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Homicide Injury Quantification

Measures of injury severity in homicide victims and associations with homicide characteristics

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Abstract
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Some previous studies have found that the amount and severity of injuries in homicide victims correlate with different homicide characteristics, such as the victim-offender relationship and drug influence of the offender. If such relationships exist, they may be used by homicide investigators as part of an offender profiling.

Furthermore, injury severity may be helpful in understanding the nature of lethal violence. If the injuries change over time or differ between regions, this may say something about the underlying causes and thus help society to take preventive measures. However, measures of injury severity are often missing in homicide epidemiology. This may in part be due to a lack of standardized and accessible ways to quantify injuries in homicide victim.

To address these issues, there is a need for methods to quantify injury severity in homicide victims. The aim of the current thesis was to investigate different types of injury measures and their applicability to homicide victims. The aim was also to use such measures to address research questions related to offender profiling.

Starting off with injury scores used in trauma research and two scores developed specifically for homicide victims, these measures were applied to a general homicide population. Since there is no obvious "gold standard" for injury severity quantification on homicide victims, one had to be defined to validate the applied methods. Out of forensic experience and rational reasoning, the Sum of all AIS scores (SAIS) was proposed as a reference measure. The other scores were then evaluated through their correlations with the SAIS.

In the following study, the injury severity in homicides from different time periods was measured. There were statistically significant increases over time with respect to excessive injuries and the number of lethal injuries per victim. These changes can reflect both a brutalization of homicidal violence, improved trauma care, or shifts in the methods by which people are killed.

Next, the associations between injury severity and homicide characteristics were analysed. No relevant associations between injury severity and victim-offender relationship were found. Neither were there any connections between benzodiazepine influence in the offender and injury severity on the victim. Thus, the studies do not support the use of injury severity scores for offender profiling in a general homicide population.

Keywords: Homicide, Injury score, Injury quantification, Offender profiling

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Dedicated to my parents, Laila and Anders

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I Tamsen, F., Klötz-Logan, F., Thiblin, I. (2015) Homicide injury quantification. Correlations and reliability of injury severity scores applied to homicide victims. *Homicide Studies*, 19(1):88–100. DOI: 10.1177/1088767914558142

II Tamsen, F., Sturup, J., Thiblin, I. (2017). Quantifying homicide injuries. A Swedish time trend study using the Homicide Injury Scale. *Scandinavian Journal of Forensic Science*, 23(2). Published ahead of print 16 jan 2018. DOI: 10.1515/sjfs-2017-0005

III Tamsen, F., Sturup, J., Thiblin, I. (2019) Homicide injury severity in association with the victim-offender relationship. *Forensic Science International*, 300:151-156. DOI: 10.1016/j.forsciint.2019.05.012

IV Tamsen, F., Sturup, J., Thiblin, I. (2019) Homicide injury severity in association with benzodiazepine influence. *Manuscript submitted to Homicide Studies.*

Contents

Abbreviations

AIS – Abbreviated Injury Scale
HIS – Homicide Injury Scale
ICD – International Classification of Disease
ICISS – ICD Injury Severity Score
ISS – Injury Severity Score
NISS – New Injury Severity Score
SAIS – Sum of all AIS
SRR – Survival Risk Ratio
TRISS – Trauma Score Injury Severity Score
VOR – Victim-Offender Relationship

Introduction

A fundamental task of society is to control interpersonal violence. In modern countries, the use of violence is monopolized by the state. Great efforts are made to prevent assaults between citizens. To direct resources for such efforts, the state needs to keep track of the epidemiology of violence. Such information helps to understand the underlying structures that generate violence and thus facilitates preventive actions.

The most serious consequence of interpersonal violence is death. Homicide is defined as *a killing of one human being by another*[1]. The term includes both legal and illegal homicides, and these categories are defined differently by different societies and changes over time. The relevant entity to study from the viewpoint of crime prevention is illegal homicides, such as murder and manslaughter.

In homicide epidemiology the number of homicides, causes of death, weapons used, motives and other characteristics of the victims and offenders are usually recorded (1,2). Even though the degree of injury inflicted in the victim can be important for the judicial verdict, and at least when severe also draws the attention of the general public, it is seldom included in homicide epidemiology data. There are several possible reasons for this. One may be that there is no obvious way to assess the degree if injury. As will be described below, attempts have been made to measure injury severity in homicides, but no generally accepted and validated method exists. Another explanation can be that people do not see any point in this measure. Injury severity measures are sometimes used to predict mortality or morbidity in trauma victims. In homicide victims, the outcome is death by definition, and a more precise measure of the injury severity might seem irrelevant.

The usefulness of measuring injury severity in homicide victims is essentially threefold. **First**, it enables comparisons to be made over time and between regions. A change in homicide rate over time can have many explanations. Improved trauma care might for example decrease the homicide rate by saving a larger proportion of the assault victims with potentially lethal injuries. It is reasonable to assume that those who are saved will have less severe injuries on average than those who still die. This will then cause the homicide victims to have more severe injuries on average than before. An injury severity measure would thus be a tool for investigating such a hypothesis, applying it

1 http://www.merriam-webster.com/dictionary/homicide

to both homicide victims and survivors. **Second**, the injury severity in a victim might correlate to characteristics of the offender or victim, or to circumstances surrounding the homicide. One might for example hypothesize that a homicide motivated by jealousy in an intimate relationship in general will result in more severe injuries than when two drunks get into a fight and one is killed without homicidal intent. Another possibility is that cases with extreme injury severity have a larger share of offenders with serious mental illness or drug abuse. If such correlations can be found, the injury severity may help homicide investigators to identify likely suspects. **Third**, the courts are often interested in the degree of violence, and they may ask the forensic pathologist if there were excessive injuries or signs of overkill. A valid injury severity measure could potentially make this assessment more objective and reliable.

The current thesis aims at investigating possible methods to measure injury severity and to use such methods to analyze some of the issues mentioned above. It is important to emphasize that the topic is *injury severity*, not the degree of violence. The degree of violence is a more complex matter that is hard to define. Besides the injuries inflicted on the victim, it can for example include the type of violence used (e.g. fist vs. knife) and the relative strengths of the offender and the victim (e.g. man to man vs. man to child). The injury severity refers to an objective measure of anatomical injuries, while the degree of violence is a subjective assessment of an assault. However, if one believes that the degree of injury correlates to the degree of violence, a measure of the first can facilitate the assessment of the latter.

Injury severity scores

The subjective judgment of injury severity will differ based on knowledge, experience and probably other factors. A forensic pathologist will probably assess cases differently from a layman, or a criminologist for that matter. This makes it hard to compare results from different assessors or researchers. One way to come around this problem is to use an *injury severity score*. Such a score summarizes a person's injuries with a single number. The scores are often based on the most severe injuries, sometimes together with physiological parameters such as blood pressure and respiratory rate.

Injury severity scores provide relatively objective ways to study injuries. It enables statistical analysis of large materials and can thus be used to compare different time periods and regions as well as associations between injuries and homicide characteristics, e.g. **the victim-offender relationship (VOR)**. A single number can of course not represent complex injury patterns without losing information. However, the strength of injury scores is at the group level. Even though they might produce counterintuitive results in individual cases, a valid score will on average provide useful information.

Use in trauma research

In trauma research there is a long tradition of using injury severity scores to analyze injuries at the group level to evaluate the effectiveness of trauma care (3–10). The scores can be based solely on anatomical injuries or in combination with physiological parameters. Two of the most commonly used anatomical scores are **the Injury Severity Score (ISS)** and **the International Classification of Disease Injury Severity Score (ICISS)** (11,12).

