ORIGINAL ARTICLE

Prevalence of drugged drivers among non-fatal driver casualties presenting to a trauma centre in Hong Kong

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CME

Objective To investigate the prevalence and characteristics of abusive drug exposure among non-fatal motor vehicle driver casualties presenting to a designated trauma centre in Hong Kong.

Design Cross-sectional study.

Setting Designated trauma centre/regional accident and emergency department in Hong Kong.

Subjects Non-fatal motor vehicle driver casualties who presented to the trauma centre from 1 January 2007 to 31 December 2007.

Main outcome measures Screening of abusive drug exposure using commercial bedside urine immunoassay kits.

Results Drug screening was performed in 395 injured drivers, 10% of whom tested positive for the drugs of interest. Ketamine was the most commonly detected abusive substance (found in 45% of the subjects). A significantly higher proportion of young drivers (aged <25 years) screened positive (odds ratio=2.3; 95% confidence interval, 1.0-5.2; P=0.04), with the rate being 21%. The presence of these drugs in urine was related to the time of occurrence of the crash; those occurring between midnight and dawn revealed a trend towards a higher proportion of casualties testing drug-positive (odds ratio=2.2; 95% confidence interval, 0.9-5.3; P=0.07). There were no significant differences in the frequency of persons testing positive for the screened drugs with respect to gender, class of motor vehicle driven, or the day of the week on which the crash occurred.

Conclusions The prevalence of drugged driving among non-fatal casualties in our series of Hong Kong drivers was 10%. The frequency of such drivers testing positive for drugs was significantly higher in persons aged less than 25 years. These findings indicate a need to amend existing laws and implement on-site drug screening for suspected drugged drivers.

Key words
Accidents, traffic; Psychotropic drugs; Street drugs; Substance abuse detection; Substance-related disorders

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Introduction

Traffic injuries represent a major public health issue and alcohol is a well-recognised risk factor for motor vehicle crashes (MVC).[1] Driving under the influence of drugs (DUID) other than alcohol is now considered to be an increasing cause of traffic accidents worldwide.[2] Exposure to illicit drugs impairs driving ability owing to their effects on the central nervous system, psychomotor performance, and risk-taking behaviour. Studies have shown the association between the use of psychoactive substances other than alcohol and increased accident risk.[3-5]

A roadside survey in Thailand showed a prevalence of psychoactive drug use among general drivers not involved in MVC to be 9.7%.[6] Alcohol or psychoactive drugs were found in 4.5% of drivers in a random sampling survey in Norway.[7] A high proportion of injured drivers have been reported to test positive in overseas studies involving psychoactive drug screening. Siliquini et al[8] revealed positive psychoactive substances present in 18.5% of the drivers involved in road traffic crashes in Italy. In a Swedish study, 13% of non–fatally injured drivers tested positive for pharmaceuticals which could impair driving.[9] A study conducted in Belgium involving 211 injured drivers showed that 12.3% screened positive for drugs, and about half of them tested positive for alcohol as well.[10] Among

injured drivers, there was a much higher prevalence of persons screened drug-positive reported from the United States, ranging from 22.6 to 50.9%.[11-14] In a local epidemiological study, 56% of the deceased drivers from single-vehicle crashes had alcohol and/or drugs in their bodies; 7% were positive for drugs only and 5% were for both drugs and alcohol.[15] However, there are no local data on the prevalence of abusive drug use in drivers of non-fatal motor vehicle casualties.

This study therefore aimed to evaluate the prevalence and characteristics of abusive drug exposure among the non-fatal motor vehicle driver casualties presenting to a designated trauma centre in Hong Kong.

