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Article

Predictors of Patient Outcomes Associated with Transfer Status to Definitive Care Hospitals: A Study of Admitted Road Traffic Injured Patients in Two Major Trauma Hospitals in The Gambia

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Abstract: The Gambia uses the Primary Health Care model with no trauma response system. Trauma patients are transferred through multiple levels of health care facilities before definitive care hospitals. This study was conducted to identify predictors of injury factors associated with transfer. In this study, we examined characteristics of transferred patients compared to those directly admitted in definitive care hospitals. The study was conducted in two major trauma hospitals in The Gambia. 251 road traffic injury (RTI) patients were either transferred (84%) from lower-level health centers or directly admitted (16%) to one of the study hospitals. Transferred patients were more likely to have been pedestrian/bicyclists (aOR = 1.81; 95% CI = 0.86 – 3.80). Administration of antibiotics was significantly associated with direct admit than transferred patients (aOR = 6.84; 95% CI = 2.38 – 19.68). Transferred patients were more likely to receive intravenous fluid compared to direct admits (aOR = 0.03; 95% CI = 0.01 – 0.08). The study results have implications for policies and planning in the healthcare setting in The Gambia and other LMICs with similar settings. Based on the findings of this study, it is essential that hospital management teams adapt to increasing reliance of RTI patients on lower-level healthcare facilities. The study results suggest increased burden on lower-level health care facilities. Efforts and resources should focus more on supporting lower-level facilities.

Keywords: Road traffic crashes; transfer status; definitive care hospitals; LMICs

1. Introduction

Globally, road traffic injuries (RTIs) are a major cause of morbidity and mortality, with disproportionate numbers occurring in low- and middle-income countries (LMICs) [1, 2]. These countries have double the RTIs fatality rates of high-income countries; 90% of global road traffic deaths occur in LMICs [1]. Within the LMICs, the hardest hit are the economically disadvantaged individuals and families, who are more likely to travel as pedestrians, bicyclists, or to operate small motorized two-wheeled vehicles compared with higher income individuals, who are more likely to be vehicle occupants. Pedestrians, bicyclists or motorized two-wheeler operators are at greater risk of severe injury, and such injuries are associated with longer hospital stays, increased costs of care, disability, and death [1]. In addition, loss of or impaired bread-winners in families could exacerbate poverty levels in LMICs, especially from long-term care and rehabilitation costs and time away from the work [3, 4]. Evidence from high-income countries indicates that efficient trauma response systems can increase survival and optimize recovery [5, 6].

The Gambia is a low-income country and one of the smallest in mainland Africa. It covers 11,000 sq. km with a population of over 2.6 million [7]. More than half of the population (58%) live in the Greater Banjul Metropolitan area [8]. The country has about 4,000 km of road networks, with 1,800 km recognized as primary roads. Eighteen percent (18.3%) of the population owns motorized vehicles (cars, trucks, and motorcycles/scooters); and the proportion is higher for urban compared to rural residents (20.1% vs. 15.7%). However, ownership of bicycles is higher for rural than urban residents (55.6% vs. 41.1%). Ownership of animal-driven carts is 35% and 2.3% for rural and urban residents, respectively [8].

Trauma response systems in LMIC like The Gambia are poorly developed. Emergency response systems lack trained personnel and equipment, and formal protocols for pre-hospital triage are often non-existent with no formal channels of communication between treating physicians in different levels of health facilities [9]. These deficiencies lead to delays for injured patients to receive timely care and inferior injury outcomes. In the event of a crash, deciding where to transport crash victims is up to the lay person who first appears on the scene, who are not trained healthcare providers. Transporting severely injured patients by non-professional healthcare providers, to poorly equipped health care facilities can lead to unacceptable injury outcomes or even death [9, 10]. Similarly, transferring patients with minor injuries to high-level trauma hospitals could overload the facilities and reduce system efficiency. The goal of a good trauma system is to deliver the patient to the appropriate level of care, and with limited possible transfers between the different levels of care without delay. At the system level, the goal is to use resources most efficiently and to optimize recovery [11, 12].