The ISS is based on **the Abbreviated Injury Scale (AIS)**, which is a consensus driven document containing a list of injuries that are graded from 1 (minor) to 6 (maximal) based on their individual severity (13). The AIS was originally developed for the assessment of motor vehicle accidents by the Association for the Advancement of Automotive Medicine. Since then, the range of injuries contained in the AIS manual has been expanded to include almost all types of injuries to meet the need of general trauma research (14,15). To calculate the ISS, the body is divided into six regions (head and neck, face, chest, abdomen, extremities, and external). The ISS score equals the sum of squares of the single highest AIS score in each of the three most severely injured body regions (11). There is also a modification of the ISS called **the New ISS (NISS)**, which is the sum of squares of the three highest AIS scores irrespective of their location (16).

The ICISS is derived from the International Classification of Disease (ICD) which is used worldwide as a diagnostic system in health care (12). In contrast to the consensus driven AIS-system, the ICISS is empirical. Based on large patient materials, **the Survival Risk Ratio (SRR)** for each ICD-code is calculated as the total number of survivors divided by the total number of patients with that code (17). The SRRs thus range from 0 to 1, with 0 meaning no survivors and 1 meaning no deaths. The ICISS can be calculated with different formulas, with the most common being the product of the SRRs associated with a person's ICD-codes. When using patient records that already contain ICD-codes, the ICISS has the advantage of being quick to apply to large numbers of cases.

The Trauma Score – Injury Severity Score (TRISS) is an example of an injury score that combines anatomical injuries with physiological parameters (18). It is calculated using the ISS together with the Glasgow Coma Scale, systolic blood pressure, and respiratory rate. Since physiological parameters are often missing in the background information of homicide cases, such scores can generally not be used for injury severity in homicides.

Use in homicide research

In contrast to trauma research, injury severity scores have not been much used in homicide research, although they were proposed for homicide injury quantification a long time ago (19). There are some studies that have applied the

ISS to homicide victims. One study describes a case where they used the ISS to assess the severity of the injuries inflicted by two different perpetrators, respectively, to facilitate the court's verdict in the case (20). This is an example of using an objective measure to reduce the subjectivity and increase the transparency of decisions. Another study used the ISS to retrospectively evaluate its ability to predict survival time in homicide victims (21). They found that the ISS could be of help in estimating survival time, but that it had to be used together with autopsy findings. The probable survival time of the victim is an often-recurring question from the courts in homicide trials.

One study evaluated the use of the AIS and the ISS on autopsy data, including some cases of homicide (22). The authors concluded that the AIS was appropriate for wounds of skin and long bones and for most internal injuries in the thorax and abdomen. According to them, the AIS was however inadequate for many serious craniocerebral and cervicovertebral injuries, as well as for injuries where the lethal mechanism is purely physiological. They believed that the reason for some of these shortcomings was due to a surgical bias in the AIS consensus committee to the effect that injuries that are visible at operation or from radiography are better accounted for than other injuries. Some of these shortcomings have been addressed in later versions of the AIS, for example the inclusion of asphyxia which is caused by physiological mechanisms rather than anatomical injuries (15).

A few studies have used injury scores that are specifically designed to measure the degree of injury in homicide victims. One such study measured injury severity by adding the number of injuries from separate trauma in a victim and applied this method to a longitudinal homicide case-series (23). The investigators found that **the total number of injuries (TNI)** per victim increased over time, as did the number of lethal injuries. This was interpreted as an indication of a general enhancement in the level of aggression from the offenders.

Another method proposed for homicide victims is **the Homicide Injury Scale (HIS)** that was developed by co-workers at the Federal Bureau of Investigation (FBI) to quantify injury severity in homicides of elderly women (24). The HIS consists of six levels from 1 (least severe) to 6 (most severe) based both on the deadly injuries and on the extent of related injuries. In their study, Safarik & Jarvis applied the HIS together with the ISS on elderly female homicide victims to analyze their associations with other homicide characteristics. They found that extreme injury may be indicative of a more youthful offender who is local to the crime scene.

In study I of the current thesis (25), a new injury scale was proposed. **The Sum of all AIS scores (SAIS)** is defined as the sum of all injuries' AIS values on a victim's body. The rationale behind this is that the score is influenced by both the number of injuries as well as their individual severities. In most homicide victims, this should reflect the extent of injury. The SAIS was further developed by another research group who calculated local SAIS scores for the

head and neck, and the face, respectively (26). One of their findings was that the SAIS face score was significantly higher when the offender was a current or former intimate partner compared with a stranger.

Homicide epidemiology in Sweden

The homicide rate in Sweden has undergone a rise and fall during the past 50 years. From the 1960s and onward there was an initial rise in the incidence to around 100-120 homicides per year in the 1980s and early 1990s. The annual rate then dropped to around 75 in the early 2010s. When the steadily increasing population is considered, the drop is even more pronounced. In the late 1980s there was approximately 1.3 homicides per 100 000 inhabitants. In the early 2010s the corresponding figure was 0.78 per 100 000.

This decline in Swedish homicide rate follows a trend seen in many other West European countries. The reasons for such a development are not known, but possible explanations are lower cultural tolerance for violence, less heavy alcohol drinking, and improvements in emergency care (2).

However, the declining trend in Sweden has been broken in the last couple of years. From 68 homicides in 2012, the number has increased and been stable on around 110 annual homicides in 2015-2017 (27). This increase coincides with an increase in homicides by shooting, from 17 cases in 2011 to 40 in 2017.

Another change concerning Swedish homicides is the legal verdicts. There has been a major increase in the number of homicide offenders convicted to life imprisonment without a corresponding increase in the rate of homicides (28). Out of many possible reasons for this increase, one factor could be an increase in brutality within the committed homicides. Investigating this hypothesis would be facilitated by a valid injury severity score.

Victim-offender relationship and injury patterns

Offender profiling are investigative techniques to identify likely suspects based on circumstances in a specific case. Factors that affect profiling in a homicide case may be the location of the killing, things done at the crime scene, methods used for killing the victim, etc. (29).

One crime characteristic that potentially can be used in profiling is the victim's injuries. For example, one study found that many sharp force injuries in a victim was associated with a lower probability of the offender being a stranger (30). Other studies have found positive correlations between facial injuries and intimate relationship (26,31); while, another study found no such link (32).

There are several possible reasons for varying results between different studies. Different study populations is one obvious reason. Depending on cultural behaviors and access to weapons, one can expect different injury patterns. Some studies may only involve domestic homicides, while others include a more general homicide population. This does not have to be a problem, as long as criminal investigators are aware of this bias and draw their conclusions based on studies with relevant populations with regard to their cases.

Another pitfall when comparing studies is that there is no consensus on how to measure injury patterns. Commonly used variables are the existence or non-existence of wounds on different parts of the body, sometimes divided into groups based on more or less arbitrary numbers, e.g. more than five, nine or 40 wounds (25,30,31). Another methodological problem is the use of vaguely defined terms such as "excessive wounding" or "overkill" which often are used without a detailed definition, making the studies hard to reproduce (24,29,32). The problem of finding valid and reproducible measures of injury severity was addressed by Allen more than 30 years ago (19). Even though improvements have been made, many of the problems he identified still remain.

Yet another source of uncertainty is which underlying injury documentation that is used. The "gold standard" is arguably the autopsy report, which is probably used in most homicide studies. However, the person who extracts the information from the report may bias the result. If it is read by a forensic pathologist, most injuries will probably be interpreted correctly, but if the person is a psychologist or a non-medical researcher there might be discrepancies.

Potential associations between injury patterns in the victim and the VOR would be valuable information for investigators. Therefore, scientific studies in this field are warranted. Both positive and negative findings are valuable; it is important for criminal investigators to know both whether they can draw conclusions from specific injury patterns or if they cannot.

Benzodiazepine influence of the offender and injury patterns

Benzodiazepines are sometimes used by clinicians as an anti-aggression drug (33). At the same time, researchers have found evidence that benzodiazepines can increase aggression and even cause sadistic behavior (34–36). Different factors such as the type of benzodiazepine, doses and populations may cause differing results between studies and clinical settings.

