European Journal of Trauma and Emergency Surgery (2019) 45:877–884
https://doi.org/10.1007/s00068-018-0939-2

ORIGINAL ARTICLE

Informing prehospital care planning using pilot trauma registry data in Yaoundé, Cameroon

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Received: 29 January 2018 / Accepted: 8 March 2018 / Published online: 10 March 2018

Abstract

Introduction About 54% of deaths in low- and middle-income countries (LMICs) are attributable to lack of prehospital care. The single largest contributor to the disability-adjusted life years due to poor prehospital care is injury. Despite having disproportionately high injury burdens, most LMIC trauma systems have little prehospital organization. An understanding of existing prehospital care patterns in LMICs is warranted as a precursor to strengthening prehospital systems.

Methods In this retrospective pilot study, we collected demographic and injury characteristics, therapeutic itinerary, and transport data of patients that were captured by the trauma registry at the Central Hospital of Yaoundé (CHY) from April 15, 2009 to October 15, 2009. Bivariate and multivariate regression analyses were used to explore relationships between care-seeking behavior, method of transport, and predictor variables.

Results The mean age was 30.2 years (95% CI [29.7, 30.7]) and 73% were male. Therapeutic itinerary was available for 97.5% of patients ($N=2855$). Nearly 18.7% of patients sought care elsewhere before CHY and 82% of such visits were at district hospitals or health clinics. Moderately (OR 1.336, $p=0.009$) and severely (OR 1.605, $p=0.007$) injured patients were more likely to seek care elsewhere before CHY and were less likely to be discharged home after their emergency ward visit as opposed to being admitted to the hospital for further treatment (OR 0.462, $p<0.001$). Commercial vehicles provided most prehospital transport (65%), while police or ambulance transported few injured patients (7%).

Conclusions Possible areas for prehospital trauma care strengthening include training lay commercial vehicle drivers in trauma care and formalizing triage, referral, and communication protocols for prehospital care to optimize timely transfer and care while minimizing secondary injury to patients.

Keywords Prehospital care · Cameroon · Injury · Trauma system · Surveillance

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Abbreviations

CHY	Central Hospital of Yaoundé
ED	Emergency department
eISS	Estimated injury severity score
EMS	Emergency medical services
KTS	Kampala trauma score
LMICs	Low- and middle-income countries
RTI	Road traffic injury

Introduction

Trauma is an increasing source of morbidity and mortality globally, disproportionately affecting low- and middle-income countries (LMICs) [1]. Over 90% of mortality due to unintentional injuries occurs in LMICs, while injury rates

in sub-Saharan Africa are among the highest in the world [2, 3]. In Cameroon, the incidence of injuries is rapidly rising with road traffic injuries ranking as the eighth leading cause of premature death [3–5]. Findings of hospital-based studies in several centers in Cameroon have highlighted the significant burden of health care utilization due to injury [6–8]. Despite a growing burden, there is limited research exploring the need, role, and function of particular components of an effective injury response system specific to resource-constrained settings.

In LMICs a lack of prehospital care for injured patients accounts for about 54% (24.3 million) of all deaths and is the single largest contributor to the 1023 million DALYs lost annually [9]. Timely access to trauma care is a predictor of morbidity and mortality; hence, the prehospital care phase of the trauma care continuum is a critical component of a trauma care delivery system [10, 11]. Deaths from injury occur (1) immediately; (2) during the intermediate or subacute phase (within several hours of the event); or (3) much later (due to infection, multisystem failure, or late complications of trauma) [12].

Organized prehospital care presents the most substantial benefits during this second phase of trauma. While prompt prehospital care may mitigate injury severity or prevent deaths, morbidity, and disability due to trauma [12–15], simply applying a system that works well in a high-income country (HIC) is unlikely to be feasible in LMICs [16]. To succeed, a prehospital trauma care system must be context-appropriate. Appropriate prehospital care planning, or attempts to develop comprehensive emergency medical services (EMS) systems, should reflect the resources available in the context [12].

