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ORIGINAL ARTICLE

Trauma burden, patient demographics and care-process in major hospitals in Tanzania: A needs assessment for improving healthcare resource management

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ABSTRACT

Background: Appropriate referrals of injured patients could improve clinical outcomes and management of healthcare resources. To gain insights for system development, we interrogated the current situation by assessing burden, patient demography, causes of injury, trauma mortality and the care-process.

Methods: We used an observational, cross-sectional study design and convenience sampling to review patient charts from 3 major hospitals and the death registry in Tanzania.

Results: Injury constitutes 9–13% of the Emergency Centre census. Inpatient trauma-deaths were 8%; however, the trauma death registry figures exceeded the 'inpatient deaths' and recorded up to 16%. Most patients arrive through a hospital referral system (82%) and use a hospital transport network (76%). Only 8% of the trauma admissions possessed National Health Insurance. Road traffic collision (RTC) (69%), assault (20%) and falls (9%) were the leading causes of injury. The care process revealed a normal primary-survey rate of 73–90%. Deficiencies in recording were in the assessment of: Airway and breathing (67%), circulation (40%) and disability (80%). Most patients had non-operative management (42–57%) or surgery for wound care or skeletal injuries (43%). Laparotomies were performed in 26%, while craniotomy and chest drain-insertion were each performed in 10%.

Conclusion: The burden of trauma is high, and the leading causes are: RTC, assault, and falls. Deaths recorded in the death registries outweigh in-hospital deaths for up to twofold. There are challenges in the care process, funding and recording. We found a functional hospital referral-network, transport system, and death registry.

African relevance

- Injury is a leading cause of mortality and morbidity in Africa, yet systems for management thereof are lacking in most developing countries
- This study assesses the trauma burden in major Tanzanian facilities and identifies areas of inefficiencies in trauma care management, while also proposing cost-effective solutions
- Professional bodies, training institutions and other relevant authorities may use these suggestions to improve trauma care in Tanzania and beyond.

Introduction

The burden and complexity of injuries is increasing in lower and middle-income countries (LMICs) [1–3]. The mortality risk after major trauma is 6 times higher than in developed countries [1]. High - income countries (HICs) achieve lower injury mortality rates because of standardized protocols, training and the availability of material resources or trauma-care system infrastructure [4–6]. For logistical and economic reasons, the WHO recommends the Essential Trauma Care (ETC) guidelines and similar approaches for LMICs, and advocates improvement of road safety and improvement of trauma-care services [1,3,7].

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The current trauma-care guidelines recommend pre-hospital care, standardized treatment protocols, material and infrastructure-resource mobilization, provision of skilled personnel, quality improvement programs, monitoring, surveillance and rehabilitation services [1,2,4–9]. Unfortunately, these recommendations are not yet commonly utilized; specialized training is limited, financing systems and quality of care initiatives are lacking, and skills lag behind the acceptable level in most LMICs [10,12].

Commonly, the standard initial trauma care is based on Advanced Trauma and Life Support (ATLS) principles [6,13], and the advanced trauma care guidelines are provided by trauma-surgery related authorities [1,4–8,13]. To improve the quality of care, trauma-care algorithms and performance indicators were applied in HICs and in some LMICs [14–16], and trauma system models have been proposed specifically for LMICs [1,17].

Tanzania is a country on the Eastern part of equatorial Africa, with a population of 59 million people, with increasing urbanization and increased access to modern transportation means. Roads, however are often poorly maintained and drivers are therefore at risk of crashes, along with the reliance on public transport by most of the population [18].

In Tanzania, like other LMICs, there is a high rate of trauma. Road Traffic Crashes are the lead cause in most of Africa [19,20]. Emergency medicine training programs have been initiated in Tanzania and there is a good progress of emergency care in the main hospitals [21], however organized trauma system models are not yet in place, trauma care training in medical curricula is deficient, and trauma-surgery specialization among health professionals is yet to start [22,23]. Resources for trauma care along with all other healthcare services compete for a meagre 32% of the National Health Insurance Fund (NHIF) coverage, and prehospital emergency services are currently not included in this public health funding (NHIF) system [24,25].

To improve the outcome for the severely injured, the quality of trauma care must be maintained beyond the Emergency Centres (ECs) and this involves other cadres such as trauma surgery and rehabilitation services. This study aims to evaluate the existing trauma-care practices to identify critical areas for improvement by adapting the context-based trauma system. Studying injury patterns and their care process offers an opportunity to assess the pre-existing standards and consequently allows for appropriate planning for improvement. This is important in LMICs where resources are limited, therefore the proposed trauma system adaptation should be cost effective and based on existing structures to avoid HICs trauma systems importation which are not feasible in LMICs [1,7].

The objective of this research was to assess: the in-hospital trauma-burden, major injury processes of care; and the trauma death burden. Findings will be important in improving the outcome of trauma care, guiding specific trauma-care skills development, and to advocate for trauma-care funding by the NHIF; and for future monitoring and evaluation.

Methods

Study design: This is observational and cross-sectional study including consecutive patients in alternative months in 2018 to include high and low peak injury incidents periods [26,27].