Another reason for different results is how the aggression or brutality is assessed. As mentioned in the *Introduction*, the degree of violence is a complex concept which will not be elaborated upon in this thesis. However, the injury severity in the victim is surely an important component when evaluating

the degree of violence, aggression or brutality. This makes it relevant to study the injury severity in the victim in relation to benzodiazepine influence of the offender. If benzodiazepines play a significant role in increasing aggression, the hypothesis is that influence of benzodiazepines in the offender would be positively correlated with the injury severity score of the victim.

Aim of thesis

The overall aim of this thesis is to investigate valid ways to quantify injuries on homicide victims and to use such scores to analyze injury severity development over time as well as associations between injury severity and homicide characteristics.

Aim of each study

Paper I: Several injury severity scores were compared to a reference method to find a valid and easy-to-use injury score.
Paper II: The HIS was used together with the number of lethal injuries per victim to study the development of injury severity over time.
Paper III: The HIS, ISS, NISS, SAIS and local variants of the SAIS were used to search for correlations between the injury severity and the victim-offender relationship.
Paper IV: The HIS, ISS, NISS, SAIS and local variant of the SAIS were used to search for correlations between the injury severity and benzodiazepine influence of the offender.

Material and Methods

Participants and injury measures

Paper I

The study had a retrospective register-based design and included 103 cases.

All deaths that were investigated at the department of forensic medicine in Stockholm, Sweden during the years 2000-2004 (n = 6,715), were assessed with respect to the cause of death-certificate. In this certificate, the forensic pathologist states the manner of death as "accident", "deliberately self-inflicted", "deliberately caused by other" or "unclear whether intention existed". All cases that were assessed as "deliberately caused by other" (n = 127) were considered for inclusion and their autopsy reports were read.

From the 127 cases, 24 were excluded; 13 due to circumstances that complicated the injury assessment at autopsy (prolonged hospital care, putrefaction, embalming, organ donation), six due to insufficient data in the autopsy report, three due to secondary injuries (drowning, fall from height, hit by car), and two that were suspected to have been misclassified as homicides (medical mistake and suicide, respectively). The remaining 103 cases were included in the study.

From the information in the autopsy report, each case was assessed with six different injury scores: SAIS, ISS, NISS, ICISS, HIS, and TNI (figure 1). Besides this, the trauma modalities (blunt, sharp, gunshot, and asphyxia) of the lethal injuries were recorded.

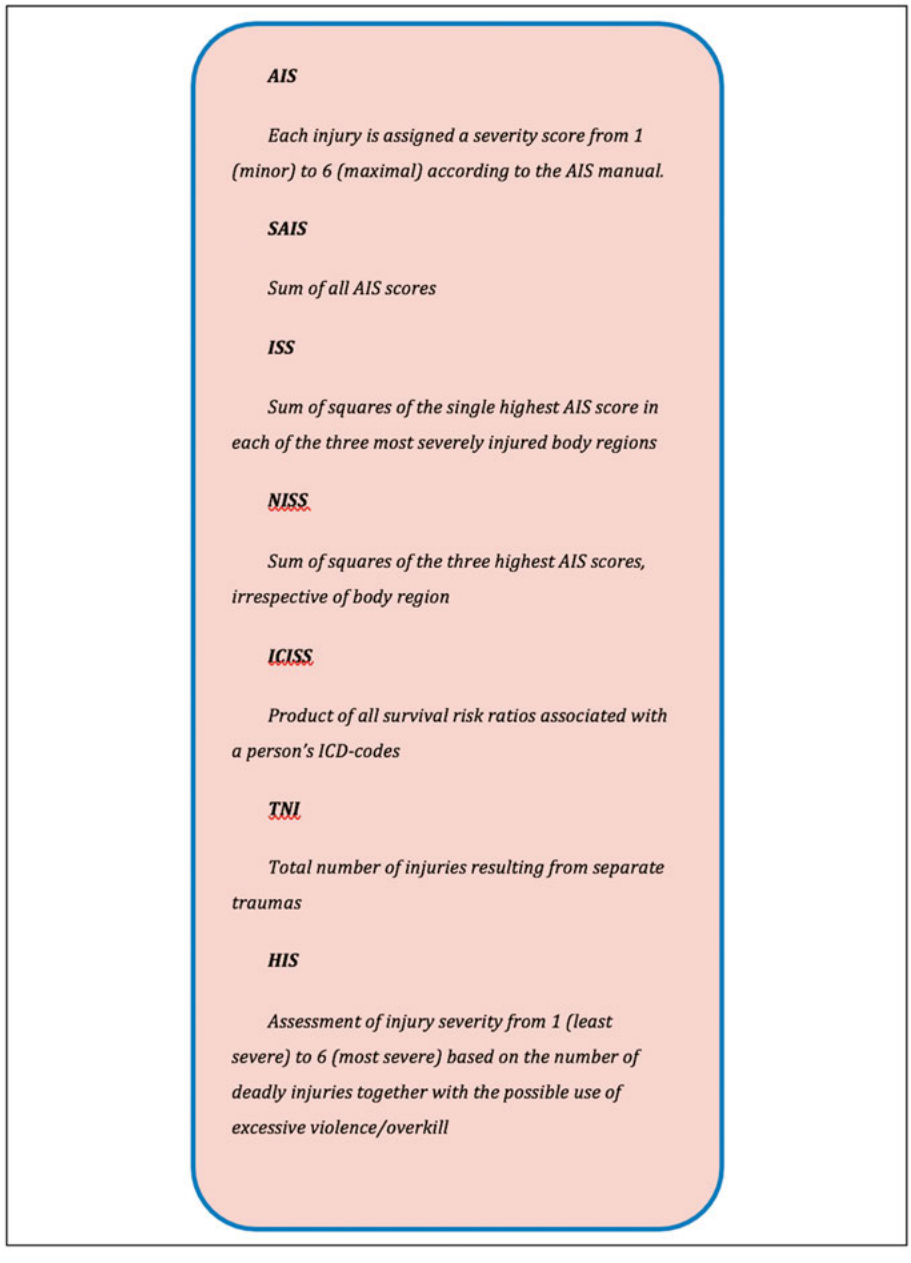

Figure 1. The injury severity scores used in Paper I. AIS = Abbreviated Injury Scale; SAIS = Sum of AIS; ISS = Injury Severity Score; NISS = New ISS; ICISS = International Classification of Disease Injury Severity Score; TNI = Total Number of Injuries; HIS = Homicide Injury Scale.

Paper II

The study had a retrospective register-based design and included 296 cases. All available cases from the department of forensic medicine in Stockholm, Sweden during the periods 1976-1978, 1986-1988, 1996-1998, and 2006-2008, where the forensic pathologist determined the manner of death as "deliberately caused by other" were considered for inclusion (n = 354). A total of 58 cases were excluded due to secondary trauma, putrefaction, prolonged hospital care, incomplete or inadequate protocols, and others. This left 296 included cases divided between the four periods as 86, 77, 70, and 63.

From the information in the autopsy report, each case was assessed with the HIS. Besides this, the number of lethal injuries and their trauma modalities were recorded as well as the age and sex of the victims.

Paper III

The study had a retrospective register-based design and included 178 cases.

All homicide victims (n = 273) in Sweden during 2007-2009 were considered for inclusion. A total number of 95 cases were excluded due to unknown VOR, secondary trauma, putrefaction, prolonged hospital care, incomplete protocols, and others.

The autopsy protocol, sex, age, and VOR and were collected for the victims. From the information in the autopsy protocol, each case was assessed with several different injury scores: HIS, ISS, NISS, SAIS, and local variants of the SAIS.

Paper IV

The study had a retrospective register-based design and included 95 offenders and 91 victims.

