Original Research

Outcomes of stab wounds presenting to Kamuzu Central Hospital in Malawi

Brittany Robinson[1], Laura N. Purcell[2], Chifundo Kajombo[3], Jared Gallaher[2], Anthony Charles[2,3]

1. School of Medicine, University of California San Francisco, San Francisco, California
2. Department of Surgery, University of North Carolina at Chapel Hill
3. Kamuzu Central Hospital, Lilongwe, Malawi

Correspondance: Anthony Charles; Email; anthchar@med.unc.edu

Abstract

Introduction

Injuries are a leading cause of morbidity and mortality worldwide, necessitating that we understand the local burden of injury to improve injury-related trauma care and patient outcomes. The characteristics, outcomes, and risk factors for mortality following stab wounds in Malawi are poorly delineated.

Methods

This is a retrospective, descriptive analysis of patients presenting to Kamuzu Central Hospital in Lilongwe, Malawi, with stab wounds from February 2008 to May 2018. Univariate and bivariate analyses were performed to compare patient and injury characteristics based on mortality. We performed Poisson multivariate regression to predict the factors that increase the relative risk of mortality.

Results

During the study, 32,297 patients presented with assault. Of those patients, 2,352 (7.3%) presented with stab wounds resulting in a 3.2% (n=74) overall mortality. The majority of wounds were to the head or cervical spine (n=1,043, 44.6%), while injuries to the chest (n=319, 13.7%) were less frequent. We found an increased relative risk of mortality in patients who presented with an injury to the chest (RR 3.95, 95% CI 1.79-8.72, p=0.001) and who were brought in by the police (RR 33.24, 95% CI 11.23–98.35, p<0.001).

Conclusion

In this study, stab wounds accounted for 7.3% of all assault cases, with a 3.2% mortality. Though the commonest site of stab was the head, wounds to the chest conferred the highest relative risk of mortality. A multifaceted approach to reducing mortality is needed. Incorporating training of first responders in basic life support, including the police, may reduce stab-related mortality.

Keyword: stab, stab injury, global surgery, adult

Introduction

Worldwide, approximately 5.8 million people die annually from traumatic injuries, and approximately 16% of all disabilities globally are caused by injury[1]. Low- and middle-income countries (LMICs) bear a disproportionate burden of trauma morbidity and mortality[2]. Although the most common mechanism of traumatic injury-related death is blunt trauma in both low and high-resource settings, usually from road traffic injuries, penetrating trauma due to gunshot or stab injuries is also a major healthcare burden in some countries, particularly the United States, England, and South Africa[1, 3-7]. Stab or puncture wounds refer to a sharp force injury caused by a sharp weapon or pointed instrument's thrust. Penetrating stab wounds, whether homicidal or suicidal, may result in devastating or life-threatening injury. Such wounds can damage internal organs or vessels, especially in the chest and abdomen, leading to infection, shock, and even death[6].

The inequitable burden of trauma and injury, with the preponderance in LMICs, is well documented[8-10]. It is necessary to understand the local burden of injury in any setting to improve trauma care and outcomes. The predominant penetrating injury type varies in any society based on the accessibility and ubiquity of weapon types. In the United States and South Africa, where gun ownership is high, gun-related violence is increased[3,6]. In contrast, within many LMICs, particularly in sub-Saharan Africa, machetes or knives are easily accessible and inexpensive tools that can be used to commit interpersonal violence[11,12]. The differences in common injury mechanisms highlight the importance of understanding the local epidemiology of penetrating trauma.

Current literature specific to the burden of stab injury in sub-Saharan Africa is relatively scarce. Malawi, a resource-limited country in southeast Africa similar to its neighboring countries, is a reasonable proxy for the prevalence of stab wounds in the region. The characteristics, outcomes, and risk factors for mortality following stab wounds in Malawi are poorly delineated. Therefore, we sought to characterize the epidemiology, outcomes, and prehospital risk factors for mortality for patients presenting with stab wounds at a tertiary hospital in Central Malawi.

Methods

Utilizing the Kamuzu Central Hospital (KCH) Trauma Surveillance Registry, a retrospective analysis of prospectively collected data was performed from February 2008 to August 2018. All patients presenting to the KCH casualty department with traumatic injuries are included in the database. Trained data clerks collect outcomes data during the patient's hospitalization. Patients were included in this study if they presented with stab wounds and were excluded if their outcomes data was missing from the database.