Like other low-income countries, The Gambia's budgetary allocation to the health sector is less than optimal resulting in an underfunded healthcare system, including trauma response, that places a heavy burden on individual families. Health insurance schemes are limited to a few parastatal's staff, mainly under private insurance systems. Total household out-of-pocket expenditure on health as a percent of private expenditure on health has been consistently high at 70%, indicating a heavy burden of health care costs on households [13]. The Gambia has no emergency medicine residency or emergency specialized doctors or nurses, and does not have a comprehensive trauma management system [1]. The country does not have a functional emergency response number to call in case of a traumatic injury event. Transfer of trauma patients from crash scenes to healthcare facilities is most frequently done by taxis and private vehicles. Ambulances are stationed in the healthcare facilities primarily for interfacility transfer, such as a transfer from minor health center to district hospital or definitive care hospital. There are no formal emergency responders. All of these factors could directly or indirectly contribute to decisions for transfer of road traffic victims to multiple levels of care before reaching definitive care facilities, hence causing delays in timely care and less optimal outcomes.

The absence of the essential elements of trauma response makes it difficult to recognize issues or problem areas that could help address the burden of RTIs and to develop strategies to improve survival and recovery. Development of pre-hospital care services and the creation of trauma centers has been successful in many regions of the world [10, 14]. Trauma systems have been shown to assist in judicious use of national health care resources and improve injury-related morbidity and mortality. Trauma management during the first hour (the "golden hour") following injury has been shown to greatly influence the outcomes for patients in RTIs [15]. The absence of a trauma system results in delays for patients reaching appropriate care, which increases the risk for death or poor injury outcomes [16, 17]. This study aimed to examine characteristics of transferred patients compared to those directly admitted. This will help to highlight the burden of injuries on non-trauma health centers, hospitals, and care of patients.

2. Materials and Methods

2.1. Setting and Study Population

This study was conducted within two major trauma hospitals in The Gambia – Edward Francis Small Teaching Hospital (EFSTH) and Kanifing General Hospital (KGH), using data from trauma registries established in 2014. The trauma registries were established to examine the predictors for injuries and injury outcome among patients admitted to the trauma hospitals in urban Gambia. Though located in the Greater Banjul Metropolitan area of The Gambia, the two trauma hospitals receive all severely injured patients from across the country. The study hospitals also provide routine healthcare needs (including trauma) of the Greater Banjul Area.

EFSTH is the main referral hospital with 500 beds and services including surgery, internal medicine, pediatrics, obstetrics & gynecology, and nursing. KGH is a 300-bed hospital with services provided to the community. EFSTH directly receives severe trauma patients (including those from KGH, and the EFSTH's Polyclinic) or through multiple transfers from the other 158 health centers/clinics/hospitals across the country. Transfer of trauma patients from one level of health care to another (for example from a primary or secondary health care facility to tertiary hospital) are determined by factors such as the degree of trauma to the injured patients, location of the accident, and socioeconomic factors. Multiple transfers of trauma patients are done before they finally get to the appropriate treatment center.

The outcome variable for the study is whether the RTI patients are transferred to the definitive care hospitals (EFSTH or KGH) or directly admitted through the emergency department. We categorized patients into those who required an interfacility transfer (transferred), and those who were directly admitted (direct admit). Transfer patients were categorized as those who were treated at another hospital prior to arrival at the study hospitals, including minor health centers (N=51), major health centers (N=108), other hospitals (N=46), and clinics/physicians' offices (N=8). Direct admit patients were those who came directly from the scene of the crash, either on their own or through police escort, to the study hospital and were admitted through the emergency department.

Patients were eligible for inclusion if they had been admitted to one of the study hospitals for treatment of an injury that occurred on the roadway or in traffic. Admitting physicians determined study eligibility based on the cause of injury, as reported by the patient. Study patients included those admitted directly to the study hospitals or those transferred from other hospitals or clinics. Patients triaged by the study hospital Emergency Department with or without documented procedures who were not admitted to the hospital were not included in this data set. Between 2017 and 2018, there were 262 admitted RTIs, 11 patients with incomplete data were excluded, leaving a study population of 251 patients. Patients who died at the scene or at lower-level facilities were not captured by this study. Patients who were seen and discharged from lower-level facilities or who were discharged from the study hospital emergency department without being admitted are also not part of this dataset.