Tanzania is a LMIC in the Eastern part of Africa with a population around 59 million people [18]. The country's health care systems are organized from lower level dispensaries, health centres, district and regional hospitals to central referral hospitals. The public health system has an inter-hospital transport network of vehicles staffed by non-trained drivers. Referral letters are required prior to transfer to a higher hierarchy hospital, and additionally trauma patients need a special police form number 3 (PF3) to attend to any hospital [18,28]. There are 4 major referral hospitals country-wide: Muhimbili National hospital (MNH) has several emergency physicians and is a training facility. Mbeya zonal referral hospital and Kilimanjaro Christian Medical Centre (KCMC) both have ECs headed by emergency medicine specialists. All hospitals serve as medical and health professions training facilities with surgical rotations. If patients arrive at higher level hospitals without the formal referral systems, these are considered 'self-referrals' as opposed to 'hospital referrals'. Additionally, local regulations in Tanzania require all deaths to be registered in the registry maintained by the Registration, Insolvency and Trusteeship Agency (RITA), hence this is a ready source of trauma death data that was drawn from RITA offices in: Moshi, Muhimbili and Mbeya [29].

We screened EC patient registries in hospitals to identify trauma patients who were treated in 2018. We included patient records from 3 hospitals: Kilimanjaro Christian Medical Centre (KCMC), Mbeya zonal referral hospital, and Muhimbili national hospital surgery wards.

We included patients who suffered major penetrating and blunt injuries from physical mechanisms, falls, road traffic accidents, or weapons. We excluded fragility fractures and injuries not primarily addressed by most trauma systems models, namely: burns, drowning, hanging, poisoning, chemical and radiation exposures.

Demographical variables included age and sex distribution; patient transport, type of referring hospital, financing options; process of care variables (initial emergency care of airway, breathing, circulation; or specific surgical treatment as per likely indication), and patient outcome i.e. death (Appendices).

We defined 'major injury' based on mechanism of injury, clinical presentations, and admission status, specifically, admitted penetrating or blunt abdominal injuries, admitted blunt or penetrating multiple injuries were considered to be major injuries.

Hospital burden of injury: based on the consideration that most hospital admissions are initially seen at an EC, we consecutively selected EC admissions from patients registers in alternative months in 2018 to estimate the proportion of injuries of the total EC census.

Care process: For the patient records retrieved, we reviewed the care-process variables for initial assessment in the EC: triaging categorization, assessment of airway, breathing, circulation, appropriateness of EC intervention; and for those admitted to definitive care: surgery options (Appendices).

Trauma deaths: similar records were accrued from the death registry for the major hospitals catchment areas (RITA offices in Moshi, Muhimbili and Mbeya) to assess trauma related deaths based on diagnosis or mechanism of injury (Appendix B) to determine what proportion of death occur in hospital versus pre-hospital.

To reduce the risk of source-document interobserver bias a peer reviewed proforma was developed based on standard trauma care guidelines and protocols [1,4–8]. The data abstraction team was familiarized and ascertained compliant with the data collection tool. All study authors from the participating hospitals verified the data before compilation and analysis. To minimize the effects of seasonal variations [27–29] in trauma incidence where some months may have more or less trauma incidences during a full year cycle i.e. major religious and social festivity, planting and harvesting seasons, school closure, rainy or cold seasons, etc. study participants were selected in alternating months in a complete 1-year cycle. This described technique [26,27] minimizes selection bias by roughly distributing major events that affect trauma occurrence in the local environment.

The study reviewed 30, 330 EC visits from MNH and 7938 from KCMC; and 13,300 outpatient records from Mbeya referral hospital medical record department, and further reviewed a total of 1138 injury admissions from MNH, KCMC and Mbeya referral Hospitals (Fig. 1).

Data from EC registries, patient files and from death registries were recorded in a Microsoft Excel® spread sheet (Microsoft, Redmond WA). After coding and data cleaning, SPPS version 20.0 for Windows (IBM, Armonk NY) was used to organize the data and compute percentages, medians (interquartile ranges), proportions, and for generating tabulated reports.