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Table 1: Demographics and Characteristics of Patients Presenting with Stab Injury

	Overall (n=2352)	Alive (n=2278, 96.8%)	Died (n=74, 3.2%)	p-value
Age: median (IRQ)	26 (21 – 33)	26 (21 – 33)	28 (23 – 33)	0.3
Male Sex: n (%)	2048 (87.2)	1985 (87.1)	63 (87.5)	0.9
Reported Alcohol: n (%)	411 (17.7)	398 (17.7)	13 (18.3)	0.9
Night Injury: n (%)	806 (34.4)	754 (33.2)	52 (70.3)	<0.001
Injury Setting: n (%)				0.3
Home	890 (38.6)	868 (38.9)	22 (31.0)	
Work	133 (5.8)	129 (5.8)	4 (5.6)	
Road/Street	736 (31.9)	716 (32.1)	20 (28.2)	
Public Space	398 (17.3)	379 (17.0)	19 (26.8)	
Other	147(6.4)	141 (6.3)	6 (8.5)	
Transport to Hospital: n (%)				<0.001
Minibus	1046 (45.2)	1041 (46.4)	5 (7.0)	
Private Vehicle	691 (29.9)	670 (29.9)	21 (29.6)	
Ambulance	281 (12.1)	275 (12.3)	6 (8.5)	
Police	175 (7.6)	137 (6.1)	38 (53.5)	
Other	121 (5.2)	120 (5.4)	1 (1.4)	
Transferred from Outside Hospital: n (%)	406 (17.3)	400 (17.6)	6 (8.2)	0.04
Time from Injury to Arrival (days): median (IQR)	0 (0 – 1)	0 (0 – 1)	0 (0 – 0)	<0.001
Injury Location: n (%)				<0.001
Head/C-spine	1043 (44.6)	1018 (45.0)	25 (33.8)	
Chest	319 (13.7)	228 (12.7)	31 (41.9)	
Abdomen/Pelvis	330 (14.1)	321 (14.2)	9 (12.2)	
Extremity	634 (27.1)	625 (27.6)	9 (12.2)	
Other	11 (0.5)	11 (0.5)	0 (0.0)	
Admission Disposition: n (%)				<0.001
Discharged from Casualty	1711 (72.8)	1711 (75.1)	0 (0.0)	
Admitted: Ward	556 (23.6)	550 (24.1)	6 (8.1)	
Admitted: High Dependecy Unit	12 (0.5)	10 (0.4)	2 (2.7)	
Admitted: Intensive Care Unit	7 (0.3)	7 (0.3)	0 (0.0)	
Died in Casualty	16 (0.7)	0 (0.0)	16 (21.6)	
Brought in Dead	50 (2.1)	0 (0.0)	50 (67.6)	
Underwent Surgery: n (%)	260 (12.9)	255 (13.1)	5 (7.7)	0.2

As the referral hospital for Malawi's central region, KCH serves a catchment area of 7.5 million people. KCH has 900-beds and is located in the country's capital, Lilongwe. The hospital has a 4-bed casualty department staffed by clinical officers, a surgical resident with oversight by consultant general surgeons. There is a 5-bed intensive care unit, 5-bed surgical high dependency unit, and male and female surgical wards. Trauma care is provided by general and orthopedic consultants, surgical registrars, and clinical officers. KCH has five operating rooms shared by general surgery, urology, orthopedics, neurosurgery, and pediatrics.

Data distribution and missing data were evaluated with univariate analysis. There was less than 3% missing data on all included variables. Bivariate analysis based on hospital discharge mortality was performed. Measures of central tendency were described in means with standard deviations and medians with interquartile ranges for normally and non-normally distributed data, respectively. χ^2 tests for categorical variables, Student's T-Test for normally distributed continuous variables, and Kruskal-Wallis for non-normally distributed continuous variables were performed to compare demographic and outcomes distribution in bivariate analysis.

To determine the factors which increase the relative risk of mortality in patients presenting with stab wounds, we performed a multivariable Poisson regression. Age, sex, injury location, time of injury, time from injury to arrival, and reported victim alcohol use were included in the model *a priori*. Mode of transport to the hospital and transfer from an outside hospital were significant on a bivariate analysis ($p<0.05$) and included in the full model.