2.2. Data collection and variables

Treating physicians identified eligible participants and trained clinical or administrative staff used a 29-item questionnaire developed by the research team to collect data at the time of admission. The questionnaire described road-user type, body parts injured, nature of injury, vehicle and driver factors contributing to a crash, treatment given, and condition at discharge from the definitive care hospitals. Data collectors were trained by the principal investigator and co-investigators. Weekly quality monitoring and random spot checking were provided by the research team from the University of The Gambia.

The outcome variable (transfer vs direct admit) was examined by individual characteristics, road user type, nature of injury, and treatment received in definitive care hospitals. Individual characteristics included age, gender, and occupation. We further coded occupation as professional (health worker, businessman, civil servant, and security officer); skilled (driver and skilled worker); unskilled (farmer); student; and other (housewife, and driver trainee).

Road users included vehicle occupants, bicyclists, motorcyclists, and pedestrians. Vehicle factors included striking-vehicle types (motor car, van, bus, truck, and motorcycle), and striking-vehicle category (private, service, or commercial cars). Motor cars were classified as passenger vehicles with at least four wheels and could be either commercial or private cars. Commercial cars were vehicles available to public use with cost and range from four passengers to 30-seater passenger minibuses. Striking-vehicle type and category apply to the vehicle involved in the crash with the injured party. Driver factors included age, gender, drug or alcohol use, and speeding. Primary nature of injury and primary body parts injured were collected on the admitted patients. Primary nature of injury was coded as soft tissue (which includes open wound, abrasion, and contusion); fracture; dislocation (including sprain and strain); and concussion/brain injury. Body parts injured were coded as: head/skull, face, and neck; trunk (including thoracic area/lumbar, spine/abdominal area); and extremity (including lower extremity, pelvis/hip, and upper extremity). Treatment factors included variables describing treatment received by admitted RTI patients in definitive care hospitals, and the treatments included antibiotics, IV-Fluid, analgesics, dressing, and surgery. Disposition from hospital or at discharge was grouped into several categories: home; left against medical advice (frequently to go to traditional healers); treated for dressing; referred to another health institution (discharge/transferred to another acute care facility, discharge to another health care facility, and discharge to a psychiatric hospital); died; and other (discharge/transferred to bone setters, or unknown).

2.3. Data Analysis

Data were summarized by frequency counts (N) with proportions (%), means (with standard deviation) and median (with interquartile range). Chi-square test of independence and Fisher's exact test of transferred and direct admit patients were examined by individual, vehicle, injury, and treatment factors. The primary nature of injury and treatment received were examined to identify the most prevalent patients' injury profiles when comparing those who were transferred to those who were not. Time to definitive care hospitals was calculated based on the patient's self report of date and time of injury and date and time patient was triaged at the definitive care hospital. Odds ratios identifying the association of covariates (gender, road user, nature of injury, IV-fluid, and antibiotics) for transferred and non-transferred patients were examined using logistic regression. Crude and adjusted odds ratios were calculated with 95% confidence intervals. Demographic, injury, and treatment variables were considered for inclusion in adjusted models and chosen based on significance of the crude variable, sufficient sample size, and absence of collinearity with other variables. Surgery was excluded due to low sample size (6/251). Dressing and analgesics were also excluded because of collinearity. In the adjusted model (after excluding variables due to collinearity and sample size), 49% of the variability in transfers was explained by variables in the model. All analysis were performed using SAS 9.4 (SAS Institute, Inc., Cary, NC, USA).

2.4. Ethics

Human Subjects Institutional Review Board approval for this study was issued by the joint Gambia Government and Medical Research Council Ethics Committee (Ethics Clearance number – R13 014v2). Data collection exercise was done in accordance with the Helsinki Declaration. A written consent was obtained from the patients or their escorts for the publication of the research results. Where patients were not mentally alert or could not answer questions, consent was obtained from an adult family member who was interviewed.

3. Results

A total of 6,491 trauma patients were treated in emergency departments at one of the two definitive-care hospitals, either EFSTH or KGH in 2017 and 2018. Of the admitted patients, 262 (12%) were seen for RTIs. Our study population comprised 251 patients (after excluding 11 with incomplete data). Two hundred and eleven of the 251 (84%) were transfers and 40 (16%) were directly admitted through the two study hospitals' emergency departments. Most of the transferred patients came from major (50.7%) and minor (23.9%) health centers, while less than a quarter (21.6%) of transfers were from other hospitals.

