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Research paper

High prevalence of previous arrests for illicit drug use and/or impaired driving among drivers killed in motor vehicle crashes in Sweden with amphetamine in blood at autopsy

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ABSTRACT

Background: Amphetamine, and to a lesser extent the secondary amine methamphetamine, are major recreational drugs of abuse in Sweden. These central stimulant amines are identified in blood from roughly 50% of people arrested for driving under the influence of drugs (DUID). However, much less information is available about the presence of amphetamine in blood of drivers killed in road-traffic crashes.

Methods: This retrospective 10-year study (2001–2010) used a forensic toxicology database (TOXBASE) to retrieve information about road-traffic crashes when the driver had amphetamine and/or methamphetamine in autopsy blood. Forensic toxicology results were available from over 95% of all drivers killed on Swedish roads during this 10-year period.

Results: Amphetamine was present in the blood of 106 drivers (3.9%) either alone or together with other psychoactive substances (e.g. alcohol, cannabis, diazepam, alprazolam, etc.). The vast majority of fatalities were male (95%) with a mean age (±standard deviation) of 37 ± 11.4 years (range 16–67 years). The mean (median) and highest concentrations of amphetamine in femoral blood were 1.36 mg/L (1.0 mg/L) and 6.74 mg/L, respectively. Many of the victims (75%) had been arrested previously for use of illicit drugs or DUID. The median number of previous arrests was 4 (range 0–83) and amphetamine or methamphetamine were among the drugs identified in blood samples from 89% of cases (0–100%).

Conclusion: The high prevalence of repeat DUID offending and/or use of illicit drugs among the drivers killed in road-traffic crashes suggests that an early intervention and treatment for stimulant abuse might have been more beneficial than conventional punishments for such drug-related crimes.

Introduction

Driving under the influence of drugs other than alcohol has become an increasing problem for traffic safety and several countries have introduced legislation making it illegal to drive after use of controlled substances (Jones, 2005; Kuypers, Legrand, Ramaekers, & Verstraete, 2012; Romano & Pollini, 2013; Vindenes et al., 2012). The major illicit drugs used by drivers in Sweden and other Nordic countries are cannabis, amphetamines and cocaine, whereas medicinal drugs are dominated by benzodiazepines and other sedative-hypnotics (Ahlner, Holmgren, & Jones, 2014; Jones, Holmgren, & Kugelberg, 2008; Morland et al., 2011).

Sweden introduced a zero-tolerance law for driving with scheduled substances in blood in 1999 and similar traffic-safety legislation has since been adopted in other European nations (Legrand et al., 2013). By contrast, DUID laws in US states are not well standardized and considerable variation exists between and within jurisdictions (Berning & Smither, 2014). Whether a forensic autopsy is performed might depend on age and gender of the deceased and there is no consistent policy regarding toxicological analysis (Berning & Smither, 2014; Voas, Dupont, Shea, & Talpins, 2013). The types of drugs deemed illegal, the cut-off concentrations for reporting positive results and whether specimens of blood or urine were analyzed seems to differ between different jurisdictions (Logan et al., 2013; Reisfield, Goldberger, Gold, & DuPont, 2012).

Central stimulant amines are major drugs of abuse in Sweden and intravenous injection is the preferred route of administration (Bejerot & Bejerot, 1977; Goldberg, 1968). Driving under the influence of amphetamine was documented during the 1960s

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(Bonnichsen, Maehly, Marde, Ryhage, & Schubert, 1970) and more recent studies show that 50% of drivers arrested by the police suspected of DUID had taken amphetamines before driving (Jones & Holmgren, 2013).

This article reports the characteristics of drivers killed in road traffic crashes in Sweden when amphetamine and/or methamphetamine were identified in autopsy blood samples. Age and gender of the deceased, the concentration of amphetamine in blood, the existence of any co-ingested drugs, single vs multiple-vehicle crashes and whether victims had previous arrests for illicit drug use or DUID were examined.

Methods

Road-traffic fatalities in Sweden

Sweden has a population of roughly 9.4 million and over 95% of all drivers killed in road traffic crashes are subjected to a forensic autopsy including toxicological analysis. The analysis of blood and urine for alcohol and other drugs is done at one central laboratory using well standardized procedures. The analytical results along with demographics of the deceased are entered into a forensic toxicology database (TOXBASE), which was used for the present study.

Forensic pathologists are instructed to obtain femoral blood for toxicological analysis before evisceration of the body. Potassium fluoride (~2% w/v) is added to blood as a preservative and specimens are shipped refrigerated to the National Laboratory of Forensic Toxicology for analysis. Femoral blood was available for analysis in 83 of the 106 amphetamine-related crashes and it is these results that provided descriptive statistics for the concentrations of amphetamine. In the remaining 23 cases amphetamine was verified as present in heart blood or pleural cavity blood.

