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

A registry based cohort study

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Abbreviations

OFI – Opportunities For Improvement AF – Audit filter CI – confidence interval GCS – Glascow Coma Scale ISS – Injury Severity Score ED – Emergency Department AUC – Area Under Curve ROC – Reciever Operating Characteristic CPR – Cardiopulmonary Resuscitation SBP – Systolic Blood Pressure WHO – World Health Organisation YLL – Years Life Lost DALY – Disability Adjusted Life Years PTSD – Post Traumatic Stress Disorder

Introduction

Trauma is defined as a physical injury of external origin together with the associated reaction of the body. This phenomenon accounts for 9% of global deaths annually [1]. Trauma affects low- and middle-income countries at a higher rate. In addition, young people are at higher risk of trauma compared to the general population. It is the leading cause of death in people between the ages of 10 and 49 [2];[3]. The most common type of trauma for people of all ages is road traffic injuries [2];[3]. In Sweden, road traffic injuries account for about 40% of injuries and falls for 40% [4].

Trauma is broadly divided into two groups according to the underlying causal mechanism: penetrating and blunt trauma. Common examples of penetrating trauma are gunshot wounds and knife cuts. Blunt trauma, on the other hand, is caused by injuries such as road traffic accidents and falls. In general, the two types of trauma can also be characterized by the size of the force causing the injury and the area of impact. Blunt trauma is caused by a high force impact over a larger area. In contrast, penetrating trauma is caused by a force applied to a smaller area, causing greater pressure so that it is penetrating and often results in deeper lacerations to tissues and organs. However, blunt trauma with sufficient force can be penetrating in nature [5].

Impact

The effects of a trauma depend greatly on the type of trauma, where it happened and whom it affected.

Trauma is responsible for 11.9% of years of life lost (YLL) worldwide [3]. In addition, trauma is associated with a higher propensity for depression, post-traumatic stress disorder (PTSD) and negative effects on cognitive function, etc. [6];[7].

It is estimated that up to 11% of trauma patients have PTSD 3 years after the traumatic event [8]. In addition, people who witness traumatic injuries are also at a higher risk of developing PTSD. Traumatic injuries are associated with 36% not returning to work within 1 year [9].

However, injuries are not only a burden on the person affected, but also on society as a whole [10]. One aspect of such societal impact is the economic cost. Attempts have been made to estimate the global cost of injuries, which is a complicated task due to their variability. However, it is estimated that the cost of road traffic injuries alone accounts for 2% of gross domestic product (GDP) in high-income countries [1].

Trauma Care Systems

Trauma care is a multidisciplinary, complex and time-critical healthcare service provided by specialised trauma centres. A variety of different specialties are involved in trauma care, including surgeons, orthopedists, anesthesiologists, emergency physicians and nurses. Trauma care is divided into three components: pre-hospital, in-hospital and post-hospital. The prehospital component is trauma centres have a significantly lower mortality rate compared to non-trauma centres. And the maturity of a trauma centre also correlates with lower mortality, demonstrating the importance of high-quality, specialised trauma care [11];[12]. A similar study in Sweden [13] showed that 30-day mortality is 41% lower in a mature trauma centre compared to a non-trauma centre. However, even in established trauma care systems, it is prone to error due to its complexity and susceptibility to delays [14];[15], which in turn can lead to complications and death. Studies between 1990 and 2014 have shown a pooled preventable death rate of 20%, with more recent studies showing less [16]. A recent study in a Swedish Level I trauma centre found a preventable death rate of 4% [17].

Quality Improvement

To minimize errors in trauma care, quality improvement (QI) programs have been established by the World Health Organization (WHO) programs by the World Health Organization (WHO) and the International International Association for Trauma Surgery and Intensive Care (IATSIC) [18]. These programs form the core of current trauma care systems and their development around the world.

QI programs consist of a series of recommended techniques aimed at facilitating discussion and analysis of the trauma process in order to take corrective action for future success. The following techniques are used: A multidisciplinary mortality and morbidity conference (MMC), a preventable death review panel, and the use of audit filters[18].

Morbidity and Mortality Conferences and Preventable Death Review Panels

The MMC is a central QI technique. It is a proven framework with the critical components of anonymity, focusing on specific adverse events, recognising flawed approaches, critical analysis, seeking change and implementing that change [19].