Of all RTIs, twice the number of hospitalized patients were males compared to females (Table 1). More than half (51%) of admitted RTI were less than 25 years of age. Almost two-thirds (64.2%) were students or unskilled/other workers and one-third were professional or skilled workers. However, the mean transfer time for students (mean=3hours/6minutes; SD=268.4) and other professions (mean=4hours/34minutes, SD=495.1) were lower than the professionals (mean=16hours/35minutes, SD=4808.2) and skilled workers (mean=5hours/28minutes, SD=695.3).

Table 1. Patients demographics by mode of transfers to definitive care

Factor	Total[6]		Transfer		Direct admit			Time to Definitive Care (mins.)			
	N	(%)	N	(%)	N	(%)	p-value[1]	Mean	SD	Median	IQR[7]
Age							0.581				
< 25	127	(51.0)	105	(82.7)	22	(17.3)		217.1	371.0	110.0	65-185
25+	122	(49.0)	104	(85.2)	18	(14.8)		559.9	2935.9	144.5	73-240
Gender							0.058				
Male	167	(67.1)	135	(80.8)	32	(19.2)		274.7	502.5	117.5	68.5-225
Female	82	(32.9)	74	(90.2)	8	(9.8)		596.4	3469.2	135.0	65-240
Occupation							0.044				
Professional[2]	44	(18.1)	42	(95.5)	2	(4.5)		995.1	4808.2	135.0	85-210
Skilled[3]	43	(17.7)	32	(74.4)	11	(25.6)		328.9	695.3	110.0	60-180
Unskilled[4]	15	(6.2)	13	(86.7)	2	(13.3)		391.5	434.0	259.5	154-488
Student	84	(34.6)	73	(86.9)	11	(13.1)		186.3	268.4	111.0	65-180
Other[5]	57	(23.4)	44	(77.2)	13	(22.8)		274.2	495.1	126.0	64-249

[1]Chi-square test for testing independence between transfers and non-transfers, α=0.05; [2]Professional includes health worker, businessman, civil servant, and security officer; [3]Skilled includes diver and skilled worker; [4]Unskilled (farmer); [5]Other includes housewife, and driver trainee: [6]Totals do not add up to 251 due to missing values: [7]Interquartile range (Quartile 1 or 25th quantile - Quartile 3 or 75th quantile).

More RTI patients were admitted as pedestrians/bicyclist (57.9%) than occupants of motorized vehicles (42.1%, Table 2). Moreover, pedestrians/bicyclists were more frequently transferred than motorized vehicle occupants. The median transfer time to definitive care hospitals were higher among pedestrian/bicyclists (7hours/28minutes) than occupants of motorized vehicles (5hours/16minutes).

Being struck by a van/mini/bus/pick-up truck was associated with a higher likelihood of receiving initial treatment at a lower-level facility before being transfer to definitive care (P<0.05); similarly, the proportion of those struck by commercial/service cars was also greater who would eventually be transferred (87.6%) than those struck by private car (81.0%, Table 2). The median transfer time to definitive care hospitals was longer among RTI patients struck by commercial/service vehicles (2hours/15minutes) than those struck by private vehicles (1hour/55minutes).

Among all admitted RTI patients, speeding was more frequently listed as the cause among those patients who were transferred. Our findings also suggest that seat-belt use was more frequent among those who were directly admitted to the study hospital. Overall, helmet use and alcohol/drug involvement were not linked to crash or transfer of RTI patients to definitive-care hospitals. Reported alcohol/drug involvement in a crash was very low (5/245), this is likely underestimated due to low testing rates following crashes.

On deposition from definitive care hospitals, 183 (73.8%) admitted RTI patients were sent home. However, those needing to come back for care (n=37); transferred to other health institutions (n=9); and those who died (n=3) were more likely to have been transferred to the definitive care hospital in the first place.

