detected
					Amph.	MDA	Metha.	MDMA	MDEA		
N61	1997	m	22	n.a.	1,08	0,02		0,23	0,12	12	Diazepam
N385	1997	m	19	n.d.		0,05		0,23	0,17	5	THC
493	1999	m	20	0,02				0,06			THC, diazepam
748	1999	m	30	2,02	0,19			0,06			THC, cocaine met.
1125	1999	m	23	0,77	0,07	trace		0,17			n.a.
1252	1999	m	27	0,01		0,02		0,45		23	Only requested cocaine-analysis: n.d.
289	2000	m	20	0,03		0,03		0,78		26	Cocaine and met., THC
405	2000	m	26	n.d.		0,04		0,80		20	THC, flunitrazepam and met.
453	2000	m	26	n.a.		0,01			0,03		Morphine, benzo.
460	2000	m	20	n.a.	0,00	0,03		1,10		37	n.a.
505	2000	m	22	0,01	0,03	0,04		0,94		24	THC, alprazolam
526	2000	m	27	0,27	0,10	trace		0,06			THC
577	2000	m	26	2,01			0,04				
580	2000	m	20	n.d.	0,12	0,04		0,42		11	n.a. THC, cocaine met., benzo.
940	2000	m	19	0,02	0,37			0,02			
1123	2000	m	28	n.d.	0,22	0,04		0,34		9	n.a. THC, cocaine met.
662	2001	m	21	n.a.	0,13	0,02		0,33		17	
877	2001	m	24	n.a.	0,46			0,15			Cocaine met.
957	2001	m	22	1,03		0,01		0,41		41	n.d.
1298	2001	m	19	n.a.	trace	trace		0,49			n.a.
1009	2001	m	19	0,08	0,06			trace			n.a.
1266	2001	m	20	n.d.	0,15	0,05		0,62		12	n.a.

BAC: blood ethyl alcohol. Amph.: amphetamine, Methamph.: methamphetamine. THC: tetrahydrocannabinol

Blank celle / n.d.: not detected. n.a.: not analysed. met.: metabolites.

Methods

Routine toxicological analyses were applied for common drugs, narcotics and alcohol. Screening for amphetamines and ecstasy was performed by RIA (amphetamine double antibody DPC), while the confirmation and quantification was done by GC/MS analysis.

The verification and quantification of amphetamines including MDMA, MDA and MDEA in whole blood were performed by liquid-liquid extraction, followed by derivatization with perfluorooctanyl chloride and GC/MS analysis (4). The derivatized amphetamines were analysed by GC/MS using deuterated internal analogs for the common amphetamine derivatives. Reference compounds were obtained from Radian Corp. and Sigma Chemical Co, respectively. Calibration standards were prepared in whole blood from horses in a range of 0,01 – 0,5 (1,0) mg/kg (compound depended). Samples were diluted if beyond the linear range.

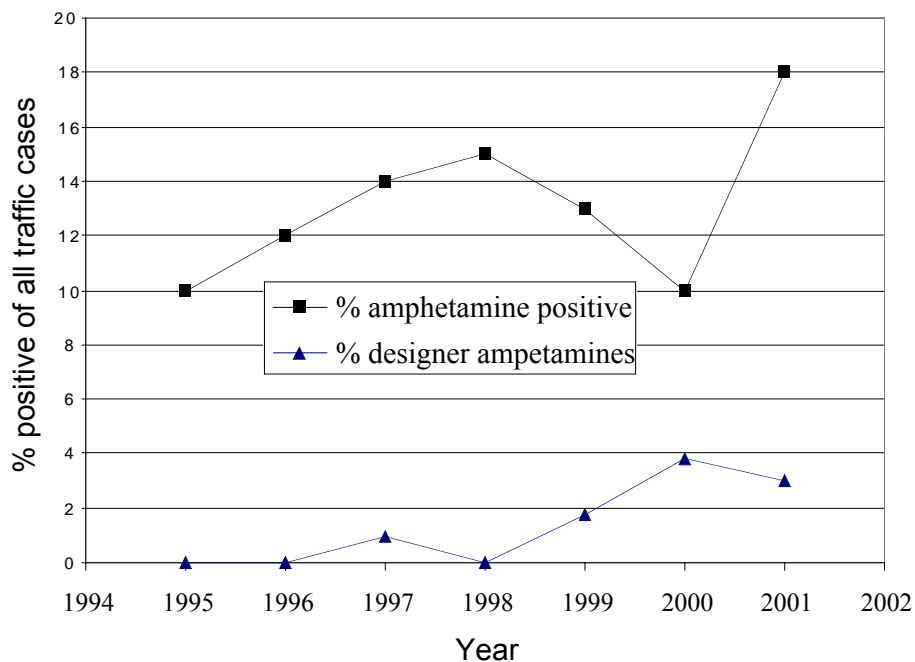
Quantitative analysis was performed on a Varian Star 3400 CX gas chromatograph with a Varian 8200 CX autosampler coupled to a Varian Saturn 4D mass spectrometer. For data treatment Varian Saturn was applied. The separation was performed on a 30 m HP5-MS capillary column (0,25 mm i.d., 0,25 μ m film). One microliter injected splitless into an injector at 210°C, an interface at 290°C and an ion trap at 210°C. The temperature program of the GC was 110°C for 1 min, then 6°/min to 160°C, then 5°/min at 210°C and finally 250°C/min to 300°C. The MS was used in scan mode for identification purpose and the quantification was done using 2-3 characteristic ions of each compound. For MDMA: m/z 162, 410, 454, MDA: m/z 162, 440 and MDEA: m/z 440, 468.

