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**Brief communication (original)**

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# Death and preventable death in trauma patients in a level-1 trauma center in Thailand

Osaree Akaraborworn*, Burapat Sangthong, Komet Thongkhao, Pratthana Chainiramol, Khanitta Kaewsaengrueang

**Abstract**

**Background:** Trauma is a major cause of death in young adults. The mortality rate is one of the key performance indices of trauma centers.

**Objective:** To demonstrate a mortality rate, cause of death, and cause of nonpreventable death in a level-1 trauma center in Thailand.

**Methods:** There was a retrospective study of the death cases from a trauma registry. The number of trauma deaths during the study period was collected to identify the death rate. The causes of death and a death analysis were obtained from the morbidity and mortality.

**Results:** The death rate was 6.6%. The most common cause of overall death was head injury, and exsanguination was the most common cause of death in the first 24 h. The preventable death rate was 2%, and the most common cause of preventable death was exsanguination.

**Conclusions:** The mortality rate of trauma patients in Thailand was not higher than that in other countries. The majority of deaths were caused from head injury. Therefore, improvement in injury prevention is needed to decrease the number of deaths.

**Keywords:** epidemiology; hospital mortality; mortality; preventable death; trauma

Unintentional injury is the major cause of death between the ages of 1 and 44 years in the United States [1], and road traffic injury is the second leading cause of death between the ages of 1 and 49 years in Thailand [2]. In 2015, the fatality rate of road traffic injury in Thailand became the second highest in the world [3]. The major cause of trauma death is traumatic brain injury followed by exsanguination [4]. This study aimed to review the causes of trauma death in Songklanagarind Hospital, which is a university-based level-1 trauma center in Thailand.

A quality improvement program has been known to improve the outcomes in trauma centers [5]. The World Health Organization (WHO) launched elements of the Trauma Quality Improvement Program (TQIP), such as a morbidity and mortality conference, preventable death panel review that consisted of multi-professional personnel to classify the deaths as preventable, potentially preventable, and non-preventable, tracking of audit filters that uses pre-identified parameters that are markers of standard of care, and tracking the events that occurred [3, 6]. Mortality rate and preventable death rate are also the benchmarks of the quality of a trauma center. The objective of this study was to report data from a quality program in the hospital.

***Correspondence to: Osaree Akaraborworn,** Department of Surgery, Faculty of Medicine, Prince of Songkla University, Songkhla 90110, Thailand, E-mail: aosaree@medicine.psu.ac.th, aosaree@gmail.com

Department of Surgery, Faculty of Medicine, Prince of Songkla University, Songkhla 90110, Thailand

# Methods

This is a retrospective cohort study that was conducted in Songklanagarind Hospital, where there is a level-1 trauma center located in Southern Thailand. The hospital has approximately 1,600 trauma admissions per year, of which 30% patients had an injury severity score (ISS) >15. The data were collected retrospectively from a prospective trauma registry of all trauma patients from January 2009 to December 2012. The study included patients who died at the emergency department, had arrest on arrival, and died during admission. Demographic data and trauma severity scores included the ISS and trauma and injury severity score (TRISS). Since autopsy was not routinely performed and only few patients underwent autopsy, the cause of death was retrieved from the medical records and morbidity and mortality conference database. This study was approved by the Institutional Review Board of the Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand (certificate of approval no. EC 45-003-10-1-3).

### Death analysis

The cases of all adult multiple trauma patients who died in the hospital were discussed in morbidity and mortality conferences for cause of death, and panels analyzed the preventability of death. Expert panel is the most common method to identify the preventability. In the panel, 2 or more physicians must be presented to discuss and decide the preventability, which is classified into 3 groups: non-preventable, potentially preventable, and preventable.

### Statistical analysis

The analysis was done using the R program and epicalc package. Descriptive data were reported as number count, percentage, mean and standard deviation or median, and interquartile range (IQR).

# Results

Among the 5,902 trauma admissions during the 4-year period, there were 391 trauma deaths (6.6%). Motorcycle crash was the most common mechanism leading to trauma death (43%). The median age of patients was 36 years (IQR 26–53 years), and the median ISS was 26 (IQR 18–34). The demographic data of the patients are given in **Table 1**.

**Table 1.** Characteristics of trauma patients

| Characteristics | N = 391 |
|---|---|
| Gender, male | 314 (80) |
| Age, year (IQR) | 36 (26–53) |
| Mechanism of injuries | |
| MCC | 53 (13.6) |
| MVC | 169 (43.4) |
| Bicycle | 22 (5.6) |
| Auto versus pedestrian | 41 (10.5) |
| GSW | 10 (2.6) |
| Stab wound | 44 (11.3) |
| Falls | 1 (0.2) |
| Assaulted | 10 (2.6) |
| Other | 41 (10.3) |
| ISS (IQR) | 26 (18–34) |
| TRISS (IQR) | 0.3075 (0.0582–0.8085) |

Data are presented as n (%) unless indicated otherwise.
IQR, interquartile range; MCC, motorcycle crash; MVC, motor vehicle crash; GSW, gunshot wound; ISS, injury severity score; TRISS, trauma and injury severity score.