Table 2. Crash/Vehicle/Driver Factors by mode of transfer to definitive care

Factors	Total[5]		Transfer		Direct admit		Time to Definitive Care (mins.)				
	N	(%)	N	(%)	N	(%)	p-value[1]	Mean	SD	Median	IQR[6]
Road User							0.118				
Pedestrian/bicyclist	139	(57.9)	112	(80.6)	27	(19.4)		448.1	2739.8	115.0	64-180
Motorized vehicle	101	(42.1)	89	(88.1)	12	(11.9)		316.3	572.5	143.5	77.5-280
Striking Vehicle Type							**0.012**				
Motor car	111	(47.0)	86	(77.5)	25	(22.5)		213.7	413.3	103.0	62-180
Motorcycle	30	(12.7)	25	(83.3)	5	(16.7)		1589.0	6051.9	156.0	100-300
Van/Mini/bus/Pickup/truck	95	(40.3)	88	(92.6)	7	(7.4)		252.0	409.5	133.5	80-255
Striking Vehicle Category							0.163				
Private	100	(42.2)	81	(81.0)	19	(19.0)		576.3	3207.1	115.0	65-200
Commercial/Service	137	(57.8)	120	(87.6)	17	(12.4)		257.0	449.5	135.0	73-240
Drug/Alcohol use[2]							0.590				
Yes	5	(2.0)	4	(80.0)	1	(20.0)		85.6	31.3	75.0	73-80
No	242	(98.0)	203	(83.9)	39	(16.1)		394.1	2095.5	125.5	69.5-235.5
Speeding							0.014				
Yes	196	(79.4)	170	(86.7)	26	(13.3)		429.9	2317.8	130.0	73-225
No	51	(20.6)	37	(72.5)	14	(27.5)		226.7	453.0	92.0	60-240
Helmet use[2,3]							1.000				
Yes	13	(25.0)	11	(84.6)	2	(15.4)		731.8	1112.4	149.0	87.5-1014.5
No	39	(75.0)	33	(84.6)	6	(15.4)		218.4	302.6	117.5	60-234
Seat belt fasten[2,4]							0.022				
Yes	16	(19.8)	11	(68.8)	5	(31.3)		273.8	707.3	90.0	65-126
No	65	(80.2)	60	(92.3)	5	(7.7)		267.6	386.7	165.0	85-295
Seating Position[2,4]							0.039				
Front seat	16	(22.5)	11	(68.8)	5	(31.3)		275.1	707.2	90.0	65-126
All other seats	55	(77.5)	50	(90.9)	5	(9.1)		274.9	414.8	150.0	80-295

[1]*Chi-square test for testing independence between transfers and direct admits, α=0.05;* [2]*Fisher exact test for testing independence between transfers and non-transfers, α=0.05;* [3]*Among bicyclists and motorcyclists;* [4]*Among in-vehicle occupants;* [5]*Totals do not add up to 251 due to missing values;* [6]*Interquartile range (Quartile 1 or 25th quantile - Quartile 3 or 75th quantile)*

Table 3. Injury characteristics/treatment given/disposition by type of transfer to definitive care

Factors	Total[5]		Transfer (210)		Direct Admit (40)			Time to Definitive Care (mins.)			
	N	(%)	N (%)	(%)	N	(%)	p-value[1]	Mean	SD	Median	IQR[6]
Nature of Injury							0.002				
Soft tissue	100	(41.5)	74 (36.6)	(74.0)	26 (66.7)	(26.0)		212.5	421.7	95.0	60-200
Fracture/dislocation	100	(41.5)	91 (45)	(91.0)	9 (23.1)	(9.0)		636.6	3212.9	134.5	80-237
Concussion/brain	41	(17.0)	37 (18.3)	(90.2)	4 (10.3)	(9.8)		199.0	259.4	135.0	90-185
Body Parts Injured							0.082				
Head/Face/Neck	106	(44.0)	83	(78.3)	23	(21.7)		238.2	452.8	115.0	60-185
Trunk	15	(6.2)	13	(86.7)	2	(13.3)		420.7	853.6	95.0	35-395
Extremity	120	(49.8)	107	(89.2)	13	(10.8)		532.9	2956.1	140.0	80-240
Antibiotics							0.004				
Yes	53	(21.2)	38 (10.1)	(71.7)	15 (37.5)	(28.3)		447.5	813.0	120	65-210
No	197	(78.8)	172 (81.9)	(87.3)	25 (62.5)	(12.7)		372.5	2288.7	126.0	73-235.5
Analgesics							0.014				
Yes	150	(60.0)	133	(88.7)	17	(11.3)		540.7	2643.4	150.0	80-280
No	100	(40.0)	77	(77.0)	23	(23.0)		148.5	191.9	103.0	60-168
Dressing							0.164				
Yes	93	(37.2)	82	(88.2)	11	(11.8)		397.2	670.1	180.0	90-300
No	157	(62.8)	128	(81.5)	29	(18.5)		382.0	2580.2	109.0	60-168
IV fluid							< 0.0001				
Yes	209	(83.6)	193 (91.9)	(92.3)	16 (40)	(7.7)		277.0	493.0	135.0	80-240
No	41	(16.4)	17 (8.1)	(41.5)	24 (60)	(58.5)		998.0	5182.2	65.0	30-108
Disposition from hospital[2]							0.069				
Home	183	(73.8)	153	(83.6)	30	(16.4)		417.3	2406.1	117.5	65-229.5
Traditional Healers	7	(14.9)	4	(57.1)	3	(42.9)		266.1	513.4	133.0	80-200
This hospital for dressing	37	(3.6)	35	(94.6)	2	(5.4)		190.8	92.8	180.0	140-240
Other health institutions[3]	9	(2.8)	8	(88.9)	1	(11.1)		734.3	1052.5	366.5	68-775
Died	3	(3.6)	2	(66.7)	1	(33.3)		213.9	246.4	140.0	95-225
Other[4]	9	(1.2)	8	(88.9)	1	(11.1)		85.3	37.1	73.0	56-127