Results

Characteristic parameters such as age, sex and concentrations of designer amphetamines in traffic cases in Denmark since 1997 are shown in Table 1.

In addition to the verification and quantification, initial screening by RIA of urine and whole blood indicated presumptive positive tests for amphetamines. Only cases, where enough blood was submitted for screening and verification, were included in this evaluation. Notice also the analysis in this study does not separate the *l*- and *d*-enantiomers of the amphetamines. It is well known that the effect of for instance MDA varies with the form, where the *d*-form have stimulating effects like amphetamine, while the *l*-form have hallucinogenic effects like LSD (1,2).

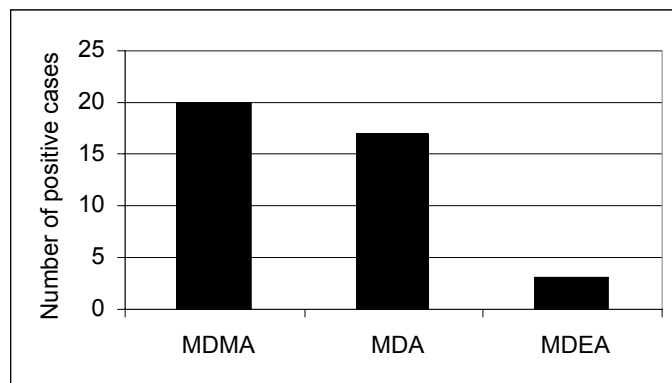
Figure 2: The development of traffic cases positive for amphetamine and designer amphetamines in Denmark from 1995 to 2001. The total number of traffic cases requested by the police for analysis of drugs was between 201-235 in the period, while about 17000 blood samples from Danish drivers were investigated annually for alcohol



All cases in Table 1 concerned only men (100%). Their age range from 19 to 30 with a median of 22 years. The first two positive ecstasy cases among drivers in Denmark were found in 1997, or 0,9% of all 213 traffic samples taken in 1997. Both cases involved MDMA, MDEA and MDA. In 1999 four cases were positive for MDMA (4/223 ~ 1,8%) and nine cases (9/235~ 3,8%) were found positive for designer amphetamines mainly MDMA in 2000. The development is illustrated in Figure 2. In general, the dominating compound was MDMA followed by MDA as illustrated in Figure 3. A few cases involved MDEA and always in a mixture with MDA and/or MDMA. The high incidence of MDA in MDMA positive cases and the fact that the concentration of MDA was about 1/20 of the concentration of MDMA in these cases concur with MDA's nature as a metabolite in MDMA consumption. Methamphetamine was detected in one case, while traffic cases positive for amphetamine in this period constituted varied from 10 to 15% as shown in Figure 2. A decrease in the number of positive amphetamine cases (5) and a simultaneously increase of positive designer amphetamines cases are noticeable.

The whole blood concentration ranged from 0,02 to 1,1 mg/kg with a mean value of 0,39 mg/kg and a median of 0,34 mg/kg. In two cases both in 2000 fatal level of MDMA were observed in a 20 and 22 year-old man, where only small concentrations of MDA were detected.

