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ORIGINAL ARTICLE

The association between hospital arrival time, transport method, prehospital time intervals, and in-hospital mortality in trauma patients presenting to Khayelitsha Hospital, Cape Town

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ABSTRACT

Introduction: Trauma is a leading cause of unnatural death and disability in South Africa. The aim of the study was to determine whether method of transport, hospital arrival time or prehospital transport time intervals were associated with in-hospital mortality among trauma patients presenting to Khayelitsha Hospital, a district-level hospital on the outskirts of Cape Town, South Africa.

Methods: The Khayelitsha Hospital Emergency Centre database was retrospectively analysed for trauma-related patients presenting to the resuscitation area between 1 November 2014 and 30 April 2015. Missing data and additional variables were collected by means of a chart review. Eligible patients' folders were scrutinised for hospital arrival time, transport time intervals, transport method and in-hospital mortality. Descriptive statistics were presented for all variables. Categorical data were analysed using the Fisher's Exact test and Chi-square, continuous data by logistic regression and the Mann Whitney test. A confidence interval of 95% was used to describe variance and a p-value of < 0.05 was deemed significant.

Results: The majority of patients were 19–44 year old males ($n = 427$, 80.3%) and penetrating trauma the most frequent mechanism of injury ($n = 343$, 64.5%). In total, 258 (48.5%) patients arrived with their own transport, 254 (47.7%) by ambulance and 20 (3.8%) by the police service. The arrival of trauma patients peaked during the weekend, and was especially noticeable between midnight and six a.m. In-hospital mortality ($n = 18$, 3.4%) was not significantly affected by transport method ($p = 0.26$), hospital arrival time ($p = 0.22$) or prehospital transport time intervals (all p-values > 0.09).

Discussion: Method of transport, hospital arrival time and prehospital transport time intervals did not have a substantially measurable effect on in-hospital mortality. More studies with larger samples are suggested due to the small event rate.

African relevance

- Trauma is a leading cause of death and a healthcare burden in Africa.
- Prehospital factors may impact mortality.
- The results can help explore prehospital care prior to district level care.

Introduction

Trauma is a leading cause of death worldwide and accounts for almost 50% of the injury-related mortality in persons between the ages of 15 and 44 years [1]. Traumatic brain injury and hypovolaemia following haemorrhage seems to be the foremost causes of death [2].

Various theories have been proposed to reduce the morbidity and mortality related to trauma. One such theory is that the method of transportation to hospital might influence trauma patients' outcome. Recent studies comparing Emergency Medical Service (EMS) transport

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to non-EMS transport failed to show any differences in severity-adjusted mortality [3,4]; while some even show a survival benefit in privately transported patients [5,6].

Trauma is known to peak outside office-hours and this phenomenon has been documented across the world [7–9]. The arrival time of trauma patients might also play a role in the mortality rate. Patients arriving during the early morning hours tend to have a higher mortality compared to other times [10]. However, this theory has been challenged by studies indicating that time of arrival had no influence on the risk for adverse outcomes [7,11].

It has long been suggested that trauma-related mortality improves with shorter out-of-hospital times [12]. One variable affecting the total prehospital time is the amount of time EMS personnel spend at the scene of the incident. The two major strategies regarding on-scene time are "load-and-go/scoop-and-run" versus "stay-and-play/treat-then-transfer". These strategies differ regarding how much diagnostics, treatment and stabilisation should be performed before leaving the scene, with the "load-and-go/scoop-and-run" strategy aiming to leave the scene as soon as possible. A systematic review has failed to show consensus or significant results regarding which technique improves mortality [13].

South Africa is a country with a large trauma burden, straining the resources of the healthcare system [14]. To decrease mortality, South Africa has prehospital EMS to treat and transport acutely sick or injured patients to hospital. The aim of the study was to determine whether method of transport, hospital arrival time or prehospital transport time intervals were associated with in-hospital mortality among trauma patients presenting to Khayelitsha Hospital in South Africa.