MMCs are regular meetings at which specific patient cases are presented for discussion. The conference participants are healthcare professionals involved in trauma care and its processes, but not necessarily the specific patient case. The selection of patient cases varies, but common themes for discussion are unexpected mortality, unexpected morbidity and errors [20].

It is recommended that they last about 40 minutes, but this varies from hospital to hospital [18].

Five themes have been proposed that broadly define QI-centred MMC: (1) clear definition of the role of the MMC (2), involvement of stakeholders, (3) recognising and selecting appropriate patient cases for presentation, (4) structuring focused discussions, and (5) formulating recommendations and assigning follow-up actions[21];[22].

When implemented effectively, MMCs serve as an important tool for error proofing without serving solely as a negative for individual care providers, but rather as an incentive for reporting. These conferences promote a more comprehensive, systems-based approach that emphasizes task analysis, teamwork and quality improvement[23]. The introduction of MMC has been shown to increase morbidity and mortality reporting[24].

Following MMC, there is an avoidable death review panel whose role is to determine whether a patient's death could have been avoided [25].

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 filters can be death and the placement of 2 large bore intravenous lines within 15 minutes from arrival to a healthcare facility [18]. 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 [26]. 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 [27]. The use of audit filters have also been associated with high frequencies of false positives, ranging from 24% to 80%.[28]; [29].

OFIs 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 [30]. OFIs are typically associated with failures in initial care [15], specifically in airway management, fluid resuscitation, haemorrhage control and chest injury management [28]; [29]; [31]. Some audit filters seem to not correlate with OFIs at all [32]

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 where 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 10 audit filters used at Karolinska university hospital.

Data sources/measurement

Data for this cohort were retrieved from the trauma registry and the trauma care quality database during the period spanning from 2012 to 2022.

The individual audit filters, was identified through the trauma registry

The OFIs was extracted from the trauma care quality database

All data were anonymized to protect patient privacy.

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. Furthermore, the process of flagging a patient case with an audit filter is done manually by a specialised nurse as mentioned above. This means that there may be a selection bias

Recall bias. Individuals who attend the MMC and has also been a witness to the speific patient case in question might not remember certain key elements that might affect the decision.

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. [33]

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: True positives / (true positives + false negatives)

The specificity is calculated accordingly: True negatives / (true negatives + false positives)

A receiver operating curve (ROC) will be made and the area under the curve (AUC) calculated in order to compare the performance of each audit filter [34]

Using a bootstrapping method with 1000 iterations of the selected data, a 95% confidence interval for sensitivity, specificity and AUC will be calculated. Furthermore, comparing AUC of each audit filter with that of coincidence (AUC = 0.5) through a one sample T test will be done to determine significance. This applies soley to any audit filter that might have an AUC confidence interval spanning 0.5.

Ethical considerations

All patient data is anonymised. However there is data on various factors like date, time of admission, etc. and different patient characteristics such as age, gender, etc. Which in theory could enable one to identify patient cases based on public knowledge through news reporting for example. However this means that such information has to be leaked somehow. The only way that would be possible is through a person with access to the registry or through a data breach. In order to minimize the risk of a potential data breach, access to the registry is only possible while connected to a VPN with a special login in key.

The study was approved by Stockholm Research Ethics Review Board, approval 107 number 2021-02541 and 2021-03531.

Results

1 Participants

1.2 Study Participants and Setting

In this retrospective cohort, a total of 8309 trauma care cases were assessed. The study was conducted at Karolinska University Hospital, which is a level I trauma center specializing in trauma care.

1.3 Participant Characteristics

Table 1 presents the baseline characteristics of the study participants. After excluding patients under 15 years old and patients not screened for OFI, a total of 8309 individuals where admitted to the hospital and also screened for an OFI. A total of 7797 of the screened individuals had no OFI and 512 had an OFI. 69% out of all patients included in the study where men and 31% where women.

Among the 512 patients with an OFI compared to the 7797 patients without, the mean age was slightly higher (mean 49 vs 42 years old) and the ISS was higher (mean 17 vs 9). The number of intubations was also higher (16% vs 8,3%). Patients with OFI had longer times to definitive treatment compared to patients without OFI (median: 144 vs 102 minutes from hospital arrival). Furthermore the time to first CT was also longer in the group with OFI compared to the group without OFI (39 min vs 33 min).

