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Original article

Outcomes of patients with thoraco-abdominal gunshot wounds operatively managed at a district hospital in Cape Town, South Africa

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ABSTRACT

Aim: Trauma is a leading cause of morbidity and mortality in the first four decades of life. Thoracoabdominal gunshot wounds carry a significant risk of mortality. This risk of death is reduced if patients are managed in dedicated units. This study examines the outcome of these patients managed in a district level hospital.
Method: In this retrospective review, patients with thoracoabdominal gunshot wounds were identified from operating room registry for the period of January 2015 to December 2018. Data was collected retrospectively from folders and analysed for the primary outcome of mortality.
Results: Sixty-eight thoracoabdominal gunshot wounds were managed operatively over the period described. Only six patients were female. The median age was 29.5 years. Fourteen patients required postoperative transfer to a level 1 trauma unit. Thirteen patients died, nine at the district hospital and four at the level 1 unit. Significant differences in organ injuries were noted in the patients that died compared to the survivors.
Discussion: The in-hospital mortality rate of patients managed at the district hospital was 13.2% which is comparable to international rates of 12–18%. However, the subset of patients that required postoperative transfer to a level 1 trauma unit had a high mortality rate of 28.6%. The DH is committed to managing unstable and unresponsive patients once they present. Improved mortality rates will only occur with better prehospital transport policies and by equipping the DH to manage these patients postoperatively.
Conclusion: Management of these patients can be successful at a district hospital. However, significant obstacles exist to their optimal care, as demonstrated by the high mortality patients requiring postoperative transfer.

African relevance

- In low- and middle-income countries, like South Africa, trauma surgery occurs at non-specialist units.
- In this study, the mortality rate for primary surgical intervention at a district hospital is comparable to internationally reported outcomes, except in patients that require post-operative care in a High Care or Intensive Care Unit.
- More cardio-vascular support is required and health systems should make provisions to support patients peri-operatively as per the South African Trauma Society Guidelines.

Introduction

Trauma is a major global public health concern. It is associated with high morbidity and mortality and is reported as a leading cause of death, hospitalization, and long-term disability in the first four decades of life [1–3]. Thoracoabdominal gunshot wounds have a particularly high mortality rate. Figures range from 8% in the United States to as high as 30% in South African [4,5].

Death from serious injury has a bimodal distribution. Most deaths from trauma occur immediately at the scene or early in hospital (<4 h from injury). Deaths occurring late (>4 h after injury) have substantially decreased [6] as there is increased capacity to support patients who have multiple organ dysfunction. Emphasis now needs to be placed on campaigns that will decrease the burden of trauma and on providing better immediate care for trauma patients [6].

The American College of Surgeons introduced criteria for the categorizing of hospitals according to the resources available to provide various levels of trauma care in 1976 [7,8]. The risk of death is

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significantly lower in systems with this stratification as patients are managed in dedicated units [1,9,10]. In South Africa, dedicated trauma units exist within the public and private health care systems. However, as trauma forms a major component of emergency surgical and orthopaedic patients, trauma systems need to extend outside specialist trauma centres to include pre-hospital care, emergency care and surgical care received at other facilities [11]. In our context, patients are not always managed at dedicated units. The Trauma Society of South Africa (TSSA) has outlined four categories of trauma centres. Level one major trauma centres are regional resource trauma centres capable of providing total care for every injury with 24 hour access to all medical specialities. Level two urban trauma centres can provide initial definitive care regardless of injury severity. Level three community hospitals can perform basic emergency stabilisation and operations and arrange transfer to facilities that can provide definitive care. Level four primary health care centres provide trauma life support before transfer for definitive care. The TSSA additionally provides guidelines on the necessary hospital staffing, resources and equipment for each level of trauma centre [12]. A facility's capacity for emergency care and stabilisation is not always equivalent to its trauma centre designation. Ideally, patients with signs of haemodynamic shock should be taken directly to either a level 1 or 2 trauma centre.

Little data exists on the spectrum of trauma, management and outcomes of patients managed at district hospitals. This objective of this study was to describe the outcomes of patients with thoraco-abdominal gunshot wounds that were managed operatively at a district hospital in South Africa.

Methods

Study setting

In the Cape Town metropolitan area, two large academic hospitals serve as level one trauma units. The South African Department of Health defines a district hospital (DH) as a hospital that serves a defined population and is primarily staffed by general practitioners and clinical nurse practitioners. District hospitals may limit specialist services within paediatrics, obstetrics and gynaecology, internal medicine, general surgery and family medicine [13]. This DH is situated in Mitchells Plain, well known for its high level of inter-personal violence. Mitchells Plain had the highest number of reported crimes in South Africa in 2016 [14]. The hospital is situated 20 km away from the nearest level one trauma unit.

