Forensic Science International 244 (2014) 25–29

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

A population-based study on toxicological findings in Swedish homicide victims and offenders from 2007 to 2009

Jonatan Hedlund [a,b,*], Johan Ahlner [c,d], Marianne Kristiansson [a,b], Joakim Sturup [a,b]

[a] National Board of Forensic Medicine, Department of Forensic Psychiatry, PO Box 4044, SE-141 04 Huddinge, Sweden
[b] Karolinska Institutet, Department of Clinical Neuroscience, SE-171 77 Stockholm, Sweden
[c] National Board of Forensic Medicine, Department of Forensic Genetics and Forensic Toxicology, Artillerigatan 12, SE-587 58 Linköping, Sweden
[d] Linköping University, SE-581 83 Linköping, Sweden

ARTICLE INFO

Article history:
Received 16 June 2014
Accepted 17 July 2014
Available online 25 July 2014

Keywords:
Homicide
Toxicology
Substance abuse

ABSTRACT

Background and objectives: Previous research on the toxicology of homicide has shown that about half of offenders and victims have psychoactive substances in their blood. The purpose of this study was to examine this topic in a Swedish setting.
Methods: Toxicological data were sought in a database for all victims ($n = 273$) and perpetrators ($n = 257$) of homicide in Sweden from 2007 to 2009. Sufficient tests were identified for 97.1% of all victims ($n = 265$) and 46.7% of all offenders ($n = 120$). Additional information was obtained from court records and police reports.
Results: A majority of individuals involved in homicides displayed positive toxicology (57.0% of victims and 62.5% of offenders). The most commonly detected substances, in both victims and offenders, were ethanol (44.9% vs. 40.8%) and benzodiazepines (8.3% vs. 19.2%). The difference between offenders and victims concerning benzodiazepines was statistically significant (OR 2.6; $p = 0.002$). Perpetrators of homicide–suicide had a lower prevalence of positive toxicology (30.8%) than other homicide offenders (66.4%; $p = 0.04$) and victims in unsolved cases more often exhibited positive drug toxicology compared to victims in solved cases (36.1% vs. 8.3%; $p < 0.001$).
Conclusions: The results of the study support the notion that substance abuse is firmly linked to committing homicide and to becoming a victim thereof.

1. Introduction

There is a voluminous and increasing body of research that lends support to a link between drugs of abuse and violence [1–6]. According to a comprehensive review on the toxicology of homicide, about half of both offenders and victims have psychoactive substances in their blood [7]. Rises in the sales of alcohol, which by far is the most important substance in the context of violence [8], have been shown to be associated with increased homicide rates [9–11]. Further, studies have established a correlation between liquor outlet density and both violence and violent death [12,13]. In countries where alcohol is a common recreational drug, its ability to elicit poor judgment and bad decision-making is arguably well known. Several studies have highlighted possible, partially intertwined, underlying mechanisms including reduction of fear, modulation of pain sensitivity, increased novelty seeking and impulsivity [8].

As proposed in a seminal work by Goldstein, the mechanisms by which drugs relate to violence may be presented in a tripartite model: (i) the direct *pharmacological effects* of a substance (e.g., intoxication and symptoms of withdrawal, etc.); (ii) violence following the need to obtain money for drugs, e.g., through robbery (the *economic–compulsive* model); and (iii) *systemic violence* resulting from activities on illicit drug markets, where disputes usually are solved violently [14,15]. This model may be of importance with respect to prevention.

Sweden has a homicide rate of approximately 1 per 100,000 inhabitants, with a higher rate among males (1.13) than females (0.71) – low figures in an international perspective [16]. Overall, the rate of homicide in Sweden has decreased since the 1990s [17] particularly with regard to three subcategories of homicide. First, one study has reported that there has been an annual 3% reduction

* Corresponding author at: Department of Forensic Psychiatry in Stockholm, National Board of Forensic Medicine, PO Box 4044, 141 04 Huddinge, Sweden. Tel.: +46 8 6071544; fax: +46 8 7117141.
E-mail address: jonatan.hedlund@rmv.se (J. Hedlund).

http://dx.doi.org/10.1016/j.forsciint.2014.07.015
0379-0738/

in homicides committed by offenders suffering from psychosis from the mid-1980s to the mid-2000s [18]. Second, another study has reported an annual 4% decrease in the rate of child homicide 1990 [19]. Lastly, and most importantly for the present study, there has been a reduction in alcohol-related homicides according to at third study [17], which, however, did not propose an explanation for the decrease.

Homicide–suicide (i.e., perpetrator suicide following homicide) represents a distinct subcategory of lethal violence, with different characteristics compared to cases of isolated homicide or suicide [20]. The topic is complex, partly owing to various definitions of homicide–suicide in the literature, with substantial incongruity regarding delimitation of the homicide–suicide interval [21]. Although the toxicology of homicide–suicide has been little examined, it seems that substance abuse is of less importance in these cases [22] – perhaps due to more severe psychopathology in offenders, compared to perpetrators of isolated homicide. The issue, however, is difficult to study as a consequence of the offenders being deceased.