Figure 3: Distribution of designer amphetamines in positive traffic cases



Additional drugs/narcotics were detected in blood in 12 cases (57% of total number) such as cannabis (THC), cocaine & metabolite (benzoylecgonine) and benzodiazepines mainly diazepam. Other studies made in 1997-2000 also showed that about 60% of the traffic cases in DK involved multiple drug use (5). However, in 7 of the 21 cases (33%) the police had only requested the analysis of amphetamines and in another case they had also requested a cocaine analysis, which was negative. Therefore only 1 of the fully analysed cases involved solely amphetamines and 92% of the amphetamines positive cases (12/13) involved additional drugs/narcotics. BAC was determined in 11 of 15 cases (73%) that were analysed for ethanol (15/21 ~71%). However, only 3 of the cases were beyond the Danish limit of traffic offences (0,05 %).

In the period from 1995 other designer amphetamines have not been detected in any of our cases except for PMA and PMMA, that concern, however some post-mortem cases. The first fatal case of designer amphetamines was seen in Denmark in 1998 involving MDMA. In 2000 5 fatal cases of designer amphetamines occurred; two of the cases involved MDMA and three involved MDMA and/or PMA/PMMA. All cases involved young men (6,7).

Discussion

These data indicate that abuse of designer amphetamines is occurring and increasing in Denmark. Amphetamine is still the most frequent compound of the amphetamines observed in traffic cases, but designer amphetamines are common now. Notice also that methamphetamine is only observed in one case, amphetamine is the preferred substance in Denmark. MDMA is the most frequent designer amphetamine and it is a very toxic substance that affects the psychomotor skills and impact driving. Furthermore, the combination of MDMA and alcohol that was observed in 73% of the investigated cases, induce longer lasting euphoria and well being than MDMA or alcohol alone. MDMA reverse the subjective sedation induced by alcohol without reducing the drunkenness feelings. MDMA do not reverse the actions of alcohol on psychomotor abilities. Subjects may feel euphoric and less sedated and might have the feeling of doing better, but actual performance ability continues to be impaired by the effect of alcohol (8).

Abuse of mixtures of amphetamines and designer amphetamines are common (5,7) and the second step in an abuse pattern of amphetamine users is probably designer amphetamines such as MDMA. The simultaneous decrease in amphetamine cases and increase of designer amphetamine

cases can very well be connected. In 2000 the strong focus in the media might have induced amphetamine users to experiments with designer amphetamines. The preventive action of the many fatal cases in the same year must be questioned.

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Driving Under The Influence Of Drugs In Ireland: A Growing And Significant Danger

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Abstract

Driving under the influence of drugs (DUID) has been a statutory offence in Ireland since the 1961 Road Traffic Act. The Medical Bureau of Road Safety (MBRS) is the independent forensic body responsible for chemical testing of intoxicants under that Act. There are graded penalties for driving under the influence of alcohol, dependant on concentration. The law does not set prohibited concentrations for drugs nor does it distinguish between legal and illegal drugs. In recent years there has been an increase in the requests by Gardai (police) for analyses for the presence of a drug or drugs. As part of the Irish Governments Strategy for Road Safety 1998 - 2002, the MBRS was commissioned to carry out a nation-wide survey on the current trends and epidemiology in DUID in Ireland. Two thousand blood and urine samples sent to the MBRS under the Road Traffic Act 1994 were analysed. 1000 of the specimens were over the limit for alcohol and 1000 specimens were under the limit. Specimens were initially analysed for alcohol concentration by HS Gas Chromatography. They were then analysed for the presence of the following drugs or drug classes: amphetamines, methamphetamine, benzodiazepines, cannabis, cocaine, opiates and methadone using an enzyme immunoassay technique. Specimens found positive were sent to the State laboratory for confirmatory analysis by GC-MS or LC-MS for all drug types found. Up to October 2001, over 1800 specimens were analysed and the preliminary results indicate 46% under the legal alcohol limit and 26% over the legal limit contain drugs. Polydrug use was observed at a level of 31% in the over the legal alcohol limit and 62% under the legal limit. The most common class found was cannabis and the least common drug was cocaine. These results indicate an increase in DUID since a previous survey in 1991. Confirmation of the findings will be presented and the distribution of drug types will be outlined. The high percentage drug positives found in the specimens tested indicates the need for analysis for the presence of drugs of all DUID specimens. The high number of polydrug use detected gives rise for concern. The legislation with regard to drugs/driving will be reviewed in light of the findings, both analytical and epidemiological. The importance of these findings from one of the larger European studies in relation to road safety is clear.

