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Effect of Direct and Indirect Transfer Status on Trauma Mortality In sub Saharan Africa

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Abstract

Introduction—Traumatic injuries account for the greatest portion of global surgical burden particularly in low-and middle-income countries (LMICs). To assess effectiveness of a developing trauma system, we hypothesize that there are survival differences between direct and indirect transfer of trauma patients to a tertiary hospital in sub Saharan Africa.

Methods—Retrospective analysis of 51,361 trauma patients within the Kamuzu Central Hospital (KCH) trauma registry from 2008 to 2012 was performed. Analysis of patient characteristics and logistic regression modeling for in-hospital mortality was performed. The primary study outcome is in hospital mortality in the direct and indirect transfer groups.

RESULTS—There were 50,059 trauma patients were included in this study. 6,578 patients transferred from referring facilities and 43,481 patients transported from the scene. The indirect and direct transfer cohorts were similar in age and sex. The mechanism of injury for transferred patients was 78.1% blunt, 14.5% penetrating, and 7.4% other, whereas for the scene group it was 70.7% blunt, 24.0% penetrating, and 5.2% other. Median times to presentation were 13(4–30) and 3(1–14) hours for transferred and scene patients, respectively. Mortality rate was 4.2% and 1.6% for indirect and direct transfer cohorts, respectively. A total of 8816 patients were admitted of which 3636 and 5963 were in the transfer and scene cohort, respectively. After logistic regression analysis, the adjusted in-hospital mortality odds ratio was 2.09 (1.24–3.54);p=0.006 for indirect transfer versus direct transfer cohort, after controlling for significant covariates.

Conclusions—Direct transfer of trauma patients from the scene to the tertiary care center is associated with a survival benefit. Our findings suggest that trauma education and efforts directed at regionalization of trauma care, strengthening pre-hospital care and timely transfer from district hospitals could mitigate trauma-related mortality in a resource-poor setting.

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Keywords

Trauma; Injuries; trauma systems; developing countries; transfer status; Malawi

Introduction

According to the 2013 Global Burden of Disease (GBD) Study, traumatic injuries account for the greatest portion of global surgical burden.[1] In the year 2010, injuries were responsible for a total of 5.1 million deaths, far exceeding the combined number of deaths from HIV-AIDS, malaria and tuberculosis (3.8 million).[2] Developing countries are disproportionately affected by injury.[3] Some sub-Saharan African countries have the highest ratios of trauma-related disability adjusted life years (DALYs) per 1,000 people.[2] Furthermore, traumatic injuries affect the most economically productive cohort of the population (age 15–44). [4] Therefore, the strengthening of surgical care, particularly trauma care in developing countries is crucial to the global public health agenda.[5]

Outcomes following injury are mainly predetermined by injury severity. In developing countries, the absence of a trauma system and indeed designated trauma centers is a major obstacle to provision of timely definitive care. Patients are more likely to seek care a hospital nearest to the scene of trauma that is most likely not a tertiary hospital in the absence of a pre-hospital care system.[6,7] This results in transfer from a primary receiving hospital due to either lack of resources and expertise necessary to treat trauma patients to a definitive care facility. In addition the absent pre-hospital care that exist in developing countries, poor inter hospital transfer facilities can be responsible for secondary injuries, and lead to preventable deaths in the hospital. For patients with acute traumatic injuries developing countries, timely transfer to definitive care is likely to be a critical predictor of outcomes.[8]

Two recent systematic reviews examined patient outcome differences between the “direct” (patients transported directly to a trauma center) and the “indirect” (patients transferred from another lower tiered hospital to a trauma center) groups reported reviewed equivalent outcomes, but acknowledged limitations of the review given heterogeneity in study design, health care settings, and numerous potential biases.[9,10] However, these studies, mostly from developed countries are not generalizable, particularly in a resource poor settings such as in Malawi. There is a paucity of data on time to definitive care and outcomes following traumatic injury in sub Saharan Africa.

In order to examine the association between time to definitive care and mortality risk, direct transfer or indirect transfer is utilized as surrogates for transfer time in the setting of a developing trauma system. We therefore conducted this study using a hospital-based trauma registry to investigate potential in hospital mortality differences between trauma patients transferred from a regional referral facility and those taken directly from the scene to the tertiary trauma center.

Methods

This is a retrospective analysis of prospectively collected trauma surveillance data at Kamuzu Central Hospital (KCH) in Lilongwe, Malawi from 2008 to 2012. KCH serves as the tertiary referral center for the estimated 6 million people residing in the central region of Malawi.

