Associations between trauma resuscitation procedures and opportunities for improvement in adult patients with severe trauma

List of Abbreviations

- ISS - Injury Severity Score
- KUH - Karolinska University Hospital
- M&M - Morbidity and mortality
- OFI - Opportunities for improvement

Introduction

Background

Trauma and trauma care

Trauma, a condition resulting from physical injury and the body's associated response, is a major cause of death and permanent disability worldwide, particularly in young people. (1,2). In 2020, it was responsible for an estimated 4.4 million deaths, accounting for approximately 8% of all deaths globally (3). Trauma can be complex and require multidisciplinary treatment and rehabilitation, resulting in a significant global public health care burden with high global personal and societal costs (2). For example, road traffic injuries estimated to cost $1.8 trillion per year (4).

The leading causes of trauma are motor vehicle accidents, falls, and penetrating trauma due to violence-related injuries. Moreover, the causes of trauma can vary over time and might be influenced by various factors such as age, population behavior, and resources for trauma prevention and treatment (3,5).

Previous studies show that the quality of trauma care plays a significant role in patient outcomes. The higher quality of trauma care, the better results (6,7).Immediate trauma assessment requires a broad series of interventions depending on the type and severity of the trauma as well as the patient's specific needs (8). Resuscitation procedures, such as airway management, and blood transfusion, are crucial in stabilizing the patient and preserving vital organ functions. Immediate, systematic, and effective implementation of these interventions will significantly improve the patient's chances of survival and recovery (8), emphasizing the importance of having a well-functioning trauma system (9–11).

A trauma system consists of an organized and coordinated network of pre-hospital and in-hospital healthcare facilities and services integrated with the local public health organization and designated to optimal provide care to injured patients (**Lendrum2012?**).

Key elements of a trauma system include specialized trauma centers, prehospital care, and quality improvement programs to provide appropriate services across the entire spectrum of trauma care (11). Trauma centers are specialized units at hospitals that are equipped and staffed with experienced medical professionals to provide multidisciplinary advanced care (1). The level of care provided by a trauma center varies from the highest (level I) to the lowest (Level IV) level of care. It is believed that implementation of trauma systems might reduce the mortality and morbidity caused by trauma (6). Moreover, it may result in a decrease in the costs associated with initial treatment and continued rehabilitation of trauma patients and hence reducing the healthcare burden

Opportunities for improvement

The quality improvement programs aim to ensure the delivery of safe and high-quality healthcare. The World Health Organization recommends conducting Morbidity and Mortality (M&M) conferences as part of these programs. These conference's aim to identify errors and areas for improvement in healthcare (12,13). Opportunity for Improvement (OFI) is a term that refers to situations where certain measures are suggested to improve the outcomes of the patients during trauma assessment. Exploring the presence end the recurring patterns OFI in trauma patient is suggested to develop new guidelines and improve the outcomes of trauma patients in the future (13).

OFIs are common during the initial resuscitation of trauma patients. Immediate and correct interventions during resuscitation is essential with significant impact the patient outcomes. The primary care objective during this phase of trauma assessment is immediate detection and treatment of life-threatening injuries including damage control with surgical intervention. The OFIs related to resuscitation are often due to clinical judgment errors and involve airway management, fluid resuscitation, bleeding control, and chest injury management (14–18).

OFIs in resuscitation procedures

There is comprehensive knowledge about resuscitation and mortality in trauma patient, including quality improvement in trauma care. However, there is limited data about the presence and patterns of OFI in relation to the resuscitation process and patient outcomes (mortality? morbidity?)

Aim

We hypothesize that the resuscitation procedures done in the emergency department, are associated with OFI. This study explores the relationship between resuscitation procedures and possible improvement in outcomes for adult patients with trauma

Methods

Study design

We conducted a registry-based study using data on trauma patients in two registries at Karolinska University Hospital (KUH): the trauma registry and the trauma care quality database. The trauma registry reports to the Swedish Trauma Registry and includes, demographics, pre-hospital, hospital, and post-hospital care information following the Utstein template (19). The trauma care quality database consists of cases selected for the M&M conference with information on OFI.