At this DH resources considered essential for level two trauma centres; an on call radiologist available within 60 min, intensive care unit, blood bank and other clinical services e.g. haemodialysis capacity; are not available. Despite a lack of resources, this DH is currently managing patients who would qualify for definitive care at a level 1 or 2 trauma centre. While the TSSA has developed the accreditation tool, very few hospitals have been accredited- only one public hospital and fifteen private hospitals in South Africa. None of the public hospitals in the Western Cape, including this district hospital, have been formally graded and accredited [15].

Doctor staffing at the district hospital is limited to the surgical on call teams during the weekend. The emergency medical centre also downscales doctor staff to two shifts of 12 h each as opposed to three overlapping shifts of 10 h each per 24 h.

Patients are managed by standard resuscitation protocol. A liberal policy of cardiac ultrasound is used to diagnose cardiac tamponade. Responders and stable patients in need of imaging are kept until radiological services are available during weekday office hours. Nonresponders and unstable patients are taken to the operating room with the goal of attempted definitive care. Patients who would benefit from care at the level 1 trauma unit but are deemed unfit for transfer are managed locally. Patients in need of specialized postoperative care remain in the operating room theatre after surgery until transport can be arranged to the level 1 trauma centre.

Study design

This study is a retrospective review of thoracoabdominal gunshot wounds (GSW) managed at a district hospital (DH) that is located within close proximity to a level one trauma unit. It describes the management and outcomes of patients and compares this to international standards. In this study, thoraco-abdominal GSW were defined as below zone one of the neck and above the inguinal ligament. Injuries to pelvis and perineum were included.

Patients were identified from the operating room registry of the district hospital for the period January 2015 to December 2018. This paper does not include patients that were transferred from the emergency centre and underwent their first operation at the trauma centre or patients who were managed nonoperatively. There were no exclusion criteria. Data were collected retrospectively, by the researchers, from patient folders. Only variables for which data point values could be reliably extracted from the clinical notes were included for analysis. This included demographic data (age, gender), pre-operative state (vitals and blood parameters e.g. pH, pO2, lactate), decision to image patients including computed tomography and ultrasound, intra-operative injuries (which were graded using the Organ Injury Scale) [16], intra-operative state (vitals and blood parameters) and outcome including transfer to level 1 facility and mortality. The revised trauma score (RTS) was also calculated for each patient [17]. The RTS is a physiologically based scoring system that incorporates Glascow Coma Scale, Systolic blood pressure and respiratory rate. Scores range from zero to twelve. A lower RTS is associated with poorer outcomes and increased need for transfer to a trauma centre [18].

Permission for this study was granted by the University of Cape Town Human Research Ethics Committee, REF: 331/2019.

Analysis was performed using *R* for statistical computing, version 3.5.3 (R Foundation for Statistical Computing, Vienna, Austria). Numerical variables were subjected to the Shapiro-Wilk test for normality. Variable statistics were expressed as mean and standard deviation if the assumptions for normality were met and otherwise as median and interquartile range (IQR). The χ^2 test for independence was used to compare categorical variables. Continuous variables will be described using means ± standard deviations (SD) if normally distributed or medians with interquartile range (IQR) if abnormally distributed. Categorical variables will be expressed as frequencies and percentages. An α value of 0.05 was used to determine significance. Two-tailed hypotheses were used for numerical analysis.

Results

A total of 68 cases of thoracoabdominal gunshot wounds were managed operatively. Six (8.8%) of the patients were female. The median age was 29.5 years (IQR 13.25 years), with the youngest patient 16 years and the oldest 54 years of age. The majority of patients (48, 70.6%) were seen over the weekend period (Friday to Monday).

Table 1
Preoperative state of the patients.

Criterion	Mean (median*)	Standard deviation (interquartile range*)
Lowest preoperative systolic blood pressure in mmHg	113	31
Highest preoperative heart rate in beats per minute (bpm)	94	25
Lowest preoperative pH	7.29*	0.2*
Lowest preoperative P_aO_2	4.95*	7.38*
Highest preoperative lactate in	4.05*	4.53*
Preoperative HB in gram per deciliter (g%)	13.2	2.7

The preoperative state of the patients is described in Table 1. The median RTS was 8 (IQR 1).

