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The occurrence of alcohol/drugs by toxicological examination of selected drivers in Hong Kong

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ABSTRACT

The study is to investigate the extent of alcohol/drug(s) use among selected drivers, *i.e.* fatally injured drivers from traffic accidents (2006–2015), drink driving (2006–2015) and drug driving (2010–2015) cases, in Hong Kong. Between 2006 and 2015, specimens from a total of 223 fatally injured drivers were received for toxicological examination. Except for one driver, all other drivers with positive findings were male. Alcohol and/or drugs were detected in 60 (27%) cases where alcohol alone was detected in 40 cases (18%) while drugs with/without alcohol were detected in 20 cases (9%). A decreasing trend is observed for cases with blood/breath alcohol concentrations above the prescribed limits in both fatally injured drivers and drivers from drink driving cases in 2006–2015. Out of the 20 cases with positive findings in drugs, 8 of them were found with alcohol in which only one case found at level above the prescribed limit. The frequency of drugs encountered that are known to affect driving in blood is 31, representing an average of about 1.7 drugs per individual. Ketamine was the most frequently detected drug in fatally injured drivers. Sedatives/hypnotics (*i.e.* diazepam/nordiazepam, midazolam, 7-aminonimetazepam, 7-aminonitrazepam and zopiclone), morphine/monoacetylmorphine, cocaine/benzoylecgonine, methamphetamine, methadone and codeine were also detected. There has been a sharp increase in the submission of blood/urine specimens for toxicological analysis related to drug driving cases since 2010 with a total of 48 cases received in 2010–2011. With the introduction of legislative amendment of drug driving law since 2012, 154 cases were received in 2012–2015. The positive rates for drug driving cases examined were found to be 90% (43 out of 48 cases) in 2010–2011 and 89% (137 out of 154 cases) in 2012–2015. Drivers with single drug use were more frequently detected (40 cases in 2010–2011 and 82 cases in 2012–2015) than multiple drug use (3 cases in 2010–2011 and 55 cases in 2012–2015) but an increase in the use of more than one drug in driving population is noted. Ketamine was detected in the majority of cases (34 cases in 2010–2011 and 104 cases in 2012–2015). However, drug driving cases in recent years revealed that increase usages of methamphetamine, cocaine and zopiclone were observed. The mean, median and range of ketamine concentrations for 134 blood samples taken from drivers in drug driving cases were 0.34, 0.27, 0.01–1.8 μg/mL respectively.

1. Introduction

Driving under the influence of alcohol and drugs is considered to be one of the major problems worldwide that contribute to traffic accidents, causing injury and fatality to many people [1]. While alcohol is still the main psychoactive substance endangering lives on the roads today, many other psychoactive substances, in particular abused drugs, are known to affect some important skills necessary for the safe operation of a vehicle, such as coordination, judgment, perception, tracking and reaction time [2]. Many studies performed in Europe [3–13], the United States [14–17], Canada [18,19], Australia [20–22] and Brazil [23] indicated that cannabinoids, amphetamines [amphetamine, methamphetamine (MA), 3,4-methylenedixoymethamphetamine (MDMA)], opiates (heroin, morphine) and cocaine were the common psychoactive drugs encountered in drugged drivers. Although similar epidemiological studies reported in literature for Asian countries were scarce, similar trends had been reported in Hong Kong [24] and a study from Thailand [25] except that ketamine in Hong Kong and mitragynine in Thailand were also encountered.

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In Hong Kong, the drink and drug driving are regulated in the Road Traffic Ordinance under the clause "driving a motor vehicle under the influence of drink or drugs" which covers both illicit and medicinal drugs. However, there was no provision in the local law before 2012 to mandate suspected drug-impaired drivers to have their body fluids such as blood and/or urine samples taken to ascertain the presence of drugs. Thus, legislative amendment for the drug driving law has been enacted since 2012 with the emphasis of tightening control over specified illicit drugs and incorporation of enforcement procedures.

The concentrations of drugs or related metabolites such as heroin [26–28], MA [29,30], MDMA [29], cannabis [31,32] and cocaine [33] found in blood samples of drugged drivers in various studies provided many useful data to assist in result interpretation but such data for ketamine was unavailable.

The abuse of ketamine has gained popularity in some Asian countries in recent years [34]. Ketamine is a dissociative anesthetic commonly used in veterinary and pediatric surgery. Abusers usually take subanaesthetic doses which can produce alterations in mood and body image, visual hallucinations, "out of body" experiences and vivid dreams (pleasant or unpleasant) [35]. Users usually experience the effects of ketamine through snorting of the powder ketamine in around 10 min, or about 20 min if it is taken orally. The systemic side effects of ketamine abuse on the central nervous system, respiratory and cardiovascular systems have been well recognized, though there were very few reported deaths. It has been reported recently that chronic use of ketamine might cause bladder dysfunction and destruction of the lower urinary tract [36,37].