因非致命交通事故被送往香港一所創傷中心的濫藥司機的比率

目的 探討因非致命交通事故被送往香港一所創傷中心的濫藥司機的比率及特徵。

設計 橫斷面研究。

安排 香港一所專責指定創傷中心／分區急症室。

參與者 2007年1月1日至12月31日期間，被送往創傷中心的非致命交通事故的傷者。

主要結果測量 用商業用床邊尿液免疫試劑檢測病人是否曾濫藥。

結果 395位接受藥物測試的受傷司機中，10%呈陽性反應。氯胺酮是最經常被檢測到的藥物，佔測試者中45%。25歲以下年輕司機對藥物測試呈陽性反應有明顯較高比率（比數比=2.3；95%置信區間，1.0-5.2；P=0.04），佔21%。本研究發現，對藥物測試呈陽性反應的個案，與發生車禍的時間有關，即午夜到清晨時分發生的車禍有較高比率（比數比=2.2；95%置信區間，0.9-5.3；P=0.07），可是與司機性別、駕駛車輛的款式、或於車禍發生的日子並無顯著關係。

結論 本研究中非致命交通事故受傷司機濫藥比率為10%。對藥物測試呈陽性反應的個案中，25歲以下的年輕司機有明顯較高的比率。這些結果顯示有需要修改法例以及對懷疑濫藥的司機實施即場藥物測試。

Methods

This study was conducted in a regional accident and emergency department, which was also one of the five designated trauma centres in Hong Kong.

The study period extended from 1 January 2007 to 31 December 2007. All motor vehicle driver casualties who presented to the trauma centre for treatment of injuries after a crash were approached for assessment. Fatal cases (certified dead in the emergency room) were excluded from the sample. All other injured drivers were considered eligible for recruitment, whatever their outcome after admission. The urine tests were performed if verbal consent was obtained from the patient or if deemed strongly indicated by the in-charge doctor (to assist management when consciousness was impaired). All eligible injured drivers who were screened had urine testing for abusive drug exposure, if there were clinical indications for drug screening or if verbal consent could be obtained. Consenting drivers were reassured that all information obtained would be kept confidential and used for scientific and not legal purposes.

We used two sets of bedside urine immunoassay kits (ACON Laboratories; San Diego, US) for screening. One was a multiple panel kit for 10 different drugs (amphetamine, methamphetamine, cocaine, 3,4-methylenedioxymethamphetamine [MDMA], tetrahydrocannabinol [THC], morphine, methadone, benzodiazepines, tricyclic antidepressants [TCAs], and barbiturates), and one was a single panel kit for ketamine. As TCAs and barbiturates are sometimes prescribed as therapeutic medications, these agents were not considered to be abusive drugs and were not included in the study. Epidemiological characteristics of the drivers were also collected.

The point prevalence of positive urine drug screening in these motor vehicle driver casualties was determined. Descriptive statistics were employed to illustrate the frequency of the positive results for different abused drugs. Binary logistic regression analysis was used to find any association between positive urine screening and characteristics of the drivers (gender, age [<25 or ≥25 years], class of motor vehicle), time of the MVC event (midnight-dawn [00:00-07:59], daytime [08:00-15:59], or evening [16:00-23:59]), and whether on a weekday (Monday to Friday) or a weekend (Saturday and Sunday).

The significance level was set at 5%. The goodness-of-fit of the regression model was examined by the log likelihood statistic. STATA (StataCorp, College Station, US) was employed for the statistical analysis. The study was approved by the cluster ethics committee of the Hospital Authority of Hong Kong and the Human Research Ethics Committee for Non-clinical Faculties of the University of Hong Kong.

Results

A total of 783 casualty drivers presented to our trauma centre during the study period, of whom 395 (50%) had urine drug screening. Among the latter, 150 drove private cars, 80 drove motorcycles, and 165 drove other vehicles. The mean and median ages of the sampled drivers were 37 and 28 (range, 18-63) years, respectively. The main reasons for not participating in the screening were withholding consent and failure to initiate the consent process prior to discharge.