The mean systolic blood pressure in the OFI group did not differ from the systolic blood pressure in the no OFI group.

The variables with the highest amount of missing data was “time to definitive treatment” [n=5990] and “time to first CT” [n=1012].

2. Individual Audit Filters

2.1. Performance of Individual Audit Filters

Table 2 summarizes the performance of each individual audit filter in identifying opportunities for improvement in trauma care by specificity and sensitivity. Table 3 summarizes the performance of each individual audit filter in identifying OFIs in trauma care by AUC.

There where varying amounts of patient cases flagged with each audit filter. The audit filter that was flagged most frequently was “>30 min until CT”. The least flagged audit filter was “GCS<9 and not intubated”.

The audit filter with the highest specificity was “GCS<9 and not intubated” (98.7% CI: 98.5-98.9) was also the audit filter with the lowest sensitivity (1.2% CI: 0.1-2).

The audit filter with the highest sensitivity was “>30min until CT” (59.2% Ci: 55.3-63.3). The same audit filter had the lowest specificity (53.8% CI: 52.7-55.2).

The confidence intervals varied between sensitivity and specificity with sensitivity having greater span.

three of the ten audit filters, “Dead at 30 days”, “GCS<9 and not intubated” and “CPR and thoracotomy” showed a performance in predicting an OFI equal to that of coincidence. >60 min until first intervention had the highest AUC.

Missing Data

“SBP<90”, “GCS < 9 and not intubated”, “>30 min until first CT”, “>60 min until first intervention”, “ISS>15 and not in intensive care unit”, “ISS>15 and no team activation”, “death in 30 days” was manually created from the data supplied by the registry. This was done in order to minimise selection bias during the manual screening for audit filters. The rest of the audit filters are not possible to create with the existing data from the registry.

The missing data from the audit filters were instead interpreted as “no audit filter”.

The audit filter that displayed the highest amount of missing data was “>60 min until first intervention” (n = 5990, 72.1%). The least amount of missing data was found in “SBP<90”

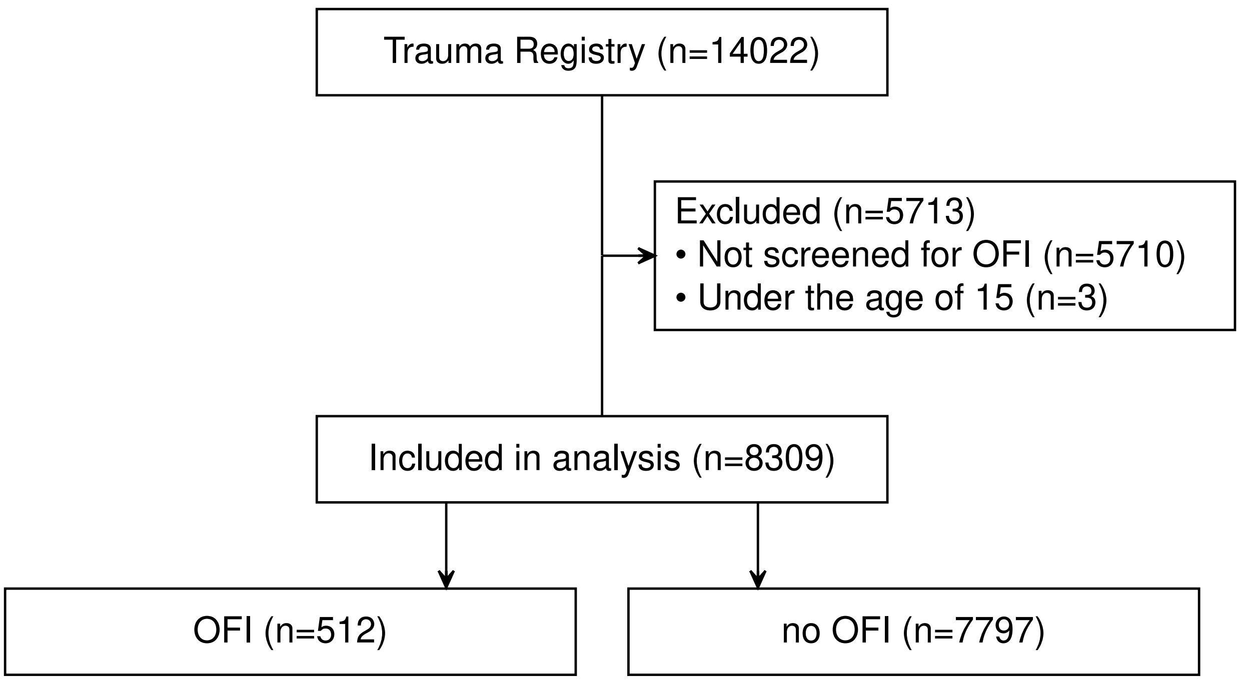

Table 1: Demographic and Clinical Characteristics of patients screened for OFI.