Methods

A retrospective analysis of an observational database was performed. Missing data and additional variables were collected by means of a chart review. A waiver of informed consent was approved by the Stellenbosch University Human Research Ethics Committee (Ref: N14/08/102).

Khayelitsha is one of many townships in and around Cape Town. Many inhabitants living in townships are typically either low-income workers or unemployed. There are approximately 400,000 inhabitants in Khayelitsha, 74% earning less than 2500 USD per year and 19% declaring no income at all. In total, 80% of the inhabitants are aged under 40 years. The main means of heating and lighting is by paraffin [15].

Khayelitsha Hospital was built in 2012 and houses 240 beds, an emergency centre, operating theatres, radiology department and laboratory. Khayelitsha Hospital provides inpatient services for surgical, medical, psychiatric, paediatric and obstetric patients. At the time of the study, there was no permanent qualified surgeon working at the hospital. Qualified emergency physicians head the emergency centre which manage around 30,000 patients per year with a 30% admission rate (personal communication: Dr. S. Lahri, 2013). The resuscitation area within the emergency centre has five monitored beds (four beds and a paediatric cot). Patients with a high acuity score according to the South African Triage Scale are managed within the resuscitation area until their condition has stabilised [16]. An EMS station is situated on the hospital premises [17].

The electronic Khayelitsha Hospital Emergency Centre database is an observational database capturing all patients managed within the resuscitation area since 1 November 2014 and has been described elsewhere [18].

All trauma-related patients presenting to the resuscitation area at Khayelitsha Hospital from 1 November 2014 to 30 April 2015 were eligible for inclusion. A filtered dataset was obtained from the database for this purpose. Exclusion criteria were patients who presented dead on arrival, patients incorrectly labelled as trauma cases and those with missing files from the Electronic Content Management system. The study was part of a six month master project and the amount of patient files captured during a scheduled 3-week data collection period (1–19 March 2016) determined the sample size. Eligible patients were randomised by use of Microsoft Excel™ prior to starting data collection.

Patient demographics (age, gender), date and time of arrival, patient acuity (according to the South African Triage Scale [19]), diagnostic tests performed, interventions received while in the resuscitation area, time spent in the resuscitation area, and disposition from the resuscitation were already captured on the database. Additional variables collected included patients' vital parameters, mechanism of injury, injuries sustained, injury distribution, transport method to the hospital, prehospital time intervals, patient location and in-hospital mortality. Injury distribution was divided into four groups; head, neck and face, thoraco-abdominal, extremity and polytrauma, also taking injury mechanism into account. Overlap between the groups was inevitable since the population might have several injuries. Polytrauma signifies the total population with injuries in two or more of the injury distribution groups.

Prehospital time intervals calculated were total prehospital time (time of incident to arrival at hospital), prehospital EMS time (time of dispatch to hospital arrival), EMS patient time (arrival on scene to arrival at hospital), EMS scene time (arrival on scene to departure from scene), and EMS transport time (scene departure time to hospital arrival) (Fig. 1). All time variables were collected as stated in the EMS reports. Times were captured as hours and minutes, were calculated in Excel using subtraction formulas and were checked for errors.

In-hospital mortality describes patients who arrived at the hospital, received treatment and died whilst still in hospital for their index admission. Patients declared dead on arrival to Khayelitsha Hospital were excluded. If patients were referred to another healthcare facility, the data on in-hospital mortality was collected by accessing the relative hospital's electronic record system. The data was anonymised before analysis by removing folder numbers and all identifiable information.

Summary statistics were used to describe all variables. Time intervals were analysed as continuous variables. The association between hospital arrival (time and date) and in-hospital mortality, as well as transport method and in-hospital mortality, was analysed using the Fisher's Exact Test. Transport times were analysed using the Mann-Whitney test for significance and by logistic regression. A 5% significance level was used. STATA 14 was used for all statistical analyses. A consultant at the Biostatistics Unit within the Centre for Evidence Based Health Care at Stellenbosch University assisted with the analysis of this through support from the Faculty of Medicine and Health Science's dean's fund.