Of 395 drivers, 38 (10%) of the screened drivers tested positive for at least one illicit drug. Ketamine

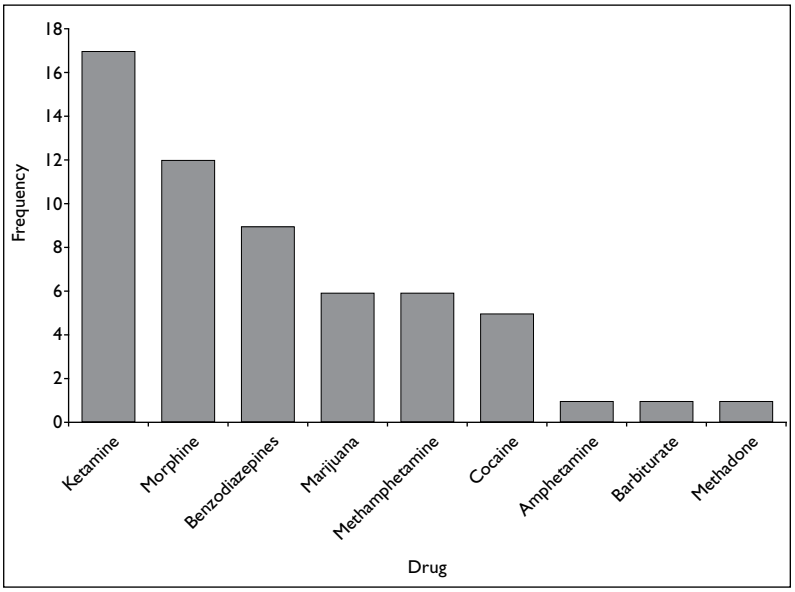

FIG. Distribution of abusive drugs detected in the screening test of injured drivers

TABLE 1. Drug combinations detected in patients with urine that tested positive

Category/drug involved	Frequency
Two positive results	
Marijuana + methamphetamine	1
Ketamine + cocaine	2
Ketamine + morphine	2
Three or more positive results	
Ketamine + methamphetamine + morphine	3
Ketamine + amphetamine + methamphetamine	1
Ketamine + benzodiazepines + cocaine + marijuana	1
Barbiturate + benzodiazepines + morphine	1
Benzodiazepines + morphine + methadone	1

was the most frequently detected abusive substance (n=17; 45%) in the sample (Fig); 26 (68%) tested positive for a single drug and 12 (32%) for more than one drug. Among the latter 12 drivers, seven tested positive for three or more drugs. The multiple drug combinations in the urine of these 12 drivers are shown in Table 1.

Table 2 shows demographic and other features of relevance to the sample of screened drivers. There were 63 (16%) drivers who were younger than 25 years, and 360 (91%) were male. Approximately 71% (281/395) of these casualties occurred on weekdays (Monday to Friday); 20% of the sampled drivers presented to the emergency department during the period 00:00-07:59 hours.

Table 2 also shows the results of binary logistic regression, which indicates a significantly higher frequency of urine testing positive for drugs among drivers aged below 25 years (odds ratio=2.3; 95% confidence interval, 1.0-5.2; P=0.04). Motor vehicle crashes occurring in the period midnight to dawn (00:00-07:59) were associated with a higher frequency of positive drug screening (odds ratio=2.2; 95% confidence interval, 0.9-5.3; P=0.07). There was no significant association with respect to vehicle types, genders, day of the accident (weekdays vs weekend) and urine testing positive. The model generally demonstrated a good fit with the observations.

Discussion

Drug abuse is an important social problem in Hong Kong. Apart from heroin, psychoactive substances such as ketamine, methamphetamine, and cannabis are commonly abused.[16] Driving under the influence of drugs has recently gained considerable attention as a potential threat to local road traffic safety. In reply to Legislative Council questions on 24 February 2010, the Secretary for Transport and Housing stated that there were four traffic accidents involving drivers suspected of DUID in the past 12 months. This may be an underestimate however, due to the limited investigation powers of the police that relate to current legislation about such driving.

Abusive drugs are mostly psychoactive substances. Theoretically, they have detrimental effects on psychomotor performance and may impair driving skills. The association between psychoactive substance use and driving impairment had been investigated in various types of studies, involving laboratories, simulators, as well as on-road and field investigations.