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Table 2: Predictors of Mortality following Intentional Stab Injury

	Relative Risk	95% Confidence Interval	p-value
Age (years)	1.01	0.99 – 1.04	0.3
Sex	1.20	0.61 – 2.35	0.6
Injury Location			
Head/C-Spine	1.57	0.69 – 3.56	0.3
Chest	3.95	1.79 – 8.72	0.001
Abdomen/Pelvis	1.36	0.52 – 3.52	0.5
Extremities	Ref	-	-
Transport Mode			
Minibus	Ref	-	-
Private Vehicle	4.65	1.50 – 14.47	0.008
Ambulance	7.76	1.01 – 59.68	0.05
Police	33.24	11.23 – 98.35	<0.001
Other	2.21	0.24 – 20.09	0.5
Time from Injury to Arrival	0.73	0.47 – 1.13	0.2
Night Injury	1.43	0.83 – 2.45	0.2
Transferred	0.47	0.08 – 2.72	0.4
Alcohol	0.64	0.34 – 1.21	0.2

This analysis was performed using StataCorp v16.0, College Station, Texas. Confidence intervals are reported at 95%. The Malawi National Health Science Research Committee and the University of North Carolina Institutional Review Board approved this study.

Results

During the study period, 32,297 (21.8%) patients presented with assault. Of those patients, 2,352 (7.3%) presented with stab wounds, Figure 1. Overall, the median age was 26 years (IQR 21 – 33) with a male preponderance (n=2,048, 87.2%). The majority of patients (n=1,546, 65.6%) were injured during the day (6 am – 6 pm). The patients' location at the time of injury was most often within the home (n=890, 38.6%) and while on the road or street (n=736, 31.9%). A large number of patients were injured on the head or neck (n=1,043, 44.6%). Overall, 12.9% (n=260) underwent surgical intervention (Table 1). By anatomic location of the injury, the proportion of patients who underwent surgical intervention was highest among those stabbed in the abdomen or pelvis (n=108, 35.3%), followed by the chest (n=43, 14.8%).

Overall mortality was 3.2% (n=74). There was no statistically significant difference in age, sex, or reported alcohol use between those who survived and died. The majority of patients who died were stabbed at night (n=52, 70.3%). Patients who died were more likely transported to KCH via police (n=38, 53.5%) or private vehicle (n=21, 29.6%), while

