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Comparative epidemiology and outcomes among trauma patients transported by private and formal pre-hospital care modes in Kigali, Rwanda

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ABSTRACT

INTRODUCTION: The burden of injuries is high in low- and middle-income countries where pre-hospital systems are being developed to improve acute injury care. This study compares the characteristics and outcomes between trauma patients transported by formal emergency medical services (EMS) and by private transport to the emergency department (ED) of the Centre Hospitalier Universitaire de Kigali (CHUK) in Rwanda.

METHODS: This retrospective cohort study analyzed a random sample of trauma patients presenting between 1 August 2015 and 30 July 2016. Descriptive analyses were performed, and differences in outcomes were assessed based on transport modalities via Pearson Chi-Squared or Fisher's Exact tests.

RESULTS: Of the 556 trauma patients analyzed, 87.1% were transported by private transport and the remainder by EMS. The median inpatient length of stay for private transport patients was 7 days (IQR:3-16 days), compared to 9.5 days for EMS patients (IQR:4-18 days) (p=0.301). More EMS-transported patients died in the ED (p=0.005), and more were admitted to the hospital. There was a higher mortality rate among patients admitted to the hospital who arrived by private transport, but the difference was not statistically significant.

CONCLUSION: The higher ED death rate among EMS-transported patients and the higher in-hospital death rate among private transport patients suggest that major differences in the two groups may or may not be related to how trauma patients are brought to the ED.

Keywords: Wounds, Injuries, Global Health, Emergency Medical Services, Rwanda

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INTRODUCTION

The Injury is a major cause of death and disability globally, accounting for approximately 5 million deaths each year [1]. Although trauma systems can improve patient outcomes, implementation is challenging in low- and middle-income countries (LMICs), where over 80% of injury-related deaths occur [2].

Pre-hospital emergency medical services (EMS) aim to provide emergency care and rapid transport to a medical facility. Many LMICs rely on informal means of pre-hospital transport because of limited formal EMS [2-5]. The data on the benefits of formal pre-hospital transport are mixed [6]. In some studies, EMS with pre-hospital interventions appears to have reduced injury-related mortality [7]. In other studies, delays in emergency transport services have been linked to increased perinatal deaths [8]. The 'scoop and run' strategy prioritizes expedient transport by lay folk and Basic Life Support crews to definitive facilities and may result in faster hospital arrival times. It is not clear whether this strategy achieves better outcomes than the alternative of 'stay and play,' which prioritizes having personnel who can provide treatment in the field [6,9].

In Rwanda, injuries account for nearly one-quarter of deaths, nearly half of which occur in the pre-hospital setting [10]. In 2007, the Rwandan government created the Service d'Aide Médicale Urgente (SAMU), an EMS system to provide formal pre-hospital care. Many patients served by EMS in Rwanda are victims of traumatic injuries, most frequently road traffic crashes (RTCs), with a 5.5% mortality rate overall [11]. This study attempts to evaluate the SAMU program's effect on outcomes.

METHODS

Study design and settings: This retrospective analysis evaluated ED trauma cases that were presented from 1 August 2015 to 30 July 2016 at Centre Hospitalier Universitaire de Kigali (CHUK). Inclusion criteria were involvement in trauma and transportation directly from the trauma scene to CHUK. Exclusion criteria were transfers from other hospitals, non-trauma patients, and those lacking documentation for the ED encounter. All eligible patients were stratified into two groups based on whether they were transported by EMS or private transport.

The study site is a tertiary-level care hospital in Kigali, Rwanda. This hospital is the main receiving center for trauma patients in Rwanda, with a population of more than 12 million [12]. CHUK provides multiple specialty services, including orthopedic and neurosurgical interventions, advanced imaging, and laboratory testing. The 24-hour ED provides care for injured adult and pediatric patients and serves non-trauma surgical, medical, pediatric, and OB-GYN patients.

An EMS system coordinates the pre-hospital clinical care and provides field stabilization throughout Kigali and various province/district hospitals of Rwanda [13]. As of 2016, 225 ambulances with trained staff were operating in Rwanda. Anyone can access the EMS system by calling a toll-free number (912). The national dispatch EMS system located at CHUK receives approximately 1200 calls monthly [14].

Data management: This analysis included patients from a previously accrued electronic dataset [15-17]. This dataset was created by using a validated data acquisition approach on the hospital database to identify all cases that presented at the CHUK ED during the accruement period and then randomly sampling a number from each month (range: 135–165 records per month) [15]. Personnel utilized a standardized data collection instrument to abstract data for entry into a secure password-protected electronic data management application, ensuring that data procedures conformed to standard quality practices for chart review research in emergency medicine [18]. Due to the time-consuming process of data extraction from paper charts to construct the electronic database and its feasibility to review all cases during the period of interest, a random subset of all encounters was used to represent data of the overall population [15]. Since this is a retrospective exploratory analysis aimed at understanding baseline characteristics of the population of interest to inform future research, no formal sample size was calculated.