The two databases were linked and analyzed to estimate the association between the resuscitation procedures and opportunities for improvement using multivariable logistic regression.

Setting

The Karolinska University Hospital is situated in Solna, Sweden, and is the primary trauma center for the Stockholm region and several other regions. This means that KUH is the main center for treating trauma for approximately 3 million people. The trauma center at KUH meets the standards of a level 1 trauma center defined by the American College of Surgeons (20). All high-priority patients in Stockholm are transported to KUH for treatment by a trauma team.

In case of suspected presence of OFI the patient is discussed in the M&M conference by a multidisciplinary team. The presence of OFI during trauma assessment is evaluated by a specialized trauma nurse on digital based audit filters protocols.

Regardless the presence OFI , all patients are recorded in the trauma care quality database.

Participants

For inclusion, patients had to be listed in both the trauma registry and the trauma care quality database. They also had to be 15 years of age or older, as the clinical management of children can differ significantly from that of adults.

The trauma registry comprises patients who either met the criteria for a trauma team activation at the hospital or were admitted without activation but had an Injury Severity Score (ISS) score of over 9.

The trauma care quality database includes all patients reviewed by the Morbidity and Mortality board, who were carefully selected by two specialized nurses.

We collected data on patients registered between 2017 and 2021 and conducted a complete case analysis, which involved excluding any patients with missing data in either the outcome variable, the covariates, or the independent variables.