Introduction

Driving under the influence of drugs (DUID) has been a statutory offence in Ireland since the 1961 Road Traffic Act. The Medical Bureau of Road Safety (MBRS) is the independent forensic body responsible for chemical testing of intoxicants under the Act. There are graded penalties for driving under the influence of alcohol, dependent on concentration. The law does not set

prohibited concentrations for drugs nor does it distinguish between legal and illegal drugs. In recent years there has been an increase in the requests by Gardai (Irish Police) for analysis for the presence of drug or drugs to the MBRS. Table 1 outlines the increases over the past seven years. The true incidence of drug use combined with driving is not known in Ireland. This is part explained by the absence of random breath alcohol testing or roadside drug screening provisions in the legislation.

Table 1: The number of specimens analysed for alcohol and drugs in Ireland in recent years

Year	Specimen Type	Alcohol Analysis	Drug Analysis
1995	B & U	4766	8
1996	B & U	5514	16
1997	B & U	6591	24
1998	B & U	7812	32
1999	B & U	8476	50
2000	B & U & BR*	10,134	78
2001	B & U & BR*	12,503	130

* Evidential breath testing for alcohol introduced late 1999.

Studies have been carried out in other European countries, some on road traffic fatalities or accidents (1-4). Other studies have been carried out on impaired drivers (5-6). An attempt to co-ordinate a direct comparison between countries was carried out for five Nordic countries (7). That study examined all blood specimens received by Nordic Forensic Institutes for one week in 1996.

De Gier in his work for The Pompidou Group of the Council of Europe, on illicit drug and traffic safety in Europe, identified that prevalence data from different countries are not comparable due to differences in the set-up of the studies (8). This lack of standardised selection outlines the need for each country to assess the DUID situation in its own jurisdiction.

Objectives

It was decided as part of the Irish Governments Strategy for Road Safety 1998-2002, to commission the MBRS to carry out a nationwide survey on the current trends and epidemiology in DUID in Ireland in 2000-2001. This study outlines the preliminary analytical findings of the survey.

Method

Sample Selection

Two thousand blood and urine samples sent to the MBRS under the Road Traffic Act 1994 were selected. 1000 specimens were over the legal limit for alcohol and 1000 were under the limit. The 1994 RTA set the alcohol limits of 80mg/100ml in blood 107mg/100ml in urine and 35µg/100ml in breath.

In December 1999, the MBRS installed 4 Evidential Breath Testing (EBT) instruments in Garda Stations. In 2000 the MBRS installed 21 EBT instruments throughout the country. The first 500 over the limit specimens were provided when only the 4 instruments had been installed and the

second 500 over the limit specimens were provided by end of year 2000 when 25 instruments were installed. The 1000 blood or urine under the limit specimens were collected over a longer time period from late 1999 to end of 2001.

The blood or urine samples were taken from Irish drivers apprehended by the Gardai and suspected of driving under the influence of an intoxicant. The law defines an intoxicant as including alcohol and drugs and any combination of drugs or of drugs and alcohol.

MBRS Analyses

All specimens were analysed for alcohol on receipt or shortly afterwards by Headspace Gas Chromatography. Specimens were stored at 4°C until analysed for the presence of a drug or drugs using an Elisa system. The microplate enzyme immunoassay kits were purchased from COZART, UK (see Table 2 List of Analytes Detected).

Table 2: Cozart kits used by the MBRS to analyse for the presence of a drug or drugs in blood and urine specimens

Kit	Analyte
Amphetamine	Amphetamine Methylenedioxyamphetamine (MDA)
Methamphetamine	Methylenedioxymethamphetamine (MDMA)
Benzodiazepine	Diazepam, Flunitrazepam, Flurazepam Nitrazepam, Nordiazepam, Temazepam
Cannabinoids	11 nor-delta – 9 carboxy – tetrahydrocannabinol
Cocaine	Cocaine, Benzoyecgonine, Ecgonine methyl ester
Opiates	Codeine, Dihydrocodeine, Morphine 6 Monoacetylmorphine (MAM)
Methadone	Methadone, 2-ethylidene – 1,5-dimethyl – 3,3 – diphenylpyrrolidine (EDDP)

All specimens were analysed for the presence of the following drug or drug classes: amphetamines, methamphetamines, benzodiazepines, cannabinoids, cocaine, opiates and methadone.

