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**Factors associated with opportunities for improvement in trauma care**

***A registry-based retrospective cohort study***

Seminar version

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**Introduction**

Previous studies have shown inconsistencies in trauma care that in most cases lead to a poor outcome for the patient. Such areas for improvement in trauma care are for instance lack of resources, delay or inaccurate diagnosis and treatment. Different methods are developed to identify preventable errors, usually including reviews by a board of specialists. To determine which cases are selected for these reviews, factors associated with preventable errors must be identified.

**Trauma**

Defined as physical injury and the body´s consequential response, trauma is one of the leading causes of mortality and morbidity (M&M) in all age groups and the leading cause of mortality in people below the age of 44 [1,2]. Approximately 4.5 million people die each year due to injury in the world, defined as death where the injury was the underlying cause. Motor vehicle crashes alone account for more than one million deaths and roughly between 20 and 50 million injuries annually [3]. With an average of more than 7 days in the hospital each stay [2], trauma is one of the most prevalent reasons for admission. In 2020 road traffic accidents were third in disease burden worldwide, measured by Disability-Adjusted Life Years (DALY), a term used to describe the impact of health problems and to measure the significance of improvement in medical care [4,5].

**Setting**

In Sweden, pre-hospital care is managed by paramedics and specially trained physicians. The trauma patient is triaged by EMS personnel at the scene, according to acuity. Patients are prioritized according to vital signs and mechanism of injury. For instance, open head injuries are priority one. All trauma patients in Stockholm with priority one are transported to Karolinska University Hospital (KUH) to receive care by dedicated trauma teams. These teams consist of a trauma surgeon, an anaesthetist, an orthopaedic surgeon, a radiologist, and specialized nurses. KUH in Solna is a level one trauma centre, with direct access to radiology, operation, intensive care, and interventions [16,17].

**Opportunities for improvement**

In many cases the outcome of the patient is mostly dependent on the quality of care acquired [6], as observed in the decline of deaths by organ dysfunction, reduced from 5% of all trauma deaths to approximately 0% after the adaptation of various treatment strategies and improvement in critical care, demonstrated by a study conducted in KUH [20]. Advances in trauma care are the leading cause of the decreased number of preventable deaths according to the American College of Surgeons Committee [3].

Inconsistencies in trauma care are prevalent in areas such as resources, diagnosis, and treatment. In a teaching hospital in Tehran, reviews of all trauma cases in 1 year displayed inappropriate care in 45% of all deaths and implied that approximately 26% of all trauma deaths were preventable [7]. Other studies have estimated preventable and potentially preventable trauma death rates up to 60% [8]. Airway management, inadequate chest compression, inadequate blood or fluid supply are some factors that previously were found in need of improvement in trauma care according to different studies [7,10].

**Mortality and morbidity conferences**

It has for a long period of time been of great importance to investigate factors that can be improved in trauma care and different methods are used to do so. The gold standard is M&M conferences during which specific cases are reviewed to further investigate the reason behind the mortality or morbidity [11]. The results are used to improve the trauma care and to decrease the number of preventable errors. Although these conferences are a vital part for advancement in trauma care, it remains a process that requires a great number of resources and is still complicated to this day.

**Audit filters**

Cases are selected for M&M conferences by specialized nurses mainly based on audit filters and reviewed by experienced specialists from all the fields involved in the trauma team. Preventable errors in the care of the patient are identified in each case and registered to SweTrau, the Swedish National Trauma Registry as a categorical variable. The absence of such errors is also registered. A plan to solve the problems identified is also presented by the board.

Despite the evidence supporting the use of predefined models for case selection, there is limited data on specific factors associated with opportunities for improvement in trauma care [12]. Therefore, methods such as audit filters are adopted in trauma quality improvement programs. Audit filters are predefined factors used in the selection of cases for review and represent an unfavorable alternation, proclaimed leading to a disadvantageous outcome [11,13]. The audit filters in KUH are systolic blood pressure under 90, Glasgow Coma Scale (GCS) less than 9 and not intubated, injury severity score (ISS) more than 15 but not admitted to the intensive care unit, time to acute intervention more than 60 minutes, time to computed tomography more than 30 minutes, and death within 30 days after trauma. A systematic review of audit filters in 2009 found no studies meeting set criteria determining the effectiveness of set audit filters [13].

**Hypothesis**

Trauma quality improvement programs rely on set filters for the selection of cases for M&M conferences. Some studies have found no major opportunities for improvement in currently used audit filters and believe further advancements are essential [14,15]. Since there is a knowledge gap in the effectiveness of used audit filters, we hypothesize that certain factors are associated with opportunities for improvement in trauma care.