Information on prehospital care can be obtained from trauma registry data [17]. Trauma registries, which are an established cornerstone of trauma system development in HICs, are becoming increasingly recognized as an important tool for injury surveillance and trauma care improvement in LMICs [17, 18]. Our objectives were to better understand the prehospital course of trauma patients who sought care at the emergency department (ED) of the Central Hospital of Yaoundé (CHY), Cameroon. Accordingly, a pilot trauma registry at CHY was created with a component of prehospital information integrated into the data collection tool. We sought to explore data from this hospital-based trauma registry to inform context-appropriate interventions to strengthen prehospital care, based on actual prehospital patterns. Findings were then used to identify context-specific opportunities for strengthening prehospital trauma patient care.

We hypothesized that: (1) demographic and injury characteristics are key predictors of the care-seeking itinerary of injured patients in Cameroon and (2) data from a trauma registry can inform prehospital care strengthening priorities, interventions and policies.

Methods

Study setting

This pilot study was conducted at CHY, a 650-bed teaching and referral hospital, estimated by the Ministry of Public Health to be the highest trauma volume facility in Yaoundé, Cameroon's capital city [19]. CHY serves a catchment of approximately 1.5–2 million people. It has a 24/7 ED that is staffed by house officers. A surgeon and some subspecialties are available for consultation. As with general services, emergency services are available at this government-funded hospital on a fee-for-service basis. Patients who cannot afford to pay are unable to access care.

Study instruments and data collection

We created a trauma registry data collection system using the WHO Guidelines for Injury Surveillance and instruments previously used in other LMICs [20–23]. Then, we implemented the data collection system at the ED of CHY. We retrospectively analyzed the data from all patients who presented to the ED of CHY with traumatic injuries from April 15, 2009 to October 15, 2009 [20].

The data collection methodology for this pilot trauma registry has been described elsewhere [7, 24]. Patients were recruited into the study as subjects if they presented to the ED of CHY on account of injury and if they gave consent. Conversely, patients were excluded from the study if they did not consent to being part of the study. Trained research assistants collected data pertaining to demographic characteristics (age, sex, socioeconomic status), injury characteristics (context, mechanism and severity), prehospital characteristics (on-scene care, first responders, therapeutic itinerary, mode of transportation) and in-hospital characteristics (process of clinical care, and outcome in the ED) of the injured. Therapeutic itinerary, in the context of this study, is defined as the patient's care-seeking journey and it encompasses all formal and informal health care providers that the patient sought or received care from. Injury severity was captured using the Kampala Trauma Score (KTS) and the estimated injury severity score (eISS) methodology. The eISS has been previously described and validated in a high-income settings and was used in this study because the information necessary for calculating a traditional injury severity score is often unavailable in resource-poor settings [25, 26].

Statistical analysis

Descriptive statistics were generated to present a demographic profile of the sample population by therapeutic

itinerary. Missing values were excluded (with the exception of imputed values associated with wealth status). Bivariate analyses were performed to explore patient characteristics' associated with therapeutic itinerary and prehospital transport mechanism, using two-sample *t* test between means for continuous variables. The Chi-square and Fisher's exact test were used to assess the difference in proportions between groups [27]. For comparative analyses, therapeutic itinerary was treated as a dichotomous variable: (1) those who "sought care at CHY first" versus (2) those who "sought care elsewhere prior to CHY". We also conducted multivariable logistic regression analyses using care-seeking behavior, mode of transport, and ED course outcome as outcome variables [27]. The data were analyzed using Stata version 13.1 [28].

Ethical considerations

Ethical approval was obtained from the Johns Hopkins Bloomberg School of Public Health Institutional Review Board; the Cameroonian National Ethics Committee; and the Division of Health Operations Research of the Ministry of Public Health in Cameroon. As per the request of the ethical review boards, patients or their surrogate decision-makers were approached for informed consent prior to data collection. Patients who did not give their consent for participation were excluded from the study.

Results

Demographic characteristics

Over the 6 month pilot period, 3137 patients presented to the ED of CHY on account of traumatic injuries. About 91% ($N=2855$) of these of patients consented to be included in the trauma registry study. The average age of the study subjects was 30.2 years (95% CI [29.7, 30.7]) and 73% were male. Most patients (88.6%) resided within Yaoundé while others (11.4%) resided in surrounding rural villages. Subjects were grouped into wealth quintiles as a reflection of their socioeconomic status.