Setting

In Malawi the health delivery system is structured in a tiered fashion, with primary medical care provided through clinics and health centers scattered across the country. Secondary level care is provided by district general hospitals located in each district capital, and the highest level of care provided at tertiary care centers located at major urban centers, such as Lilongwe and Blantyre. Primary care centers offer basic outpatient care, maternity and antenatal care. District general hospitals located in each of Malawi's 28 districts, provide more extensive care including basic surgical procedures with some diagnostic adjuncts such as plain radiography and laboratory testing. However, the district hospitals are usually staffed with clinical officers (COs) or physician extenders and few trained general practice physicians with some exposure to the management of surgical diseases. Trauma care is not in the scope of practice for the clinical officers in the district hospitals. For complex and critical patients, district hospitals transfer patients to the 4 tertiary facilities in the country, including KCH, that offer more specialized care.[11]

KCH hospital has 600 beds, a 24-hour casualty department, an intensive care unit, four operating theaters, a dialysis unit, and several medical and surgical specialists, including a team of clinical officer anesthetists. The hospital has one computed tomography machine, a basic pathology department, and access to a blood bank.

Data Collection and Variables

Trained data entry clerks present 24 hours a day in the casualty department collect data for the KCH trauma registry. They obtain pre-hospital phase data (demographics, location and mechanisms of injury, alcohol use, etc.) from the patient or guardians, and clinical data (vital signs, injury characteristics and disposition) from the clinicians. Alcohol involvement is defined as a positive history of alcohol use in the immediate period prior to the traumatic event based on history, or a determination of alcohol use based on clinical signs of intoxication and or the smell of alcohol on the patient's breath at the time of data collection. Information is recorded in a standardized data collection form and later entered into an electronic database. The exposure variable of interest was transfer status, stratified into an indirect transfer cohort (transferred from another health facility) and a direct transfer cohort (transported directly to KCH from the scene of trauma). Our main outcome variable of interest was in-hospital mortality. Other registry variables used in this study included basic demographic data, mode of transport, mechanism of injury, severity of injury, and disposition. Severity of injury of was determined by the initial disability/neurological assessment, also known as the AVPU (alert, verbal stimuli response, painful stimuli response, or unresponsive) scale. A score of 1- indicates an Alert and Awake state, 2 - indicates response to Verbal stimuli, 3- indicates response to Painful stimuli and 4 -indicates complete Unresponsiveness.[12] As a global measure of injury severity, we also utilized the Revised Trauma Score (RTS). The RTS is a physiological scoring system based on the first set of data obtained on the patient, and consists of Glasgow Coma Scale, Systolic Blood Pressure and Respiratory Rate, A lower score indicates a higher severity of injury and higher probability of mortality.[13] Initial cardiovascular stability was determined by shock index, defined as the ratio of heart rate to systolic blood pressure, and categorized into level of shock based on previous literature. Those brought in dead were assigned a shock index of 99 and excluded from further analysis.[14] Mode of transport to the hospital was categorized into non-motorized (on foot, bicycle), motorized (motorcycle, bus, private, and public vehicle) and emergency vehicle (ambulance, police). Mechanism of injury was categorized into blunt trauma (including motor vehicle accident, fall, crush, hit), penetrating trauma (including stabbing, laceration, gunshot wound), and other (including burn, electrical injury, and hanging). Hours to presentation represents time interval between injury and admission to the emergency department at KCH. Length of stay is time interval from admission to discharge or death.

Data Analysis

We performed bivariate analysis to assess differences between the indirect and direct transfer cohorts. We also examined differences in mechanism and median time to presentation between the two cohorts. We performed additional bivariate analysis to assess differences based on demographic and injury characteristics. We used Pearson's chi-square test to assess differences in proportions and Student t-tests to assess differences in means. Furthermore, we used the Kruskal – Wallis equality-of-populations rank test to assess differences in medians. We performed logistic regression modeling in admitted patients only to assess in-hospital mortality differences between the two cohorts. We selected variables that were clinically and substantively relevant to be included in the adjusted logistic regression model to account for confounding bias. We report the adjusted odds ratio for mortality, after controlling for age, sex, Injury mechanism, Shock Index, mode of transportation, and RTS. Time to presentation was excluded from our regression model, as there is co-linearity with transfer status.

Data were analyzed using STATA (Release 12: StataCorp LP, College Station, TX, USA). Statistical significance was determined using two-sided tests with alpha=0.05. The University of North Carolina Institutional Review Board and the Malawi National Health Sciences Review Committee approved the study.