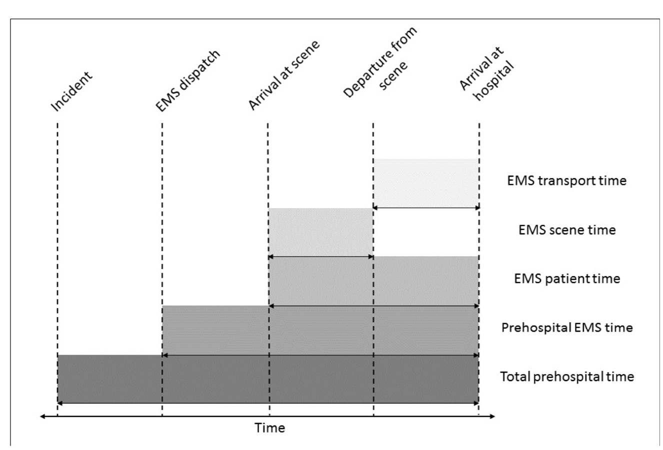

Fig. 1. Prehospital time intervals. EMS, Emergency Medical Services.

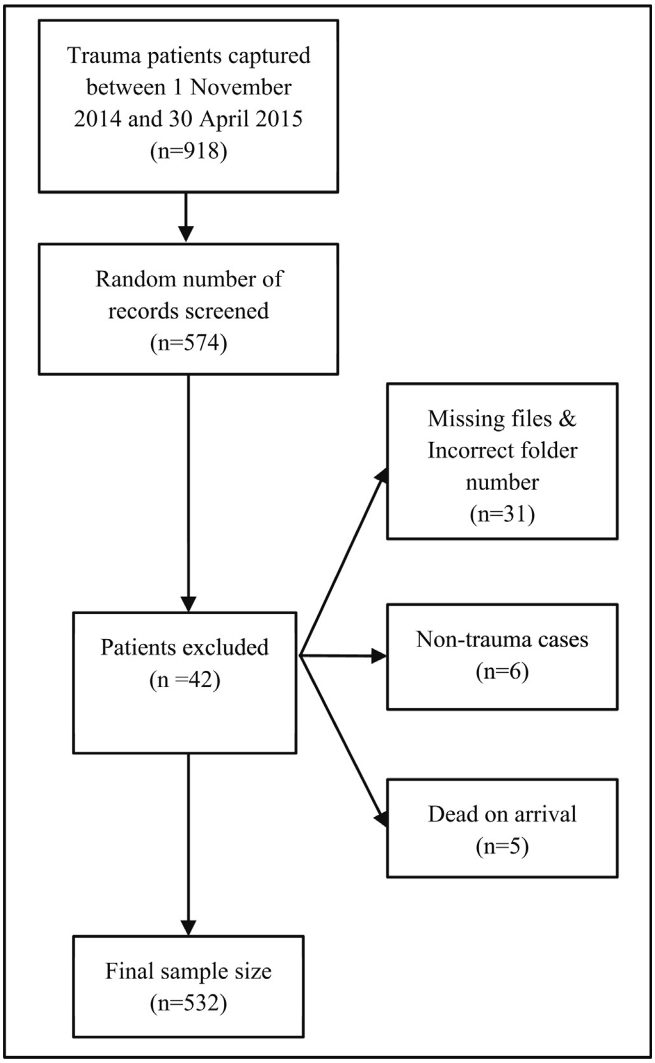

Fig. 2. Flow diagram depicting final study population.

Results

The Khayelitsha Hospital Emergency Centre database had 918 eligible trauma patients, of which 574 (63.5%) records were screened during the data collection period. The final sample analysed included 532 patients (Fig. 2).