	No, (N = 7797)	**Yes**, (N = 512)	**Overall** (N = 8309)
Gender			
Female	2,411 (31%)	143 (28%)	2,554 (31%)
Male	5,386 (69%)	369 (72%)	5,755 (69%)
Age	42 (27, 61)	49 (30, 67)	43 (27, 61)
ISS	9 (1, 17)	17 (10, 25)	9 (2, 17)
Unknown	11	0	11
ED Systolic Blood Pressure	135 (120, 150)	135 (120, 151)	135 (120, 150)
Unknown	155	15	170

	No, (N = 7797)	**Yes**, (N = 512)	**Overall** (N = 8309)
ED GCS	15.00 (14.00, 15.00)	15.00 (14.00, 15.00)	15.00 (14.00, 15.00)
Unknown	816	50	866
Time to first CT	33 (21, 65)	39 (25, 70)	33 (21, 66)
Unknown	967	45	1,012
Intubated at ED			
No	7,149 (92%)	430 (84%)	7,579 (91%)
Yes	646 (8.3%)	82 (16%)	728 (8.8%)
Unknown	2	0	2
Dead at 30 days			
No	7,102 (91%)	469 (92%)	7,571 (91%)
Yes	686 (8.8%)	41 (8.0%)	727 (8.8%)
Unknown	9	2	11
Time to definitive treatment	102 (49, 251)	144 (90, 289)	107 (53, 260)
Unknown	5,748	242	5,990
Highest level of care			
1	1,478 (19%)	22 (4.3%)	1,500 (18%)
2	2,955 (38%)	123 (24%)	3,078 (37%)
3	1,449 (19%)	146 (29%)	1,595 (19%)
4	343 (4.4%)	50 (9.8%)	393 (4.7%)
5	1,572 (20%)	171 (33%)	1,743 (21%)
Trauma			
1	5,040 (65%)	342 (67%)	5,382 (65%)
2	2,115 (27%)	102 (20%)	2,217 (27%)
4	228 (2.9%)	17 (3.3%)	245 (3.0%)
33	405 (5.2%)	50 (9.8%)	455 (5.5%)
Unknown	9	1	10

Auditfilter	(N)	Specificity (%)	Sensitivity (%)
AF_sap_less90	501	94.1 (93.6-94.6)	8 (5.6-10.1)
AF_death_30d	727	91.2 (90.5-91.9)	8 (5.7-9.8)
AF_iss_15_ej_TE	583	93.8 (93.3-94.5)	20.1 (16.5-23.6)
AF_mass_transf	337	96.3 (95.8-96.7)	9.4 (6.8-12)
AF_gcs_less9_ej_intubTE	107	98.7 (98.5-98.9)	1.2 (0.1-2)
AF_iss_15_ej_iva	1295	85.7 (85-86.6)	35.4 (31-38.9)
AF_mer_60_min_interv	1668	81.5 (80.6-82.5)	43.9 (39.4-47.8)
AF_mer_30min_DT	3907	53.8 (52.7-55.2)	59.2 (55.3-63.3)
AF_hlr_thorak	149	98.2 (97.9-98.6)	2 (0.7-3.1)
AF_lever_och_mjaltskada	398	95.5 (95.1-96.1)	9.4 (7.2-12.1)
AF_ej_trombrof_TBI_72h	241	97.3 (96.8-97.7)	5.7 (3.2-7.5)

Definition of abbreviations: OFI = Opportunity for Improvement; ED = Emergency Department; GCS = Glascow Coma Scale; ISS = Injury Severity Score; CPR = Cardiopulmonary Resuscitation; AUC = Area under the receiver operating characteristic curve.