Results

There were 51,361 trauma patients were enrolled in our trauma registry. Transfer status data was available on 50,059 patients. 43,481(86.9%) were admitted to KCH directly from the scene and 6,578 (13.1%) were transferred from other facilities. Table 1 summarizes demographic, injury-specific, and outcome data of the patients based on their transfer status. The mean age of patients in the transfer group was statistically higher compared to the scene group. Sex distribution was similar in both groups. There was more alcohol involvement in the scene group compared to the transfer group (7% vs. 4%; P<0.001). More patients in the transfer group arrived by emergency vehicle compared to patients in the scene group (73% vs. 8%; P<0.001). Patients from the direct transfer group suffered significantly more penetrating injuries (24% vs. 15%; P<0.001) and fewer blunt injuries (71% vs. 78%; P<0.001) compared to the indirect transfer group. The median time to presentation to the tertiary care center was longer in the indirect transfer patients compared to the direct transfer group (13 (4–30) hours vs. 3 (1–14) hours; P<0.0001) and they had statistically significant longer hospital LOS (6.8 days vs. 0.8 days; P<0.0001). (Table 1.)

Mortality rate was higher among the indirect transfer cohort as compared to the direct transfer group (4.2% vs. 1.6%; p<0.001). Mortality rates were higher in men compared to women (2.3% vs. 1.3%; p<0.001). Patients transported by emergency vehicles had significantly higher mortalities rates (8.2%) compared to those transported by motorized and non-motorized vehicles (1.0% vs. 0.2%, respectively; p <0.001). Increased mortality was significantly associated with lower initial AVPU scores (2.5 vs. 3.4; P<0.001) and higher shock index scores (90.8% mortality in severe shock vs. 1.1% in no shock).

Using logistic regression analysis based on transfer status in the admitted cohort (table 2), the crude odds s for mortality in the indirect transfer group compared to the direct transfer group is 1.36 (95% CI 1.08–1.71);p=0.007. After adjusting for clinically and or statistically significant covariates based on our bivariate analysis (age, sex, alcohol involvement, mode of transport, mechanism of injury, shock index and RTS) the adjusted odds ratio for mortality associated with being in the indirect transfer cohort compared to the direct transfer cohort was 2.09 (1.24–3.54); p=0.006.

Discussion

In this study, we show that in a sub Saharan African setting direct transport of trauma patients from scene directly to a tertiary care hospital confers a survival advantage in admitted patients after controlling for confounding variables such as shock index and mechanism of injury and time from injury to definitive care and injury severity. Transfer status is a surrogate for time to presentation for definitive care, which was significantly greater in the indirect transfer cohort as compared to those presenting directly from the scene. This disparity in survival is indicative of the absence of a trauma system in Malawi, as is the case in most sub Saharan African countries. The fundamental tenet of a trauma system is to get the right patient to the right hospital at the right time. This hinges on the implementation of an organized trauma system with a well-defined pre-hospital destination criteria, inter-facility transfer protocols, and education of caregivers.[15]

The reasons for the survival advantage noted in our study are multifactorial. Pre-hospital care is a critical aspect of trauma care that is inadequate in most LMIC. The management of injured patients on the field is often left to bystanders at the scene of accidents.[16] The goal of an efficient pre-hospital trauma system is to combine minimal transport time with adequate resuscitation.[17] In Malawi, few victims receive treatment at the injury scene and even fewer receive safe transport to the hospital by ambulance. Injured people are usually cared for and transported to the hospital by relatives, untrained lay people, or commercial drivers.

The injured are often taken directly to the nearest health care facility, which may or may not have the capacity to manage trauma patients. Many patients who present to district or rural hospitals require surgical treatment for trauma, abdominal and orthopedic emergencies. Often surgery cannot be safely performed as many district hospitals in developing countries have no specialist surgical teams and are staffed by medical, CO personnel who perform a limited range of surgical procedures, often with inadequate training. The quality of surgical care is often further constrained by poor facilities, inadequate diagnostic adjuncts and limited supplies of medications and other essentials. [18] Furthermore, there is minimal communication with tertiary centers and reliable transportation is usually not available for timely transfer. However, tertiary care centers in Malawi have a more robust health care delivery infrastructure, in addition to the sizeable increased physician and surgical workforce compared to regional district hospitals or rural primary health centers. Particularly, KCH has a more complete set of trauma resources such as computerized tomography, laboratory testing, operating theaters, and more health care personnel, particularly surgeons and surgery residency training program.[11]

Additionally, with a per capital health expenditure is US$25/person/year, a physician density of 2 physicians per 100,000 Malawians, and around 16 fully trained surgeons for the entire country,[11] Malawi's health care delivery system cannot overcome the high surgical burden that exists. These disparities in resource allocation across the tiered health care delivery system can partially explain the results observed in this study. It is important to note however, that those injured in rural areas may still benefit from receiving initial care at the closest hospital from the scene of injury, as direct transfer to a trauma center may be impractical and imprudent depending on the injury severity.