All victims (n = 273) and perpetrators (n = 257) of homicides in Sweden during 2007-2009 were considered for inclusion. A total number of 178 cases were excluded due to missing toxicology data of the offender, secondary trauma, putrefaction, prolonged hospital care, incomplete protocols, and others.

The data collected for the victims included the autopsy protocol, sex, and age. The data collected for the offenders were the VOR, sex, age, and the presence or absence of benzodiazepines[2] or z-drugs[3]. From the information in the autopsy protocol, each case was assessed with several different injury scores: HIS, ISS, NISS, SAIS, and local variants of the SAIS.

[2] Diazepam, Nordazepam, Oxazepam, Temazepam, Lorazepam, Alprazolam, Nitrazepam, Flunitrazepam, Klonazepam, Klometiazol, Triazolam

[3] Zopiklon, Zolpidem, Zaleplon

Statistical analyses

Paper I

Distributions and correlations of the injury severity scores were visualized with plots and histograms. The Spearman rank correlation was used to analyze the correlation between the injury severity scores and the SAIS which was used as the "gold standard". Inter-rater reliability was tested with the Spearman rank, the Cohen's kappa and simple agreement.

Paper II

Distributions and correlations of the injury severity scores were visualized with plots and histograms. Differences between time periods were analyzed by using the Kruskal-Wallis test with the Mann-Whitney U test as post hoc, and the Fisher's exact test. Bonferroni corrected p-values were used for pairwise comparisons.

Paper III

The data distribution was visualized with multiple scatterplots. Comparisons of injury severity between different VORs were made with the Kruskal-Wallis test. The cases were also subdivided into five groups according to the type of lethal injuries: blunt, sharp, gunshot, asphyxia, and two or more types. These subgroups then went through the same comparisons with respect to the VOR. The VOR was also analyzed in relation to the type of lethal injuries with Fisher's exact test and Bonferroni correction.

Paper IV

The data distribution was visualized with multiple scatterplots. The cases were subdivided into five groups according to the type of lethal injuries: blunt, sharp, gunshot, asphyxia, and two or more types. Comparisons of injury severity between offenders positive vs. negative for benzodiazepines were made with the Mann-Whitney U test.

Results

Paper I

Out of the six injury severity scores used in paper I (table 1), the Sum of all AIS (SAIS) was chosen as a reference ("gold standard") for evaluating the other scores. Correlations between the SAIS and the other scores were all statistically significant ($p < 0.05$) and were as follows: TNI 0.82, HIS 0.71, ICISS -0.59, ISS 0.38, and NISS 0.26. The inter-rater reliability for the HIS was 0.85 (Spearman rank) and 0.67 (Cohen's kappa, unweighted).

	Mean	Median	Minimum	Maximum	SD
ISS (interval scale, range 0-75)	34	27	10	75	18
NISS (interval scale, range 0-75)	44	43	11	75	18
SAIS (interval scale, range 0-infinity)	47	35	6	241	39
ICISS (interval scale, range 0-1)	0.60	0.61	0.092	0.94	0.20
HIS (ordinal scale, 1, 2, 3, 4, 5, 6)	3.6	3	1	6	1.1
TNI (interval scale, range 0-infinity)	22	18	1	91	22

Table 1. Characteristics and results of the injury severity scores used in Paper I. ISS = Injury Severity Score; NISS = New ISS; SAIS = Sum of AIS; ICISS = International Classification of Disease Injury Severity Score; TNI = Total Number of Injuries; HIS = Homicide Injury Scale.

Paper II

The HIS scores were divided into two groups, one without overkill[4] in their definition (HIS 1-4) and one with overkill (HIS 5-6). The proportion of cases with overkill was significantly higher in 1996-1998 compared to 1976-1978 (figure 2). The mean number of lethal injuries per victim increased steadily during all periods, with significantly higher numbers in 1996-1998 and 2006-2008 compared to 1976-1978 (figure 3). Concerning the four studied trauma

[4] A case was considered "overkill" if at least one of the following criteria was met:

- three or more sharp wounds located at the head, neck, or trunk with internal organ injuries (including the pleura and large blood vessels)
- three or more gunshot wounds located at the head, neck, or trunk with internal organ injuries (including the pleura and large blood vessels)
- A total of 40 or more skin injuries (blunt, sharp, gunshot)

types, or modalities, (blunt, sharp, gunshot and asphyxia) there were some significant changes. Asphyxia showed a decrease from 1976-1978 to 1986-1988, while the proportion of gunshots was higher in 1996-1998 compared to 1976-1978 (figure 4).

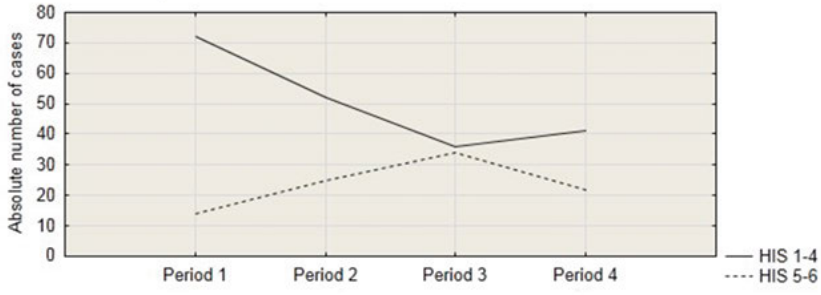

Figure 2. Non-overkill (HIS 1-4) vs. overkill (HIS 5-6) in absolute numbers. Period 1 = 1976-1978; Period 2 = 1986-1988; Period 3 = 1996-1998; Period 4 = 2006-2008.

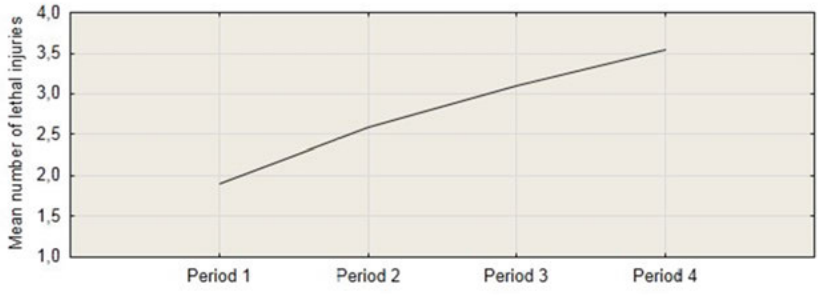

Figure 3. Mean number of lethal injuries per victim. Period 1 = 1976-1978; Period 2 = 1986-1988; Period 3 = 1996-1998; Period 4 = 2006-2008.

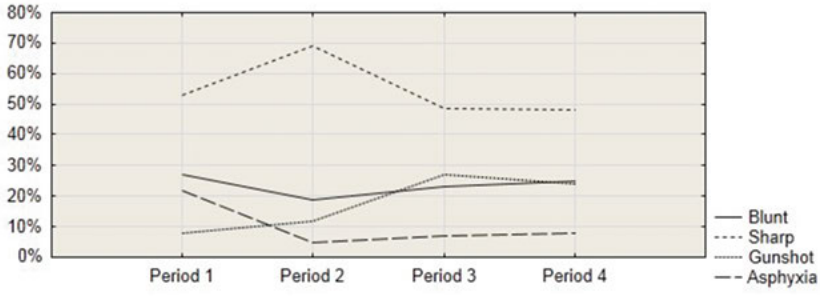

Figure 4. Proportions of different trauma modalities. Some victims had lethal injuries in more than one modality, causing the fractions to sum up to more than 100%. Period 1 = 1976-1978; Period 2 = 1986-1988; Period 3 = 1996-1998; Period 4 = 2006-2008.

Another observation was that the HIS was either 3 or 5 in most cases. These two scores are given to cases with a single type (or modality) of lethal injuries with and without overkill, respectively. Thus, the HIS behaved almost dichotomous as a separator of overkill from not overkill. An exception from this were cases with asphyxia, where the score of 2 was the most common.