Descriptive data of the study population is presented in Table 1. The mean patient age was 28.2 (± 10.4 standard deviation) years and the majority of patients were males aged between 19 and 44 years of age (n = 427, 80.3%). A total of 322 (60.5%) patients were deemed unstable (triaged orange or red). Penetrating trauma was the most prevalent mechanism of injury (n = 343, 64.5%). A total of 277 (52.1%) patients had stab wounds and 38 (7.1%) suffered gunshot wounds. Most stab wounds were to the chest (87/277, 31.4%), the abdomen (36/277, 13.0%) and the head (19/277, 6.9%). Road traffic incidents were the most prevalent cause of blunt-force injuries (78/179, 43.6%). Thirty-four patients (6.4%) were intubated, 26 (4.9%) received emergency transfusion of packed red blood cells, and 108 (20.3%) had an intercostal chest drain inserted. Overall, 236 (44.4%) patients had an ultrasound performed (point-of-care and radiology combined).

The median time spent in the resuscitation area was 2 h 47 m (IQR 1 h 35 m to 4 h 40 m, maximum 105 h) (missing data n = 278). After receiving care in the resuscitation area, 160 (30.1%) patients were transferred to referral tertiary hospitals. Eighteen (3.4%) patients died of which 11 (61.1%) were male between the ages of 15 and 29 years.

Table 1
Descriptive data of trauma patients managed in the resuscitation area of the Khayelitsha Hospital (n = 532).

Age (years)	n (%)
0–12	20 (3.8)
13–18	49 (9.2)
19–25	171 (32.1)
26–30	113 (21.2)
31–44	143 (26.9)
45–59	29 (5.5)
≥60	7 (1.3)
Gender	
Male	454 (85.3)
Female	78 (14.7)
Patient acuity	
Green (non-urgent)	45 (8.5)
Yellow (urgent)	165 (31.0)
Orange (very urgent)	221 (41.5)
Red (emergent)	101 (19.0)
Mechanism of injury	
Penetrating trauma	334 (62.8)
Blunt trauma	179 (33.6)
Burns	10 (1.9)
Blunt and penetrating trauma	9 (1.7)
Disposition	
Referred to specialties within Khayelitsha hospital	174 (32.7)
Referred to tertiary hospital	160 (30.1)
Managed by Emergency Centre clinicians	115 (21.6)
Discharged home	43 (8.1)
Died whilst in the resuscitation unit	9 (1.7)
Missing data	31 (5.8)

Overall, 258 (48.5%) patients arrived with their own transport, 254 (47.7%) by ambulance (i.e. by EMS) and 20 (3.8%) with the South African Police Service. Most EMS transports were directly from the scene of the incident (n = 159, 72.3%), compared to being transferred from another healthcare facility (n = 61, 27.7%) (missing data n = 34, 15.5%). Fig. 3 presents the patient method of transport according to acuity and transport method regarding injury distribution. Patients transported by EMS were mostly thoraco-abdominal injuries (n = 113, 44.5%), followed by head, neck and face (n = 104, 40.9%), polytrauma (n = 94, 33.5%) and extremities (n = 46, 18.1%). Patients transported by non-EMS were roughly the same with thoraco-abdominal injuries (n = 117, 42.1%), followed by head, neck and face (n = 100, 36.0%), polytrauma (n = 93, 33.5%) and extremities (n = 46, 16.6%). Total patients in EMS and non-EMS groups were also largest in the thoraco-abdominal group (n = 230, 43.2%), followed by head, neck and face (n = 204, 38.4%), polytrauma (n = 187, 35.2%) and extremities (n = 92, 17.3%). Burns and combined blunt and penetrating trauma as injury mechanism was a rare occurrence and deemed insignificant. In the head, neck and face injured group, patients with penetrating injuries were significantly more often transported by non-EMS rather than EMS ($p < 0.001$). Of the 18 patients that died, 11 (61.1%) arrived via EMS and seven (38.9%) via non-EMS transport. There was no significance between transport method and in-hospital mortality ($p = 0.26$).