Ketamine has begun to be one of the commonly abused drugs in Hong Kong since 2001 [38]. With the drug driving cases frequently encountered with ketamine, it prompted us to investigate and document the ketamine concentrations found in local scenario. Previously, our laboratory reported an epidemiological study for fatally injured drivers in 1996–2000 where all drivers with positive findings were male in the age group of 21–30 (median 25) [24]. Of the 197 cases examined, 66 cases were detected with alcohol and 45 cases with alcohol levels above the prescribed limit of 50 mg/100 mL blood. For those 12 cases with drug(s) detected, the drugs involved were MDMA, MA, cannabis, benzodiazepines and ketamine [24]. It was noted 15 years ago that there were concerns of ketamine abuse particularly in the driving population. As there was a lack of on-site device(s) in the market at that time such that only an impairment approach such as the Drug Evaluation and Classification Program (DECP) could be employed for identification.

In this study, we present a retrospective study for i) the findings of toxicological examination of body fluids taken from fatally injured drivers between 2006 and 2015, ii) the alcohol findings of drivers who were arrested for suspected drink driving in 2006–2015 and iii) the toxicological findings of drivers who were arrested for suspected drug driving in 2010–2015. In particular, the prevalence of ketamine found in biological specimens of the selected drivers in Hong Kong is also investigated.

2. Materials and methods

2.1. General information

In this study, as the only designated laboratory responsible for forensic toxicological examination in Hong Kong, all cases requiring toxicological examination in Hong Kong under the categories of fatal traffic accidents and drink driving in 2006–2015, and drug driving in 2010–2011 and 2012–2015 were examined. In general, the drivers for suspected drink/drug driving would first be required to perform the screening breath test (SBT). If the drivers failed the SBT (*i.e.* above the prescribed limit of 22 μg alcohol/100 mL breath), they would be required to perform the evidential breath test (EBT) or have blood/urine samples taken for alcohol analysis. If the drivers failed the EBT or blood/urine alcohol analysis (*i.e.* above the prescribed limit), they would be charged with the offence of drink driving. After passing the breath test, the drivers would be screened for drug if the observed impairment/erratic driving was believed not to be caused by alcohol. Before 2012, the police officers would assess the drivers based on circumstantial evidence(s) such as the presence of suspected illicit drug(s) in the case, observed physical state of the driver and his manner of driving. If the police officers considered the drivers suspected to be under the influence of drugs, consents would be required to obtain from the drivers before taking blood/urine for analysis but the drivers could refuse to do so. After the amendment of the drug driving law in 2012, the drivers would, according to procedures, be dealt with for screening of drug driving by an on-site preliminary test, drug influence recognition observation, followed by an impairment test which would be conducted in a police station before forming an opinion that the drivers could have under the influence of drugs. If the drivers failed the impairment test, they would be charged with drug driving. They were immediately taken to the hospital for body fluid collection. Body fluids including blood and/or urine samples were collected by medical professionals and the urine samples could also be taken by law enforcement officers. The body fluids from the fatally injured drivers were usually taken by pathologists. While blood samples were the preferred specimens of choice, unavailability of blood samples were also encountered in some of cases included in this study, and that only urine samples were taken and requested for toxicological examination according to operational/enforcement and/or local drug driving law requirements. For blood samples taken from suspected drunken drivers for alcohol analysis, suspected drugged drivers for drug analysis, and also blood samples and vitreous humor taken from fatally injured drivers for alcohol analysis, special tubes with sodium fluoride as preservative and potassium oxalate as anti-coagulant were used. For other biological specimens, no preservative was added. All the biological specimens were stored at 4 °C before analysis.

2.2. Reagents and standards

The ethyl alcohol calibrators at various levels of 20–200 mg/100 mL were purchased from Cerilliant (Round Rock, TX, USA). The ethyl alcohol control at levels of 50 mg/100 mL and 100 mg/100 mL were purchased from Medichem (Steinenbronn, Germany). The reference standards including morphine, codeine, ketamine, norketamine, amphetamine, MA, MDMA, 3,4-methylenedioxyamphetamine, cocaine, benzoylecgonine, ecgonine methyl ester, delta-9-tetrahydrocannabinol (THC) and 11-nor-9-carboxy-delta-9-tetrahydrocannabinol (THC-COOH) were purchased from Cerilliant and/or Lipomed (Arlesheim, Switzerland) as 1 mg/mL solutions in methanol (except THC-COOH which was 0.1 mg/mL). Diazepam, nordiazepam, midazolam, hydroxymidazolam, methadone and zopiclone were purchased from Cerilliant as 1 mg/mL solutions in methanol. Isotope-labeled internal standards were purchased from Cerilliant. Monoacetylmorphine, methaqualone, nalorphine, prazepam and zolpidem were purchased from Lipomed. 7-aminonimetazepam and brotizolam were purchased from TRC (Toronto, Canada). Other drug standards were purchased from Cerilliant or Lipomed. All reagents and solvents used were of analytical grade or equivalent and used as received.