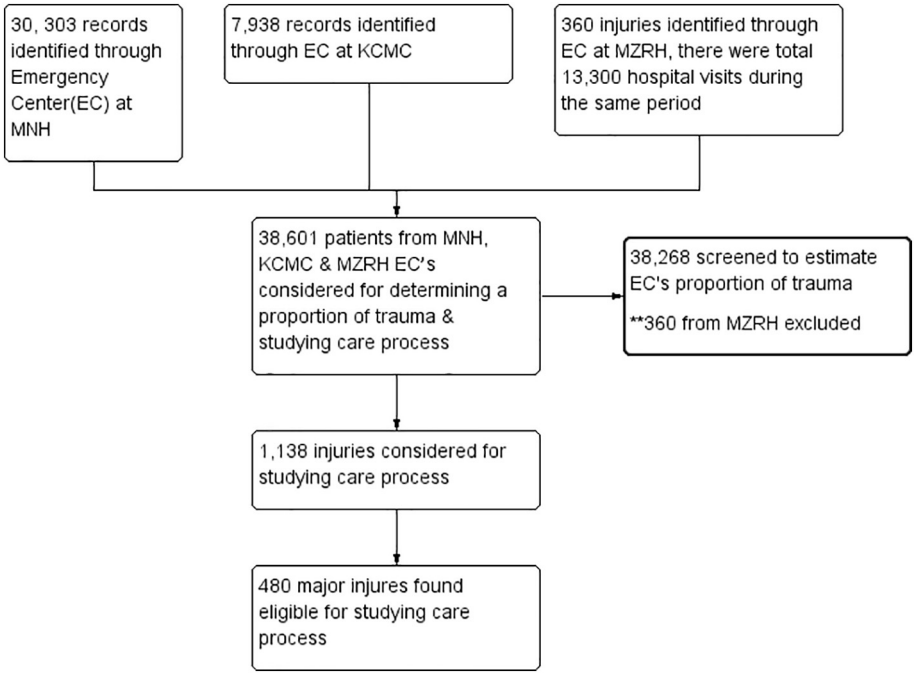

Fig. 1. Emergency Centre visits and in-hospital trauma admissions.

Results

The EC caseloads at MNH and KCMC (38,268) showed the proportion of trauma patients ranged between 9 and 13%, Mbeya referral hospital caseloads were excluded due to inconsistency and deficiency in reporting. The total number of trauma cases admitted to various facilities was 1138 e.g. MNH (485), Mbeya referral hospital (358), and KCMC (295). Admitted cases defined as major injuries were reviewed for possible audit of the emergency and inpatient care processes: After applying selection criteria 480 of these cases were selected and subsequently assessed. From the same regional facilities, the death registries across these major hospital catchment areas yielded 2654 records and their characteristics were categorized to determine causes and the proportion of trauma-related deaths (Fig. 1).

Hospital trauma-admissions: age, gender and other characteristics

Adults accounted for 89% of all trauma patients, and males predominated at 84%. Median age [IQR] in adults was 30 years [24–40] and in the paediatric group was 6 years [4–10]. While 91% of the injured patients at EC did not have any medical insurance coverage, meaning they paid out-of-pocket for their care, only 8% possessed National Health Insurance Fund (NHIF) cover. Most injured persons were brought to the EC as a referral from lower level facilities (82%). Trauma-admissions were self-referred in 11% or brought by the police in 6%. Seventy-seven percent of the patients were transported by hospital vehicles (not formal ambulances) and 17% used personal vehicles or cars. The rest of the patients (< 6%) walked-in or were brought in a police van.

The top causes of injury were road traffic collisions (RTC) 69%, violence 20% and falls 9%. Other minor causes were attacks by animals and industrial injuries. There were missing records in most categories owing to an absence of adequate documentation, e.g. 80% on mode of transport to the facility, 14% on the mechanism of injury, and 23% on the mode of arrival (Table 1).

Care-process and outcome of the admitted trauma patients across major hospitals in Tanzania

Airway patency and Oxygen saturation (SPO_2) was normal in 51%. Respiratory rate (RR) was normal or mildly elevated in 88% of the cohort, generally breathing assessments that considered inspection, palpation, percussion and auscultation were normal in 25% of patients. Airway, breathing and respiratory-rate assessment were, however, inadequately recorded for 41%, 53%, and 67% of cases respectively (Table 2).

Pulse rates ranged between 60 and 100 in 67% of the cohort. Systolic blood pressure and diastolic blood pressure were normal in 59% and 73% respectively, and therefore the mean arterial pressure (MAP) was normal in 90%. Extremity assessment for capillary refill, temperature and diaphoresis was recorded as within normal limits in 93%. Blood pressure and pulse rate were reported in 90% and 86% respectively, while the examination of extremity was poorly recorded, being present in only 40% of charts (Table 3).

Many patients were reported to have normal Glasgow Coma Score/AVPU parameters (73%), however examination of pupils, and power of the extremity to detect clinical features of intracranial hematoma was not recorded in the majority (80%). Only Mbeya referral hospital and MNH reported the AVPU parameter, revealing a deficit in recording at the other facilities.

Multiple injuries with head injury were reported in 50%, isolated fracture was 26%, visceral injuries (chest & abdomen) 14%, and soft tissue injuries 10%. Blood tests were limited to haemoglobin, blood grouping and cross-matching, and full blood count and were only performed in 22% of the trauma patients. Ultrasound-scans were performed in 45% of the admissions, and over 90% were 'focused assessment with sonography in trauma' (FAST). Other radiological tests performed were plain x-rays (35%), skull x-ray (20%) and computer-tomography-scan (CT-scans) 28%.

Fractures and related wound management were the most reported operations in 43% and laparotomy in an additional 26% of admissions. Chest drains and craniotomy were each reported to be performed in 10%. Other procedures, such as tracheotomy, fasciotomy or amputations were performed in < 1% of the total cohort. Non-operative management in general surgery was 57%, and in Orthopaedics it was

Table 1
Age, sex, funding, referral, transport and mechanisms of injury (n = 480).