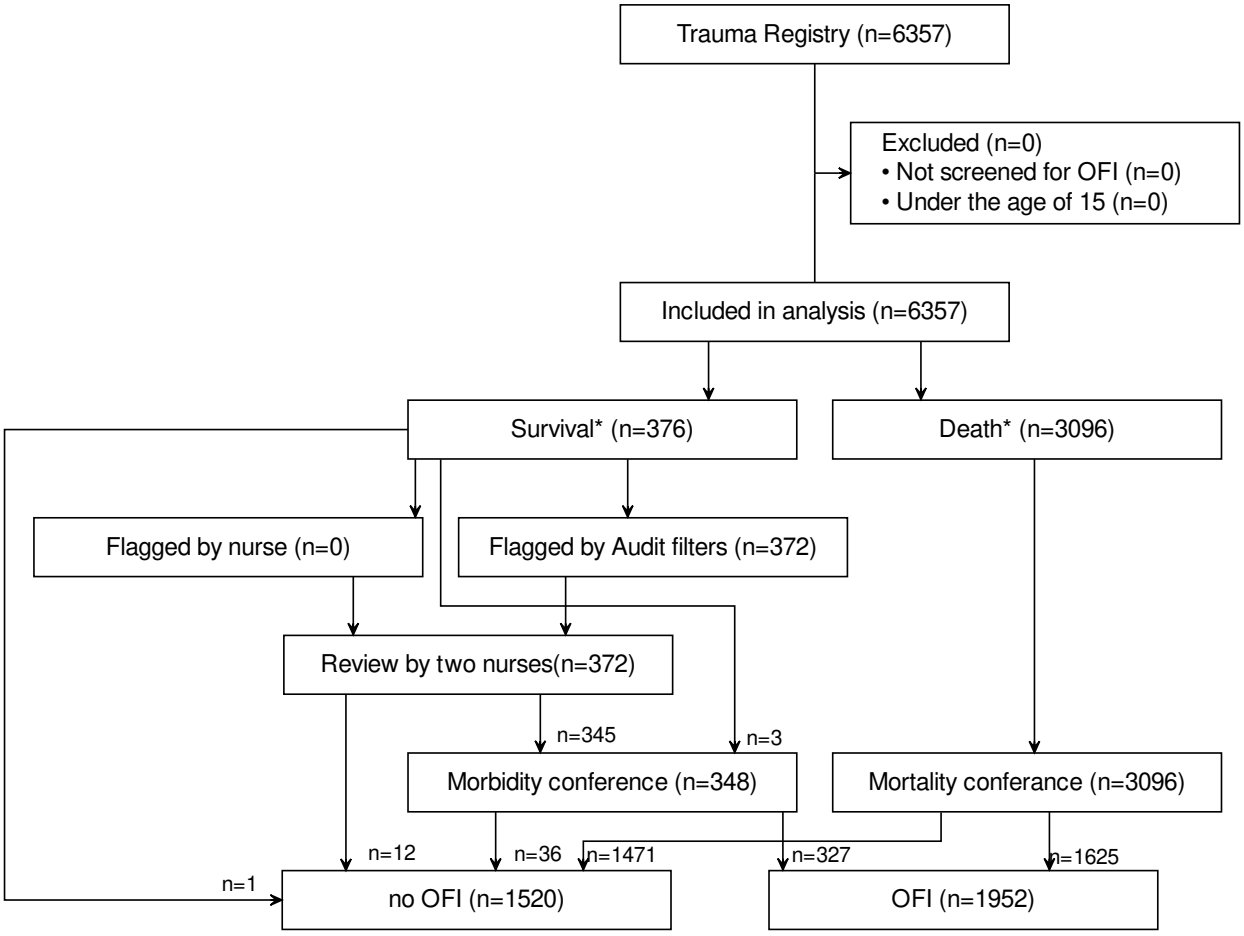

Figure 1: Flowchart describing the exclusions made and the process of trauma cases from arrival until OFI decision.

Variables

Study outcome

The study's primary endpoint will be the binary variable "opportunities for improvement." The outcome will be assigned either as "Yes" if at least one OFI is identified or "No" if no OFIs are identified. The data for this outcome will be obtained from the trauma care quality database.

Exposures

These variables include thoracotomy, laparotomy, pelvic packing, revascularization, radiological intervention, craniotomy, intracranial pressure measurement, thoracic drain, external fracture fixation, major fracture surgery and operating room wound revision.

Potential confounders

Gender, age, blood pressure, respiratory rate, Glasgow Coma Scale (GCS) and ISS.

Bias

Bias is avoided by using synthetic data during the development of the analysis model, which is later implemented on patient data.

Study size

We will include all patients in both the KUH trauma care quality registry and the corresponding information from the KUH trauma registry. Registration took place between 2017 and 2021, with a total of approximately patients.

Statistical methods

The data was compiled and analyzed using R, a statistical computing language(**R?**). The conversion and handling of variables were done according to the SweTrau manual (21). Multivariable logistic regression was conducted to find the significant association between resuscitation procedures and opportunities for improvement. The results were presented with a 95% confidence level and a p-value less than 0.05 was considered significant.

Ethical considerations

Respect for autonomy

The information used in this study was collected from SweTrau, a database that stores data on all trauma patients in Sweden. Patients were informed about their participation and were notified via letter that their data could be used for further research. Patients were also given the right to be excluded from the study and could withdraw their participation at any time. To prevent the risk of data breach, the patient information is stored in a secure database where patient names and ID numbers are fully anonymized.

The Principle of Justice

The inclusion criteria for the study are based solely on the nature of the patient's condition and are not affected by any demographic or background factors. This approach ensures that the study results will be applicable to a broad population and that no groups will be excluded based on their characteristics.

The Principle of Beneficence

By identifying areas for improvement in resuscitation procedures, we can implement changes that will ultimately lead to reduced mortality and morbidity among future trauma patients. Also, this has the potential to alleviate the burden that trauma injuries place on public health systems.

The Principle of Non-malefience

The study uses an existing database of patient information and does not involve any treatment or intervention. This way the patients will not be exposed to any harm. With authorized personnel being the only ones with access to the database and the data being anonymized and securely stored, the risk of data misuse and leakage is kept to a minimum.

Ethical permit

Stockholm Research Ethics Review Board approval number 2021-02541 and 2021-03531.

Results

Patient caracteristics

The study included `total_pts`, out of which `excluded_pts` were excluded due to incomplete data. Patent characteristics for the remaining patients are summarized in Table 1.

The median age of patients was `age_median , min, max)` years. `Tota_men_count(Tota_men_ptc`%) of the patients were male. The mean ISS rates was `iss_mean`. The patient had a respiratory rate of `rr_mean` breaths per minute. The mean systolic blood pressure and mean GCS were `sbp_mean` mmHg and `gcs_mean`, respectively.

The mortality rate in within 30 days after trauma was `dead_pct`%. The most common emergency procedures were `ed_emerg_proc_list_top_3`.