Paper III

There were no relevant associations between injury severity scores and the VOR (figure 5-7). When trauma modalities were compared between different VORs there were significant differences between asphyxia vs. gunshot and asphyxia vs. sharp force (table 2). In death from asphyxia, the perpetrator was often a partner and never a stranger. When the victim had been shot, the offender was usually an acquaintance.

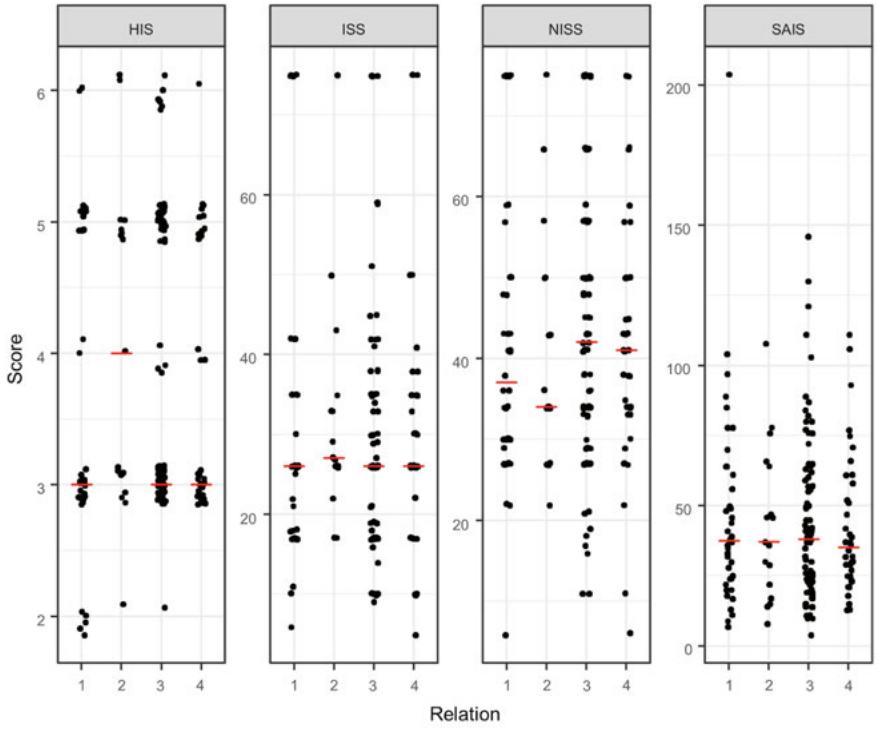

Figure 5. Injury scores (HIS, ISS, NISS, and SAIS) by relationship in 178 Swedish homicide cases. Each dot represents a victim, red lines represent the medians. Relationships are divided into four categories. 1 = Partner; 2 = Other relative/family; 3 = Acquaintance; 4 = Stranger.

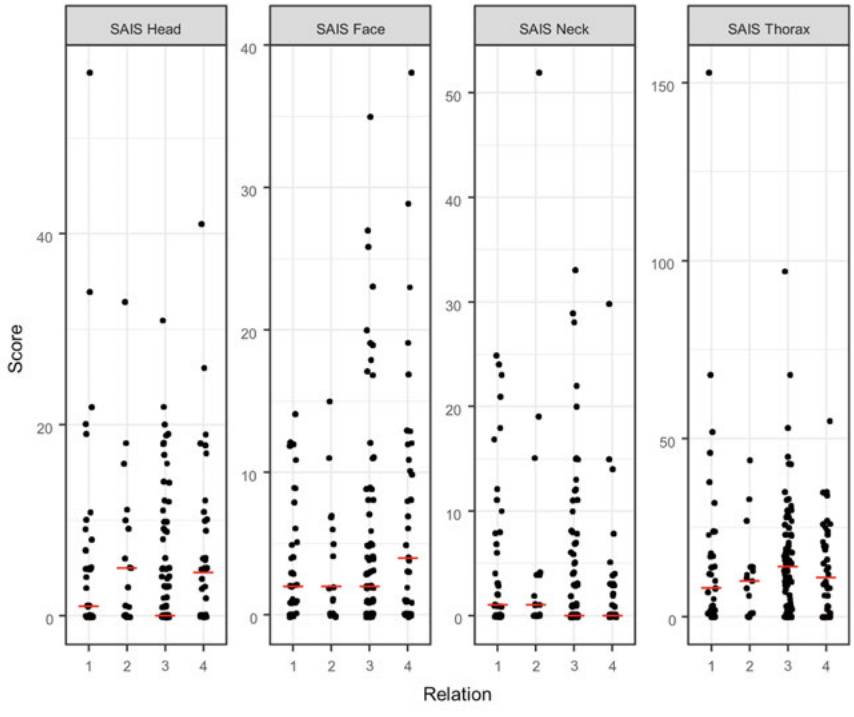

Figure 6. Injury scores (SAIS Head, SAIS Face, SAIS Neck, and SAIS Thorax) by relationship in 178 Swedish homicide cases. Each dot represents a victim, red lines represent the medians. Relationships are divided into four categories. 1 = Partner; 2 = Other relative/family; 3 = Acquaintance; 4 = Stranger.

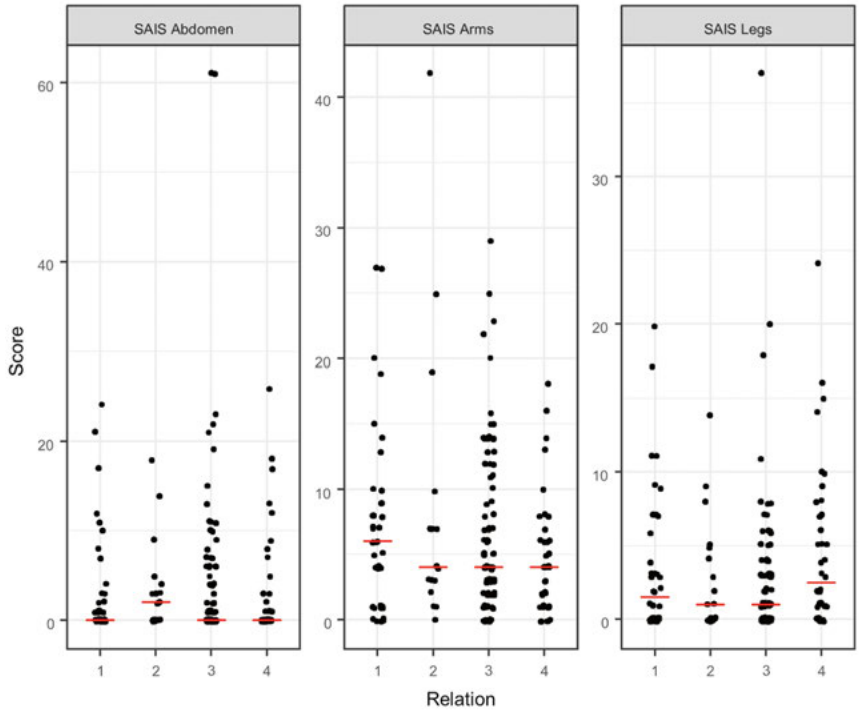

Figure 7. Injury scores (SAIS Abdomen, SAIS Arms, and SAIS Legs) by relationship in 178 Swedish homicide cases. Each dot represents a victim, red lines. Relationships are into four categories. 1 = Partner; 2 = Other relative/family; 3 = Acquaintance; 4 = Stranger.