Screening Cut-Off concentrations are outlined in Table 3.

Specimens found positive were forwarded to the State Laboratory for confirmatory analysis.

State Laboratory Analyses

All specimens were frozen on receipt in the State Laboratory and analysed by either GC-MS or LC-MS over the period of the survey and to date. The specimens were confirmed positive using drug limits of detection (LOD) as outlined in Table 3.

Table 3: Screening cut-off concentrations and confirmation LOD levels

Drug/Drug Classes	Screening Cut Off (ng/ml)		Confirmation Cut Off (ng/ml) at LOD	
	Amphetamines	50 (B)	300 (U)	50 (B)
Methamphetamines	50 (B)	300 (U)	20 (B)	50 (U)
Benzodiazepines	*50 (B)	50 (U)	20 (B)	20 (U)
Cannabinoids	*10 (B)	10 (U)	5 (B)	5 (U)
Cocaine	100 (B)	100 (U)	50 (B)	50 (U)
Opiates	*25 (B)	25 (U)	50 (B)	50 (U)
Methadone	25 (B)	25 (U)	30 (B)	30 (U)

* After consultation with State Laboratory, the following cut-off levels were adjusted upward: Benzodiazepines and Opiates to 100ng/ml and Cannabinoids to 20ng/ml.

Results

The number of specimens forwarded to the State Laboratory for confirmatory analysis was 722 (36% of the 2000) based on Elisa results. 46% of the under the legal alcohol limit specimens and 26% of over the legal limit specimens indicated the presence of drugs. The number of results confirmed to date is 391 (19.6% of the 2000) with 74 specimen results outstanding. The number of drug positive specimens with alcohol levels below the limit was 263 (26% of that 1000) with 113 (11%) specimens positive for drugs only. The number of drug positive specimens with alcohol levels above the limit was 128 (13% of that 1000). The frequencies of individual drug/drugs classes found are shown in Table 4.

Table 4: The frequencies of individual drug/drugs classes found

Drug/Drug Classes	Specimens >alcohol limit	Specimens <alcohol limit
Amphetamines	14	73
Methamphetamines	14	72
Benzodiazepines	33	79
Cannabinoids	79	156
Cocaine	9	17
Opiates	6	57
Methadone	6	56

Table 5 outlines the drugs found in the blood and urine specimens for both over and under the alcohol limit.

Table 5: Frequency of drugs found in blood and urine specimens

	Blood > alcohol limit	Blood < alcohol limit	Urine > alcohol limit	Urine < alcohol limit
Total	61	112	67	151
Cannabis	27	49	52	107
Amphetamines	3	24	11	49
Methamphetamines	5	31	9	41
Opiates	2	10	4	47
Cocaine	2	3	7	14
Methadone	1	15	5	41
Benzodiazepines	27	45	6	34

The frequency of polydrug use was found to be 139 (36% of 391 confirmed). Again the frequencies are given for the different categories in Table 6.

Table 6: Drug Survey - Polydrug Frequency

Drug Classes Positive	Over Limits	Drug Classes Positive	Under Limits
1 Drug	113	1 Drug	139
2 Drug	8	2 Drug	58
3 Drug	6	3 Drug	49
4 Drug	1	4 Drug	14
5 Drug	0	5 Drug	3
6 Drug	0	6 Drug	0
7 Drug	0	7 Drug	0

Discussion

The results of this large study indicated that 36% of all specimens screened positive for the presence of a drug or drugs excluding alcohol. A more reliable figure of 20% were confirmed positive by GC-MS or LC-MS. Initial identification or cut off values for the Elisa analysis were chosen based on the low control values issued with the Elisa assay kits. These values were increased during the study to give greater concordance in specimen selection between screening and confirmatory analysis. The figure of 20% positives is in close agreement with the results reported by Denmark, Finland and Iceland using a smaller sample size (7).

It has been suggested that the higher levels of detection in Norway and Sweden may be attributed to the different selection criteria made by the police in the different countries.

The most common drug encountered apart from alcohol was cannabis. Similar findings have been reported in other European countries such as France (3) and Switzerland (5).

In the study of the five Nordic countries only Denmark found cannabis to be the most common drug (7). Recently in Scotland morphine has surpassed cannabis as the most common illegal drug detected in DUID drivers (6).

