# Non-survivors after admission to trauma centre

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## ABSTRACT

**INTRODUCTION:** Knowledge of trauma patients is often based on US studies. However, these may not be representative of the Scandinavian population. Knowing which trauma patients are at risk of dying might help us target and optimise their treatment. The purpose of this study was to examine the epidemiological characteristics and the mortality among patients who did not survive after being admitted to a Danish trauma centre.

**MATERIAL AND METHODS:** This was a historical cohort study. The study population comprised trauma patients admitted to Aarhus University Hospital from January 2000 to July 2011. Those admitted alive and who subsequently died while still at the hospital were analysed as dead. All injuries were scored according to the abbreviated injury scale, and the mechanisms of trauma were categorised by the NOMESCO classification system. The annual odds ratios (OR) for death were calculated adjusting for potential confounders using logistic regression analysis.

**RESULTS:** During the study period, a total of 6,299 trauma patients were admitted of whom 280 (4.4%) died. The OR for death was significantly lower in 2004 than in the remaining years, but there was no difference in mortality during the rest of the study period. Most patients died within the first 24 hours (67%), and 87% died within the first week. The primary cause of death was damage to the central nervous system (56%) and exsanguination (13%).

**CONCLUSION:** Survival has not been improved in the period from January 2000 to July 2011. Initiatives that could potentially improve survival include the introduction of an increased focus on older patients, treatment within the first 24 hours and treatment of cerebral and vascular injuries.

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By establishing large, centralised units for receiving and treating trauma patients, we expect to save lives. Knowing which trauma patients are at risk of dying might help us to direct and optimise their treatment.

To improve survival, we must be able to identify patients at risk and understand the underlying pathologies causing their deaths. Today, our knowledge is primarily based on foreign studies.

Many studied are from outside Scandinavia [1-7], primarily from America [5, 6]. A few studies were published from Norway [8, 9], and we found a single study from Denmark [10].

Foreign studies and data may not be representative of the Danish population. In American studies, there are high rates of penetrating injuries, including gunshots, which are seldomly seen in Denmark and Scandinavia. These differences in trauma mechanisms yield different injury patterns, i.e. gunshots more often result in exsanguination injuries as opposed to blunt trauma – which is more often seen in Scandinavia. We therefore believe that this study may help us gain a better understanding of the characteristics of our trauma patients.

The purpose of this study was to examine the epidemiological characteristics of Danish trauma patients who did not survive after being admitted to a level 1 trauma centre. We also sought to establish whether survival had improved over the past decade.

## MATERIAL AND METHODS

This was a historical cohort study including trauma patients admitted to the regional trauma centre at Aarhus University Hospital from January 2000 to July 2011. Those admitted alive and who subsequently died while still at the hospital were analysed as dead. Patients who were declared dead before or upon arrival were excluded.

Data were extracted from the hospital trauma register, and all charts of dead patients were reviewed for supplementary information by two of the authors. Diagnoses, treatments and time of death were registered. In the event of any uncertainty, both investigators reviewed the file, and a consensus was reached.

All injuries were classified according to the abbreviated injury scale (AIS), and the injury severity score (ISS) was calculated. The mechanism of injury was categorised by the NOMESCO classification systems [11] according to the descriptions in the file.

Reception of a patient at the trauma room – have we improved?

ORIGINAL ARTICLE

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FIGURE 1

Odds ratio (OR) for death with 95% confidence intervals (CI) for every year in the 2001-2011 period. The year 2000 is used as a reference with an odds ratio of 1. The ratios were calculated for each year by adjusting for the severity of the injuries using injury severity scores.

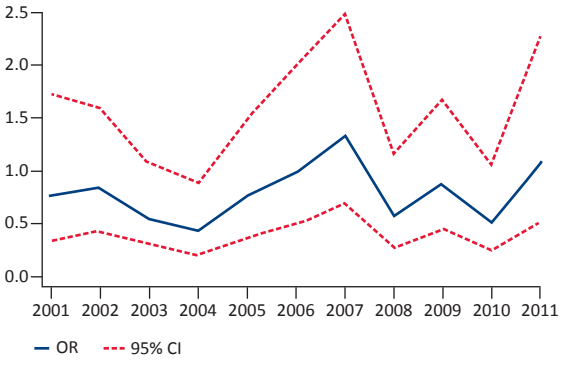
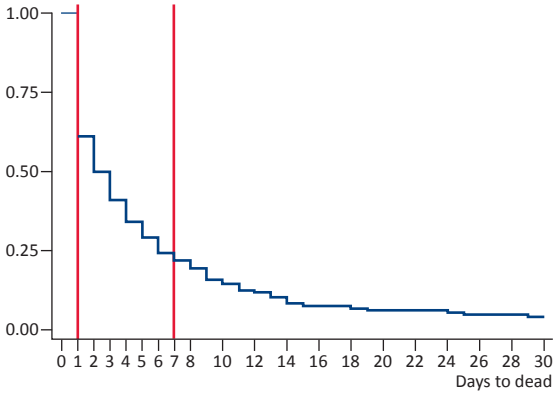