2. The Swedish setting

Sweden has a population of 9.6 million inhabitants, and all suspected unnatural deaths are investigated by a forensic pathologist to determine cause of death. Autopsies are performed at six sites in the country under the direction of the National Board of Forensic Medicine and are combined with toxicological investigations. When requested by local police authorities, toxicological analyses are also performed on offenders. The Department of Forensic Toxicology and Forensic Genetics at the National Board of Forensic Medicine bears nationwide responsibility for conducting forensic-toxicological analyses, and biological specimens are sent there for analysis in special refrigerated containers.

In the present study, homicide is defined as murder, manslaughter, infanticide and causing another's death by means of assault. The term toxicology is defined as the presence or absence of licit or illicit psychoactive substances of abuse in a biological specimen, and the term drug is defined as a licit or illicit psychoactive substance other than ethanol.

3. Aims of the study

The aims of the current study are to examine the prevalence of licit and illicit psychoactive substances among perpetrators and victims of homicide in Sweden and to describe positive toxicological tests with respect to time and location of the offense. Further aims are to investigate whether analyses of unsolved cases and cases of homicide–suicide yield diverging results.

4. Materials and methods

4.1. Methods and case identification

The study has a retrospective, register-based, consecutive-case-series design. All victims ($n = 273$) and perpetrators ($n = 257$) of homicide in Sweden from January 1, 2007, to December 31, 2009, were included. Victims were identified from a database administered by the National Board of Forensic Medicine, which encompasses all individuals that have undergone an autopsy. The database includes the police-report identification number for every victim, by way of which the police reports were identified and collected. Offenders were identified through the National Crime Register, which is administered by the Swedish National Council for Crime Prevention. Further, with the aid of information in court documents, linkage of offenders and victims was performed. Data regarding crime location and time and type of day were collected from police reports and court records.

The Department of Forensic Toxicology and Forensic Genetics provided toxicological data for victims and offenders. Test results for the latter were included only if they were obtained within 48 h of the offense. With that time frame, toxicological results were deemed reasonably likely to be of relevance for the mental status of the perpetrator at the time of the offense. In a subset of cases, ambulance charts and medical records were studied in detail to clarify whether positive toxicology results were attributable to health-care interventions, in which case the results were excluded ($n = 9$).

4.2. Biological specimen

We used the Department of Forensic Toxicology and Forensic Genetics in-house database (ToxBase) to retrieve information concerning the concentrations of ethanol and drugs determined, in the majority of cases (82.5%), in femoral blood. Analytical work was performed at one central laboratory, and over the 3-year study period, the methods used have remained more or less unchanged. Specimens of femoral blood, urine and vitreous humor were obtained at autopsy and submitted for analysis in tubes containing potassium fluoride (2.0%, wt./vol.), added as a preservative and enzyme inhibitor. A broad range of toxicological analyses were carried out to determine the concentrations of ethanol and illicit and prescription drugs in femoral blood samples.

4.3. Analysis of blood ethanol

Blood–ethanol concentration was determined in duplicate by headspace gas chromatography using a well-established method as described in more detail elsewhere [23]. In this study, we have chosen to report all positive ethanol toxicology results. However, there is a small risk of false-positive results owing to post-mortem ethanol formation. These processes are dependent on multiple factors, and it is not possible to establish a cut-off level that firmly separates cases of pre-mortem ethanol ingestion from cases with post-mortem formation [24].

4.4. Analysis of substances other than ethanol

Analysis of substances other than ethanol was accomplished by initial use of a broad screening protocol with immunoassay methods (EMIT and/or CEDIA), aimed at identifying presumptive positive cases. The screening was intended mainly to detect various classes of illicit drugs (amphetamines, opiates, cannabis and cocaine) and was done with specimens of urine. If no urine was available, blood samples were used after precipitation of proteins with acetone. All positive results from the screening tests were verified by more specific chromatographic methods, such as gas chromatography–mass spectrometry (GC–MS) with deuterium-labeled internal standards.

Prescription drugs, including methadone and other strong opiate analgesics, were analyzed in blood after solvent extraction with n-butyl acetate and capillary-column gas chromatography with a nitrogen-phosphorous detector. This analytical method allows simultaneous screening and quantitative analysis of about 200 different weakly acid, neutral and basic drugs, as well as many metabolites. The analytical limits of quantitation for reporting positive results differed for different substances.

4.5. Statistics and ethics

The study is descriptive, and statistical significance testing was conducted by a chi-squared test or Fisher's exact test. Odds ratios