VOR	Two or more	Blunt	Sharp	Gunshot	Asphyxia	Total
Partner	4 (19% / 10%)	6 (26% / 15%)	18 (19% / 45%)	5 (17% / 12%)	7 (64% / 18%)	40 (- / 100%)
Other relative/family	3 (14% / 18%)	2 (9% / 12%)	9 (10% / 53%)	1 (3% / 6%)	2 (18% / 12%)	17 (- / 100%)
Acquaintance	10 (48% / 12%)	6 (26% / 7%)	46 (49% / 55%)	19 (66% / 23%)	2 (18% / 2%)	83 (- / 100%)
Stranger	4 (19% / 11%)	9 (39% / 24%)	21 (22% / 55%)	4 (14% / 11%)	0 (0% / 0%)	38 (- / 100%)
Total	21 (100% / -)	23 (100% / -)	94 (100% / -)	29 (100% / -)	11 (100% / -)	178

Table 2. Victim-offender relationship (VOR) vs. trauma modality in 178 homicide cases. Number of victims with each combinations (column/row percentages).

Paper IV

There were no relevant associations between the injury severity on the victim and benzodiazepine influence of the offender. Results for the SAIS are shown as an example in figure 8.

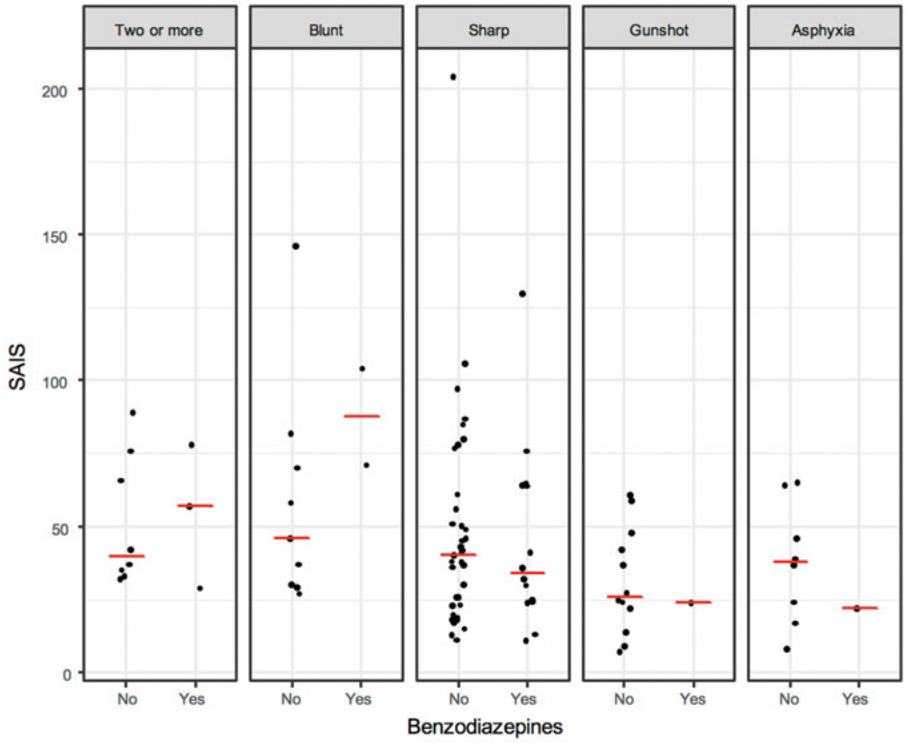

Figure 8. SAIS by benzodiazepine influence and injury type in 95 Swedish homicide offenders and their victims. Dots indicate individual victims; red lines are median values.

SUMMARY OF FINDINGS

I The SAIS was used as a reference method for the assessment of injury severity in homicide victims. The HIS was validated through a strong correlation with the SAIS and can therefore serve as an easier and faster proxy method for injury assessment. The ISS and NISS were of less value in homicide victims, since they at most take three different injuries into account.

II Overkill as defined by the modified version of the HIS increased between 1976-78 and 1996-98 in the Stockholm area. The number of lethal injuries per victim was significantly higher in 1996-98 and 2006-08 compared to 1976-78. The HIS behaved almost as a dichotomous variable of overkill vs no overkill, which raises the question if it is too crude to measure nuances in injury severity in a general homicide population.

III The study does not support the hypothesis that injury severity scores can be used to predict the VOR in profiling cases, at least not in a general homicide population.

IV The study does not support the hypothesis that benzodiazepine or z-drug influence of the offender causes him or her to inflict more injuries on the victim, at least not in a general homicide population.

Discussion

Comments on main findings

Paper I

The validity of injury severity scores

To find a measure for something, one need to know what one wants to measure. As self-evident as this may be, it is sometimes overlooked. Some things that are measured are obvious; the speed of a car, the length of a person or the weight of a barbell. Other things, like the creditworthiness of a potential borrower, are more complex.

Different models for measuring creditworthiness may be proposed. By evaluating which of these that best predict repayment, a model can be chosen and termed *valid*, i.e. it measures what one wants. The process of validation is fundamental to evidence-based measures.

When it comes to finding a measure for injury severity in homicide victims, the process of validation is less obvious. When a forensic pathologist performs an autopsy of a homicide victim, he or she will reflect over the severity of injuries and compare it to his or her own knowledge and experience in this area. In some cases, one may reflect on that a victim was unfortunate to die from such relatively sparse injuries, other times there are multiple injuries that each by themselves would suffice to kill a person. And then there are all the cases in between.

This subjective assessment was part of what was sought to find measures for in the current thesis. Besides the potentially lethal injuries, the non-lethal ones are also interesting in this context, as they may reflect the amount of violence and the time-frame in which the assault took place. That is, the measure should reflect both the amount of injuries as well as their severity.

Finding a valid method

Injury severity has been measured for decades in trauma research (4). The purpose is often to evaluate the quality of trauma care. If two hospitals receive patients with similar degree of injuries, the hospital with higher survival rates is probably the best in treating trauma victims.

When injury severity scores are used in this context, they can be evaluated by how well they predict morbidity and mortality. Because there eventually is

a “correct answer” on the outcome for these patients, one can look back and see how well the score predicted the outcome. Thus, there is a natural way of validating these trauma scores.

In homicides, and for the purpose formulated in this thesis, there are no such definite answers with which one can compare the scores. The subjective assessments of injury severity will most probably differ somewhat depending on professional training, experience, culture, background information in individual cases, etc. Thus, solely relying on subjective measures of injury severity in scientific studies will make it hard or even impossible to compare results from different studies due to their low inter-rater reliability.

The approach to this problem was to try to find a measure that contained properties of injury severity that all professionals would agree are important, irrespective of the above-mentioned reasons for differences in subjective assessments. The method should also be easy to use and quick to apply, so that large populations could be scored within a reasonable time and preferably without the need of a profound medical knowledge.

The conclusion was that the two most basic things to observe when assessing an injury pattern are a) the number of injuries and b) the individual severity of these injuries. Both characteristics have been used in previous studies, either by themselves or in combination (24,31,32,37).

Given the subjective nature of some definitions in the HIS, e.g. the term “overkill”, there was a need to validate it against a more objective method. The AIS is a multidisciplinary consensus-derived scale that has been used in numerous studies, either by itself or through injury severity scores like the ISS. Furthermore, the descriptions in the AIS are detailed and explicit, leaving little room for ambiguity, and it has been shown to have a moderate to substantial inter- and intra-rater reliability (38).

The SAIS is based on the AIS and is affected by both the number of injuries as well as their individual severity (25). Therefore, it was concluded that the SAIS could serve as an objective reference method (“gold standard”).

Comparing injury scores

In paper I the anatomically based injury severity scores that are often used in trauma research were investigated, namely the ISS, NISS and ICISS. Compared to the SAIS, the ISS and NISS had weak correlations. This was not surprising since they only consider a maximum of three injuries. They have been proven valuable in trauma research to predict morbidity and mortality, but they fall short in representing the overall injury pattern in homicide victims.

The ICISS had a strong correlation with the SAIS, which reflects that it is also affected by the number of injuries as well as their individual severities. The ICISS is quick to apply when a patient material is studied, since it uses the ICD-diagnoses already in the patient charts. However, in homicide victims these codes are missing if the patient died outside the hospital. Furthermore,

the ICD-coding in hospitals is usually far from as detailed as coding from autopsy reports. Another problem with the ICISS is that it is based on empirical material. This makes comparisons between studies problematic if they have used different SRRs. These shortcomings make the ICISS unsuitable for homicide studies.