The median time from presentation to the emergency centre to the start of surgery was 111.5 min (IQR 116.25). A total of six patients underwent computed tomography (CT) imaging pre-operatively, which significantly delayed time to surgery (187 min (IQR 233) versus 99 min (IQR 101) (p value <0.01)).

The most commonly injured organs were the small bowel (n = 30, 44%), the colon (n = 25,37%) and the liver (n = 17, 25%). A detailed description of organ injury grades per organ can be found in Appendix 1 (Table 5). The intraoperative state of the patients is described in Table 2.

A total of 13 (19.1%) patients died. Nine patients (13.2%) died at the DH including eight intraoperative deaths, while one patient died in the ward after surgery. The median time from the start of surgery to death in these nine patients, was 60 min (IQR 92 min).

The hospital did not have the facilities to manage 14 (20.3%) patients. 11 patients were transferred from the operating room to a level 1 trauma centre as they required ongoing management in a High Care or Intensive Care Unit. Of these 4 required a second surgery for definitive management at the level 1 unit. The remaining three patients were transferred post-operatively from the surgical wards and emergency centre for specialist investigations and intervention; one was transferred from the emergency centre one week post operatively with per rectal bleeding, one was transferred on the day of surgery for a ureter injury and one was transferred post-surgery from the surgical ward for percutaneous drainage of wound site sepsis. The mortality rate of the transferred cohort is 28.6%.

Non-survivors had significantly shorter door to surgery times, higher markers of shock severity (Table 3) and more cardiac, pulmonary and thoracic and abdominal vascular injuries (Table 4).

Discussion

The gender imbalance in this civilian cohort reflects those seen in many other units both locally and internationally [19–21]. The trauma is similarly inflicted on a younger age group.

The majority of cases were seen during the weekend (including Monday). This is consistent with trauma patterns seen in other studies in the area and South Africa [22–25]. As peaks in trauma occur, thought should be given to increasing capacity of medical personnel during these times.

In this cohort all patients had a RTS of <10 and therefore required urgent care [17]. The management of these patients was per protocol as directed by the supervising level 1 trauma unit. It is unknown if patients who had indicators of shock would have had better outcomes if primary management had taken place at a level 1 trauma centre.

The presentation of these patients to the DH instead of the level I trauma unit is driven by a variety of factors including an overburden of the healthcare system, emergency services capacity, and self-referral to the DH by either the patient or by bystanders.

The public Emergency Medical Service (EMS) in the Cape Town Metropolitan area has a direct trauma transfer criteria which allows major adult trauma to bypass lower levels of care and be transferred to appropriate trauma facilities [26,27]. This includes patients who are in shock with a "stop and intervene" addendum for certain procedures such as intubation or placement of an intercostal chest drain. However, available studies suggest non-adherence to this policy; 88% of admissions at a Level 1 trauma centre in South Africa were inter-hospital transfers of EMS transported patients [28], patients that arrived via EMS were 2.68 times more likely to be admitted or transferred than patients that presented directly to the EC at another district hospital in the Western Cape [23]. EMS services are currently overburdened by high patient volumes with a limited number of trained personnel – of the 25,000 paramedics in South Africa only 1000 are registered for Advanced Life Support [29]. There is also a lack of clear South African guidelines on the capabilities of Emergency Departments; perhaps making it difficult to choose an appropriate trauma facility [30].

The mortality rate due to gunshot injuries, reported in the literature, is between 12% and 18%, with thoraco-abdominal injuries at the higher end of this scale [31]. The in-hospital (DH) mortality rate (9 patients, 13.2%) was similar to these international findings. The transferred patients were more unwell intra-operatively. Patients who died were more likely to have had cardiac, pulmonary or great vessel injuries (thoracic and abdominal). It is possible that a better outcome could have been achieved if patients had been primarily managed at a level 1 or 2 trauma unit. Additionally the transfer of patients post-operatively from the theatre to the level 1 trauma unit adds strain to the EMS and occupies the emergency operating theatre for longer than necessary, impacting the care of other patients. Improved mortality rates of patients managed at dedicated trauma units are apparent when patients have more severe injuries [32]. The American College of Surgeons Committee of Trauma recommends that patients with penetrating injuries to the head, neck, torso and proximal to the elbow or knee be directly transferred to a trauma centre [33]. The TSSA does not provide definitive guidelines for level of care based on injury pattern. While the implementation of triage models and pre hospital care from high income countries is not feasible; evidence from other low-middle income countries have emphasised the potential positive impact of improving the efficacy of EMS and triage systems [34]. An improved initial triage system of illness severity that includes physiological parameters and anatomic site of injury could facilitate immediate transport of selected patients to the dedicated trauma unit [35]. However, in this patient cohort, the impact of additional factors such as delays in transfer to specialized units post-operatively and delayed definitive surgeries is unknown and could be contributory.