Demographic data were collected for each patient, including age, sex, mechanism of injury, and triage severity. Triage severity at CHUK is determined using the South African Triage Scale (SATS) [19,20], consisting of Green (routine), Yellow (urgent), Orange (very urgent), and Red (emergency) categorizations. At CHUK, the red triage category is further divided into "alarm," the most severe category, characterized by evidence of imminently dangerous compromise of the airway, breathing,

circulation, or neurological status, and "no alarm," determined purely by SATS-specified vital signs. Glasgow Coma Scale (GCS) scores were also collected. Other data gathered included patient transfer method, length of stay (LOS) in the ED and inpatient settings, deaths in ED, and in-hospital mortality.

Data analysis: Descriptive and inferential analyses were completed for the overall cohort and stratified based on whether they were transferred by EMS or private transport. Continuous data were reported as means with standard deviations or medians with interquartile ranges (IQR) and categorical data as frequencies and percentages. Patient characteristics and outcomes between the two transportation method cohorts were compared. The comparative outcomes of interest were the need for inpatient admission, length of stay (LOS), and mortality. Mann-Whitney tests for continuous measures and Pearson Chi-Squared or Fisher's Exact tests for categorical data were used to assess for significant differences or relationships between groups using a standard p-value cut-off of <0.05.

The CHUK ethics committee approved the research activities (EC/CHUK/513/2018) and the University of Rwanda College of Medicine and Health Sciences (No: 421/CMHS IRB/2017).

RESULTS

The database query generated 22,117 unique encounters between August 2015 and July 2016, of which 4,620 cases were randomly selected and screened. Of those, a random sample of 556 trauma patients met the inclusion criteria and were analyzed (Figure 1). Private transport was used by 87.1% (484) of the patients, while EMS transported 12.9% (72).

There was no significant association between transport method and age, sex, or SATS triage severity (p=0.190, 0.147, and 0.198, respectively). For the entire cohort, the median age was 28 years (IQR:18-39). Slightly more than half of the patients (52.1%) had serious injuries (triaged as Orange or Red). More EMS patients (58.8%) were severely injured than those brought by private transport (51.0%), but the difference was insignificant. Likewise, RTC as the mechanism of injury was higher, but not significantly higher, among patients brought by EMS. Overall, approximately two-thirds of the entire cohort were RTC victims. Other mechanisms of injury were evenly divided between the two groups. The Glasgow Coma Scores of the two groups were similar (Table 1).
The most consulted team for further management was orthopedics (45.0%), followed by acute care surgery (30.5%).

The median ED LOS, 1 day (IQR:0-2) for private transport patients and 1 day (IQR:1-2) for EMS patients, did not differ significantly between the two groups (p=0.103). For admitted patients, median inpatient LOS was 7 days for private transport (IQR:3-16) and 9.5 days for EMS

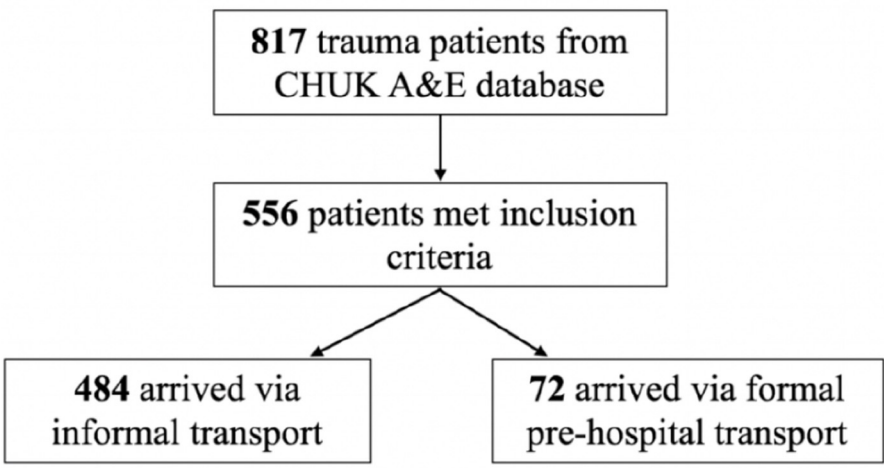

Figure 1: Study population analyzed

Table 1: Demographics of patients brought to ED via formal pre-hospital transport (EMS) and private transport.

		Private Transport	EMS	p-value
Age (years)		29.8 ± 18.4	32.4 ± 16.2	0.190
Sex	Male	336 (69.4%)	56 (77.8%)	0.147
	Female	148 (30.6%)	16 (22.2%)	
South Africa Triage Scale Categories	Red alarm	8 (1.8%)	2 (2.9%)	0.198
	Red no alarm	35 (7.9%)	9 (13.2%)	
	Orange	183 (41.3%)	29 (42.7%)	
	Yellow	149 (33.6%)	16 (23.5%)	
	Green	28 (6.3%)	2 (2.9%)	
	Unknown	40 (9.0%)	10 (14.7%)	
Mechanism	Road traffic crashes	291 (60.1%)	57 (80.3%)	0.010*
	Burn	25 (5.2%)	0 (0%)	
	Fall	88 (18.2%)	7 (9.9%)	
	Animal injury	2 (0.4%)	1 (1.4%)	
	Blast	2 (0.4%)	1 (1.4%)	
	Other blunt	15 (3.1%)	0 (0%)	
	Other penetrating	46 (9.5%)	2 (2.8%)	
	Unknown	15 (3.1%)	4 (5.6%)	
Glasgow Coma Scale	3-8	17 (4.8%)	3 (4.5%)	0.987
	9-12	39 (10.9%)	7 (10.5%)	
	12-15	301 (84.3%)	57 (85.1%)	
Median length of stay (ED)		1 day	1 day	0.103
Median length of stay (inpatient)		7 days	9.5 days	0.301
Mortality (total)		4.5%	1.4%	0.339

**Statistically significant; EMS: Emergency medical services*

(IQR: 4-18); this difference was not found to be statistically significant (p=0.301).