Besides the well-established scores of ISS, NISS and ICISS, two scores specifically designed for homicide victims were also used; TNI and HIS. The TNI considers the number of injuries but not their severities. Since the SAIS is highly affected by the number of injuries, it is natural that it had a strong correlation with the TNI. However, since the TNI is almost as time consuming to calculate as the SAIS, it was deemed inferior because it does not consider the individual injury severities.

The HIS on the other hand is much quicker to apply than both the SAIS, TNI and ICISS. After modifying it by explicitly defining the concept of "overkill", it had a good inter-rater reliability. It also had a strong correlation with the SAIS and was thus considered a valid measure to use at a group level. Therefore, the HIS was proposed as a quick and easy method for measuring injury severity in homicide victims.

Paper II

The significant increases that were seen over time in the HIS as well as in the number of lethal injuries is consistent with the hypothesis of a general increase in the level of aggression by offenders. However, it could also be explained by an improvement in trauma care (39). Such an improvement may result in a higher proportion of assault victims with moderate injuries to be saved, while the severely injured victims still die. If this is the case, the victims that die will on average have more severe injuries. To test such a hypothesis, both surviving and dead assault victims need to be studied together in the same region and period. The study design is thus not adequate for clarifying the reason for these changes in injury severity.

When the HIS was divided into different modalities, there were some discrepancies. Asphyxiated victims deviated the most with a dominant proportion of HIS 2. All the other modalities had mostly HIS 3 followed by HIS 5. The reason for this is the physiological nature of asphyxia, which may leave no severe anatomical injuries. This indicates that the HIS is sensitive to injury modality. Asphyxia, and the other modalities, should therefore perhaps be analyzed separately.

Another aspect of the HIS was that it mostly took the values of 3 or 5. This is an indication that the HIS is too crude to convey more information than a dichotomous separation of homicide without and with "overkill", respectively. For this reason, the HIS may not be such a good alternative to the SAIS as previously assumed in paper I. The HIS was originally developed to assess

homicides of elderly females (24). Perhaps it is better suited for this subpopulation of victims. However, the HIS seems to be of less value for measuring homicide injury severity in a general homicide population.

Paper III

No relevant associations were found between the injury severity and the VOR. Even though positive findings are more rewarding, negative findings are equally important. When it comes to offender profiling, criminal investigators need to know both whether they should draw conclusions from specific injury patterns, and whether they should not.

The field of offender profiling has been criticized for partly lacking a theoretical foundation and for working with non-falsifiable hypotheses (40). Paper III addressed the first part of this critique. With explicitly defined and objective injury measures, previous findings and claims of associations between injury patterns and the VOR were investigated. Especially interesting was that none of the injury scores used were significantly different between the VORs. While this is merely the result from one study, one can wonder how many unpublished studies there are which did not find such an association. The claim that facial injuries tend to be more severe in intimate relationships because the offender wants to "destroy" the victim's personality is so unpleasant that it probably sticks in people's minds. This may cause a bias for homicide investigators and researchers to find such a link. If this causes a selection of positive findings to be noticed or published, it will further strengthen a claim that may not be true, at least not in a general homicide population. This may lead homicide investigations astray.

The remedy for over-interpretation of injury patterns is to challenge and investigate dogmas in a scientific way. Clearly defined measures and falsifiable theories must be defined prior to data analysis.

Paper IV

No associations were found between benzodiazepine or z-drug influence of the offender and injury severity on the victim. Thus, the findings do not support that these drugs cause more, or less, aggression in the offender. However, it is important to remember that this result refers to the specific injury scores used. One may reasonably argue that these are too crude to differentiate "normal" homicidal violence from sadistic, which some previous studies found in relation to benzodiazepine use (35).

Methodological considerations

Paper I

The way of comparing different injury severity scores or scales with a reference method by the Spearman rank correlation is straightforward. The question is whether these scores sort, or rank, the cases in the same way as the reference, which is what the Spearman rank measures. What is not straightforward however, is how to choose the reference method. This issue is discussed thoroughly in the discussion section above.

An observation to be made with paper I is that all homicides together were analyzed together. Injury scores may to some extent be dependent on injury modality. For example, deaths from asphyxia generally have a lower HIS score than deaths caused by sharp force.

Paper II

The reason that data from three-year periods was selected was that the first three time periods had already been collected and by adding the fourth, there was data that spanned over four decades. To make assessments of time trends of injury severity, it would have been better to have randomized samples from the whole decades. This was however hard to do since the early time periods lacked a digital archive and to search through all acts in the paper archives would have been overwhelming.

Another reason for the choice of these time periods was that the first three periods had been studied previously with other injury measures (23). Thus, there was an opportunity to see if the results of the previous study were replicable with other scores.

As in paper I, all modalities were mixed in the analysis. This may not have been optimal since there were also significant shifts in trauma modality over time, which may have affected the injury scores.

Paper III

The homicide population is Swedish, and the results may not be representative of other countries. Differences in culture may cause different injury patterns with respect to the VOR.

The division of cases into different trauma modalities was made because it has been noticed that injury scores can behave differently depending on the type of trauma. However, this made some groups quite small which weakened the statistical analysis.

Paper IV

The study is quite small, which warrants caution when interpreting the results. However, had there been a strong connection between benzodiazepine or z-drug use and injury severity, some correlations would probably have been found.

Another important thing to keep in mind is that a large group of drugs were analyzed together. Different benzodiazepines may have different effects on aggression. Earlier studies have hypothesized that this can be the explanation of differing results between studies (41). Also, therapeutic vs. high intake of benzodiazepines have been found to differ with respect to aggression (35,36).

Another weakness of the study is that the drug test of the offender was performed up to 48 hours after the homicide. Thus, one cannot be sure that it reflected the status at the time of the event.

Ethical considerations

Paper I and II used the same kind of data concerning deceased people and did not require ethical approval according to an advisory statement from the Regional Ethical Review Board in Uppsala on paper I (2013/013). Paper III and IV were approved by the Regional Ethical Review Board in Stockholm (2010/1764-31/5).

Conclusion

Injury severity scores inspired from the field of trauma research can be used to assess injury severity on homicide victims at a group level. However, all tested scores do from time to time produce counter-intuitive results at a case level. This must be kept in mind when interpreting the results for individual homicide victims.

Injury severity scores can have different sensitivity to different trauma types, and a division of homicide cases with respect to trauma modality is probably preferable when analyzing injury severity.

From the applications of injury severity scores on general homicide populations, it was concluded that there has been an increase in injury severity in homicides from the Stockholm area during the time periods studied. No support was found for using the scores in offender profiling concerning the victim-offender relationship. Neither was there any association between injury severity on the victim and influence of benzodiazepines or z-drugs in the offender, in contrast to the hypothesis that there would be a positive correlation.

However, this result does not contradict earlier studies that claim a causal relationship between benzodiazepine influence and an increased level of aggression and violence.

