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# Abstract

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# Introduction

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Trauma is a major global public health concern. It causes over four milion death and affects hundreds of millions each year, among those younger populations are the most affected (1). The initial management of trauma patients once they reach hospital is very time sensitive and error prone (2) [(3)](4), and shock is the most common potentially preventable death within the first 24h of injury(5). It is also the second major cause of early mortality in trauma patients (6), and patients in shock have a higher mortality rate than those not(7).

The definition for shock is circulatory failure leading to insuficient perfusion and oxygenation of tissue and organ(8). There are four types of causes, which are hypovolemic, obstructive, cardiogenic and distributive. These causes can occur alone or in combination. The most usual one during trauma are hypovolemic in form of a large bleeding(3).

To differentiate the severity of trauma shock, we can divide shock into different degrees. One of such classification is the ATLS classification for major haemorrhage. The classification is divided into four classes, based on the patients: estimated bloodloss, heart frequency (HF), bloodpressure (BP), pulse pressure, respiratory rate (RR), mental status and urine output. However, this only meant to be used for hypovolemic shocks and not the other types. There is other classifications for predicting massive transfusion (TASH,TBSS, ABC), triaging (RETTS) or tracking the clinical deterioration of patients (NEWS2). The common denominator for these classifications is they are all roughly based on vital parameters, however none of them is specifically designed to classify trauma shock degree regardless of the type/cause of shock. ATLS in this regard, even though having its own shortcomings(9), still is one of the most used classifications for this topic(Källa).

One way to improve trauma care quality is trough identifying Opportunities for Improvement (OFI). This method has an advantage compared to traditional mortality reviews in that it also includes non-fatals. There are different processes to finding OFIs, but one of the primary ways is through structured multidisciplinary morbidity and mortality reviews of patient cases (10). In order for the review content to be as comprehensive as possible for trauma care, the Donabedian quality of care framework can be used(11). It is based on the three factors of structure, process and outcome. By following this framework, healthcare providers will be able to systematically find and address OFIs[källa?]. This will in turn improve the effectiveness of trauma care, directly impacting mortality and morbidity[källa?/8].

This study aims to describe the types of opportunities for improvement for adult trauma patients arriving in shock, and to assess how the degree of shock is associated with opportunities for improvement.

# Methods

## Study design

We conducted a registry based retrospective cohort study, using data from the trauma registry and trauma care quality database at the Karolinska University Hospital in Solna. We then linked the two databases to assess what types of OFI occurred in patients arriving in shock and use logistic regression to assess the association between the degree of shock and odds of opportunities for improvement.

## Setting

The trauma registry includes about 14000 patients treated at Karolinska University Hospital in Solna between 2014 and 2023. The “problem” database is a subset of the trauma registry and includes about ? patients selected for review. The Karolinska University Hospital in Solna treats all major trauma in the greater metropolitan area of Stockholm.

## Participants

To qualify into the trauma registry, requires admission by trauma team activation or any admission with an Injury Severity Score (ISS) of more than nine.

Every trauma patient at Karolinska University Hospital is included in a morbidity and mortality review process, which involves both individual case evaluations by specialized nurses and audit filters. Patients identified with a high potential for OFIs are discussed at multidisciplinary conferences. The identified OFIs are then categorized into broader areas. The multidisciplinary conferences are held every six to eight weeks, during which an average of ten patient cases are reviewed by experienced specialists from all trauma-related fields. The presence or absence of OFIs is determined by consensus among all participants and is documented in the trauma care quality database.

We included all patients in “SWETRAU” and “Problem” between 2014 and 2023 We excluded patients younger than 15 and/or were dead on arrival.

## Variables and data sources/measurements

The outcome was defined as presence of atleast one OFI, determined by the multidisciplinary M&M conference in the “problem” registry. An OFI can be various types of errors, which are categorized into: clinical judgement error, inadequate resources, delay in treatment, missed injury, inadequate protocols, “preventable death” (den här var väl inte ens med i “problem”, fast fanns med i studien som Martin delade på discord) and other errors.

In this study, the outcomes will be studied in two ways, one is the amount of occurrence for various types of OFI in shock patients, and the other is binary where odds of OFI for every shock class i calculated out of presence of OFI or not. (kanske inte ens en del av metod)

To classify the patients the following measurement will be used as independent variables for classification of shock regardless of their cause. Heart rate(HR), systolic blood pressure(SBP), respiratory rate(RR) and mental status. Based on these four measurements, the patients will be classified into four groups roughly based on the same value as in the ATLS trauma shock classifications.