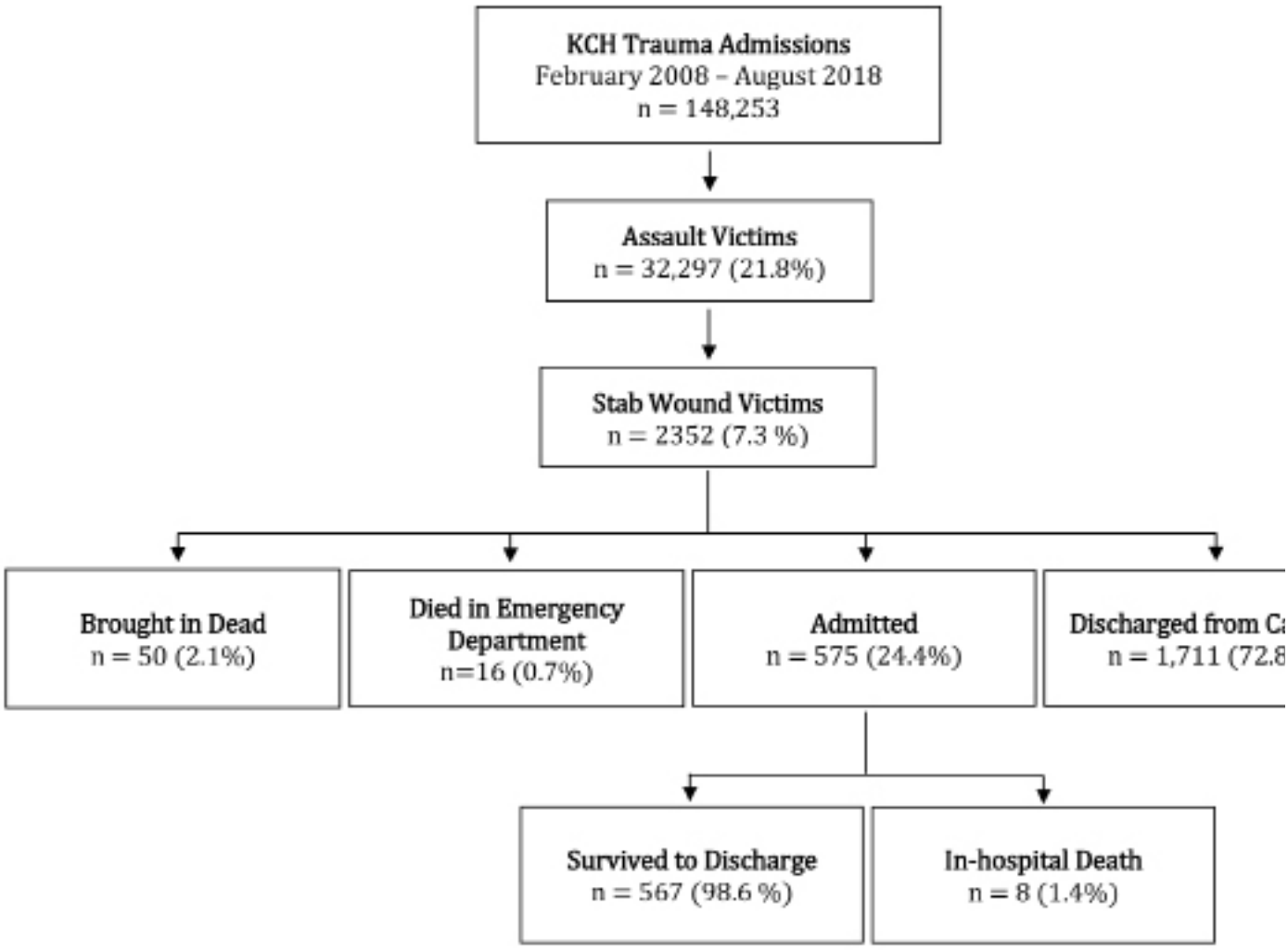

Figure 1: Inclusion Flow Diagram showing Stab Victim Admission Disposition at Kamuzu Central Hospital (KCH)

survivors were more likely transported by minibus (n=1041, 46.4%, p<0.001). Patients who died were also less likely to be transferred to KCH from an outside hospital (n=6, 8.2% vs. n=400, 17.3%, p=0.04). The primary anatomic injury location for those who died was the chest (n=31, 41.9%), while the primary injury location for survivors was the head or neck (n=1,018, 45.0%, p<0.001) (Table 1).

In a multivariate Poisson regression model for risk factors associated with mortality, stab wound to the chest increased the risk of mortality compared to extremity injury (RR 3.95, 95% CI 1.79 – 8.72, p=0.001). In addition, patients transported to the hospital via police (RR 33.24, 95% CI 11.23 – 98.35, p<0.001) or private vehicle (RR 4.65, 95% CI 1.50 – 14.47, p=0.008) had an increased relative risk of mortality when compared to patients transported via minibus (Table 2).

Discussion

The prevalence and mortality of penetrating injury secondary to interpersonal violence are highly variable around the world. In this study, we showed over ten years, stab wounds accounted for 7.3% of all assaults, with a mortality of 3.2% at a tertiary hospital in central Malawi. Though the most common stab wound site was the head, wounds to the chest conferred the highest relative risk of mortality. Patients transported by private vehicle or police had an increased relative risk of mortality compared to a minibus.

The initial management of patients presenting with stab injury is in line with managing all trauma patients at KCH. The patients are evaluated in the casualty, and a primary survey focusing on airway, breathing, and circulation is performed. If the primary survey is reassuring, the evaluation moves on to secondary assessment where a detailed injury, past medical and surgical history is obtained. A head-to-toe physical examination is performed, and the stab injury is thoroughly assessed and a treatment plan initiated. Specifically, injuries to the neck, chest, and abdomen require thorough evaluation to include diagnostic adjuncts such as chest radiography or local wound exploration. Patients with pneumothorax are managed appropriately with a tube thoracostomy. Patients in which the anterior rectus fascia has been violated or with evisceration or frank peritonitis undergo an exploratory laparotomy. Patients with zones I or II neck injuries that have violated the platysma muscles are taken to the operating room for a formal neck exploration. Patients with injures to the extremities with active bleeding have a tourniquet placed to control bleeding and subsequently undergo wound exploration and blood vessel ligation as appropriate. All minor lacerations are sutured. Patients are routinely given tetanus toxoid and antibiotics and re-evaluated in the outpatient clinics. Successful management of stab wounds in our setting is very dependent on the availability of diagnostic adjuncts such as plain radiography, computerized tomography, and ultrasonography and timely access to the operating room.