The distribution of hospital arrivals is expressed in Fig. 4. There was a significant correlation between arrival day and in-hospital mortality ($p = 0.012$). Most patients died on Tuesdays (n = 2) or Fridays (n = 2). No significant correlation between arrival time and in-hospital mortality ($p = 0.22$) was detected. Categorisation of the data into weekend (Friday–Sunday) vs weekdays (Monday–Thursday), did not yield a significant association with regards to in-hospital mortality ($p = 0.08$).

Prehospital time intervals for patients transported directly from scene by EMS are presented in Table 2. There was no significant relationship between transport times and in-hospital mortality (all p-values > 0.09).

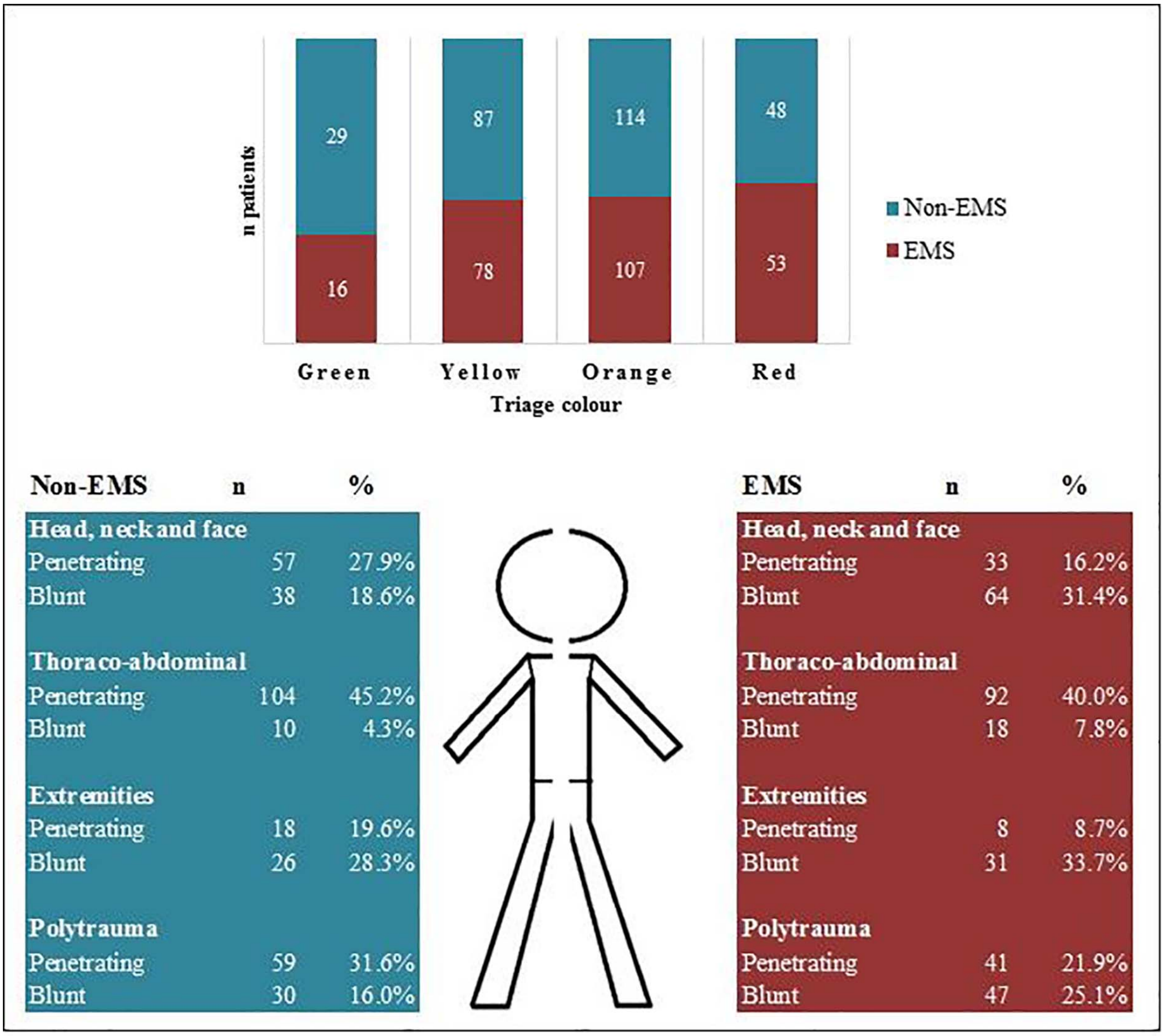

Fig. 3. Distribution of triage score, injury pattern and mechanism of injury according to transport method (The red and orange coded patients are regarded unstable whilst green and yellow are regarded to have less severe injuries). Burns and a combination of blunt and penetrating wounds were excluded due to low occurrence. EMS, Emergency Medical Services, Polytrauma = Injuries to two or more regions of the body.

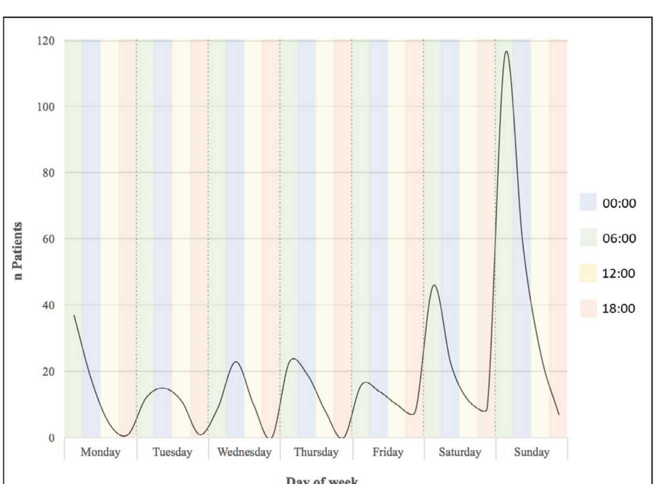

Fig. 4. Hospital arrival distribution according to day of week and categorised into six-hour intervals.

Table 2
Prehospital time intervals of patients transported by Emergency Medical Services directly from the scene to the resuscitation unit of Khayelitsha Hospital.

Time interval	Median (IQR in minutes)
Total prehospital time (n = 133)	45 (36–63)
Prehospital EMS time (n = 134)	39 (30–49.8)
EMS patient time (n = 136)	31 (21–38.2)