		KCMC n(%)	MNH n(%)	MZRH n(%)	Total n(%)
Age	0–14	28(10)	9(10)	15(15)	52(11)
	15–44	216(74)	69(78)	73(72)	358(74)
	45 or >	47(16)	10(11)	13(13)	70(15)
	Total	291(100)	88(100)	101(100)	480(100)
Sex	Male	252(87)	77(87)	76(75)	405(84)
	Female	39(13)	11(13)	25(25)	75(16)
	Total	291(100)	88(100)	101(100)	480(100)
Finance-mode	NHIF	22(8)	4(5)	10(10)	36(8)
	None	269(92)	80(90)	91(90)	440(91)
	Not recorded	0(00)	4(5)	0(0)	4(1)
	Total	291(100)	88(100)	101(100)	480(100)
Referral mode	Healthcare facility	235(80)	72(82)	0(0)	307(64)
	Police	22(8)	2(2)	0(0)	24(5)
	Self-referral	31(11)	9(10)	0(0)	40(8)
	Not recorded	3(1)	5(6)	101(100)	109(23)
	Total	291(100)	88(100)	101(100)	480(100)
Transport mode to the receiving hospital	Hospital transport	0(0)	66(75)	0(0)	66(14)
	Police van	0(0)	2(2)	0(0)	2(0.4)
	Private car or for fee	0(0)	14(16)	0(0)	14(3)
	Walking or on a stretcher	0(0)	3(3.5)	0(0)	3(0.6)
	Not recorded	291(100)	3(3.5)	101(101)	395(82)
	Total	291(100)	88(100)	101(100)	480(100)
Mechanism of Injury	RTC	201(69)	11(12.5)	73(72)	285(59.5)
	Fall	30(10)	2(2)	7(7)	39(8)
	Assault	35(12)	4(5)	19(19)	58(12)
	Stab	3(1)	11(12.5)	0(0)	14(3)
	Gunshot	0(0)	10(11)	1(1)	11(2)
	Industrial/machinery, animal bite/attack/injury, self-inflicted, hanging	3(1)	1(1)	0(0)	4(1)
	Not recorded	19(7)	49(56)	1(1)	69(14.5)
	Total	291(100)	88(100)	101(100)	480(100)

KCMC - Kilimanjaro Christian Medical Center; MNH - Muhimbili National; MZRH - Mbeya Zonal Referral Hospital; NHIF - National Health Insurance; RTC - road traffic collision.

42%. The average length of hospital-stay was 9.5 days, the average length of ICU stay was 8.2 days, and proportion of deaths among those admitted was 8%.

Death registry statistics: age, gender, causes of death and characteristic of subjects in the main hospital-catchment areas

A review of all the deaths recorded at the regional mortuaries was performed to identify the causes and determine the proportion of trauma deaths in the total cohort. Mortality causes ranged from infections, medical illnesses and related complications 54%, acute surgical related deaths (including trauma) 21%, neoplasia 19% and Paediatric conditions 7%. Trauma deaths occurred in 13% of the total death cohort, it constituted 67% of surgical related deaths and ranged between 8 and 16% of total deaths between the sampled regions.

In general, deaths incorporating trauma and non-trauma causes were dominated by adults at 95% and males by 58%. Similarly, trauma deaths occurred in adults in 93%, with median age [IQR] 42 years [24–44] in adults, and 9 years [5–13] in paediatric cases, however the proportion of trauma showed an 84% male predominance.

Eight percent of the trauma deaths were treated at the hospital prior to death, while 13% were admitted directly due to deaths on scene.

Table 2
Airway patency and breathing assessment among the admitted trauma patients in Tanzania (N 480).

		KCMC n(%)	MNH n(%)	MZRH n(%)	Total n(%)
SPO2 & airway-assessment	Normal SPO_2, patent airway	148(51)	82(93)	42(42)	272(57)
	Normal SPO_2, deficient airway patency	1(0.3)	0(0)	1(1)	2(0.4)
	Abnormal Spo2 or patency, and inadequate measurement of variables	42(14.4)	5(6)	23(22.7)	70(14.6)
	Normal SPO2 or patency and inadequate measurements of parameters	91(31.3)	1(1)	35(34.7)	127(26)
	Not recorded	9(3)	0(0)	0(0)	9(2)
	Total	291(100)	88(100)	101(100)	480(100)
Breathing rate	< 20	22(7.5)	21(24)	2(2)	45(9)
	20–30	44(15)	54(61)	7(7)	105(22)
	30–40	3(1)	5(6)	0(0)	8(2)
	> 40	0(0)	2(2)	0(0)	2(0.4)
	Not counted	222(76)	6(7)	92(91)	320(67)
	Total	291(100)	88(100)	101(100)	480(100)
	Normal RR& breathing	32(11)	62(70)	7(7)	101(21)
	Abnormal RR or breathing	28(10)	20(23)	3(3)	51(11)
	Inadequate examination	175(60)	5(6)	73(72)	253(52)
	No record or assessment reported	56(19)	1(1)	18(18)	75(16)
	Total	291(100)	88(100)	101(100)	480(100)

KCMC - Kilimanjaro Christian Medical Centre; MNH - Muhimbili National Hospital; MZRH - Mbeya Zonal Referral Hospital; SPO2 - arterial partial pressure of oxygen; RR - respiratory rate.