Between 2001 and 2010, a total of 2696 drivers were killed on Swedish roads. A forensic autopsy and toxicological analysis was requested by the police in over 95% of these traffic fatalities.

Analysis of amphetamine in blood

The same analytical method was used for determination of amphetamine in forensic blood samples during the 10-year period (Jones, Holmgren, & Ahlner, 2011). In brief, to 1 mL of blood was added 100 μL of deuterium labelled amphetamine (d_8) as an internal standard. The mixture was made alkaline by adding 0.5 mL of sodium hydroxide (2 M) and basic drugs were extracted by mechanical shaking with ethyl acetate (5 mL) for 5 min. After centrifugation the organic phase was removed and transferred into a clean dry glass vial. The solvent was evaporated to near-dryness under a stream of nitrogen without applying any heat and a few drops of trifluroacetic acid (TFAA) added to prepare a derivative for gas chromatographic (GC) analysis. The reaction tubes were allowed to stand in a warm block (60 °C) for 15 min, cooled to room temperature and excess TFAA evaporated under a constant stream of nitrogen without applying heat. The residue was reconstituted into 40 μL of ethyl acetate and transferred into micro-vials in preparation for GC analysis.

GC–MS verification analysis

Gas chromatography–mass spectrometry (GC–MS) purchased from Hewlett Packard (HP) – Agilent Technologies (HP5890A or HP 6890N) and HP 7693 auto-sampler was used for analysis. The chromatography was done on a DB-5 capillary column (J & W Ltd.) with a temperature program run from 60 °C to 270 °C in 3 stages. For selected ion monitoring the following ions were used; m/z 118 and m/z 126 (amphetamine and d_8-analogue), and at least one qualifier ion. Amphetamine calibration curves were linear from 0.02 to 2 mg/L and the limit of quantitation (LOQ) was 0.03 mg/L for both amphetamine and methamphetamine. If initial results showed amphetamine concentrations exceeding 2 mg/L, the analysis was repeated starting with a smaller volume of blood and dilution to 1 mL with drug-free blood.

Statistical methods

Means, medians and 90th, 95th and 97.5th upper percentiles were used as descriptive statistics to report concentrations of amphetamine in blood. Two median concentrations were compared using the Mann–Whitney non-parametric test. The mean age of men and women were compared by using Student's independent t-test. The differences between proportions of male and female users of amphetamine were evaluated by the chi-squared test. An association between the driver's age and the concentration of amphetamine in blood was tested by regression analysis and calculating the Pearson correlation coefficient.

Results

Demographics of victims

The mean age of drivers killed with amphetamine in blood was 37 ± 11 years (range 16–67 years) and the vast majority were male (95%). The five females drivers killed were about 10 years younger (mean 28 years) than their male counterparts (mean age 37 years).

Blood-amphetamine concentrations

Of the 106 traffic deaths, 87 (82%) were verified positive for amphetamine, 15 (14%) were positive for both amphetamine and methamphetamine and in 4 cases (3.8%) only methamphetamine was present in autopsy blood. Both amines are pharmacologically active, so concentrations were added together to arrive at a total concentration of the central stimulants.

Fig. 1 shows a relative frequency distribution of the concentrations of amphetamine in femoral blood (N = 83). This distribution is markedly skewed to the right with mean and median of 1.36 mg/L and 1.00 mg/L, respectively. Also shown is a cumulative frequency distribution, which indicates that the concentrations of amphetamine exceeded 2.0 mg/L in 20% of all traffic deaths.

The blood-concentration of amphetamine was higher in the 5 female victims (mean 4.5 mg/L, median 5.6 mg/L) compared with all fatalities (mean 1.36 mg/L and median 1.00 mg/L). Otherwise there

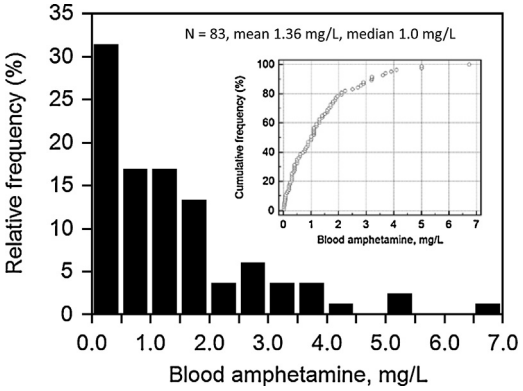

Fig. 1. Relative frequency distribution of the concentrations of amphetamine in femoral blood of drivers killed in road-traffic crashes in Sweden. The insert graph shows a cumulative frequency distribution of the concentrations of amphetamine in blood.

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