

Performance of individual audit filters in predicting opportunities for improvement in adult trauma patients

A registry based cohort study

Josef Al-Khalili

Introduction

Trauma is defined as a physical injury of external origin together with the body's associated response. This phenomenon constitutes 9% of global deaths each year (Organization et al. 2014). It is the leading cause of death for individuals between the ages 10 to 49 (Vos et al. 2020); (Roth et al. 2018).

Trauma is broadly categorized into two groups by the underlying causal mechanism: penetrating and blunt trauma. Common examples of penetrating trauma are bullet wounds and knife cuts. Blunt trauma, however, is attributed to injuries like road traffic injuries and falls. Generally speaking, the two types of trauma can also be characterized by the size of force causing it and the area of impact. Blunt trauma is caused by a high-force impact over a larger surface area. In contrast, penetrating trauma results from a force applied to a smaller surface area causing greater pressure thus acting in a piercing manner and often resulting in deeper lacerations to tissues and organs. Blunt trauma with enough force can however be penetrating in character (Hexdall and Miglietta 2011).

Globally, the leading cause of injury are road traffic accidents (Vos et al. 2020); (Roth et al. 2018) In Sweden, road traffic incidence account for around 40% of injuries and falls account for 40% of injuries (SweTrau 2022).

Impact

The impact of trauma depends greatly on the type of trauma, where it occurred and to whom it affected. Trauma contributes for 11.9% of global Years of life lost (YLL) (Roth et al. 2018). Furthermore, Trauma is associated with higher tendency to depression, post traumatic stress syndrome (PTSD), negative effects on cognitive functions etc. (North 1999); (Muscatelli et al. 2017).

Injuries are, however, not only a burden to the afflicted individual but also to communities and to society as a whole (Newnam et al. 2014). One aspect of such societal effects are the economic costs. There have been attempts to estimate the global cost of injury it is a complicated task due to its variability. It is however estimated that the cost of road injuries alone account for 2% of gross domestic product (GDP) in high-income countries (Organization et al. 2014).

Trauma Care Systems

Trauma care is a multidisciplinary, complex, and time-critical provision of healthcare delivered by specialized trauma centres. A myriad of different specialities are involved in trauma care, including but not limited to surgeons, orthopaedics, anaesthesiologists, emergency doctors and nurses.

Trauma centres have shown significantly less mortality compared to non-trauma centres. And the level of maturity of a trauma center is also correlated with reduced mortality which shows the significance of high quality and specialized care for trauma (Alharbi et al. 2021); (Mann et al. 1999). A similar study in Sweden (Candefjord, Asker, and Caragounis 2020) showed 41% less 30-day mortality in a mature trauma centre compared to a non-trauma centre. However,

even with established trauma care systems, due to its complexity and sensitivity to delay, it is prone to errors (Nikouline et al. 2021);(Vioque et al. 2014) which in turn can lead to complications and death. Studies between 1990 and 2014 have shown a pooled preventable death rate of 20% with newer studies showing less (Kwon, Garbett, and Kloecker 2014). In a more recent study in A Swedish level I trauma centre they showed a 4% preventable death rate (P. Ghorbani and Strömmer 2018).

Quality Improvement

In order to minimize errors in trauma care, Quality improvement (QI) programs were established by the World Health Organisation (WHO) and the International Association for Trauma Surgery and Intensive Care (IATSIC) (Organization et al. 2009). These programs are at the core of current trauma care systems and its development all around the world.

QI programs consist of a set of recommended techniques that seek to enable discussion and analysis of the trauma process in order to take corrective measures for future success. Following techniques are being used: A multidisciplinary mortality and morbidity conference (MMC), A preventable death review panel and the use of audit filters(Organization et al. 2009).

Morbidity and Mortality Conferences and Preventable Death Review Panels

The MMC is a central QI technique. It is an established framework of crucial components of anonymity, a focus on specific adverse events, realising flawed approaches, critical analysis and lastly the effort to change and practice that change. (Gregor and Taylor 2016)

The MMC are regularly scheduled meetings in which specific patient cases are brought up and discussed between healthcare professionals from all the different disciplines involved in trauma care and its processes. It is recommended that they are around 40 minutes but this varies between different hospitals (Organization et al. 2009).

Five themes have been proposed that broadly define QI centred MMC: (1) clear definition of the role of MMC (2), involving stakeholders, (3) detecting and selecting appropriate patient cases for presentation, (4) structuring goal-directed discussion, and (5) forming recommendations and assigning follow-up(Giesbrecht and Au 2016);(Churchill, Murphy, and Smith 2020).

When effectively implemented, MMC serve as a crucial fault-examining tool without being solely negative marks against individual care providers, instead being incentives for reporting. These conferences promote a broader, system-based approach that emphasizes the analysis of tasks, teamwork, and quality improvement(Lazzara et al. 2022). The implementation of MMC have been shown to increase reporting of morbidity and mortality(Kong and Clarke 2016).

Following the MMC there is a preventable death review panel with the sole purpose of determining whether the death of a patient could have been preventable (Poya Ghorbani et al. 2014).