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References

1. Demetriades D, Murray J, Sinz B, Myles D, Chan L, Sathyaragiswaran L, et al. Epidemiology of major trauma and trauma deaths in Los Angeles County. J Am Coll Surg. 1998 Oct;187(4):373–83.
2. Granath S. Det dödliga våldet i Sverige 1990-2014: en beskrivning av utvecklingen med särskilt fokus på skjutvapenvåldet. Stockholm: Brottsförebyggande rådet; 2015. 72 p. (Rapport / Brottsförebyggande rådet (BRÅ)).
3. Nathens AB, Xiong W, Shafi S. Ranking of trauma center performance: the bare essentials. J Trauma. 2008;65(3):628–35.
4. Tohira H, Jacobs I, Mountain D, Gibson N, Yeo A. Systematic review of predictive performance of injury severity scoring tools. Scandinavian Journal of Trauma Resuscitation & Emergency Medicine [Internet]. 2012;20. Available from: <Go to ISI>://WOS:000312635600001
5. Holcomb JB, McMullin NR, Pearse L, Caruso J, Wade CE, Oetjen-Gerdes L, et al. Causes of death in U.S. Special Operations Forces in the global war on terrorism: 2001-2004. Ann Surg. 2007;245(6):986–91.
6. Tiret L, Garros B, Maurette P, Nicaud V, Thicoipe M, Hatton F, et al. Incidence, causes and severity of injuries in Aquitaine, France: a community-based study of hospital admissions and deaths. Am J Public Health. 1989;79(3):316–21.
7. Nasrullah M, Razzak JA. Firearm injuries presenting to a tertiary care hospital of Karachi, Pakistan. J Inj Violence Res. 2009;1(1):27–31.
8. Hitosugi M, Takatsu A. Injury severity in motor vehicle occupants. Leg Med (Tokyo). 2000;2(3):166–70.
9. Leth PM, Ibsen M. Abbreviated injury scale scoring in traffic fatalities: comparison of computerized tomography and autopsy. J Trauma. 2010;68(6):1413–6.
10. Ndiaye A, Chambost M, Chiron M. The fatal injuries of car drivers. Forensic Sci Int. 2009;184(1–3):21–7.
11. Baker SP, O'Neill B, Haddon J W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma. 1974;14(3):187–96.
12. Osler T, Rutledge R, Deis J, Bedrick E. ICISS: an international classification of disease-9 based injury severity score. J Trauma. 1996;41(3):380–6; discussion 386-8.
13. Keller WK, Dillihunt RC, Fenner HA, Hobbs NM, Jolley FL, Keeney AH, et al. Rating the severity of tissue damage. I. The abbreviated scale. JAMA. 1971;215(2):277–80.
14. Gennarelli TA, Wodzin E. AIS 2005: a contemporary injury scale. Injury. 2006;37(12):1083–91.
15. Gennarelli TA, Wodzin E. Abbreviated Injury Scale 2005 - Update 2008. Barrington: Association for the Advancement of Automotive Medicine; 2008.
16. Osler T, Baker SP, Long W. A modification of the injury severity score that both improves accuracy and simplifies scoring. J Trauma. 1997;43(6):922–5; discussion 925-6.

17. Gedeborg R, Warner M, Chen LH, Gulliver P, Cryer C, Robitaille Y, et al. Internationally comparable diagnosis-specific survival probabilities for calculation of the ICD-10-based Injury Severity Score. J Trauma Acute Care Surg. 2014;76(2):358–65.
18. Champion HR, Copes WS, Sacco WJ, Lawnick MM, Bain LW, Gann DS, et al. A new characterization of injury severity. J Trauma. 1990;30(5):539–45; discussion 545-6.
19. Allen RB. Measuring the severity of physical injury among assault and homicide victims. Journal of Quantitative Criminology. 1986 Jun;2(2):139–56.
20. Schmidt P, Orlopp K, Dettmeyer R, Madea B. [Practical application of the Injury Severity Score (ISS) in expert forensic testimony]. Arch Kriminol. 2002;210(5–6):172–7.
21. Cros J, Alvarez JC, Sbidian E, Charlier P, de la Grandmaison GL. Survival time estimation using Injury Severity Score (ISS) in homicide cases. Forensic Sci Int. 2013;233(1–3):99–103.
22. Adams VI, Carrubba C. The Abbreviated Injury Scale: application to autopsy data. Am J Forensic Med Pathol. 1998 Sep;19(3):246–51.
23. Ericsson A, Thiblin I. Injuries inflicted on homicide victims - A longitudinal victiminologic study of lethal violence. Forensic Science International. 2002;130(2–3):133–9.
24. Safarik ME, Jarvis JR. Examining attributes of homicides - Toward quantifying qualitative values of injury severity. Homicide Studies. 2005;9(3):183–203.
25. Tamsen F, Klötz-Logan F, Thiblin I. Homicide Injury Quantification: Correlations and Reliability of Injury Severity Scores Applied to Homicide Victims. Homicide Studies. 2015;19(1):88–100.
26. Li F, Liu S, Lu X, Ou Y, Yip PSF. Application of the injury scales in homicides. Forensic Science International. 2018 Nov;292:83–9.
27. Brottsförebyggande rådet (BRÅ). Kriminalstatistik 2017. Konstaterande fall av dödligt våld. En granskning av anmält dödligt våld 2017. [Internet]. Stockholm; [cited 2018 Oct 25]. Report No.: URN: NBN: SE: BRA-759. Available from: https://www.bra.se/statistik/statistik-utifran-brottstyper/mord-och-drap.html
28. Sturup J, Karlberg D, Fredriksson B, Lihoff T, Kristiansson M. Risk assessments and recidivism among a population-based group of Swedish offenders sentenced to life in prison. Crim Behav Ment Health. 2016;26(2):124–35.
29. Douglas JE, Burgess AW, Burgess AG, Ressler RK. Crime Classification Manual: A standard system for investigating and classifying violent crimes. 2nd ed. San Fransisco: Jossey-Bass; 2006.
30. Karlsson T. Sharp force homicides in the Stockholm area, 1983-1992. Forensic Sci Int. 1998;94(1–2):129–39.
31. Trojan C, Krull AC. Variations in Wounding by Relationship Intimacy in Homicide Cases. Journal of Interpersonal Violence. 2012 Sep;27(14):2869–88.
32. Last SK, Fritzon K. Investigating the nature of expressiveness in stranger, acquaintance and intrafamilial homicides. Journal of Investigative Psychology and Offender Profiling. 2005 Oct;2(3):179–93.
33. Hoaken PNS, Stewart SH. Drugs of abuse and the elicitation of human aggressive behavior. Addict Behav. 2003 Dec;28(9):1533–54.
34. Weisman AM, Berman ME, Taylor SP. Effects of clorazepate, diazepam, and oxazepam on a laboratory measurement of aggression in men. Int Clin Psychopharmacol. 1998 Jul;13(4):183–8.

35. Dåderman AM, Fredriksson B, Kristiansson M, Nilsson L-H, Lidberg L. Violent Behavior, Impulsive Decision-Making, and Anterograde Amnesia While Intoxicated With Flunitrazepam and Alcohol or Other Drugs: A Case Study in Forensic Psychiatric Patients. The Journal of the American Academy of Psychiatry and the Law. 2002;30(2):238–51.
36. Lundholm L, Haggård U, Möller J, Hallqvist J, Thiblin I. The triggering effect of alcohol and illicit drugs on violent crime in a remand prison population: A case crossover study. Drug and Alcohol Dependence. 2013 Apr;129(1–2):110–5.
37. Jordan CE, Pritchard AJ, Duckett D, Wilcox P, Corey T, Combest M. Relationship and Injury Trends in the Homicide of Women Across the Life Span: A Research Note. Homicide Studies. 2010;14(2):181–92.
38. MacKenzie EJ, Shapiro S, Eastham JN. The Abbreviated Injury Scale and Injury Severity Score: Levels of Inter- and Intrarater Reliability. Medical Care. 1985;23(6):823–835.
39. Harris AR. Murder and Medicine. The Lethality of Criminal Assault 1960-1999. Homicide Studies. 2002(6):128–66.
40. Muller DA. Criminal Profiling. Real Science of Just Wishful Thinking? Homicide Studies. 4/2000(3):234–64.
41. Nilsonne G, Tamm S, Golkar A, Sörman K, Howner K, Kristiansson M, et al. Effects of 25 mg oxazepam on emotional mimicry and empathy for pain: a randomized controlled experiment. Royal Society Open Science. 2017 Mar;4(3):160607.

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