The high percentage of drug positives found in the specimens tested indicates the need for analysis for the presence of drugs in all DUID specimens. Since the beginning of this year 2002 the MBRS analyse all the under the limit for alcohol specimens for the presence of drugs.

The high number of polydrug and alcohol and drug use detected gives rise for concern. The legislation with regard to DUID will be reviewed in light of the findings both analytical and epidemiological. The importance of these findings from one of the larger European studies in relation to road safety is clear.

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Alcohol And Drug Use Among A Large Cohort of Injured Vehicular Occupants And Pedestrians Treated In A Trauma Center

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Keywords

Alcohol, drugs, injury, vehicular crashes, pedestrians

Abstract

Most studies of substance abuse among injured crash victims have focused on vehicular occupants. This study compared demographic factors and toxicology test results (alcohol, cocaine, opiates, cannabis) in a large cohort of injured occupants and pedestrians admitted to a trauma center. Data were analyzed from a large clinical toxicology database from 1996 through 2000. There were 9,947 occupants and 1,547 pedestrians available for study. Alcohol and other drug testing rates were 98% and 47%, respectively, with no testing biases. Sixty-one percent of occupants and 73% of pedestrians were men ($p<.01$). Thirty-four percent of occupants were ≥ 40 years compared with 39% of pedestrians ($p<.01$). Compared with occupants, significantly higher percentages of pedestrians tested positive for alcohol (27% vs 20%, $p<.01$), cocaine (20% vs 9%, $p<.01$) and opiates (24% vs 18%, $p<.01$) There was no statistical difference in the percentage of pedestrians (13%) and occupants (15%) testing positive for cannabis.

Introduction

In 2000, 41,821 individuals were killed in vehicular crashes on roads in the United States (1). Eighty-seven per cent of those killed were vehicular occupants. Of the remaining non-occupant fatalities, 85% were pedestrians ($n=4,739$).

Over the past three decades systems of care (2), which includes trauma centers (3), have been developed in the United States to care for patients with serious injuries. For each of the over 40,000 people killed annually in vehicular crashes, 45 others require care in an emergency department, and 9 sustain injuries that are serious enough to require admission to a hospital, often to a trauma center (4). Data from the American College of Surgeons (5) for 109,822 patients admitted to 67 trauma centers in 29 states for the years 1994 through 1994 reveal that, while over 37,000 were vehicle occupants, only 4,553 were pedestrians.

There is little available information about substance abuse among injured pedestrians treated in United States trauma centers. The lack of data concerning this subject is illustrated by four studies summarized in Table 1.

Table 1: Alcohol Use Among Injured Pedestrians Treated in U.S. Trauma Centers

Report	Number	Alcohol Tested	Alcohol Positive (% of those tested)
Derlet et al (1988) (6)	154 ^{a1}	24 ^{b1}	24 (100%)
Brainard et al (1989) (7)	115 ^{a2}	85 ^{b2} (74%)	55 (65%)
Rivara et al (1993) (8)	185 ^{a3}	185 ^{b3}	126 (32%) ^c
Kong et al (1996) (9)	273 ^{a4}	92 ^{b4} (34%)	45 (49%)

a1. ≥16 years of age

a2. mean age 35 years

a3. ≥18 years of age

a4. 200 (73%) ≥16 years of age

b1. BAC “measured inconsistently” b2. Testing per “discretion of the treating physician”

b3. Only BAC tested patients included in study. Overall, 82% of 3,242 patients were tested.

b4. Those who “admitted to alcohol intake,” or “suspected by trauma physician to be intoxicated” were tested.

c. “Intoxicated,” i.e., had a BAC ≥100 mg/dl

Data from some of these studies involving large numbers of patients, i.e., 100 or more; and the lack of other large studies demonstrate that there is a dearth of data from United States trauma centers involving pedestrian trauma patients, and alcohol testing procedures are inconsistent or are not considered part of routine care at many centers. Further, none of the aforementioned studies involved testing for drugs of abuse other than alcohol.

Considering the above discussion, our goal was to assess alcohol and other drug use among a large number of injured pedestrians treated in a trauma center. These results would then be compared with those of injured vehicular crash occupants.

Methods

Study Period. The study period encompassed the five calendar years of 1996 through 2000.

