



## Necessity of including medico-legal autopsy data in epidemiological surveys of individuals with major trauma



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### ABSTRACT

**Background:** It is rare that epidemiological surveys of patients with major trauma include both those admitted to the emergency department and those sent for medico-legal autopsy. The main aim of the present population-based study of major trauma was to examine the importance of medico-legal autopsy data.

**Methods:** A new injury severity score (NISS) > 15 or lethal outcome was used as criteria for major trauma and to identify patients at the emergency, anaesthesiology and forensic departments and/or being within the jurisdiction of the Malmö police authority and subjected to a medico-legal autopsy between 2011 and 2013. According to Swedish legislation all trauma related deaths should be reported to the police who refer these cases for medico-legal autopsy.

**Results:** Among the 174 individuals included, 92 (53%) died and 81 (47%) underwent medico-legal autopsy. One hundred twenty-six patients were primarily admitted to hospital and 48 died before admission to hospital and were sent directly for medico-legal autopsy. Forty-four in-hospital deaths occurred, of whom 33 (75%) were sent to medico-legal autopsy. In those sent directly to the department of forensic medicine the proportion of accidents was lower ( $p < 0.001$ ), self-inflicted injuries higher ( $p < 0.001$ ) and gunshot wounds higher ( $p = 0.002$ ) in comparison with those sent to hospital. The most prevalent drugs detected by forensic toxicology screening in the 81 fatalities were ethanol (20%), sedatives (16%), anti-depressives (15%) and illicit narcotics (9%). Forty-four cases (54%) were positive for at least one drug, and twenty-eight cases (35%) were positive for two or more drugs. Factors associated with a lower rate of medico-legal autopsies among trauma-related deaths at hospital were high age ( $p < 0.001$ ), lower NISS ( $p < 0.001$ ), a longer duration between trauma and death ( $p < 0.001$ ), falls ( $p = 0.030$ ) and trauma-related infections ( $p < 0.001$ ).

**Conclusion:** This population based study covering clinical and forensic data shows that more than half of the individuals sustaining major trauma died. An additional 25% of the in-hospital fatalities should have undergone medico-legal autopsy according to legislation, but did not. The high proportion of positive toxicological findings among fatalities examined at medico-legal autopsy implies that toxicology screening should be routine in major trauma patients, in order to improve treatment and prevention.

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### Introduction

Injury is the largest single factor of death and severe disability in people under 40 years and the third leading cause of lost disability-adjusted life-years worldwide [1]. Trauma studies often

involve either case series with only in-hospital patients or only cases subjected to medico-legal autopsy. It is important to have an integrated and multi-disciplinary data collection system, otherwise significant loss of data may occur [2]. Combined analyses of both populations are rarely performed and the importance of including medico-legal autopsy data in epidemiological surveys of major trauma is unknown. Forensic experts are involved in the examination of traumatic death, by documenting the injuries, establishing the cause of death and the causality between the trauma and death [3,4]. The toxicological analyses are an

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important part of the forensic investigation and are primarily using blood from the femoral vein to detect pharmaceuticals, alcohols and illicit drugs.

Reporting standards of trauma makes data on injury severity in relation to outcome understandable and generalisable to other settings. The new injury severity score (NISS) [5] is a consensus-derived, anatomically based scoring system, which seems to perform superior to other scoring systems in mortality prediction of blunt injuries [6]. In Scandinavia, blunt trauma has been reported to occur more frequently than penetrating [7].

The main aims of this study of major traumas were to investigate the extent and characteristics of trauma fatalities not registered at hospital and subjected to a medico-legal autopsy and the cases treated at hospital but not subjected to a medico-legal autopsy.

## Materials and methods

The study was approved by the Regional Ethical Review Board in Lund, Sweden (Dnr 2014/287).

### Setting

The emergency department at Scania University Hospital in Malmö has a primary catchment population of 400,000 inhabitants. The emergency department is yearly visited by 84,000 patients, of whom 700 are trauma alarms. Individuals that die at the trauma scene or at hospital are transferred to the Department of Forensic Medicine in Lund, for a medico-legal autopsy requested by the police authority. Approximately 1000 medico-legal autopsies including toxicological analysis are performed annually at this forensic department. Among 590 medico-legal autopsies requested by the Malmö police authority between 2011 and 2013, 245 revealed the cause of death to be unnatural. Patients were excluded for the following reasons [8]: erroneous personal identification data ( $n = 3$ ), burns without any other traumatic injuries ( $n = 22$ ), hangings ( $n = 7$ ), drownings ( $n = 4$ ) and asphyxia ( $n = 2$ ).