Table 3
Assessment of the admitted trauma patients in major hospitals: the initial findings on heart rate, and blood pressure (N 480).

		KCMC n(%)	MNH n(%)	MZRH n(%)	Total n(%)
Pulse rate	< 60	3(1)	0(0)	2(2)	5(1)
	60–100	188(64)	55(63)	35(35)	278(58)
	100–120	70(24)	15(17)	12(12)	97(20)
	120–140	11(4)	9(10)	2(2)	22(4)
	> 140	4(1)	5(6)	2(2)	11(2)
	Not recorded	15(5)	4(4)	48(47)	67(14)
	Total	291(100)	88	101(100)	480(100)
SBP range	< 70	1(0.3)	1(1)	0(0)	2(0.4)
	70–79	2(0.7)	2(2)	0(0)	4(0.8)
	80–89	9(3)	2(2)	3(3)	14(2.9)
	90–125	175(60)	44(50)	32(31)	251(52)
	126–140	71(24)	24(27)	15(15)	110(23)
	> 140	21(7)	8(9)	15(15)	44(9)
	Not recorded	12(4)	7(8)	36(36)	55(11)
	Total	291(100)	88(100)	101(100)	480(480)
DBP range	< 40, or un recordable	2(0.6)	2(2)	0(0)	4(1)
	40–50	23(8)	7(8)	2(2)	32(7)
	51–59	42(14)	7(8)	7(7)	56(12)
	60–80	164(56)	43(49)	33(32)	240(50)
	81–90	32(11)	21(24)	17(17)	70(14)
	> 90	16(5)	2(2)	6(6)	24(5)
	Not recorded	12 (4)	6(7)	36(36)	54(11)
	Total	291(100)	88(100)	101(100)	480(100)
MAP range	< 65mmhg	13(4)	7(8)	3(3)	23(5)
	65-75mmhg	43(15)	9(10)	5(5)	57(12)
	76-110mmhg	216(74)	61(69)	50(50)	327(68)
	> 110	7(2)	5(6)	7(7)	19(10)
	Not recorded	12(4)	6(7)	36(35)	54(11)
	Total	291(100)	88(100)	101(100)	480(100)
Assessment of the extremity	Normal findings[a]	42(14)	57(65)	76(75)	175(36)
	Abnormal findings[b]	5(2)	7(8)	1(1)	13(3)
	Not recorded	244(84)	24(27)	24(24)	292(61)
	Total	291(100)	88(100)	101	480(100)

KCMC - Kilimanjaro Christian Medical Centre; MNH - Muhimbili National Hospital; MZRH - Mbeya Zonal Referral Hospital; DBP - diastolic blood pressure; SBP - systolic blood pressure; MAP - mean arterial pressure.

[a] Normal findings - normal-capillary refill and warm

[b] Abnormal findings - cold, sweaty & clammy.

Discussion

In this study, like many in LMICs [1,30–32] we observed that trauma primarily affected the younger population (aged 15–44) and males (Table 1), and like other reports [19] trauma comprised 10–13% of EC admissions. Deaths occurring before hospital admission were two-fold that of hospital trauma deaths, i.e. in one hospital, trauma deaths were 8% while the corresponding rate from the death-registry during the same period was 16%, suggesting many deaths prior to hospital arrival. Furthermore, trauma contributed to most causes of deaths after surgical intervention (64%). It is likely this rate is underestimated by the undetermined deaths and inadequate recording. These findings are comparable to a pattern of trauma deaths that has been previously reported [1,30–32] and suggests that 'in-hospital' data underestimates the scourge of trauma [31,32]. Trauma care requires a significant amount of material resources, time and highly skilled providers [1,2,4–6,8] hence appropriate planning based on needs is desired. Previous work [9,34,35] supports the review of death registries in LMICs for trauma surveillance as this may offer more robust data for realistic planning and performance assessment.

Most patients arrive at the EC by hospital transport while relatively few arrive by police vehicles or private transport. Further, it was noted that most referred patients arrived from the surrounding lower-level hospitals and did not possess health-insurance. Road traffic collisions were the most common cause of injuries, the other causes being assaults and falls. The presence of hierarchical hospital networks, hospital transport systems and the involvement of police in transferring patients offers an opportunity to forge a practical pre-hospital trauma system, since the vehicles exist, and the facilities exist, but need additional staff training and equipment. In similar contexts, researchers have constructed pre-hospital trauma systems using lay-persons and pre-existing primary hospital networks [7].