Injury characteristics

Road traffic injuries (RTIs) (60%), falls (7%), and stab injuries (6%) were the most frequent injury mechanisms encountered. The majority (59%) of injuries were of mild severity (eISS < 9). Commercial vehicles, namely taxis and buses, comprised the majority of prehospital transport (64.7%), followed by private cars (24.7%), while police and ambulance transported injured patients 4.6 and 2.9% of the time, respectively (Fig. 1). There were no significant differences

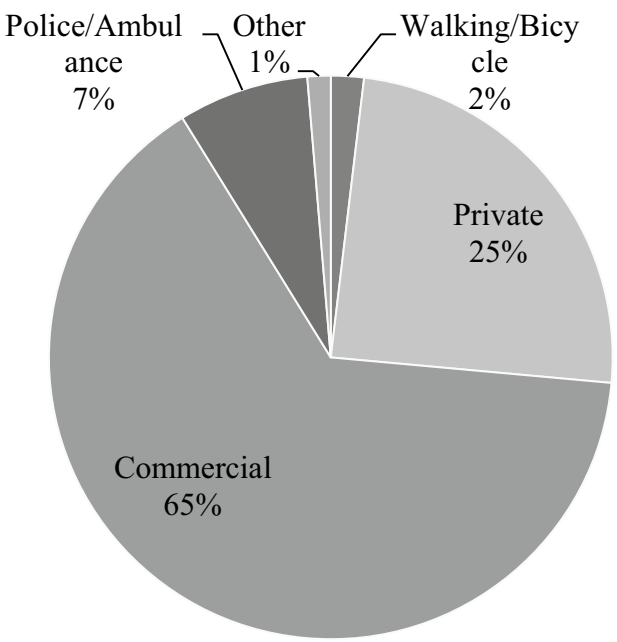

Fig. 1 Proportion of patients by mode of transportation to CHY ($n=2855$)

in patients' modes of transport to CHY by patient address ($p=0.082$), injury severity ($p=0.158$), or disposition from the hospital ($p=0.405$); however, profound injury severity (eISS ≥ 25) was a significant predictor of police or ambulance transport to CHY when adjusted for age, sex, address, road traffic incident as mechanism of injury, care-seeking behavior, and wealth (AOR 2.67, $p=0.035$). SES was the most significant predictor of use of a commercial vehicle for transport to CHY, as patients falling into higher wealth quintiles were less likely to use taxis or buses as transport (AOR 0.425, $p<0.001$) and more likely to use private cars (AOR 2.88, $p<0.001$).

Therapeutic itinerary

The significant predictors of therapeutic itinerary were socioeconomic status, gender, rural address, mechanism of injury, and injury severity [29]. Therapeutic itinerary data, which were available for 97.5% ($N=2783$) of patients, showed that CHY was the first care site for most (81%) patients, while others (19%) first sought care elsewhere (Table 1). Among the latter group ($N=519$), health clinics (47%) and district hospitals (35%) were the first care sites of choice (Fig. 2). A majority of patients who sought care from traditional healers were among the poorest wealth quintiles (first and second quintiles) (Fig. 3). In contrast, patients belonging to the higher SES groups (fourth or fifth wealth quintiles) comprised the majority of the patients who first sought home care before attending CHY. Among patients