[1]*Chi-square test for testing independence between transfers and non-transfers, α=0.05;* [2]*Fisher exact test for testing independence between transfers and non-transfers, α=0.05;* [3]*Other health institutions includes: acute care facility, another health care facility (rehabilitation or long-term care), psychiatric hospital;* [4]*Other includes: bone setters, and unknown;* [5]*Totals do not add up to 251 due to missing values;* [6]*Interquartile range (Quartile 1 or 25th quantile - Quartile 3 or 75th quantile.*

Overall, most admitted RTI patients were treated for soft tissue injuries or fracture/dislocation (83%) (Table 3). Transferred patients frequently had fractures/dislocations and were more likely to have extremity and trunk injuries than head/face/neck injuries. The median time for those needing to come back to hospital for dressing, transferred to another institution, or died were higher than other forms of deposition from definitive care hospitals. For example, those needing to come back for dressing, transferred to other institutions, or died were 3hrs, 6hrs, 2hrs 20 minutes compared to other forms of disposition from the hospitals which were less than 2 hrs.

Pedestrians/bicyclists were 1.77 times as likely to be transferred than directly admitted (95% CI = 0.80 – 3.89) (Table 4a). Patients admitted with concussions/brain injuries (vs. soft tissue injuries) were less likely (aOR = 0.6; 95% CI = 0.16 – 2.20) to be transferred than directly admitted. Patients with fractures/dislocations (vs. soft tissue) had a decreased odd (aOR=0.3; 95% CI = 0.11 – 0.82) of transfer compared to those directly admitted (Table 4b).

Among the treatments received by admitted RTI patients in definitive care hospitals, receiving antibiotics (vs. no antibiotics) had higher odds (aOR=6.84; 95% CI=2.38-19.68) of being transferred than directly admitted and this was significant. The odds of patients transfer negatively correlated with IV-fluid infusion (aOR = 0.03; 95% CI = 0.01 – 0.08) in the definitive care hospitals.

Table 4a. Predictors of personal characteristics by transfer to definitive care

Factors	Total	Transfer			
		Crude		Adjusted	
	N	OR	95% CI	aOR	95% CI
Age (Years)					
> 25	128	0.97	0.41 - 2.283	NA	NA
25+	124	Ref	NA	Ref	NA
Gender*					
Male	168	2.41	1.00 - 5.83	2.38	0.99 - 5.70
Female	85	Ref	NA	Ref	NA
Occupation					
Professional/skilled	76	Ref	NA	Ref	NA
Student/unskilled/other	130	1.13	0.46 - 2.77	NA	NA
Road User Type					
Pedestrian/bicyclist	139	1.77	0.80 - 3.89	1.81	0.86 - 3.80
Motorized vehicle	104	Ref	NA	Ref	NA

**Significant at the $p < 0.05$ level; Ref = Reference Group*

Table 4b. Predictors of nature of injury/treatment given by transfer to definitive care