Most trauma patients had normal assessment variables during primary survey. Recordings were deficient on the usage of primary survey adjuncts such as cervical-spine or chest x rays. The usage of skull x-ray was as high as 20% and was comparable to the proportion of computer tomography (CT) scan for head and neck (28%). The primary survey variables: airway, breathing, circulation and disability statuses are fundamental to trauma protocols [1,4–6]. Likewise, primary-survey adjuncts such as 'FAST scan' ultrasound, chest and pelvic x-rays, gastric and urine catheters are key in guiding initial management and may offer a significant benefit in LMICs context [1,7]. The usage of CT scan, which is a mandatory investigation for assessment of traumatic brain injury [36] was noted to be low. In comparable studies originating from high-income countries the use of CT scan amounts to 87% of all trauma cases [37]. A previous study in Tanzania showed high user fee-cost and the low knowledge of traumatic-brain-injury protocols among the providers limited a wider utilization of CT scan, which may contribute to the low usage rates [38].

Hospital charts and theatre registers showed most patients were treated non-operatively (42%–57%) or by wound care and fracture related therapies (42%). The higher risk surgical operations such as laparotomies and craniotomies were only performed in 24% and 10% respectively, some types of operations involving major chest injuries or vascular injuries were completely absent. The expectation would be for the major and more complex trauma operations to be undertaken in referral hospitals [13]. The minor and moderate surgeries observed could indicate over-triage in the referring lower level hospitals, or

simply non-survival of major injuries and failure to arrive to appropriate hospitals.

Admission of only minor and moderate injuries to the highest-level hospitals may additionally exhaust scarce resources that could otherwise be allocated for more severely injured patients and may deskill professionals, through lack of skill-performance. Although studying reasons for the absence of major injuries in the referral hospitals is beyond the scope of the current study, these findings are similar to a previous report from Tanzania [30] and is an important observation for stimulating further research. Countries with well-developed trauma systems [4,5,8] maintain stringent regulations in designating trauma hospitals for ensuring centralization of crucial resources. High flow of major trauma cases to these hospitals would in turn necessitate a high-level of trauma-surgery skills. Where a functional trauma system exists, practitioners are subjected to the necessary continuing educational programs to maintain proficiency [5,6,13].

Trauma care systems are designed to support lower level hospitals in providing adequate services according to their capacity [4,5]. Where resources are limited such as in our context, the trauma care-packages recommended [1,2,7] ensures cost-effective use of resources and will likely lead to improved patient outcomes. Ideally governments should incorporate essential trauma-care packages [2] into existing health-funding systems [39], and to develop trauma care evaluation programs similar to those used for other essential services [39,40]. Additionally, local health-financing systems (such as the NHIF) and other public healthcare funders [41,42] need to design financing models for pre-hospital trauma care services, as this appears to be a major deficit in the continuum of healthcare-funding in Tanzania. Regulation at various levels will be necessary to ensure standardization of pre-hospital training and equipment standardization [43–45].

Regarding limitations: since this is a hospital-based study, it cannot estimate the overall burden of trauma across the entire community; the findings therefore are limited to the hospital-population. Additionally, we did not achieve 100% capture of trauma incident data, due to raw data inefficiencies, which may further underestimate the real trauma burden. Although we selected 480 admissions to study the care-process, the large amount of unrecorded data because of 'deficient clinical recording' may have reduced the data quality. Despite the described limitations, our results represent care process of the traumatic injured patients in Tanzania as it has included most of the major hospitals country-wide (3 out of 4 hospitals) and sampled major injured patients admitted across high and low peak injury periods. Further these results may be generalized to describe other situations in LMICs.

Conclusion

The study found a functional referral network from lower levels to major hospitals, and functional death registry systems across the country, however there were deficiencies in medical record documentation, utilization of trauma protocols during primary survey, and potential over-triaging in the referring hospitals.

Given the deficiencies noted in improving trauma care services, the researchers recommend:

1. Improving the care-process in referral hospitals by adopting similar tools from the existing standardized treatment protocols and record-templates, procedural guidelines and outreach plans to lower-level hospitals within their catchment area.
2. Mechanisms should be developed for funding of trauma-care services, including pre-hospital services (e.g. coverage provided by the NHIF and its subsidiaries [community health fund]). Other funding options, such as the motor vehicle road accident fund and motor-vehicle insurance services should also be explored.
3. For improved clinical care it is important to incorporate components of the 'trauma care-process' and other necessary skills into the health-science curricula, with central regulation of post-graduate short-courses to enhance the provision of care.
4. Multidisciplinary teams of surgeons and other professional bodies (Tanzania Surgical Association and Emergency Medical Association of Tanzania among others) must regulate, oversee and adopt advanced levels of trauma education [6,45,46] or equivalent courses for implementation locally, especially for care beyond the EC and in smaller facilities. To be able to accurately document the disease burden, it would be prudent to adopt practical trauma-registry formats (such as the recently proposed WHO minimum trauma dataset [47]) into medical record systems countrywide, to ensure adequate recording of data.

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Dissemination of results

Results were shared with staff members at the data collection site through an informal presentations, and through emails to the National institute of medical research (NIMR), Registration, Insolvency and Trusteeship Agency (RITA) and hospital directors at KCMC, Tumbi, Mbeya-referral, Muhimbili hospitals in Tanzania. Further we have shared our findings with trauma surgeons through conference presentation during the 2019 Cape Town International Trauma Conference in Cape Town, South Africa.