Due to lack of data on FAST, type of injury and clinical chemistry, we will not be able to use categorisations such as TASH, TBSS and ABC with better sensitivity and specificity than ATLS[(12)](13)(14).

Version 1, Due to the tenth edition of ATLS classifications lack actual numbers, we will be using simplified and numerical version approximated by Dunham et al(15). (INSERT PICTURE)

Version 2, Due to the tenth edition of ATLS classifications lack actual numbers, we will be approximating numbers to the values. For HR and RR we will be using the numbers from the ninth edition of the classification. The SBP will be divded into class I and II where the SBP is >110, class III 110-90mmhg and class IV <90mmhg. This selection is based on tenth edition, where SBP is defined as normal i class I to II and normal/below in class III and clearly below normal i class IV. These two studies, redefined hypotension as 110mmhg respective 90mmhg dependent on age[(16)](17), therefore we choose class III as 110-90mmgh and class IV below 90mmhg. For mental status, according to the tenth edition ATLS, class I and II should have normal GCS, and class III and IV have lower GCS. Therefore we decided to use GCS 15 for class I + II and GCS <15 for class III and IV.

* Hur gör vi med de som hamnar mellan klasserna? To classify, all of the parameters in one class needs to be fulfilled. In the cases where the parameters belong in different classes, we will be classifying according to the most severe parameter in the same way as Dunham et al(15). At same time ATLS manual states one of the common pitfalls is “Diagnosis of shock can be missed when only a single parameter is used.” therefore to improve sensitivity we decided to use the worst parameter for classification.

To prevent classifying non-shock traumatic brain injury as class III and worse shock based on GCS, we decided to only include those who also present a circulatory parameter in accordance with class III or IV. - eller ta bort GCS helt och hållet? För i enlighet med ovan kommer GCS alltid att prioriteras bort och då finns ingen anlending att ha med det…

Version 3, simplaste och den jag gillar mest, men kan andra sjukdomar som gluykolen förgiftning sabba tanken? We will be only using the base deficit parameter according to the tenth edition of the ATLS classification for haemorrhage. There are three reasons. The first one is ATLS tenth edition lack numerical values for vital parameters. The second one is that bace deficit is superior to vital parameters as a predictive parameter for mortality(15). The third one is due to nature of having multiple parameters, makes it difficult to categorise a patient with vital parameters in two or more classes and difficult to separate lower GCS due to traumatic brain injury from shock as cause. The classes will be divided into class I: 0 - (-2), class II: (-2)-(-6), class III: (-6)-(-10), and class IV: <(-10).

## Bias

## Study size

All available data in “SWETRAU” and “Problem” database will be included.

## Quantitative variables

## Statistical methods

The statistical analysis will be performed using R, a programing language and environment for statistical computing. We will present the type of OFI as percentage distributions and then visualize it in a pie chart. Bivariable logistic regression will be used to determine the association between the OFI and degree/class of shock according to ATLS. It will be presented as odds ratios (OR) between presence of OFI, and shock classes. The OR will be determined with 95% confidence intervals, and a significance level of 5% will be used. All statistical analysis will first be done on synthetic data and later implemented on the data collected from the trauma registry and the “problem” database to ensure objectivity.

# Results

You can include code in this document like this:

Characteristic

No N = 1,5721

Yes N = 5,0101

Age (Years)

56 (33, 78)

56 (34, 79)

Gender (M/F)

    Female

755 (48%)

2,535 (51%)

    Male

817 (52%)

2,475 (49%)

Pre-injury ASA

    1

246 (23%)

851 (26%)

    2

310 (29%)

819 (25%)

    3

248 (24%)

821 (25%)

    4

247 (24%)

827 (25%)

    Unknown

521

1,692

Systolic blood pressure (mmhg)

148 (99, 194)

143 (94, 194)

    Unknown

6

19

Injury Severity Score

25 (12, 42)

25 (12, 41)

    Unknown

32

103

Shock class classified according to BE

    Class 1

113 (7.2%)

313 (6.3%)

    Class 2

210 (13%)

625 (13%)

    Class 3

172 (11%)

607 (12%)

    Class 4

597 (38%)

1,810 (36%)

    no shock

474 (30%)

1,637 (33%)

    Unknown

6

18

Base Excess (BE)

-6 (-15, 2)

-6 (-14, 2)

    Unknown

6

18

Shock class classified according to SBP

    Class 1

148 (9.5%)

531 (11%)

    Class 2

319 (20%)

1,119 (22%)

    no shock

1,099 (70%)

3,341 (67%)

    Unknown

6

19

1 Median (Q1, Q3); n (%)

You can also embed plots:



You can also mix text and code, so called inline code, like this: 7.

# Discussion

# Conclusion

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