Factors	Total	Transfer			
		Crude		Adjusted	
	N	OR	95% CI	aOR	95% CI
Nature of Injury*					
Soft tissue	100	Ref	NA	Ref	NA
Fracture/dislocation	100	0.31	0.11 - 0.86	0.3	0.11 - 0.82
Concussion/brain	41	0.53	0.14 - 1.97	0.6	0.16 - 2.20
Antibiotics*					
Yes	53	12.91	3.56 - 46.82	6.84	2.38 - 19.68

No	197	Ref	NA	Ref	NA
Analgesics*					
Yes	150	0.42	0.14 - 1.31	NA	NA
No	100	Ref	NA	Ref	NA
Dressing					
Yes	93	0.44	0.14 - 1.39	NA	NA
No	157	Ref	NA	Ref	NA
IV Fluid*					
Yes	209	0.05	0.017 - 0.13	0.03	0.01 - 0.08
No	41	Ref	NA	Ref	NA

**Significant at the $p < 0.05$ level; Ref = Reference Group*

4. Discussion

We examined individual and injury characteristics among admitted RTI patients in the two major trauma hospitals in The Gambia, stratified by whether the patient was transferred to the definitive care hospital facility or directly admitted through the hospital emergency department. We found that among admitted RTI patients, 213 (83%) were transferred from non-trauma health centers/hospitals and 40 (15.7%) were admitted directly into one of the definitive care hospitals. This high number of transferred patients indicates that a high volume of patients are treated at a lower-level facility before arrival at the definitive care hospital, which could indicate high burden on the system at levels unprepared to handle trauma care and additional costs to patients for care provided at multiple locations.

We also found that among admitted RTI patients, those injured as pedestrians/bicyclists were more likely to be treated at a lower-level facility before being transferred. Individuals and families who are injured as vehicle occupants are more likely to have the ability to pay for transportation or travel to the definitive care hospital in their personal vehicles. The study further revealed that RTI involving vans/minibus/service truck and commercial vehicles were more common among transfers compared to direct admits indicating that the injured patients were taken to the closest facility rather than the most appropriate facility. The commercial vehicles in The Gambia vary from four passenger cars to 14-passenger vans, and mini-buses carrying 22 or more passengers. They transport people and goods, and are predominant all over the country, especially in rural areas. Commercial vehicles are often poorly maintained, overloaded with passengers and goods, and without restraint options (seatbelts) for rear-seat occupants. Though alcohol consumption is reported to be low in this study (2%), commercial vehicle crashes due to substance abuse can be very hazardous for both the driver and occupants of other vehicles involved in the crash [18, 19]. Impaired driving is kept in check in developed countries by strict monitoring mechanisms to detect substance use that is not as readily available in LMICs [20, 21].

Those with fractures/dislocations and concussions/brain injuries (compared to soft tissue injuries) were more likely to be first taken to a lower-level facility and then transferred to definitive-care hospitals than directly admitted to either EFSTH or KGH. Timely treatment of fractures/dislocations [22, 23] and concussions/brain injuries [24, 25] are necessary for optimal recovery. For example, stabilizing fractures as soon as possible after the injury can greatly reduce complication rates. Injuries to the extremities, which are often fractures or dislocations, are associated with longer hospital stays, which elevate treatment cost directly and indirectly [26, 27]. Therefore, seeking alternative treatment for fractures in LMICs settings like The Gambia becomes an attractive option for more patients. In one hospital-based study in The Gambia, Bickler and Sanno-Duanda (2000) found that many injuries, especially those involving extremities, are often managed by traditional healers in a community setting. Although research is scarce, the authors further concluded that, among trauma patients treated by bone setters, gangrene was prevalent and occurred almost exclusively (89%) in children from rural areas, where access to health care was limited [28]. To this day, Gambians continue to trust traditional healers, especially the bone setters, to treat fractures and dislocations. The traditional bone setters use local knowledge of anatomical positions to re-orient and stabilize bones. However, complication rates such as infection are high due to compromised hygiene practices. Thus, inadequate treatment by bone setters likely increases the risk of sepsis, incorrect orientation of healed bones, permanent disabilities, or even death [28, 29]. In this study, we found antibiotic treatment, unlike other treatments, was associated with transferred compared to direct admit patients. This could be as a result of delay in seeking treatment and/or due to complication leading to sepsis from seeking traditional treatment. The application of herbal concoction creams, which has no consideration for antisepsis, and the practice of scarification over the fracture site predispose to the development of bone infection [28, 29]. In addition, complicated fractures with either blood vessel or nerve injuries can easily be infected if hygiene procedures are not considered during treatment. Therefore, it is important to educate traditional healers on the type of injuries they can manage and identifying those that need immediate transfer to an orthopedic specialist.