Authors' contribution

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: MM contributed 60%; TCH 20%; HS 8%; and FS, JM, SU, AM, LNM and PB contributed 2% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

Prof Tim Hardcastle and Dr Hendry Sawe are editors of the African Journal of Emergency Medicine. Prof Hardcastle and Dr Sawe were not involved in the editorial workflow for this manuscript. The African Journal of Emergency Medicine applies a double blinded process for all manuscript peer reviews. This study was supported through a CHS PhD scholarship from the University of KwaZulu-Natal. The authors declare no further conflicts of interest.

Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.afjem.2020.01.010.

References

1. Mock C, Lormand J. D, Goosen J, et al. Guidelines for essential trauma care. World Health Organization: Geneva; 2004. http://whqlibdoc.who.int/publications/2004/9241546409.pdf accessed on 5th October 2019.
[2] Luboga S, Macfarlane SB, Von Schreeb J, et al. Increasing access to surgical services in sub-Saharan Africa: priorities for national and international agencies recommended by the Bellagio Essential Surgery Group. PLoS Med 2009;6(12):e1000200.
3. Developing global targets for road safety risk factors and service delivery mechanisms World Health Organization: Geneva; 2017. https://www.who.int/violence_injury_prevention/road_traffic/road-safety-targets/en/ accessed on 5th October 2019.
4. The Intercollegiate Group on Trauma Standards-Interim Guidance for Commissioners. Regional trauma systems: The Royal College of Surgeons of England; 2009. https://www.rcseng.ac.uk/-/media/files/rcs/library-and-publications/non-journal-publications/regional_trauma_systems.pdfaccessed on 5thOctober 2019.
5. Committee on Trauma. Resources for optimal care of the injured patient. 6th ed. American College of Surgeons: Chicago Il; 2016. https://www.facs.org/~/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care.ashx accessed on 5thOctober 2019.
6. Committee on Trauma. Advanced trauma life support for doctors: student course manual. 9th ed. American College of Surgeons: Chicago Il; 2012. https://www.44c.in.ua/files/book11.pdf accessed 5thOctober 2019.
[7] Sasser S, Varghese M, Kellermann A, Lormand JD. Pre-hospital trauma care systems. World Health Organization: Geneva; 2005. http://apps.who.int/iris/bitstream/10665/43167/1/924159294X.pdf accessed on 2nd. October 2019.
[8] Hardcastle TC, Steyn E, Boffard K, et al. Guideline for the assessment of trauma centers for South Africa. S Afr Med J 2011;101:189–94.
[9] Mock C, Quansah R, Kobusingye O, et al. Trauma care in Africa: the way forward. Afr J Trauma 2014;3(1):3–10.
[10] London JA, Mock CN, Quansah RE, et al. Priorities for improving hospital-based trauma care in an African city. J Trauma Acute Care Surg 2001;51(4):747–53.
[11] Arreola-Risa C, Mock CN, Padilla D, et al. Trauma care systems in urban Latin America: the priorities should be prehospital and emergency room management. J Trauma Acute Care Surg 1995;39(3):457–62.
[12] Mohammad A, Branicki F, Abu-Zidan FM. Educational and clinical impact of advanced trauma life support (ATLS) courses: a systematic review. World J Surg 2014;38(2):322–9.
13. Boffard KD(Ed).Manual of Definitive Surgical Trauma Care 3Ed. London: CRC Press; 2011.
[14] Bernhard M, Becker TK, Nowe T, et al. Introduction of a treatment algorithm can improve the early management of emergency patients in the resuscitation room. Resuscitation 2007;73(3):362–73.
[15] Wurmb TE, Frühwald P, Knuepffer J, et al. Application of standard operating procedures accelerates the process of trauma care in patients with multiple injuries. Eur J Emerg Med 2008 Dec 1;15(6):311–7.
[16] Ruchholtz S, Waydhas C, Lewan U, et al. A multidisciplinary quality management system for the early treatment of severely injured patients: implementation and results in two trauma centers. Intensive Care Med 2002 Oct 1;28(10):1395–404.
[17] Celso B, Tepas J. Langland-Orban, et al.. A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. J Trauma Acute Care Surg 2006;60(2):371–8.
18. Wikipedia, Tanzania https://en.wikipedia.org/wiki/Tanzania accessed on 8th Jan 2020.
[19] Casey ER, Thielman NM, Maya E, et al. Analysis of traumatic injuries presenting to a referral hospital emergency department in Moshi, Tanzania. Int J Emerg Med 2012;5(1):28.
20. Global Health Observatory Data Repository. United Republic of Tanzania, Estimated road traffic death rate (per 100 000 population), 2016. World Health Organization: Geneva; 2017. http://apps.who.int/gho/data/node.main.A997 accessed on 5th October 2019.
[21] Reynolds TA, Mfinanga JA, Sawe HR, et al. Emergency care capacity in Africa: a clinical and educational initiative in Tanzania. J Public Health Policy 2012;33(1):S126–37.