FIGURE 2

Kaplan-Meier survival curve presenting time to death. Time 0 was the time of admission to the hospital. Most patients died within the first 24 hours (67%), and 87% died within the first week (red lines).




The cause of death was divided into either the central nervous system (CNS) including damage to the spinal cord, exsanguination, multi organ failure (MOF), damage to the heart and large vessels, or infections including sepsis. If death was caused by two or more of the above, the cause of death was categorised as a combination of multiple causes.

Statistical analysis was performed using STATA version 12. The annual odds ratios (OR) for death were calculated adjusting for ISS scores and age using logistic regression analysis. The year 2000 was chosen as reference year.

*Trial registration*: not relevant.

## RESULTS

During the study period, a total of 6,299 trauma patients were admitted to the trauma centre; 280 (4.4%) of these patients died. The average age of the dead patients was 47 years. This was significantly higher than the age of those who survived (35 years).

Males accounted for 192 (69%) of those who died and 4,037 (67%) of those who survived. There was no significant difference between the groups.

The majority of injuries occurred in traffic (66%), followed by rural (21%) and production settings (3.5%). In traffic, 18% were pedestrians, 17% were riding a bike, and 43% were injured while driving or being a passenger in a motor vehicle accident (MVA). The average ISS score for all the dead patients was 36, and the lowest score was four. This was significantly higher than the score of those who survived in whom the mean ISS score was nine.

Compared with trauma patients admitted to the hospital in the year 2000, the OR for death was significantly lower in 2004, but no difference was observed in mortality during the rest of the study period (**Figure 1**).

Most patients died within the first 24 hours (67%), and 87% died within the first week (**Figure 2**). A substantial daily variation was seen with the mortality being much higher (7.8%) in the early hours of the night around 4-5 a.m. (**Figure 3**). Conversely, it was much lower in the morning (7-8 a.m.) and in the afternoon (14-15 p.m.) when mortalities of 2.8% and 2.6% were observed, respectively. The primary causes of death were damage to the CNS (56%), exsanguination (13%), MOF (4%), infections (1%); and in 10% of cases, death was caused by a combination of multiple causes.

## DISCUSSION

We found that trauma patients who died after admission were older, arrived in the early hours of the night, and that the predominant cause of death was CNS injuries. Injures most often occurred in traffic, and most deaths occurred within the first 24 hours.

Our findings correlate well with other European studies regarding the place and mechanism of injury, which was most often traffic-related, and the main type of injury was MVA [1, 4, 7, 8]. The mean age and ISS score of those who died were also similar [4, 8] – patients who died were generally older and had a higher ISS score.

The primary cause of death in our study was CNS injury followed by exsanguination. A similar pattern was seen in several other studies, with CNS injuries generally being the leading cause with around 50% [1, 3, 4, 8]. MOF or infections were very rarely the cause of death in this study as opposed to rates of 10% reported in other studies [1, 3, 4, 8]. As expected, this was very different from what was reported in US studies, where penetra-

ting injuries, including gunshots, are much more common [5, 6]. Exsanguination was seen much more often in US-based studies; in as many as 40-50% of cases; and this is explained by the differences in trauma mechanism. This underscores why US experiences may not be applicable to the European population.

Our study identified a very low overall mortality rate of only 4.4% which is similar to what was found in another study by Dutton et al from Maryland, but lower than those reported by other Danish and English studies [1, 3, 10]. The difference in mortality could very well arise from differences in inclusion criteria, e.g. people who died before reaching the hospital were included in the Danish study [10].

As described by others, deaths mainly occurred during the first 24 hours [4]. We found that two thirds of all non-survivors died within the first 24 hours. This underlines that the first 24 hours of treatment is crucial for patients' outcome – and that this is where we should make improvements to save more lives.