Ecstasy, also known as MDMA, and methamphetamine (ice) are commonly abused drugs in Hong Kong. Exposure to these stimulants could cause divided attention deficits in performing tasks and decreased appreciation of risks during driving.[17] However, laboratory studies have yielded inconsistent results with respect to impaired driving performance.[18] Low blood concentrations of amphetamine, methamphetamine, and ecstasy have been found in persons arrested for DUID.[19] The increased risk of MVC may actually be related to fatigue and sleep deprivation. In contrast to such stimulants, the relationship between the risk of MVC and benzodiazepine use has been well proven.[20] Apart from alcohol, cannabis is the most frequently detected abused substance in drivers involved in MVC reported in the literature.[18] Compared with ketamine, cannabis abuse in Hong Kong is less common and there is actually a decreasing trend.[16] Experimental studies show that THC, the major psychoactive compound in cannabis, acutely impairs cognition, psychomotor function, and driving performance in a dose-related manner. According to epidemiological analyses, combined use of alcohol and cannabis significantly increases the risk of a MVC.[21]

In Hong Kong, heroin is one of the most

commonly abused substances.[16] However, the association of opioid intoxication and consequential sedative effects with the risk of MVC has not been well studied.[18] In Hong Kong, there has been a sharply rising trend in ketamine abuse in recent years,[16] but no local study has explored its impact on road traffic safety. Ketamine use is associated with poor body coordination and balance,[22] which could impair driving performance.

When purchasing standard comprehensive private vehicle insurance policy in Hong Kong, being 'a young driver' results in an excess charge. A young driver is usually defined as aged less than 25 years. According to the data for the year 2003 to 2007 from the local Transport Department, 8 to 10% of motor vehicle drivers involved in crashes were under 25 years.[23] Notably, motor vehicle driver casualties in persons aged under 25 years accounted for 34% (13/38) of our sample who tested drug positive, which is substantially higher than that anticipated from the proportion of young subjects in our cohort of drivers who crashed. This observation is consistent with our finding that being a driver aged under 25 years was an independent factor associated with positive drug screening (odds ratio=2.3). Positive drug screening should not be interpreted as equivalent to drug intoxication. On the other hand, a drug abuse habit may be associated with other forms of high-risk driving behaviour, including drink driving, an increased risk of crashing, and having an adverse crash outcome. Therefore, the exact association between abused drug intoxications and crash outcomes cannot be established directly from the present study that used drug screening as the main measure of outcome.

According to the voluntary reporting system of the Central Registry of Drug Abuse, heroin and ketamine are the most commonly reported abused drugs. Ketamine is the most popular psychoactive substance abused by the persons aged less than 21 years.[16] Our study revealed that ketamine was the most frequently detected drug among drivers who screened positive. Among those testing positive for more than one drug, ketamine was also the commonest drug used in the combination (Table 1). In general, drugs detected in impaired drivers could reflect the general pattern of drug use in the community,[18] and our results indicate a high frequency of ketamine use in Hong Kong.

This study showed that driver casualties presenting to our trauma centre during the dawn to morning period were more likely to have urine specimens that screened positive than those presenting during the daytime. This result may be explained by the wider range of entertainment activities (dancing and clubbing) taking place at night. However, there was no significant difference in the association with respect to testing drug-positive

TABLE 2. Characteristics of sampled drivers and results of binary logistic regression for the prevalence of drugged drivers*

	No. (%) of drivers (n=395)	No. (%) of test positive	Odds ratio (95% confidence interval)	P value
Time				
00:00-07:59	79 (20)	14 (18)	2.2 (0.9-5.3)	0.07‡
08:00-15:59	156 (39)	12 (8)	1	
16:00-23:59	160 (41)	12 (8)	0.9 (0.4-2.2)	0.89
Age (years)				
<25	63 (16)	13 (21)	2.3 (1.0-5.2)	0.04†
≥25	332 (84)	25 (8)	1	
Vehicle				
Motorcycle	80 (20)	7 (9)	1.2 (0.4-4.2)	0.74
Private car	150 (38)	21 (14)	1.9 (0.6-5.5)	0.26
Taxi	82 (21)	5 (6)	1.0 (0.3-3.7)	0.98
Others	83 (21)	5 (6)	1	
Gender				
Male	360 (91)	34 (9)	0.8 (0.3-2.5)	0.69
Female	35 (9)	4 (11)	1	
Day				
Weekend	114 (29)	10 (9)	0.9 (0.4-1.9)	0.73
Weekday	281 (71)	28 (10)	1	

* Log likelihood ratio statistics=13.62
† Statistically significant at the 5% level
‡ Statistically significant at the 10% level

and weekdays as opposed to weekends.