**Aim**

The aim of this study is to assess how patient level factors are associated with opportunity for improvement in trauma care for later development of models trained to identify cases with capacity for improvement. This will lead to the identification of areas in need for improvement in trauma care and adequate reaction.

**Contribution**

Medical student Elias Joneborg is performing a parallel sibling project with the same supervisors. He aims to calculate the incidence of opportunities for improvement in five different cohorts using the same database as this project. The cohorts are blunt multisystem, shock, penetrating, elderly, and traumatic brain injury. The whole team have weekly meetings were the progress and need of help are discussed.

**Methods**

**Study design**

A retrospective cohort study using data from the KUH trauma registry, and the trauma care quality database was conducted. Established in 2004, the trauma registry includes information of pre-hospital, hospital, and post-hospital care in accordance with the Utstein template. Factors such as demographics, vital signs, time to procedure and time to intervention are registered. The trauma care quality database consists of the cases selected for review and the presence of opportunity for improvement is noted. The registries will be linked, and possible factors associated with opportunities for improvement are to be extracted. All statistical analysis is first done on synthetic data to ensure objectivity. Bi- and multivariable logistic regression will be used to determine associations with the presence of opportunity for improvement.

**Participants**

The trauma registry includes all patients admitted with trauma team activation, regardless of ISS, as well as patients admitted without trauma team activation but found to have an ISS of more than 9. The previously mentioned audit filters are used to select patients for inclusion in the trauma care quality database and M&M review. The inclusion criteria for this study are patients included in the database, the registry and aged at least 15 years. A complete case analysis was conducted, hence patients with missing data in any of the covariates or outcome with the exception of GCS, respiratory rate, and systolic blood pressure are excluded. Data was collected for approximately 21 000 patients registered between 2014 and 2021.

**Variables**

*Study outcome*

The outcome variable is the presence of opportunities for improvement, as labelled by the mortality and morbidity review board, and defined as a binary variable with the levels “Yes - At least one opportunity for improvement identified” and “No - No opportunities for improvement identified”. Presence of opportunities for improvement is defined as preventable error made in a specific patient case. Data on this outcome will be extracted from the trauma care quality database.

*Predictors*

As our aim is to assess how patient level factors are associated with opportunity for improvement, the database used will therefore have some factors that can be further examined [18]. The selection of variables to be further examined are made through discussion within the research team and partly based on locally used audit filters and factors frequently registered in the database. Selected factors to be further examined are divided into categorical and continuous variables [Table 1]. The categorical variables are sex, survival after 30 days, highest level of hospital care, GCS, respiratory rate, systolic blood pressure and intubation of the patient. The continuous variables are age, ISS, time from arrival at the hospital until first CT and time from arrival at the hospital until first intervention.

Systolic blood pressure and respiratory rate are registered to the database as either a continuous or a categorical value according to the Revised Trauma Score (RTS), but never both. The decision to convert the continuous values, if registered, into corresponding categorical value and treat them all as categorical was therefore made. All vital signs had to be treated similar and GCS will therefore be divided into categories based on RTS [Table 1].

**Data sources and measurements**

All the data is extracted from the KUH trauma registry and the trauma care quality database. Age and sex are registered to the registry via the patient’s personal number. Vital signs are measured on arrival to the emergency department and the other variables are registered from the patient´s charts.

**Bias**

Since this is not a blinded study it is of utter importance to acknowledge the risk of bias. Synthetic data will however be used to develop the analysis model and after satisfactory results implement it on the data collected from the databases. This is done to lower the risk of bias.

Tabell 1. Selected variables with definition

|  |  |  |
| --- | --- | --- |
| **Variable** | **Definition** | **Value** |
| Sex | The sex of the patient. | Male or Female |
| Age | The age of the patient at the time of injury. | 15–110 |
| Intubated | If the patient is intubated during the hospital stay. | 1.Intubated in the ED.  2.Not intubated.  3.Intubated before arrival. |
| Hospital care level | Highest level of in-hospital care. | 1–5 |
| Survival | Survival after 30 days. | True or False |
| ISS | Injury Severity Score | 0–75 |
| GCS | Glasgow Coma Scale | Mild:13–15, Moderate:9–12, Severe:3–8 |
| RR | Respiratory Rate | 1. 1–5 2. 6–9  3. 30–70 4. 10–29 |
| SBP | Systolic Blood Pressure | 1. 1–49, 2. 50–75, 3. 76–89, 4. >89 |
| CT | Time from arrival at the hospital until first Computed Tomography. | 0–1500 minutes |
| Procedure | Time from arrival at the hospital until first Procedure. | 0–2100 minutes |

The data is collected from KUH trauma registry, Swetrau. Intubated is a variable created in R, using the combination of two variables. Glasgow Coma Scale, Respiratory rate, and Systolic Blood Pressure are converted in accordance with the revised trauma score.