Table 1 Summary statistics of trauma patients by care-seeking behavior

Characteristic	Sought care at the Central Hospital Of Yaoundé first ($n=2264$)	Sought care elsewhere first ($n=519$)	p Value
Age, mean (in years) ± SD	30.3 ± 13.9	29.8 ± 15.3	0.508
Sex, *n* (%)			
Female	597 (26.5)	150 (29.2)	0.224
Male	1652 (73.5)	364 (70.8)	
Address, *n* (%)			
Yaoundé	2038 (90.9)	393 (76.6)	< 0.001*
Outside of Yaoundé (rural)	205 (9.1)	120 (23.4)	
Mechanism of injury, *n* (%)			
Road traffic injury	1379 (61.6)	271 (52.8)	< 0.001*
Fall	155 (6.9)	49 (9.6)	0.040*
Gunshot	18 (0.8)	3 (0.6)	0.782
Animal bite	62 (2.8)	32 (6.2)	< 0.001*
Burn	56 (2.5)	19 (3.7)	0.131
Stab/cut	113 (5.0)	40 (7.8)	0.014*
Blunt trauma	79 (3.5)	20 (3.9)	0.685
Poisoning	3 (0.1)	1 (0.2)	0.562
Other	374 (16.7)	78 (15.2)	0.408
Transportation to hospital, *n* (%)			
Walking/bicycle	32 (1.4)	5 (1.0)	0.004*
Private	534 (23.7)	150 (29.0)	
Commercial	1473 (65.4)	331 (64.0)	
Police/ambulance	187 (8.3)	22 (4.3)	
Other	28 (1.2)	9 (1.7)	
eISS category, *n* (%)			
Mild (< 9)	1381 (61.0)	274 (52.7)	0.002*
Moderate (9–15)	615 (27.2)	163 (31.4)	0.032*
Severe (16–24)	157 (6.9)	50 (9.6)	0.027*
Profound (≥ 25)	59 (2.7)	13 (2.6)	0.933
KTS category, *n* (%)			
Mild (14–16)	2067 (94.6)	472 (92.9)	0.152
Moderate and severe (≤ 13)	119 (5.4)	36 (7.1)	
SES quintile, *n* (%)			
First (poorest)	336 (18.5)	112 (25.8)	0.007*
Second	371 (20.4)	86 (19.8)	
Third	369 (20.3)	85 (19.5)	
Fourth	360 (19.8)	82 (18.9)	
Fifth (wealthiest)	384 (21.1)	70 (16.1)	

Statistical analyses tested differences in means (two-sample *t* test) and independence (Chi-square, Fisher's exact test) between care-seeking groups

Asterisk denotes a statistically significant result

who patronized traditional healers majority (77%) belonged to the two lowest wealth quintiles. On the other hand majority of those who attempted home care prior to visiting the ED at CHY belonged to the highest wealth quintiles (Fig. 3). Patients who sought care elsewhere prior to arrival at CHY were more likely to reside outside of Yaoundé (AOR 3.53, $p < 0.001$). Men were less likely (OR 0.76, p value 0.027) to seek care elsewhere prior to CHY first [29].

Patients who visited multiple care sites prior to CHY were more likely to have a moderate eISS ($p = 0.032$) or greater (i.e., severe or profound) ($p = 0.027$) eISS. Such patients were less likely to have been involved in a road traffic incident (Table 1) than other mechanisms of injury (AOR 0.66, $p < 0.001$). For each additional care site that was visited before arriving at CHY, patients were more likely to have had moderate (OR 1.336, $p = 0.009$) or

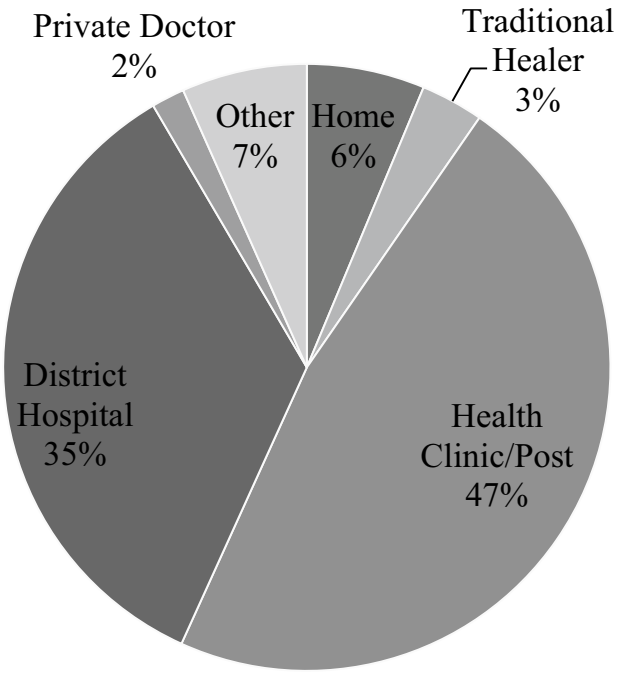

Fig. 2 First treatment sought among patients seeking care elsewhere prior to CHY ($n=519$)