Attributing mortality to the delayed transfers alone is difficult. While the indirect transfer cohort had a higher mortality than our direct transfer group, they also had a higher injury severity as measured by the RTS. Even after adjusting for injury severity and other covariates, mortality was still higher in the indirect transfer cohort. Whether severely injured patients should be transported directly to a tertiary center or whether they can be safely stabilized at a lower tier hospital and then transferred to a trauma is still debatable.[19,20] If severely injured patients are initially transported to a hospital not properly equipped to care for the patient, the initial stabilization needs be done quickly with good communication between the lower tier hospital and the tertiary center physicians and plans made for prompt transfer. However, in the absence of a formalized trauma system, patients may not reach the tertiary centers in a timely fashion and may not be appropriately treated or stabilized prior to transfer.

Given our findings, priority in public health interventions should be given to building adequate pre-hospital care services and to improving transport of trauma patients from the injury scene to a tertiary care center for definitive trauma care if possible. Resources necessary for the initial management and timely stabilization of the critically injured trauma patient at lower tier hospitals must be provided. Hence getting trauma patients to tertiary centers in a timely manner is key to reducing mortality differences between groups, particularly those with higher injury severity.

Attention must be directed at increasing trauma education and training focused at the physician or COs at the district hospital level.[21] Training on securing an airway, initial resuscitation, and stabilization of life-threatening conditions followed by emphasis on early transfer of appropriate patients to definitive care at the closest tertiary care center should be instituted. The curriculum of the International Trauma Life Support course, which is specifically designed for delivery in developing and resource constraint environments or some modification of the American College of Surgeon Rural Trauma Team Development Course, which was developed by the to address the increased mortality of the rural trauma patient may meet this need. [22,23,24]

To address the significant workforce shortage crisis and brain drain of health professionals in sub Saharan African countries, local specialized training programs are imperative. In-country surgery training programs have the potential to produce a generation of surgeons to best serve their communities and to become leaders and advocates for surgical care in their countries. [25,26] Task-shifting from surgeons to trained clinical officers to perform basic surgical procedures can also be an effective strategy while the shortage of fully-trained surgeons persists.[27] Of note in our study, only 5% of those who were indirectly transferred were admitted. This is reflective of the lack of knowledge and surgical oversight available at the referring lower tier hospitals and hence minimally injured patients are referred.

There are several limitations to our study including those inherent to any database study with retrospective methodology. Missing data is a potential weakness, particularly disposition data in both the direct and indirect transfer cohorts; however, there was no statistically significant difference in the proportion of missing disposition data between groups. Therefore, missing data did not affect the validity of the results for the logistic regression. Secondly, AVPU score and shock index are imperfect measures of injury severity and RTS was only available for 35 % of the entire cohort. There was no comparison between those transferred and those who were admitted, treated, and discharged from the district hospitals. Patients who were transferred were more likely to be critically ill but also stable enough for the transfer. In addition, early mortality at the district hospital could not be accounted for in this study. Therefore, baseline characteristics of the transferred group are only the best representations of the unknown source population, generating a source of selection bias. Lastly, the external validity of the study is limited to patient populations residing in urban centers of Malawi and other similar sub-Saharan African countries where there is a tertiary care center providing definitive trauma care.

This study reveals that direct transport of trauma patients from scene to a tertiary care center without initial assessment and treatment at a regional health facility is associated with a survival benefit as a result of reduced time from injury to definitive care. Indirect transfer patients had twice the odds of mortality in our study cohort. With limited resources to improve trauma care in this setting, the attention of the Ministry of Health should be focused on implementation of a trauma system and improving the capacity of district hospitals for initial trauma evaluation with emphasis on early and appropriate transfer to a regional designated trauma center.