A high proportion of transferred patients were treated with IV-fluid (209/250) once they arrived at the definitive-care hospitals. We also found that patients who received IV-fluid (vs. not) were more likely to be transferred than directly admitted to the definitive care hospitals and that treatment was continued after admission. IV-fluids are an important aspect of fluid management for trauma patients, helping to maintain blood pressure. Providing the training and supplies of IV-fluid at lower-level hospitals and clinics may improve injury outcomes, allowing important treatment to be started earlier. Thus, availability of IV-fluid therapy should be made a priority in health centers/clinics and other lower-level hospitals in The Gambia. Considering the importance of stabilization of trauma patients before transfer to definitive care hospitals, a goal should be to build pre-definitive care hospital programs in rural areas. Some countries have successfully implemented training programs for laypersons (individual/community members, commercial drivers) as first responders [30, 31]. For efficiency, material resources for stabilizing injuries should also be allocated to first responders. Moreover, strengthening health centers/clinics and other lower-level hospitals so they have the resources to stabilize patients before transfer to definitive-care hospitals is also critical.

Given that injury represents a significant burden of disease and is a leading cause of disability and mortality in The Gambia, efforts to reduce injuries should focus on improving trauma care. In high-income countries, established trauma systems significantly decrease injury-related mortality [32-34], and some evidence suggests that this holds true in low-income countries [35]. In The Gambia, efforts to improve injury outcomes should address trauma care, not only in definitive-care facilities, but also at health centers/clinics and other lower-level hospitals. The present study explores resources needed by a low-income country, The Gambia. To improve trauma care and subsequently injury outcomes, clear-cut goals must be established. This study does not only provide a snapshot of the common RTI injuries associated with trauma burden, but also suggests how to improve care of trauma patients.

Like other studies with data from trauma registries, this study disproportionately represents more severe injuries. The study hospitals are located in urban Gambia and do not treat all injuries in the country. Injuries that require advanced care are likely to be treated in one of the two study hospitals. However, because the trauma registries are integrated into very busy hospitals without electronic medical records, we do not collect information on injury severity. This is because we want to be judicious with time and resources. Moreover, since the focus is on admitted patients with RTI, those who die before arrival or die at the emergency room are not captured in the study. There are also variables that could be associated with transfers that were not measured, such as neurological status, hypotension, and pre-existing comorbid conditions.

The study was also limited to the data available in the trauma registries at EFSTH and KGH. We lacked data on the treatment received in health facilities prior to admission to definitive-care hospitals. Data about the duration of medical treatment in health centers/clinics/other hospitals prior to transfer was also not available. Time to definitive care was estimated using the date and time of the RTI to date and time of admission to study hospital. This was less than ideal. The data in this study is an underestimation of the true burden of RTIs in The Gambia. Not all RTIs are transferred or admitted to the definitive care hospital, patients may be treated by alternative medicine, treated, and discharged from lower-level facilities, or die prior to definitive care. Despite these limitations, results from this study encourage future research to examine factors that predict transfer from lower-level facilities to definitive care hospitals in The Gambia. More research is needed to understand the burden placed on lower-level facilities in The Gambia, including financial, logistical (supplies), and capacity needed to care for these complex RTIs.

5. Conclusions

This study revealed how a patient's transfer status is associated with the type of treatment received in definitive care hospitals. RTI patients were frequently transferred from lower-level health care facilities to definitive-care hospitals for further treatment and management of injuries. Among admitted RTI patients, pedestrians/bicyclists, and those presented with fractures/dislocations or concussions/brain injuries were frequently transferred. The mean transfer time for these road users and injuries is between 3.5 hrs to 10.5 hrs, well beyond the golden hour rule. Considering these results, it will be useful to focus resources on personnel, equipment, and supplies, as well as those lifesaving treatments, like IV-Fluid, at lower-level health care facilities to adequately manage and treat trauma patients with fractures/dislocations, and concussions/brain injuries.

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