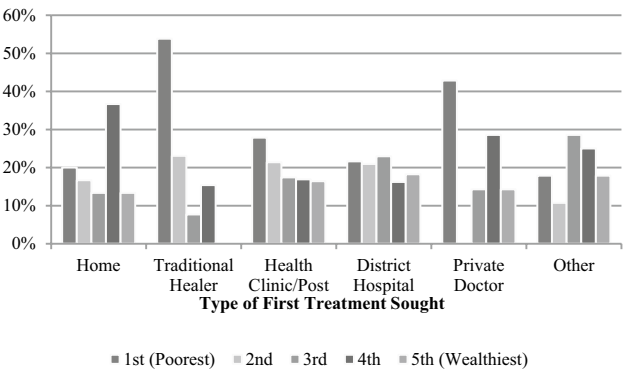

Fig. 3 Distribution of wealth (quintile) by type of first treatment sought among patients seeking care elsewhere prior to CHY ($n=427$)

severe (OR 1.589, $p=0.009$) eISS compared to mild severity. Common outcomes of ED visits for patients include discharge home, hospital admission, transfer out of the emergency ward, or a fatality. Compared with patients who went directly to CHY, patients who visited multiple care sites prior to CHY were less likely (AOR 0.53, $p<0.001$) to be discharged home after their ED visit when compared to those who came directly to CHY (Table 2). This relationship remained significant after controlling for injury severity. KTS was not a significant predictor of therapeutic itinerary and was consequently not considered for multivariate analysis.

Discussion

This study identified residing in a rural or distant location as key predictors of seeking care elsewhere prior to CHY, while wealthier patients were also more likely to directly seek care at CHY. In the absence of prehospital care, wealthier patients use private transport while poorer patients were more likely to use commercial transport for prehospital care. Additionally, ambulance or police transport were more likely to be for severely injured patients. Correlating these findings with an understanding of the local context and resources will lay the foundation for efforts to create context-appropriate policy recommendations and trauma care systems quality improvement recommendations and interventions that strengthen prehospital care systems in Cameroon.

Prehospital trauma care systems in Cameroon are rudimentary [30, 31]. Two-thirds of the subjects were transported to CHY via commercial vehicles, without an accompanying trained first responder. It is possible that many of these injured patients, especially those with moderate and severe eISS, travel without a trained first responder to the hospital during the critical subacute (intermediate) phase of the trauma care continuum [32]. Such patients were more likely to have sought care at another formal care site, prior to CHY; possibly because individuals with a perceived sense of injury acuity may elect to quickly seek care at the closest available facility, regardless of level of care. In contrast, the most severely injured (profound eISS) patients arrived at CHY directly from the site of injury, mostly via ambulance or police vehicles. This may be because ambulances or police vehicles in Cameroon may have a predilection for transporting patients to the bigger, better-equipped facility in the region (CHY).

In the absence of formally trained first responders in Cameroon, there is a need to explore innovative ways of providing timely care at the injury scene and transporting the patient to the appropriate health facility. Hemorrhagic shock, which frequently occurs among femur fracture patients, is the primary cause of preventable death among injured patients [33]. Appropriate tourniquet or external pressure application and timely patient transport could be lifesaving. Without prehospital care the risk of adverse outcomes like exsanguination and infection among such patients is higher [33]. Layperson trauma training can be done to equip individuals with little formal education with such basic skills. This has been done in similar settings and could facilitate early intervention and safe transport of the injured in Cameroon [34–37]. A similar study in Ghana showed 71% of injured patients used commercial transport and inspired the rationale for layperson trauma

Table 2 Odds of discharge home from CHY based on prehospital factors ($n=2090$)