Clinical Site/Patient Population. The R Adams Cowley Shock Trauma Center of the University of Maryland Medical Center, which was founded over thirty years ago, has served as the prototype for many trauma centers established throughout the United States and abroad. It is a Level I center, the highest level of adult trauma care described by the American College of Surgeons' Committee on Trauma (3). It serves as a regional trauma center for the most populated counties of Central Maryland, and as an areawide trauma center for the quadrant of Baltimore City

surrounding the University of Maryland Medical Center. Hence, the profile of patients admitted to the center from rural, suburban and urban settings is representative of the aggregate of patients admitted to trauma centers in the United States (5).

Toxicology Screening. Toxicology testing for alcohol and other drugs of abuse is routinely performed at the Shock Trauma Center for clinical care, i.e., to identify patients at risk of withdrawal, to assist in pain/anesthetic management, and to screen patients for substance abuse problems. Blood alcohol concentrations (BACs) are determined from whole blood samples using gas-liquid chromatography which detects BACs ≥ 20 mg/dL. Drug use is determined from urine specimens using enzyme immunoassay technique. While an admission blood specimen is obtained for almost all patients, a urine sample is obtained only from those for whom there is need to rule out genitourinary tract injury, or for those who require admission for several days or weeks. There are no testing biases relative to sex, minority status, or being a victim of violence (10). Testing is not done for legal reasons, e.g., reporting impaired drivers to the police.

Trauma Registry. The Shock Trauma center maintains a clinical trauma registry which contains patient information, including, sex, age, and mechanism of injury (11).

Research Center and Toxicology Database. The National Study Center for Trauma and EMS maintains a confidential clinical toxicology database for the trauma center's patients (10).

Data Analysis. Toxicology data were merged with trauma registry data to identify vehicular crash occupants or pedestrians. Patient information was linked to toxicology results. Statistically significant differences in data between the two groups of patients were ascertained using chi-square analysis. A p-value of .05 or less was considered statistically significant.

Results

During the 5-year period a total of 9,947 vehicular crash occupants and 1,547 struck pedestrians were admitted to the Shock Trauma Center for treatment of their injuries. The patient profile of these two groups and toxicology testing rates are presented in Table 2.

Table 2: Injured Vehicle Occupants and Pedestrians Patient Profile, Alcohol and Drug Testing

	Occupants (N=9,950)	Pedestrians (N=1,548)	P
Sex:			
Men	61%	73%	
Women	39%	27%	<0.01
Age:			
Mean Age	36 years	37 years	NS
14-20 years	21%	18%	NS
21-39 years	45%	42%	NS
40 or more years	34%	39%	<0.01
Testing Rates:			
Alcohol Testing Rate	98.2%	98.3%	NS
Drugs Testing Rate	47.4%	42.5%	NS

One notes that a significantly greater proportion of struck pedestrians were men compared with vehicle occupants. While the mean age was similar for both groups, a significantly greater proportion of pedestrians were ≥ 40 years of age, being 39% vs 34%, $p < 0.01$.

Toxicology testing results relative to sex and age are presented in Table 3.

Table 3: Injured Occupants and Pedestrians - Toxicology Test Results Relative to Sex & Age

	Occupants	Pedestrians	P
Alcohol:			
Overall test positive	20%	27%	<0.01
Men – test positive	25%	31%	<0.01
Women – test positive	12%	16%	0.02
14-20 years	16%	10%	0.02
21-39 years	27%	32%	0.01
40 or more years	14%	30%	<0.01
Cocaine:			
Overall test positive	9%	20%	<0.01
Men – test positive	11%	20%	<0.01
Women – test positive	6%	21%	<0.01
14-20 years	3%	2%	NS
21-39 years	14%	28%	<0.01
40 or more years	6%	19%	<0.01
Opiates:			
Overall test positive	18%	24%	<0.01
Men – test positive	19%	23%	0.04
Women – test positive	17	26%	<0.01
14-20 years	15%	13%	NS
21-39 years	19%	26%	<0.01
40 or more years	20%	26%	0.02
Cannabis:			
Overall test positive	15%	13%	NS
Men – test positive	20%	16%	NS
Women – test positive	7%	6%	NS
14-20 years	25%	25%	NS
21-39 years	18%	15%	NS
40 or more years	5%	6%	NS

Except for cannabis, a significantly greater percentage of pedestrians, both men and women, and groups of patients 21 years of age or older tested positive for alcohol, cocaine, and opiates. In contrast, there was no significant difference in cannabis use relative to type of injury, sex or age.