**Statistical methods**

The programming language R was used for all analyses. The necessary data on the outcome and predictors was collected from Swetrau. The analysis model was first developed on synthetic data with all the possible outcomes for each variable but scrambled between the patients, and later implemented on the collected data. This is done to decrease the risk of bias.

The data used is all from the ED except for GCS and respiratory rate, in some cases. Patients intubated before arrival at the hospital are registered in the database as 99 in both GCS and respiratory rate upon arrival at the hospital. Those cannot be excluded since the variable intubation is part of the study and needs to be examined. Therefore the decision made was to use the GCS registered by the paramedics and place it into corresponding group in accordance with RTS in the case of intubation before arrival at the hospital.

To replace 99 as respiratory rate used for intubated patients before arrival at the hospital, it was determined that the most reasonable solution would be to use the pre-hospital respiratory rate, also converted into corresponding RTS-value. In the case of respiratory rate and GCS, if no pre-hospital value was registered, the value measured in the hospital would be used. If both were missing, the patient would still not be excluded, and the missing vital sign is then registered as missing. Patients with no registered systolic blood pressure would also be included with the value ¨Missing¨.

Logistic regression was used to assess unadjusted and adjusted associations between independent variables and the outcome. This is done to control for confounding factors and determine any association between set variables. Results are to be presented in a confidence level of 95%, and a p value of less than 0,05 will be considered significant.

**Ethical considerations**

This study is conducted with accordance to the following ethical principles as there is a minimal risk of leakage of private information.

**Respect for autonomy**

All the information is gathered from SweTrau, a database for all trauma patients in Sweden. The patients are informed of their contribution and that registered data can be used for further advancements in trauma care and other studies via letter. They also have the right to be excluded and can at any time submit a withdrawal.

**The Principle of Justice**

This study contains no treatment nor intervention and can in no way harm the patients. The patients involved only need to consent to the use of already gathered information. We also believe that the results from this study can improve trauma care and even implemented in other medical fields.

**The Principle of Beneficence**

We believe that this study has potential to decrease the number of preventable errors, improve patient safety and trauma care in general. The patients that consented to be part of this study also wants to be involved in potential improvements.

**The Principle of Non-malefience**

As previously mentioned, the study can in no way harm the patients included since it contains no intervention. Sensitive information is used during the study. However, we will use secure networks when working on non-scrambled data. We believe the risk of sensitive information leakage is minimal.

**Ethical permit**

Ethical permit is acquired, ethical review numbers are 2021-02541, 2021-03531

**Progressrapport och tidsplan**

Vid inlämning av projektredogörelse så har jag hunnit med följande:

* Gjort en timeline med viktiga datum och allt som ska hinnas med varje vecka.
* Skrivit en study plan med bakgrund och metod som är mer kompakt än projektredogörelsen och som förhoppningsvis ska publiceras i slutet av terminen. Även fått feedback från handledare och korrigerat.
* Fått tillgång till scrambled data och på så vis påbörjat kodandet.
  + Importerat scrambled data.
  + Selekterat ut valda variabler från databasen och gjort en egen data frame.
  + Kodat hur variablerna ska tolkas
* Gjort en table.1 med valda parametrar

Det som ska göras

* Fortsätta med kodandet
  + Se till att alla variabler fungerar på scrambled data
  + Ändra kod efter feedback från handledare
  + När koden är klar så kan den användas på riktiga data
  + Importera riktig data från databasen
  + Köra koden på den datan
* Registera resultat
* Tolka resultat
* Få med allt i tabeller
* Skriva diskussion
* Korrigera efter feedback
* Publicera

**Reservplan**

Ligger i nuläget i god tid enligt egen timeline, har däremot varit många hinder i kodandet och val av variabler. Vi har bestämt att i fallet då inte allt hinns med i slutet så kommer handledare och bihandledare att hjälpa till för att få med allt. Däremot är tanken att jag börjar med ett fåtal variabler, vilket jag troligtvis kommer hinna med. Om det mot all förmodan inte skulle gå vägen så kommer jag få hjälp. Annars lägger jag till flera variabler om jag är klar i god tid. Sedan är tanken också att jag ska hinna skriva en artikel som ska publiceras.

**GANNT-Diagram**

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