[22] Hardcastle TC, Oteng R. Trauma care in Africa: triumphs and challenges. Afr J Emerg Med 2011;2(1):53–4.
[23] Kakande I, Mkandawire N. Thompson MI. A review of surgical capacity and surgical education programmes in the COSECSA region. East Cent Afr J Surg 2011;16(3):6–34.
24. National Health Insurance Fund (NHIF) fact sheet 2018–2019 < http://nhif.or.tz/uploads/publications/en1564738372-First%20Quarter%20Fact%20Sheet%202018-19.pdf > .
[25] Kuzma K, Lim AG, Kepha B, et al. The Tanzanian trauma patients' prehospital experience: a qualitative interview-based study. BMJ Open 2015;5(4):e006921.
26. World Health Organization (2004) How to investigate the use of medicines by consumers; seasonal bias, https://apps.who.int/medicinedocs/en/d/Js6169e/7.5.html accessed on 9th January 2020.
[27] Christiansen CF, Pedersen L, Sørensen HT, et al. Methods to assess seasonal effects in epidemiological studies of infectious diseases—exemplified by application to the occurrence of meningococcal disease. Clin Microbiol Infect 2012;18(10):963–9.
[28] Kwesigabo G, Mwangu MA, Kakoko DC, et al. Tanzania's health system and workforce crisis. J Public Health Policy 2012;33(1):S35–44.
29. The births and deaths registration act, Cap. 29.R.E 2002 < http://www.rita.go.tz/page.php?pg=82&lang=en > accessed 12th October 2019.
[30] Chalya PL, Mabula JB. Dass RM, et al. Injury characteristics and outcome of road traffic crash victims at Bugando Medical Centre in Northwestern Tanzania. J Trauma Manag Outcomes 2012;6(1):1.
31. ShahramBS, Yadollahi M, Reza AH, et al. Injury patterns among various age and gender groups of trauma patients in southern Iran a cross-sectional study. Medicine 2017; 96:41(e7812).
[32] Hsia RY, Ozgediz D, Mutto M, et al. Epidemiology of injuries presenting to the national hospital in Kampala, Uganda: implications for research and policy. Int J Emerg Med 2010;3(3):165–72.
[33] Hussain LM, Redmond AD. Are pre-hospital deaths from accidental injury preventable? BMJ 1994;308(6936):1077–80.
[34] Moodley NB, Aldous C, Clarke DL. An audit of trauma-related mortality in a provincial capital in South Africa. S Afr J Surg 2014;52(4):101–4.
35. Makata A, Manyere R, Massambu C, et al. 162 Implementation of a mortuary-based fatal injury surveillance (FIS) system in rural and Urban Hospitals in Tanzania (2010–2015) 2016; A59–A60 http://apps.who.int/iris/bitstream/10665/75351/1/9789241504072_eng.pdf accessed on 5th October 2019.
[36] Lee B, Newberg A. Neuroimaging in traumatic brain imaging. NeuroRx 2005;2(2):372–83.
[37] Kehoe A, Smith JE, Edwards A, et al. The changing face of major trauma in the UK. Emerg Med J 2015;32:911–5.
[38] Boniface R, Lugazia ER, Ntungi AM, et al. Management and outcome of traumatic brain injury patients at MuhimbiliOrthopaedic Institute Dar es Salaam, Tanzania. Pan Afr Med J 2017;26:140. https://doi.org/10.11604/pamj.2017.26.140.10345.
39. Mapping of the medicines procurement and supply management system in Tanzania. Ministry of Health and Social Welfare. 2008, http://www.who.int/medicines/areas/coordination/tanzania_mapping_supply.pdf accessed on 5th. October 2019.
40. Tanzania mainland Expanded Program of Immunization review (2010). Ministry of Health and Social wefare. 2010 http://ihi.eprints.org/1918/1/EPI_review_final_document%282%29.pdf accessed on 10th February 2018.
41. Dutta A. Prospects for sustainable health financing in Tanzania: baseline report. Health Policy Project Futures Group: Washington DC; 2015. https://www.healthpolicyproject.com/pubs/788_ProspectsforSustainableHealthFinanciFINAL.pdfaccessed on 1st Feb 2018.
42. Saqware BA. Victims of road accidents in Tanzania: challenges on third-party insurance compensation. AJFM 2016;22(1):S1 http://journal.ifm.ac.tz/index.php/AJFM/article/view/219 accessed on 5th October 2019.
43. Comprehensive Community Based Rehabilitation in Tanzania (CCBRT) ambulance training < http://www.ccbrt.or.tz/news/detail/news/ambulance-training/?tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Baction%5D=detail&cHash=fd844ea97f0a1285ea51b9b65d17870f > accessed on 5th October 2019.
44. Emergency Medicine Association of Tanzania (EMAT) short-courses. http://www.emat.or.tz/emat-short-courses.htmlaccessed on 5th October 2019.
45. Trauma Society for Nurses, Advanced trauma course for nurses http://www.traumanurses.org/atcn accessed on 5th October 2019.
[46] Bergman S, Deckelbaum D, Lett R, et al. Assessing the impact of the trauma team training program in Tanzania. J Trauma Acute Care Surg 2008;65(4):879–83.
47. World Health Organization, Emergency and trauma care < http://www.who.int/emergencycare/gaci/activities/en/ > [accessed 5th October 2019].