In our cohort of patients who were stabbed, similar to trauma patients in other settings, there was a high male preponderance[6,13-16]. While there is a lack of studies specific to intentional stab wounds in sub-Saharan Africa, the existing literature allows us to draw a few comparisons. Mortality for patients in our study following abdominal or pelvic stab injury was 2.7%, congruent with a South African study of 496 patients who presented with abdominal stab injury resulting in 2% mortality[7]. In our setting, stab injury to the chest resulted in a mortality of 9.7%, similar to a Nigerian study that evaluated mortality from penetrating chest trauma with a mortality of 7.7%[15]. In contrast, HIC data have shown mortality ranging from 0.4 – 4% following stab injuries[5,17-19].

The high mortality from stab injury seen in our cohort is likely attributable to prehospital and in-hospital factors. Delays in seeking and reaching care are well-documented prehospital causes of increased morbidity and mortality[20-22]. Delays to seeking care often stem from financial and geographic restrictions, cultural beliefs, poor education, disconnection from formal health systems, and minimal awareness of or confidence in available services[21]. Though Malawi has made many strides in cultivating human capital, poverty, and inequality likely impact patients' ability to seek care[23]. Even though the provision of trauma services at KCH is free for patients, patients may still face additional prehospital and in-hospital barriers to care.

Deficits in prehospital transportation and a lack of emergency response infrastructure likely contribute to the high mortality seen in our study, as it negatively impacts patients' ability to reach care[20,21]. In Malawi, many patients must find their transportation to the hospital as there is no centralized or protocolized emergency response service. Of the patients with stab wounds who died, transportation by police or private vehicles was the most common transportation mode. In Malawi, ambulances are reserved for inter-hospital transfer, given the shortage of available ambulances[24]. Potential low-cost, high-return interventions to reduce trauma mortality include basic life support training for first responders, especially the police, provision of supplies for basic field intervention, and – given the high rate of mortality for chest injuries – training in performing needle thoracostomies[22,25,26].

Once patients reach the hospital, additional in-hospital barriers may delay or limit care leading to increased mortality. A multi-country survey of over 2,000 hospitals and health centers in sub-Saharan Africa found a lack of infrastructure necessary to follow minimum standards and practices to provide emergency and surgical care set forth by the World Health Organization[27]. In our setting, a lack of robust blood banking, inadequate chest tubes, and limited imaging modalities likely contribute to the high stab injury mortality rate.

The problem of limited blood supply is experienced worldwide, and only 27% of hospitals in LMICs report on-site blood banks[20]. Though Malawi successfully launched its national blood transfusion service in 2003, there are often shortages of blood products[28]. Shortages are possibly due to the high prevalence of anemia and transfusion transmissible illness, limiting the number of eligible donors[20,29]. Continued efforts to encourage blood donation from voluntary, non-remunerated donors to offset reliance on family replacement blood donors in Malawi are critical to addressing the shortage.

The management of patients in our study was mostly nonoperative, and there was no significant difference in operative management between those who died and survived. Stab injury management is dependent on the anatomical location of the injury. Operative intervention was more common in patients with stab injuries to the abdomen and pelvis. The current management of abdominal stab wounds is based on selective nonoperative management and serial abdominal examination[17,30,31]. In the absence of diagnostic laparoscopy and ultrasound or computed tomography,

peritonitis or evisceration prompts the need for exploratory laparotomy[7].

Current practice dictates the necessity of chest radiographs in the evaluation for patients with stab wounds to the chest. Most injuries can be treated with simple interventions, such as thoracostomy, and managed non-operatively[15,25]. There was a high relative risk of mortality for stab wounds in our setting, which is in part due to chest tube and diagnostic imaging-resource constraints. When thoracostomy kits are limited, clinicians are forced to improvise interventions and delay care. Additionally, pronounced delays obtaining adjunctive diagnostic plain radiography and ultrasound, rather than utilizing clinical exam, to rule out life-threatening conditions such as massive pneumothorax or hemothorax potentially increase mortality[25,30,31]. To reduce mortality following chest stab wounds, it is critical that basic resources to appropriately diagnose and treat patients, such as thoracostomy supplies and x-ray, are readily available in the casualty department.