### Retrieval of patients

This is a population based study of major trauma in both adults and children that were admitted to the emergency department at Malmö University Hospital or/and being within the jurisdiction of the Malmö police authority and subjected to a medico-legal autopsy at the Department of Forensic Medicine in Lund, between 1st January 2011 and 31st December 2013.

### Definition of major trauma

Injury severity score in each trauma patient was assessed by new injury severity scoring (NISS) [9]. The Abbreviated Injury Scale (AIS) classification system is a consensus-derived, anatomically based injury scoring system with categories ranging from 1 (minor injury) to 6 (maximal injury). NISS is calculated by summing the squares of the three highest AIS injuries, regardless of body region. The NISS scale ranges from 1 to 75 (unsurvivable). Major trauma was defined as a NISS > 15 or as a patient sent for medico-legal autopsy after trauma.

### Medico-legal autopsy and toxicology

During a medico-legal autopsy the forensic pathologist documents all external and internal injuries and signs of disease. Histological examination of selected organs is performed in the majority of cases. Based on the characteristics of the case, the

forensic pathologist determines if bodily fluids are to be sampled for toxicological analyses and selects analyses. The specimens are preserved by adding potassium fluoride and are shipped refrigerated (4 °C). Toxicological analyses are performed at the Department of Forensic Toxicology in Linköping, Sweden. This department handles all toxicological analyses in medico-legal autopsies performed in Sweden. The preferred bodily fluids for sampling are blood from the femoral vein, urine and vitreous fluid. The toxicological analyses primarily cover pharmaceuticals, alcohols and illicit drugs. The regular screening method using blood from the femoral vein covers over 220 substances including a number of illicit drugs. Usually both urine and blood from the femoral vein are screened for alcohols. Vitreous fluid is used if no urine is available and for certain specific analyses (e.g. glucose, insulin, potassium). Some substances are not detected by the routine screening protocols and need to be specifically addressed in order to be detected (e.g. synthetic cannabinoids, lithium, glycol, CO-haemoglobin etc.). The mean time from death to autopsy and collection of specimens was approximately 2–3 days. Based on the findings during the autopsy and the results of the additional investigations, the forensic pathologist determines the cause and manner of death.

### Statistical methods

Data management and statistical analysis were performed using SPSS for Windows, version 20.0 (SPSS Inc., Chicago, IL). Differences in proportions were analysed using chi-squared or Fisher's exact test. Continuous variables were expressed in medians and interquartile ranges (IQR), and group differences were evaluated by using the Mann–Whitney *U* test. Cause-specific mortality ratios were expressed as number of deaths from major trauma per thousand forensic autopsies. Incidence rates were based on the number of overall, hospitalised and forensic autopsy-verified major trauma cases, respectively, and were expressed as number of cases per 100,000 person-years. Confidence intervals (CIs) were calculated assuming a Poisson distribution of events, using the normal approximation method for numbers > 15. *p*-Values < 0.05 were considered significant. Twenty patients with NISS > 15 admitted to hospital and twenty individuals undergoing medico-legal autopsy were randomly generated from the SPSS programme to be rated again by the second NISS rater. Inter-rater reliability of NISS score among patients admitted to hospital and individuals undergoing medico-legal autopsy was evaluated by two clinicians and two forensic pathologists, respectively. The inter-rater reliability between the first and second NISS rater were evaluated with intra-class correlation (ICC) with 95% confidence intervals (CI). A value of > 0.7 was regarded as satisfactory [10].

## Results

### Inter-rater reliability of NISS score

The inter-rater reliability expressed as intra-class correlation coefficient (ICC) between the first and second rater was 0.83 (95% CI 0.58–0.94) in 20 major trauma patients admitted to hospital. Among trauma victims undergoing medico-legal autopsy, inter-rater reliability was evaluated in two different subgroups of 20 individuals, ICC was 0.92 (95% CI 0.80–0.97) and 0.96 (95% CI 0.90–0.98), respectively.

### Epidemiology of major trauma

The overall incidence of major trauma was estimated to 14.5 (95% CI 12.1–16.9)/100,000 person years. The incidence of hospitalised major trauma patients was 10.5 (95% CI 8.7–12.3)/100,000 person

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