There was a statistically significant relationship between ED disposition and patient transport method (p=0.005), with 73.6% of EMS patients requiring admission compared to 59.5% of privately transported patients. In the ED, 0.8% of private transport patients and 1.4% of EMS-transported patients died. In the inpatient setting, none of the EMS patients died, while 5.9% of the admitted private transport patients died during hospitalization. The relationship between inpatient outcome and transport method was not found to be statistically significant (p=0.248) (Table 2). Overall, the total combined ED and inpatient mortality was 4.5% among private transport patients and 1.4% among EMS patients, a difference that was not statistically significant (p=0.339).

Table 2: Emergency Department and inpatient dispositions for patients brought via EMS and informal pre-hospital transport

		Private Transport	EMS	p-value
ED disposition	Death	4 (0.8%)	1 (1.4%)	0.005*
	Transferred	7 (1.4%)	0 (0%)	
	Admitted	289 (59.5%)	53 (73.6%)	
	Discharged	100 (20.6%)	18 (25.0%)	
	Eloped	1 (0.2%)	0 (0%)	
	Unknown	83 (17.1%)	0 (0%)	
Inpatient disposition	Death	17 (5.9%)	0 (0%)	0.248
	Transferred	25 (8.7%)	8 (15.1%)	
	Discharged	245 (84.8%)	45 (84.9%)	
	Eloped	1 (0.4%)	0 (0%)	
	Unknown	1 (0.4%)	0 (0%)	

**Statistically significant; EMS: Emergency medical services*

DISCUSSION

This study is the first known report from Rwanda comparing patients transported for emergency trauma care by formal EMS and private transport. Similar to prior publications, a high proportion of trauma patients were brought to the CHUK ED by private transport. This fact indicates that the EMS system in Rwanda is still in the developmental stage [21,22]. Factors such as lack of public knowledge or trust may prevent the Rwandan public from using this government-funded medical resource. It is unclear whether the public is adequately informed about the availability of EMS services in Rwanda. In Ghana, national and local government agencies have made concrete and proactive policy changes to widely publicize the availability of national ambulance services and prioritized calls directed to such services [22].

The most common injury mechanism was RTC in both groups of patients. The proportion of injuries due to RTCs is higher in this study than has been found in other sub-Saharan countries [24], perhaps reflecting ongoing increased motor vehicle usage in Rwanda.

The ED mortality and admission rates were higher among EMS patients, but the inpatient mortality rate was lower. However, these differences in inpatient outcomes and mortality rates between the two groups were not statistically significant. The only significant association was between transport method and ED disposition. A higher rate of hospital admission among EMS patients suggests a higher level of acuity among these patients and thus suggests that EMS may be responding to more complex and severe injuries and, therefore, being used appropriately. Although total mortality was higher among private transport patients than EMS patients, this difference was not statistically significant. The median inpatient LOS was longer among EMS patients, but this difference was also not statistically significant.

Trauma systems have been shown to improve outcomes [7], but the positive effects are not always apparent [6,9,23]. In Ghana and South Africa, ambulances have been found to transport a larger percentage of higher acuity and critically injured patients than private transport methods [22,23]. The question of whether ambulance transportation translates into improved outcomes is of critical importance. As private transport methods will also continue to be used in Rwanda into the foreseeable future, training laypeople in basic emergency care and evaluating patient outcomes, as has been trialed in neighboring Uganda [3], could be beneficial while EMS continues to develop in Rwanda.

This study was retrospective and limited by available data's quality and accuracy. The sample size may have been too small to identify important

differences in demographics and outcomes. While group characteristics appeared roughly similar, this study could not account for all possible confounding factors, including prior medical history or chronic conditions, involvement of substance use in the trauma mechanism, quality of care received at the scene, and length of time between the accident and arrival at the hospital. Finally, the time frame of data accruement, while the most recent data available at the time of collection, is limited by a previously built database and may not reflect the current situation in Rwanda's rapidly developing healthcare system. As Rwanda changes to an electronic health care data system, future studies will provide more definitive answers to the many questions the current study has raised.

CONCLUSION

Most trauma patients seeking ED care at CHUK are transported by private conveyances rather than the formal EMS pre-hospital system. The higher admission rate among EMS-transported patients and a significant association between ED disposition and transport method suggest that major clinical differences between the two groups may be associated with the transport method. As EMS grows in Rwanda, further research will be needed to assess the impact of formal pre-hospital transport of injured patients on outcomes.

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