Discussion

This study documents for the first time a comparison of alcohol and other drugs of abuse among large cohorts of injured vehicular crash occupants and pedestrians treated in a trauma center. There are a limited number of studies with which to compare the results.

Compared with a Shock Trauma Center study involving fiscal years 1976 and 1977 (12), the current study documents substantial decreases in the percentage of injured drivers and pedestrians who were BAC+. Further, a higher proportion of pedestrians are now BAC+ compared with occupants. In that prior study, which involved a much smaller number of subjects, 51% of occupants (n=806) and 41% of pedestrians (n=92) were BAC+. In a subsequent Shock Trauma Center study involving fiscal year 1986 (13), with a yet a smaller number of patients, the reversal was noted, where 34% of occupants (n=532) and 43% of pedestrians (n=71) were found to be BAC+. Of the aforementioned studies (Table 1), only the one by Rivara and colleagues (8) involved at patient population in which alcohol testing was considered part of routine care. In that study, the percentages of intoxicated occupants (31%) and pedestrians (32%) were similar but higher than those of the current study.

As noted, none of the aforementioned trauma center reports (Table 1) documented substance abuse other than alcohol. Relative to cannabis, current study results can be compared with those of the Shock Trauma Center study (13) involving fiscal year 1986 in which leftover serum samples of unselected patients were tested for Δ^9 -tetrahydrocannabinol (Δ^9 -THC), the active ingredient in marijuana. As in the case of the present study, there was no significant difference in the proportions of occupants (33%) and pedestrians (34%) who tested positive for marijuana. It is important to note that the current study results of a 15% of occupants and 13% of pedestrians testing positive for cannabis probably represent a much greater decrease in pre-injury marijuana use. The current study utilized urine samples which detect metabolites of marijuana days to weeks after last use. In contrast, the previous study tested for Δ^9 -THC, which is detectable in the blood only up to 4 hours after use. Hence, detection of marijuana use in the previous study had a close temporal association between use and injury, whereas positive results in the current study could have been associated with last use days or even weeks before injury.

Overall, this study documents that, compared with injured vehicular crash occupants, injured pedestrians more frequently use (alcohol, opiates, cocaine), or use with similar frequency (cannabis), psychoactive drugs prior to injury. Test positive results for both alcohol and other drugs often are an indication of an underlying diagnosable substance use problem (8, 14). Because there are only a small number of other large studies with which to compare results from the current study, the magnitude of substance use problems among injured pedestrians treated in trauma centers is not known. Testing of all trauma patients admitted for the treatment of injuries should include alcohol and other drug testing for medical management (10, 14). This includes identifying patients at risk of substance use disorders and the provision of intervention or treatment to prevent future injury episodes. Surveillance of test positive results allows for the monitoring of trends in substance abuse among various groups of trauma patients (10).

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The Influence of Cannabis and Alcohol on Driving

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Abstract

This research had two primary objectives: Firstly, to provide reliable data, under laboratory conditions, on the impairing effects of the combination of moderate doses of cannabis and alcohol on driving. Secondly, to provide an overview of the attitudes and habits of cannabis and alcohol users in relation to driving and explore factors which may influence the decision to drive under their influence.

These objectives were addressed using experienced cannabis and alcohol users carrying out laboratory-based tasks and driving in a simulator. Two cannabis conditions: placebo and low THC; and two alcohol conditions: placebo and a dose to give a breath alcohol level of approximately 50ug/100ml, were used.

The few studies that have combined the effects of cannabis and alcohol on driving performance have used relatively high doses of alcohol and have been inconsistent in terms of methodology, making comparisons difficult. Anecdotal evidence suggests that regular cannabis users occasionally drink an amount of alcohol below the legal limit for safe driving, and then smoke cannabis before driving. It was therefore important to establish the degree of impairment caused by a moderate dose of alcohol in combination with cannabis.

Results using the TRL driving simulator confirm the results from these previous studies. A reduction of average speed and an increase in headway on simulated motorway driving was observed with cannabis, whether or not alcohol was also consumed. A possible explanation for this is that drivers are aware of their impairment, but attempt to compensate for their impairment by driving more cautiously. Cannabis also adversely affected drivers tracking ability. In terms of road safety, it could not be concluded that driving under the influence of cannabis with or without alcohol, at the dose levels used in the study, is not a hazard. There are effects on various aspects of driver performance and these are unpredictable.