EMS scene time (n = 136)	20.5 (11–28.3)
EMS transport time (n = 142)	9 (6 to 12)

IQR = Interquartile range; EMS, Emergency Medical Services.

Discussion

This is the first study describing the trauma burden within the resuscitation area of a South African district-level hospital. It identifies young men as mostly affected by violent trauma and that penetrating trauma was the most frequent mechanism of injury. In-hospital mortality was not significantly affected by transport method, hospital arrival time or prehospital transport time intervals. This might be explained by the low number of deaths (n = 18) recorded in the study population.

South Africa has arguably the best prehospital system in Africa [20], yet less than half (49%) of the patients in our study were transported by EMS. This proportion is much higher than the figures reported in published data from neighbouring healthcare facilities (7–39%) [21–23]. Comparisons are however rendered meaningless as these studies included non-trauma patients and none of these facilities functioned at district-level. Although EMS systems play a vital role in effective healthcare systems [24], non-EMS transported patients are often more likely to survive [5,25]. Our study didn't show any significant difference relating to in-hospital mortality, but did indicate a tendency towards EMS transporting more critically injured patients. These results also bring to light the discussion of whether care administered by EMS would improve mortality. However, since transport times did not have any significance regarding mortality in this study, we draw the conclusion that there was no correlation between EMS intervention either.