The mortality displayed an unmistakable daily variation with a higher mortality in the early hours of the night. We have no obvious explanation for this, and to our knowledge it has not been studied in detail. At this time of day, people may be more prone to be drinking and driving which could lead to more severe injuries. Another contributing factor could be that the trauma team is less rested at this time compared to in the morning or afternoon. Also, there may be less availability of trauma-specialists at this time. More studies are needed if this variation is to be elucidated.

Another finding was an unchanged overall OR for death during the study period. There was a significantly lower OR for death in 2004, but there was no difference in mortality during the remainder of the period. This is a very interesting finding as many things have changed during this period, including the training of the receiving team as well as the availability of CT-scans. Chalkley et al from London have reported a decrease in mortality during this period, but mortality is difficult to compare due to different inclusion criteria [3]. Conversely, in another study from Maryland there was a slight increase in mortality [1].

The limitations of this study are that it is a purely descriptive study which does not allow us to be certain of any links between causes and effects. Furthermore, all data and scores were based on the clinical assessments of the patients and no autopsy reports were used. Other studied have shown a good correlation between the clinical assessment of significant injuries and autopsy result [7, 12, 13]. We aimed to calculate the Trauma and Injury Severity Score, but this was not possible due to lack of information on the respiratory frequency in several cases.

With these results, we hope to provide insight into how we could improve survival of trauma patients and provide evidence as to where future improvement may be directed. In our opinion, the focus should be on treatment of CNS and vascular injuries.

CNS injuries constituted the major cause of death in our study; and even though many are beyond saving, a US study found a significant reduction in mortality from 22% to 13% while adherence to brain trauma guidelines increased [14].

A similar trend was seen in a Saudi Arabic study on intensive care patients where those treated according to protocol had a significantly lower mortality (19% vs. 28%) [15].

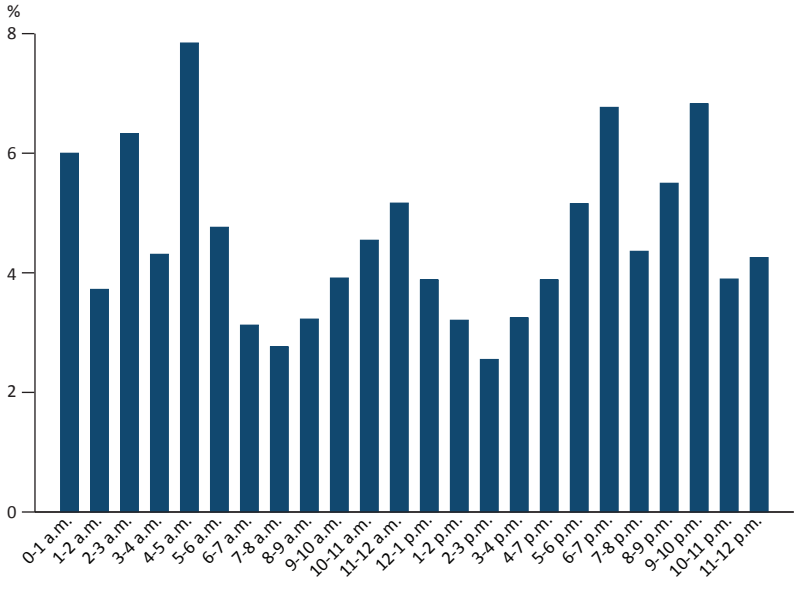
Although many might not recover to a good outcome, research conducted in this area will hopefully result in new treatment options. Some areas of research focus are the effect of cooling [16], decompressive craniotomy [17] and to validate biomarkers with outcomes [18].

Exsanguinations deaths have a greater potential for improvement than other traumas as treatment options are more readily available and strategies for managing these patients (e.g. damage control surgery and/or correction of coagulopathy) have gained increasing focus in later years [19].

Although we are not able to provide statistical significant evidence of benefits of survival, every life saved would be worthwhile.

**FIGURE 3**

The daily variance of mortality among trauma patients. The x-axis depicts the time at which the patient arrived at the trauma centre. The y-axis presents the percentage of trauma patients who died.



## CONCLUSION

Trauma patients who do not survive after being admitted to a Danish trauma centre have distinct epidemiological characteristics. Survival has not been improved from January 2000 to July 2011.

If we are to improve survival, focus should be on older patients, treatment during the first 24 hours, and treatment of cerebral and vascular injuries. Prevention of fatal injuries should still focus on traffic accidents.

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