Opportuneties for improvement in relation to clinical data

At least one OFI was identified in `rofi_yes_count`(`ofi_yes_pct`)% patients. The median age in the OFI patient group was `ofi_yes_age_median` (`min, max`) and in the no-OFI patient group median was `ofi_no_age_median` (`min, max`). In the OFI-group, `ofi_yes_male` (`ofi_yes_male_ptc`) were male and `ofi_yes_female` (`ofi_yes_female_ptc`) were female. The corresponding rates in non-OFI group were `ofi_no_male` (`ofi_no_male_ptc`) and `ofi_no_female` (`ofi_no_female_ptc`), respectively.

The GCS mean rates were higher in the `ofi_yes_gcs vs ofi_no_gcs` patient group compared to ofi_yes_gcs vs ofi_no_gcs`OFI in systolic blood pressure, respiratory rate, Glasgow Coma Scale score, and Injury Severity Score?? Moreover, the emergency procedures that had most OFI was` …… ‘.

Table 1: Demographic and Clinical Characteristics of patients screened for OFI.

	OFI	No OFI	Overall
	(N=366)	(N=1142)	(N=1508)
Age			
Mean (SD)	57.0 (24.9)	57.1 (24.6)	57.1 (24.7)
Median [Min, Max]	57.5 [15.0, 102]	57.0 [15.0, 102]	57.0 [15.0, 102]
Gender			
Female	190 (51.9%)	589 (51.6%)	779 (51.7%)
Male	176 (48.1%)	553 (48.4%)	729 (48.3%)
Injury severity score (ISS)			
Mean (SD)	28.4 (19.8)	27.4 (18.7)	27.6 (18.9)
Median [Min, Max]	26.0 [0, 75.0]	25.0 [0, 75.0]	25.0 [0, 75.0]
Respiratory rate			
Mean (SD)	27.2 (15.4)	27.9 (15.4)	27.7 (15.4)
Median [Min, Max]	27.0 [0, 60.0]	27.0 [0, 60.0]	27.0 [0, 60.0]
GCS			
Mean (SD)	9.10 (3.88)	9.09 (3.77)	9.10 (3.79)
Median [Min, Max]	9.00 [3.00, 15.0]	9.00 [3.00, 15.0]	9.00 [3.00, 15.0]
Systolic Blood Pressure			
Mean (SD)	143 (57.7)	145 (59.7)	144 (59.2)
Median [Min, Max]	140 [0, 257]	144 [0, 285]	143 [0, 285]
Emergency procedure			
Thoracotomy	59 (16.1%)	126 (11.0%)	185 (12.3%)
Laparotomy - hemostasis	47 (12.8%)	136 (11.9%)	183 (12.1%)
Pelvic packing	38 (10.4%)	135 (11.8%)	173 (11.5%)
Revascularization (including surgery for pulseless extremity)	45 (12.3%)	156 (13.7%)	201 (13.3%)
Radiological intervention (Endovascular = embolization, stent, stent graft)	41 (11.2%)	146 (12.8%)	187 (12.4%)
Craniotomy	47 (12.8%)	142 (12.4%)	189 (12.5%)
Intracranial pressure measurement as sole intervention	45 (12.3%)	148 (13.0%)	193 (12.8%)
OTHER INTERVENTIONS	44 (12.0%)	153 (13.4%)	197 (13.1%)
OTHER INTERVENTIONS			
Thoracic drainage	84 (23.0%)	223 (19.5%)	307 (20.4%)
External fixation of fracture	75 (20.5%)	211 (18.5%)	286 (19.0%)
Major fracture surgery	67 (18.3%)	221 (19.4%)	288 (19.1%)
Surgical wound revision	66 (18.0%)	251 (22.0%)	317 (21.0%)
Other intervention	74 (20.2%)	236 (20.7%)	310 (20.6%)
Mortality (within 30 days)			
Dead	180 (49.2%)	571 (50.0%)	751 (49.8%)
Alive	186 (50.8%)	571 (50.0%)	757 (50.2%)

Definition of abbreviations: OFI = Opportunity for Improvement; ED = Emergency Department; GCS = Glascow Coma Scale

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