Stab wound prevention, like all types of injury prevention, has both individual and societal components. Victims can follow simple tips like walking with a group of people in well-lit areas and avoiding alleys, vacant lots, wooded areas, and secluded areas to reduce their risk of assault. Being aware of one's surroundings is critical and can best be achieved if one is not inebriated. In Malawi, we have previously shown the relationship between interpersonal violence injuries and employment status[32]. Specifically, interpersonal violence is more common in the unemployed. Reducing societal violence should be a government priority, and alleviation of poverty is an injury prevention strategy[33].

This study has several limitations, primarily due to its retrospective nature. The KCH Trauma surveillance registry has undergone several revisions, adding vital signs after 2012. Also, there is no pre-hospital system in Malawi, and therefore have no vitals data on any patients brought in dead. As a result of this, our analysis could not account for injury severity, except for AVPU. Adaptations to the database since its inception have subsequently allowed for reliable vital signs and GCS obtainment. Secondly, complete details on the type of weapon and the relationship between the perpetrator and victim are unknown. Lastly, we do not have any information regarding prehospital care. The presence of prehospital vital signs and treatment may have altered outcomes.

We show an increased relative risk of mortality for patients who present with a stab injury to the chest at a tertiary hospital in central Malawi. Additionally, transportation by private vehicle or police conferred an increased relative risk of mortality. A multifaceted approach to reducing stab injury mortality is needed. Health system strengthening and continued development of a prehospital system that incorporates the existing ambulance system and basic life support trained first responders may reduce stab-related mortality.

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References

1. World Health Organization, 2010. Injuries and violence: the facts.

2. Hofman K, Primack A, Keusch G, Hrynkow S. Addressing the growing burden of trauma and injury in low- and middle-income countries. Am J Public Health. 2005;95(1):13-17.

3. Dijkink S, krijnen P, Hage A, Van der Wilden GM, KasotakisG, denHartog D et al. Differences in characteristics and outcome of patients with penetrating injuries in the USA and the Netherlands: a multi-institutional comparison. World J Surg. 2018;42(11):3608-3615.

4. Sakran JV, Mehta A, Fransman R, Nathens AB, Joseph B, Kent A et al. Nationwide trends in mortality following penetrating trauma: Are we up for the challenge. J Trauma Acute Care Surg. 2018;85(1):160-166.

5. Maxwell R, Trotter C, Verne J, Brown P, Gunnell D. Trends in admissions to hospital involving an assault using a knife or other sharp instrument, England, 1997–2005. Journal of public health. 2007 Jun 1;29(2):186-90.

6. Mnguni MN, Muckart DJ, Madiba TE. Abdominal trauma in Durban, South Africa: factors influencing outcome. International surgery. 2012 Oct;97(2):161-8.

7. Exadaktylos A, Stettbacher A, Edul S, Nichols A, Bautz P. Successful management of abdominal stab wounds with clinical evaluation: experiences of an South-African trauma unit with 496 consecutive patients. Der Unfallchirurg. 2003 Mar;106(3):215-9.

8. Stewart B, Khanduri P, McCord C, Ohene-Yeboah M, Uranues S, Vega Rivera F, et al. Global disease burden of conditions requiring emergency surgery. British Journal of Surgery. 2014 Jan;101(1):e9-22.

9. Alleyne G, Breman J, Claeson M, Evans D, Jamison D, Jha P, et al. Disease control priorities in developing countries.

10. Krug, E. G., L. L. Dahlberg, J. A. Mercy, A. B. Zwi, and R. Lozano. 2002a. World Report on Violence and Health. Geneva: World Health Organization.

11. Miller TR, Cohen MA. Costs of gunshot and cut/stab wounds in the United States, with some Canadian comparisons. Accident Analysis & Prevention. 1997 May 1;29(3):329-41.

12. Donnally CJ, Hannay W, Rapp DA, Lekic N, Dodds SD. Machete injuries to the upper extremity. Archives of orthopaedic and trauma surgery. 2017 Dec 1;137(12):1615-21.

13. Leow JJ, Lingam P, Lim VW, Go KT, Chiu MT, Teo LT. A review of stab wound injuries at a tertiary trauma centre in Singapore: are self-inflicted ones less severe?. Singapore medical journal. 2016 Jan;57(1):13.