Auditfilter	AUC	p-value
AF_sap_less90	0.51 (0.5-0.52)	<0.0001
AF_death_30d	0.5 (0.49-0.52)	1
AF_iss_15_ej_TE	0.57 (0.56-0.59)	<0.0001
AF_mass_transf	0.53 (0.52-0.54)	<0.0001

AF_gcs_less9_ej_intubTE	0.5 (0.49-0.51)	0.5
AF_iss_15_ej_iva	0.61 (0.59-0.64)	<0.0001
AF_mer_60_min_interv	0.63 (0.61-0.66)	<0.0001
AF_mer_30min_DT	0.56 (0.54-0.58)	<0.0001
AF_hlr_thorak	0.5 (0.49-0.51)	0.0662
AF_lever_och_mjaltskada	0.52 (0.5-0.53)	<0.0001
AF_ej_trombrof_TBI_72h	0.51 (0.49-0.51)	<0.0001

Definition of abbreviations: OFI = Opportunity for Improvement; ED = Emergency Department; GCS = Glascow Coma Scale; ISS = Injury Severity Score; CPR = Cardiopulmonary Resuscitation; AUC = Area under the receiver operating characteristic curve.

Audit filters	Missing values (n (%))
SBP < 90	13 (0.2)
Death at 30 days	11 (0.1)
ISS > 15 and no team activation	21 (0.3)
Massive transfusion	978 (11.8)
ISS > 15 and not in ICU	866 (10.4)
GCS < 9 and not intubated	11 (0.1)
> 60 min until first intervention	5990 (72.1)
> 30 min until first CT	1012 (12.2)
CPR and thoracotomy	404 (4.9)
Liver or spleen injury	1929 (23.2)
No anticoagulantia within 72 hours after TBI	2986 (35.9)

Definition of abbreviations: OFI = Opportunity for Improvement; ED = Emergency Department; GCS = Glascow Coma Scale; ISS = Injury Severity Score; CPR = Cardiopulmonary Resuscitation; TBI = Traumatic Brain Injury

Discussion

Interpretation of Results

The aim of the study was to determine the performance of individual audit filters in predicting OFI in order to assess whether they are a good tool as a screening method for morbidity and mortality conferences.

Male admission to trauma centres outnumbered females with almost double. This is similar to other studies.

The possible reason behind the audit filters generally having a high specificity relative to their sensitivity may be due to the outcome being rather uncommon whilst every individual audit filter miss the majority of OFI. Theoretically, adding all audit filters together would result in the sensitivity increasing.

The explanation behind the relatively high specificity is due to the amount of true negative values being high. A patient case with no audit filter will often also have no OFI to them.

Earlier review articles sought to review the evidence for audit filters found no evidence supporting the use of audit filters in improving trauma care [27]. This shows that even though audit filters are wildly used there is not much support for the use of it.

The audit filters that did not prove to be better than randomness suggest that their use as a screening method for determining OFI is not valuable and should not be used for that purpose.

in a 2008 study by Willis [35] they look at the individual risk for poor outcome in 14 audit filters. Out of these 14 audit filters only three audit filters showed an increased risk for poor outcome while the rest showed no significant ability to predict poor outcome. One audit filter, “GCS<9 and not intubated”, which was used by Willis is also used at the trauma center at Karolinska University Hospital. Similarly the audit filter showed no significant ability to predict poor outcome.

Some of the audit filters, however, showed promising results in predicting OFI.

Both audit filters measuring delay (">60 until first intervention and >30min until CT") showed promising results in predicting opportunities for improvement which could be explained by the fact that delay have shown to correlate with increased risk for adverse outcomes like preventable death [36]. An injured individual might be standing on a thin line between survival and death if the adequate intervention does not occur in time. This makes delay in general a good predictor of outcome.

[37] evaluated quality indicators through interdisciplinary peer review and found that, similarly, that various audit filters regarding time to different care processes had consensus on its relevance in trauma care.