An earlier Hong Kong study showed that among all classes of vehicle drivers involved in local road traffic accidents in 2007, motorcyclists had the highest driver fatality rate (4.4 per 1000 drivers).[23] Our study did not demonstrate a significantly higher proportion of urine screened drug-positive among motorcyclists, but our results could be limited by the small number of motorcyclists in our sample.

In most of western countries, DUID is covered by specific legislation; different countries having passed different types of related statutes. These statutes require that either the drugs achieve a level that renders the driver incapable of driving safely, or adopt a zero tolerance whereby drugged drivers are prosecuted if defined drugs or metabolites are detected in their bodies.[24] In Hong Kong, the definition of drug driving is not clear. What the legislation states is that "a person who drives or attempts to drive or is in charge of a motor vehicle on any road while he is under the influence of drink or drugs to such an extent as to be incapable of having proper control of the motor vehicle commits an offence".[25] In contrast to drink driving, police officers are not empowered to conduct random checks or obtain blood or urine samples from DUID suspects for the purpose of prosecution under the existing law. Amendment of the existing legislations to implement on-site compulsory testing of suspected drugged drivers may be an important combating strategy. Compulsory testing should be considered in drivers involved in any MVC and particularly persons who pass the breath alcohol test but fail field sobriety testing. For the implementation of random checks, the issue may be more complicated and a careful balance between the public acceptance and the benefits of deterring DUID should be considered. Concerning the feasibility of obtaining body fluid samples at the scene, saliva could be the preferred matrix for roadside drug screening. At present, however, there is no commercially available roadside saliva testing device for ketamine that has satisfactory sensitivity and specificity.

Limitations

Accuracy of immunoassay tests

The cross-reactivity of tested substances with other structurally similar compounds often cause false positives when based on immunoassays.[26-30] In legal settings requiring proof that a particular drug is present beyond doubt, confirmation by gas chromatography/mass spectrometry is preferable. However due to the limitation of resources and the design of our study, all urine testing positive by us were considered true positives. Notwithstanding this limitation, results from overseas studies involving toxicology screening in trauma patients revealed a high correlation between drug screening results and subsequent laboratory confirmation.[31,32]

Supportive evidence of driving under the influence of drugs by the positive drug screening results

It is often difficult to establish the causal relationship between a positive screening result and the MVC. Positive screening merely indicates recent exposure to the abused drug(s). Some drug screening tests detect inactive metabolites of the abused drugs, for example, those of cocaine, which persist in the body for much longer time than the active compound(s). Thus, urine tests provide no proof that the driver was under the influence of a drug (ie was intoxicated) and that this caused the event.

Selection bias and response rate of the sample

Santamariña-Rubio et al[33] reported that gender, attendance time, and waiting time could be independent factors for non-participation in drug screening tests. We did not assess our sample for any such selection biases. Due to voluntary participation, the response rate for urine screening was expected to be low. Persons who had been exposed to abused drugs were considered more likely to refuse the tests. Our participation rate was slightly above 50%. Thus, 10% may represent a minimal estimate of the local prevalence of abused drug exposure in motor vehicle driver casualties.

Conclusions

Driving under the influence of drugs is a recognised potential threat to road safety in Hong Kong. Our result indicating a 10% prevalence for abused drug exposure in local non-fatal motor vehicle drivers probably represents a fair-to-conservative estimate. The estimated prevalence among drivers aged less than 25 years (21%) was significantly higher. These results indicate an urgent need to explore objective means of identifying DUID and update existing laws for the prosecution of this offence.

Declaration

This study did not involve any direct financial interest with any commercial organisation. The findings of the study have also been submitted (by the first author) to the Hong Kong Poison Information Centre for partial fulfilment of the requirement for a Diploma of Clinical Toxicology. The bedside urine immunoassay kits (ACON) used in this project were donated by the Transport Department of the HKSAR Government and the donor has in no way influenced the authors in the conduct of this study and reporting of its results and conclusion.

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