As a retrospective review, the number of variables for which data could be accurately corrected was limited. A root cause analysis of deaths was not done. A prospective data collection system has been implemented at this DH to facilitate future research into predictors of mortality.

All the patients in this cohort received operative management at the DH. Patients who died pre-operatively, who were transferred to a level I hospital from the Emergency Department or who had non-operative management were not included in this study. It is unknown what proportion of GSW seen at this DH receives operative management. This limits the ability of this study to provide a complete context of care and outcomes for GSW at this district hospital. More data is needed on the how patients present to the Emergency Centre (i.e. self-presentation or being brought by the EMS), characteristics, management (including non-operative management) and outcomes of cases of major gunshot wounds at district hospitals in South Africa.

Identification of 68 gunshot wounds managed operatively over the 4 year period is surprising given the volume of inter-personal violence in the community that the DH serves. Patients records were only drawn if the operation description included the term gunshot wound or its abbreviation i.e. GSW. It is possible operations may have been missed if they were documented differently.

Table 2
Intraoperative state of the patients.

Criterium	Mean (median*)	Standard deviation (interquartile range*)
Lowest intraoperative systolic blood pressure	85* mm Hg	21* mm Hg
Highest intraoperative heart rate	115* bpm	23* bpm
Lowest intraoperative pH	7.25*	0.35*
Lowest intraoperative P_aO_2	19* kPa	11.* kPa
Highest intraoperative lactate	3.9*	5.1*
Intraoperative HB	8.8* g%	3.4 g%

Table 3
Differences in epidemiology, pre- and intraoperative states, and logistics.

Criterium	Mean (median*) Alive	Standard deviation (interquartile range*) Alive	Mean (median*) Dead	Standard deviation (interquartile range*) Dead	Test statistic	p value
Age in years	30*	13*	28*	19*	264.5	0.96
Time from presentation to OR in minutes	116.5*	126.8*	56*	40*	374.5	0.02
Lowest preop systolic BP in mmHg	115	29	89	37	2.29	0.03
Highest preop HR in bpm	92	24	114	27	−2.253	0.03
Lowest preop pH	7.3*	0.36*	7.3*	0.36*	146	0.39
Lowest preop P_aO_2 in kPa	5.1	7.2	4.5	16.3	136	0.99
Highest preop lactate in	3.5*	3.85*	9.75*	4.55*	56	0.02
Preop H in g%	13.3	2.7	12.6	3.1	0.59	0.56
Lowest intraop systolic BP in mmHg	117*	41*	83*	40*	116.5	0.18
Highest intraop HR in bpm	120*	21*	115*	25*	132	0.97
Lowest intraop pH	7.29*	0.18*	6.84*	0.05*	191	<0.01
Lowest intraop P_aO_2 in kPa	18.9	11.1	21.6	18.3	−0.39	0.70
Highest intraop lactate in	3.8*	3.8*	13.9*	2.2*	0	<0.01
Intraoperative HB in g%	8.8*	3.7*	6.8*	0.3*	90.5	0.08

Shaded = significant result.

Table 4
Significant difference in organ injury class between death and survival groups with organ injury scores of between 3 and 5.

Organ	Alive (number (%))	Dead (number (%))	P value
Cardiac	2 (3,45%)	2 (22,22%)	<0,01
Lung	2 (3,5%)	3 (33,33%)	0,01
Thoracic vascular	2 (3,5%)	2 (22,22%)	<0,01
Major abdominal vessel injuries	3 (5,26%)	3 (33,33%)	0,02

Conclusion

This cohort of patients with thoraco-abdominal gunshot wounds managed operatively at a South African District Hospital had a high mortality, especially more severely injured patients who required transfer or High Care and or Intensive Unit Care post operatively. A concerted effort towards increasing the uptake of TSSA accreditation, possible improval of resources at the district hospital and a review of the EMS trauma destination selection guidelines should be considered.

Dissemination of results

The findings of this study have been discussed with the Surgical Department at the District Hospital where the study was conducted.

CRediT authorship contribution statement

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: JK contributed 35%, HM 35%, and JV, DC, SL, TM, JZ and JC 5% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declared no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.afjem.2020.11.008.

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