A similar german study [38] looked at correlation between audit filters and mortality on top of a interdiciplinary expert review according to the QUALIFY process. They looked at two methods in assessing the performance of auditfilters: The indicator approach and the clinical approach. The indicator approach in assessing performance of audit filters was to assess wether the desired indicator level was associated with a lower mortality compared to without the desired level. The clinical aproach compared different hospitals and ranked them as "good hospitals or"bad hospitals". Good hospitals had a lower 5-year mortality rate among a selected patient group with quality indicator parameters of interest compared to the RISK II predicted mortality. Evaluation of each approach ranked the usefullnes of each audit filter between "strong association with mortality", "unclear association with mortality" and "no association with mortality". The expert review was carried out in the same fashion as Bieler et. al. Only 3 audit filters was similar to the audit filters used in Karolinska university hospital: "prehospital intubation in patients with GCS $<$ 9", "Time to whole body CT", "time to first emergency procedure". prehospital intubation showed an unclear correlation to mortality in the clinical approach, a strong association in the indicator approach and scored high by the review panel. In this study "GCS $<$ 9 and not intubated" showed no association with OFI. "Time to whole body CT" showed unclear association with mortality in both approaches but scored high in expert review. "more than 30 min until first CT" was in our case associated with OFI. "time to first emergency procedure" had no correlation with mortality but expert review agreed that it was still useful. ">60 min until first intervention" was in our case associated with OFI. It is important to note that OFI in our case was not only a reflection of mortality but a much broader concept encompassing different aspects of care quality. It is therefore not a comparison that holds much weight. If anything it highlights the difference between hospitals in what audit filters are in use and how they are being assessed.

The reason behind the fact that audit filter 2 showed no difference from randomness could be because severe traumatic injuries might inevitably die within 30 days of admission to the hospital resulting in no consensus on the existence of an OFI in such particular case.

A similar explanation can be done with audit filter 9 which also showed a insignificant performance in predicting OFI. CPR and thoracotomy generally has a very low survival rate and might only be done to those who are severely injured.

We can compare this with the audit filters that performed well in predicting OFI which generally have a low mortality. For example, ">60 min until first intervention". Also involves a large patient pool.

[39] looked at patient factor associated with OFI and found that delay of between 30-60 minutes until first CT was associated with OFI. Higher levels of care was associated with OFI. Similarly they found no clear association between 30 day survival and OFI. The found that higher ISS was associated with higher OFI occurences, mosy likely due to the increased complexity of patient cases with higher ISS, therefore prone to OFI. This could partly explain the association between "ISS $>$ 15 and no team activation" and OFI predicition and similarly regarding "ISS $>$ 15 and not in intensive care unit".

Interestingly, the vital signs systolic blood pressure, respiratory rate, and GCS as well as intubation were all significantly associated with OFI in the unadjusted analysis but not in the adjusted analysis. This could be because these factors indicate more severe trauma, which was more effectively captured by ISS in the adjusted analysis.

[17] found that the most common error in trauma care was due to delay in treatment, delay to CT and clinical judgement errors as in inappropriate treatment or procedural errors. This stands well with our findings where delay to first intervention and to CT was associated with OFI.

[28] OFIs predominantly exist in the ED and relate to airway management, fluid resuscitation, and chest injury management

Generalizability

Since the screening method for identifying an OFI may vary at different trauma centres there will be a difference in results.

The audit filters being used differ between trauma centrer which adds to the difficulty of creating a standard screening system.

Strengths

As stated in the method section, some audit filters whose criteria were possible to be retrieved from the registry was manually created instead of relying on the selection process by the specialized nurse. This was done in order to minimize misclassification bias.

Limitations

Opportunity for improvement, while defined as a binary variable, includes a diverse set of outcomes ranging from preventable deaths to bad documentation. This makes it difficult to create audit filters that do well in predicting an OFI.

The current screening system for OFI might also introduce bias since the filters would favour the identification of some, but not all, errors

Future research should focus on identifying potential subgroups of OFI that proves to be relatively hard to predict and adjust accordingly.

The way the audit filters performance were individually calculated, as stated in the method section, was to look at every patientcase with or without an OFI and silmuntaniously flagged or not flagged with the audit filter. THis means that even tho an audit filter presented a true positive correlation with an OFI, there is still a chance, if the same patient case had more than one audit filter flagged, that it was not the tested audit filter that predicted truthfully rather it was the other audit filter.

Future Studies

With the ever expanding field of artificial intelligence and machine learning, newer studies should focus on using these tools in order to screen for patient cases who risk having an OFI.

Health Equity

Conclusion

Audit filters can be a great tool in predicting OFI. However there is a great importance in evaluating the relevance of them.

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Tables

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#Appendices