The arrival of trauma patients to the resuscitation unit at Khayelitsha Hospital peaked during the weekend and was especially noticeable between midnight and 6 a.m. This confirms that the burden of trauma-related presentations is predominantly a weekend problem as seen not only in Cape Town [9] but also in other areas of South Africa [8]. Our study indicated that in-hospital mortality was meaningfully influenced by the day of the week ($p = 0.012$), but failed to show an association with time of day ($p = 0.221$). These results should be interpreted with caution due to low mortality events ($n = 18$) and the large patient influx on Sundays. We still hypothesise that the arrival day and time could have an impact on mortality, although the effect is still unclear [7,10].

Our study showed no association between transport times and in-hospital mortality. The total prehospital time of trauma patients was 45 min and is similar than reported times of patients taken to a local tertiary trauma centre [26]. The principle that patients have a better chance of survival if they receive definitive care within an hour (the golden-hour rule) has ensured that prehospital time intervals have been deemed as an important measurement in EMS Continuous Quality Improvement programs. However, the golden-hour rule has recently been challenged [27–29], with studies from both developed and developing countries indicating that prehospital time was not associated with increased mortality [30,31]. The opposite, however, has also been shown [32].

A significant difference ($p < 0.001$) was noted between patients with penetrating injuries to the head, neck and face region being transported by non-EMS compared to EMS. We reason this result derives from general knowledge about sensitive structures in the head, neck and face area amongst the public combined with the visual effect of penetrating trauma, thus creating a sense of urgency that pushes the trend of transport method towards non-EMS. We acknowledge that interventions made by EMS staff might have influenced the time intervals and triage scores, unfortunately interventions performed by EMS were not well noted. As discussed earlier, none of the time intervals significantly influenced in-hospital mortality, thus, any time spent to improve the patient's prehospital condition seemed to not have affected the outcome. This study is however underpowered and it shouldn't be interpreted that EMS efforts are largely ineffective.

This is the first study describing the trauma burden experienced within Khayelitsha and could be a basis to develop innovative preventative measures. However, the major limitation of this study was the small event rate, a larger sample with more events would be able to demonstrate a more reliable association. The nature of the study automatically excluded out-of-hospital deaths where prehospital time intervals and prehospital interventions might have played a role. The fairly long prehospital time for EMS could in itself have negatively impacted the outcome in the EMS group. The study didn't investigate reasons for this and it might be worthwhile to explore at a later stage. The absence of a permanent surgeon could have also impacted the outcome, although this would have been spread between both transport method groups.

Furthermore, the results of this study are limited to the resuscitation area within Khayelitsha Hospital and might not be fully representative of other district-level healthcare facilities in South Africa. Although the electronic Khayelitsha Hospital Emergency Centre database is a good starting point for future research, a 10% error was recorded. The imported data was also not cross-checked before analysis which might have introduced some errors. Nevertheless, we are confident that the results from this study remain valid.

Trauma places an immense burden on the resuscitation area at Khayelitsha Hospital, with young men being mostly affected. Method of transport, hospital arrival time and prehospital transport time intervals did not have a substantially measurable effect on in-hospital mortality. More studies with larger samples are suggested since the events of the primary outcome in this study were too few to find any statistically significant effects of the parameters that were analysed.

Conflicts of interest

The authors have no conflicts to declare.

Dissemination of results

Results from this study were shared with staff members at Khayelitsha Hospital's emergency centre through an informal presentation.

Authors' contributions

AM, DH and LK designed the study, revised and finalised the paper. LH and SL provided crucial data acquisition and revision. AM, LK, LH, SL and DH approved the final version that was submitted.

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