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Table 1

Demographic, injury characteristics and outcome of trauma patients in scene vs. transfer groups

Sample Characteristic	Total (%) (n=50,059)	Transfer (%) (n=6,578)	Scene (%) (n=43,481)	*p* Value
Average age ± SD	23.1(15.5)	24.1 (18.5)	23.0 (15.0)	
Age Groups				
<14	15,949 (32)	2,525 (39)	13,424 (31)	<0.001
15–44	29,332 (59)	3,082(47)	26,250 (61)	
>=45	4,311 (9)	910(14)	3,401 (8)	
Sex				
Male	35,922 (72)	4,644 (71)	31,278 (72)	0.03
Female	14,060 (28)	1,920 (29)	12,140 (28)	
Alcohol involvement	3,161 (6)	293 (4)	2,868(7)	<0.001
Season				
Rainy	12,092 (24)	1,502 (23)	10,590 (24)	
Lush/green	12,706 (25)	1,577 (24)	11,129 (26)	<0.001
Cold dry	12,471 (25)	1,721 (26)	10,750 (25)	
Hot dry	12,761 (26)	1772 (27)	10,989 (25)	
Mode of transport				
Non-motorized vehicle	3,179 (6)	221 (3)	2,959 (7)	
Motorized vehicle	38,581 (78)	1,577 (24)	37,004 (85)	<0.001
Emergency vehicle	8,006 (16)	4,744 (73)	3,264 (8)	
Mechanism of injury				
Blunt injury	35,464 (71)	5,073 (78)	30,391 (71)	
Penetrating injury	11,278 (23)	944 (15)	10,224 (24)	<0.001
Others	2,725 (6)	477 (7)	2,240 (5)	
Initial AVPU (SD)	3.37(0.53)	3.39(0.60)	3.36 (0.52)	
Low (1)	389 (0.8)	122 (1.9)	267 (0.6)	
Medium (2–3)	29,813 (61)	3,502 (54)	26,311 (62)	0.0001
High (4)	18,846 (38)	2,813 (44)	16,033 (38)	
***Average Shock Index (HR/SBP) ±SD**	5.1 (20.2)	3.6 (0.4)	5.1 (0.2)	<0.0001
<0.6 (No shock)	3,644 (32)	430 (31)	3,214 (32)	
>=0.6 & <1.0 (mild shock)	6,757 (59)	794 (58)	5,963 (59)	
>=1.0 & <1.4 (moderate shock)	474 (4)	92(7)	382 (4)	
>=1.4 (severe shock)	559 (5)	59 (4)	500 (5)	
Mean Revised Trauma Score ± (SD)	7.14 (5.2)	6.09 (5.3)	7.33 (5.2)	<0.0001
Hours to presentation (Hour) (Median)	3 (1–16)	13 (4–30)	3 (1–14)	<0.0001
Admission disposition				
Discharged from ED	40,330 (79)	2,756 (43)	37,574 (87)	<0.001
Admitted to wards	8,816 (20)	3,636 (56)	5,180 (12)	
Died upon arrival	560 (1)	57 (1)	503 (1)	
Length of stay (Days)	1.5 (7)	6.8 (14)	0.8 (5)	0.0001
Outcome				

Sample Characteristic	Total (%) (n=50,059)	Transfer (%) (n=6,578)	Scene (%) (n=43,481)	*p* Value
Survived to discharge	45,501 (98)	4,895 (96)	40,606 (98)	
Died(%)	872 (2)	211 (4)	661 (2)	<0.001

Table 2

Logistic regression model for in hospital mortality by transfer status in admitted patients only (n=8,816)

Logistic regression model**	**Odds Ratio (95% CI)**	***p* Value**
Unadjusted: Indirect Transfer	1.36(1.08–1.71)	0.007
Adjusted *: Indirect Transfer	2.09 (1.24–3.54) *	0.006
Age (years)	1.01 (0.99–1.03)	0.15
Female Sex[b]	0.28 (0.11–0.69)	0.006
Positive Alcohol[a]	1.69(0.77–3.67)	0.18
Motorized Transportation[δ]	0.37(0.072–1.94)	0.24
Blunt Injury Mechanism[φ]	0.75 (0.4–1.4)	0.37
Revised trauma Score	0.72 (0.65–0.80)	0.00
Shock Index	0.53 (0.2–1.4)	0.20

*Adjusted for age, sex, alcohol involvement, mode of transport, mechanism of injury, shock index score, Revised Trauma Score

**Statistical significance of model =0.000

[b] comparative reference is Male (OR=1)

[a] comparative reference is Negative Alcohol Use (OR=1)

[δ] comparative reference is non-motorized transportation (OR=1)

[φ] comparative reference is Penetrating Trauma (OR=1)