14. Johannesdottir U, Jonsdottir GM, Johannesdottir BK, Heimisdottir AA, Eythorsson E, Gudbjartsson T, et al. Penetrating stab injuries in Iceland: a whole-nation study on incidence and outcome in patients hospitalized for penetrating stab injuries. Scandinavian journal of trauma, resuscitation and emergency medicine. 2019 Dec;27(1):7.

15. Thomas MO, Ogunleye EO. Penetrating chest trauma in Nigeria. Asian Cardiovascular and Thoracic Annals. 2005 Jun;13(2):103-6.

16. Meer M, Siddiqi A, Morkel JA, van Rensburg PJ, Zafar S. Knife inflicted penetrating injuries of the maxillofacial region: a descriptive, record-based study. Injury. 2010 Jan 1;41(1):77-81.

17. Zafar SN, Rushing A, Haut ER, Kisat MT, Villegas CV, Chi A,et al. Outcome of selective nonoperative management of penetrating abdominal injuries from the North American National Trauma Database. British journal of surgery. 2012 Jan;99(S1):155-64.

18. Civil ID, King M, Paice R. Penetrating trauma in Auckland: 12 years on. Australian and New Zealand journal of surgery. 1998 Apr;68(4):261-3.

19. Schreyer N, Carron PN, Demartines N. Stab wounds in a Swiss emergency department: a series of 80 consecutive cases. Swiss medical weekly. 2010 Aug 24;140(3334).

20. Meara JG, Leather AJ, Hagander L, Alkire BC, Alonso N, Ameh EA, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. The Lancet. 2015 Aug

8;386(9993):569-624.

21. Grimes CE, Bowman KG, Dodgion CM, Lavy CB. Systematic review of barriers to surgical care in low-income and middle-income countries. World journal of surgery. 2011 May 1;35(5):941-50.

22. Nielsen K, Mock C, Joshipura M, Rubiano AM, Zakariah A, Rivara F. Assessment of the status of prehospital care in 13 low-and middle-income countries. Prehospital Emergency Care. 2012 Jun 6;16(3):381-9.

23. Overview. World Bank. www.worldbank.org/en/country/malawi/overview. 2019 Oct 10.

24. Samuel JC, Akinkuotu A, Villaveces A, Charles AG, Lee CN, Hoffman IF, et al. Epidemiology of injuries at a tertiary care center in Malawi. World journal of surgery. 2009 Sep 1;33(9):1836-41.

25. Demetriades D, Velmahos GC. Penetrating injuries of the chest: indications for operation. Scandinavian Journal of surgery. 2002 Mar;91(1):41-5.

26. Jayaraman S, Mabweijano JR, Lipnick MS, Caldwell N, Miyamoto J, Wangoda R, et al. First things first: effectiveness and scalability of a basic prehospital trauma care program for lay first-responders in Kampala, Uganda. PLoS One. 2009;4(9).

27. Hsia RY, Mbembati NA, Macfarlane S, Kruk ME. Access to emergency and surgical care in sub-Saharan Africa: the infrastructure gap. Health policy and planning. 2012 May 1;27(3):234-44.

28. World Health Organization. The Malawi success story. WHO feature; no. 207. 2005.

29. M'baya B. Seroprevalence and trends in transfusion transmissible infections among voluntary non-remunerated blood donors at the Malawi Blood Transfusion Service-a time trend study. Malawi Medical Journal. 2019;31(2):118-25.

30. Leppäniemi AK, Haapiainen RK. Selective nonoperative management of abdominal stab wounds: prospective, randomized study. World journal of surgery. 1996 Oct 1;20(8):1101-6.

31. van Haarst EP, van Bezooijen BP, Coene PP, Luitse JS. The efficacy of serial physical examination in penetrating abdominal trauma. Injury. 1999 Nov 1;30(9):599-604.

32. Purcell LN, Kayange L, Gallaher J, Varela C, Charles A. The Inter-Relationship Between Employment Status and Interpersonal Violence in Malawi: A Trauma Center Experience. World J Surg. 2020 Sep;44(9):2927-2934.

33. Morrow V, Barnett I, Vujcich D. Understanding the causes and consequences of injuries to adolescents growing up in poverty in Ethiopia, Andhra Pradesh (India), Vietnam and Peru: a mixed method study. Health Policy Plan. 2014 Jan;29(1):67-75.