**Table 2.** Causes of death

| Causes of death | In the first 24 h (N = 237) | Overall causes of death (N = 391) |
|---|---|---|
| Exsanguination | 110 (46.4%) | 128 (32.8%) |
| Head injury | 83 (35.0%) | 174 (44.5%) |
| Multiple trauma | 33 (13.9%) | 47 (12.0%) |
| Respiratory failure | 10 (4.2%) | 22 (5.7%) |
| Multiorgan failure | 6 (2.5%) | 35 (8.9%) |
| Sepsis | 1 (0.4%) | 32 (8.2%) |
| Arrest on arrival | 100 (42.2%) | 109 (27.9%) |
| Others | 10 (4.2%) | 21 (5.4%) |

Data are presented as *n* (%).

### Causes of death

The most common cause of death was head injury followed by exsanguination. A total of 61% of the total deaths occurred in the first 24 h. The majority of deaths in the first 24 h were due to exsanguination. Details of the causes of death are given in **Table 2**.

### Death analysis

From 391 cases, 288 cases were reviewed in the morbidity and mortality conferences. Five cases were preventable (2%), 43 cases were potentially preventable (15%), and 240 cases were

non-preventable (83%). The details of preventable deaths are given in **Table 3**.

### Severity scores and death

Most of the patients who died were critically ill trauma patients defined by ISS >25 (65%), and 30% of the patients who died from trauma had a TRISS >0.75. The details of the severity score and trauma death are given in **Table 4**. Deaths were classified by severity score.

**Table 3.** Details of preventable deaths

| Gender | Age (years) | ISS | PS | Causes of death | Cause analysis |
|---|---|---|---|---|---|
| Male | 67 | 20 | 0.7538 | Exsanguination | Delayed diagnosis |
| Male | 54 | 29 | 0.9575 | Sepsis | Protocol problem |
| Male | 57 | 34 | 0.6955 | Heart failure | Delayed diagnosis |
| Male | 64 | 21 | 0.9381 | Exsanguination | Delayed diagnosis |
| Male | 43 | 57 | 0.1522 | Head injury | Inadequate resource |

ISS, injury severity score; PS, propensity score.

**Table 4.** Deaths classified by severity score

| Injury severity scores | N = 386 |
|---|---|
| **Classified by ISS** | |
| ≤15 | 68 (18%) |
| 15–24 | 65 (17%) |
| ≥25 | 253 (65%) |
| **Classified by PS** | |
| 0–0.75 | 272 (70%) |
| >0.75 | 114 (30%) |

Data are presented as n (%).
ISS, injury severity score; PS, propensity score.

## Discussion

This is one of the few studies that report the results of a death analysis, which was part of a TQIP in Thailand. The overall death rate in Songklanagarind Hospital was the same as other trauma centers, which was 5%–6% of trauma admissions [6]. The preventable death rate in our study was reported as 2% of trauma deaths. This was much lower compared with the preventable death rate of around 40%–60% in other lower middle-income countries [7, 8]. Even though this study was done in a middle income country, the hospital is a university-based hospital that has a well-equipped level-1 trauma center, which might make the results better than previous studies done in the same setting.

The causes of death in our study were similar as those in previous studies. The most common cause of death in the first 24 h was due to exsanguination, which was the same as that in a review from Kauvar et al. [9] that showed hemorrhage accounted for almost 50% of deaths in the first 24 h and the majority of overall deaths was due to head injury [10].

The preventable death rate in our study was lower than that reported in a study conducted in India by Roy et al. [7]. They reported a preventable death rate of 58%. The preventable death rate of 2% in our study was as low as that in a study conducted by Teixeira et al. [6], who analyzed data from the US and reported a preventable death rate of around 2.5% of trauma deaths. All of these studies used the WHO method to identify preventable death. Since panels were used for death analysis, variation within the members on the panels may cause different results.

The first limitation in our study was the type of cases included in the death analysis. The death analysis in this study resulted from the morbidity and mortality conferences in the Division of Trauma. Therefore, the patients included in the analysis were only those who had multiple trauma. Isolated head injury patients or isolated orthopedic patients were not included in the analysis. Therefore, the results of the death analysis imply that only multiple trauma patients were included in the study. Another limitation was the causes of death that could not be obtained from autopsy reports because the autopsy rate of trauma patients in the institute was almost 0 because of the limitation of the social context that made the autopsy not to be performed routinely.

### Conclusions

The most common causes of death in trauma patients in Thailand were due to head injury and exsanguination. Almost half of the patients who died in the first 24 h were arrest on arrival, which the methods to decrease this number are encourage of injury prevention and improving pre-hospital care.

**Author contributions**. OA and BS contributed substantially to the conception and design of this study. KT, PC, and KK contributed substantially to the acquisition of data. OA analyzed and interpreted the data. OA drafted the manuscript. BS, KT, PC, and KK contributed substantially to its critical revision. All the authors approved the final version submitted for publication and take responsibility for the statements made in the published article.

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**Conflict of interest statement.** The authors have completed and submitted the International Committee of Medical Journal Editors Uniform Disclosure Form for Potential Conflicts of Interest. None of the authors disclose any conflict of interest.

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