Audit filters and Opportunities for improvement

Audit filters also known as quality indicators are specific established criteria involved in trauma processes and care. It is used to detect deviation from standardized care in order to further analyse the cause behind complications in trauma patients. An audit filter can be death and the placement of 2 large bore intravenous lines within 15 minutes from arrival to a healthcare facility (Organization et al. 2009). The purpose of audit filters is to improve quality of care.

Earlier studies showed a reduction in trauma related mortality after the implementation of audit filters (Chadbunchachai et al. 2001). However, newer studies seem to differ. In 2009 there was an extensive review made that sought to determine if audit filters could be used in improving processes of trauma care however none of the studies met established inclusion criteria (Evans et al. 2009). The use of audit filters have also been associated with high frequencies of false positives, ranging from 24% to 80%.(Sanddal et al. 2011); (Roy et al. 2017).

OFls are the endpoint and aim of MMC. Following the review of individual patient cases there is a consensus decision made regarding the existence of an OFI. It has been shown that such review process is associated with high-quality trauma care (Santana, Stelfox, et al. 2014). OFIs are typically associated with failures in initial care (Vioque et al. 2014), specifically in airway management, fluid resuscitation, haemorrhage control and chest injury management (Sanddal et al. 2011); (Roy et al. 2017); (O'reilly et al. 2013). Some audit filters seem to not correlate with OFIs at all (Lewis et al. 2017)

Aim

The aim of the study is to determine whether audit filters are good indicators for predicting OFIs.

Methods

We conducted a registry-based cohort study which uses data from the trauma registry and trauma care quality database at the Karolinska University hospital in Solna in order to evaluate the performance of individual audit filters in predicting OFIs.

Study setting and population

Karolinska University Hospital is classified as a Trauma level I hospital. Every year around 1500 patients receive treatment at the hospital. If a patient case results in team activation it is added to the Karolinska trauma registry. If no team activation occurred but the patient had ISS>9 retrospectively it is also included in the registry. The Karolinska trauma registry reports to the Swedish Trauma registry (SweTrau). The registry includes data on vital signs, times, injuries, and interventions as well as patient demographics according to the European consensus statement, the Utstein template

The Karolinska trauma registry also contains a care quality database including specific audit filters and OFIs that are determined in MMC conferences through consensus decision.

This process of determining OFIs unfolds in multiple stages, characterized by escalating levels of scrutiny. Notably, instances of mortality are directly referred to the multidisciplinary conference, where, in addition to assessing OFIs, a determination is made regarding whether the death was preventable or potentially preventable, a classification also falling under the purview of OFIs.

From 2013 to 2017 there was an effort put forward in identifying adverse outcomes which were unrelated to mortality, the review process underwent subsequent refinement and formalization during the study period. During the initial period each trauma patient case underwent individual assessments by a specialized trauma nurse in order to identify potential OFIs. It was, however not until 2017 in which this procedure was formalized and it became standardized to incorporate a preliminary individual evaluation by a specialized trauma nurse upon data registration in the trauma registry and the trauma quality database. The trauma quality data underwent screening of audit filters. All cases falling within the criteria delineated by these filters, along with those trauma patients flagged by the nurse during the initial review for possible care failures, were subjected to a secondary review by two specialized nurses. Subsequent identification of a potential OFI during this second review prompted a comprehensive evaluation of the respective trauma patient's case.

Participants

In this study, we included all who underwent screening for OFIs. Exclusion criteria were applied to individuals under the age of 15, as their clinical management process has notable distinctions compared to those applicable to the adult population.

Variables

Outcome

The outcome variable in this study is an OFI, as established by the MMC conference through unanimous decision and furthermore valued as a binary variable with “Yes - At least one OFI identified” and “No - No OFI identified”.

Exposures

The exposure variable is the audit filters. The following audit filters are of interest:

- Systolic blood pressure less than 90
- Glasgow coma scale less than 9 and not intubated
- Injury severity score greater than 15 but not admitted to the intensive care unit
- Time to acute intervention more than 60 minutes from arrival to hospital
- Time to computed tomography more than 30 minutes from arrival to hospital
- No anticoagulant therapy within 72 hours after traumatic brain injury
- The presence of cardio-pulmonary resuscitation with thoracotomy
- The presence of a liver or spleen injury
- Massive transfusion, defined as 10 or more units of packed red blood cells within 24 hours.

Data sources/measurement

The data will be retrieved from the trauma registry and the trauma care quality database during the period spanning from 2012 to 2022.

Bias

Selection bias since the outcome of this study has already occurred.

There is a possibility that consensus decisions from the MMC conferences are flawed which causes misclassification bias.

Study size

The study cohort encompasses all eligible patients treated at the hospital from 2012 to 2022. There were only two patient cases from 2012.

Statistical methods

The study results are generated by statistical analytics methods with the help of the statistical programming language, R. (R Core Team 2022)

To calculate the sensitivity and specificity of each individual audit filter in predicting an OFI a mathematical equation is used:

The sensitivity is calculated accordingly: $\text{True positives} / (\text{true positives} + \text{false negatives})$

The specificity is calculated accordingly: $\text{True negatives} / (\text{true negatives} + \text{false positives})$

This project will link the two databases and assess the performance of each audit filter in terms of discrimination and accuracy. Logistic regression and a 5% significance level and 95% confidence level will be used.

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