Variable	Unadjusted odds ratio	95% CI	*p* Value	Adjusted odds ratio	95% CI	*p* Value
Age (in years)	0.99	0.98–0.99	0.003	1.00	0.99–1.01	0.854
Male sex	0.77	0.63–0.95	0.013	1.07	0.81–1.39	0.639
Rural address	0.37	0.29–0.47	< 0.001	0.49	0.35–0.69	< 0.001*
Road traffic injury mechanism	0.89	0.75–1.07	0.217	0.82	0.65–1.04	0.098
Care-seeking behavior						
CHY	–	–	–	–	–	–
Elsewhere	0.46	0.38–0.57	< 0.001	0.53	0.40–0.70	< 0.001*
Method of transport						
Walking/bicycle	–	–	–	–	–	–
Private	0.58	0.24–1.42	0.232	0.54	0.16–1.89	0.335
Commercial	0.57	0.23–1.37	0.209	0.52	0.15–1.80	0.306
Police/ambulance	0.42	0.17–1.06	0.067	0.41	0.11–1.52	0.182
Other	0.47	0.15–1.46	0.192	0.62	0.13–2.99	0.547
eISS category						
Mild (< 9)	–	–	–	–	–	–
Moderate (9–15)	0.15	0.12–0.19	< 0.001	0.15	0.12–0.20	< 0.001*
Severe (16–24)	0.06	0.04–0.08	< 0.001	0.07	0.05–0.11	< 0.001*
Profound (≥ 25)	0.02	0.01–0.04	< 0.001	0.04	0.02–0.08	< 0.001*
SES quintile						
First (poorest)	–	–	–	–	–	–
Second	1.60	1.20–2.14	0.001	1.52	1.08–2.14	0.017*
Third	1.94	1.44–2.61	< 0.001	1.77	1.25–2.52	0.001*
Fourth	2.79	2.03–3.84	< 0.001	2.17	1.49–3.15	< 0.001*
Fifth (wealthiest)	1.97	1.46–2.64	< 0.001	1.38	0.97–1.97	0.076

*A statistically significant result

'–' Indicates reference group for category

care training in that context [37, 38]. Given that commercial vehicle drivers are the leading transporters of injured patients, they can be trained to perform specific lifesaving trauma care interventions. In other Sub-Saharan African countries, laypersons of different backgrounds and educational levels have successfully been taught to perform external hemorrhage control, airway management, splinting, and patient positioning [35, 37, 39, 40]. An exploration of the effectiveness and impact of such training on prehospital trauma care in Cameroon is warranted.

Strategies to standardize field triage, referral, and hand-off of patients' procedures are vital and should be explored as part of the prehospital capacity building. Redundancy in the care site visit for patients is a reflection of inefficiencies in these procedures. There is a need to streamline the therapeutic itinerary of injured patients. Formalizing the procedures for patient triage, referral, and transfer with the care site will expedite care and improve patient outcomes [12]. An understanding of the availability of trauma care resources and services among health facilities within the health system is key to deciding where to refer an injured patient. Laypersons in Cameroon (the leading first responders and transporters of injured patients) may not have such knowledge. Since CHY is the biggest and highest-level hospital in the region, officially designating CHY or a similarly resourced hospital as the preferred destination for injured individuals may encourage commercial vehicle drivers to take clients there first [36]. Nevertheless, the potential benefit(s) of the latter recommendation must be weighed against workforce, financial factors, resource allocation, and other context-specific implications.

Prehospital communication between first responders and the elected care site is vital to prehospital care. In a survey conducted in Kenya, lay first responders highlighted the importance of establishing an appropriate emergency communication system and providing first aid and triage trauma training to first responders [41]. These responders, who by default handled patient triage, also reported a substantial risk of secondary injuries sustained during transport to formal care [41]. Additional studies have emphasized the critical need to improve care at the scenes of injury and during transport due to long response times [42, 43]. Establishing communication between the lay providers and the formal providers notifies the care site of inbound injured victim(s),

enhances preparedness of formal providers, and can be used to update formal providers about the status of the patient. If appropriate, the same medium can be leveraged to guide lay providers on how to perform certain time-sensitive lifesaving interventions on the scene or while in transit. Innovative solutions to enhance prehospital communication in LMICs include radio referral systems, which was demonstrated as being cost-effective in Niger, and mobile-based solutions [44]. Efforts to explore the feasibility of similar or other technologies in Cameroon may prove beneficial.

This pilot study of a single-institution trauma registry has some limitations. Being a retrospective study, we were unable to gather geographic and temporal information, which would be relevant to evaluating the timeliness of prehospital transport and care. Further investigation could probe for patterns regarding which specific facilities were visited. Sites that are commonly visited prior to arrival at CHY may benefit from targeted trauma care training so that patients can be appropriately stabilized prior to transfer. We are unable to comment on patients who did not arrive at CHY, such as those who died prior to arrival, ultimately sought care elsewhere, or not at all. As we do not have outcome data beyond the ED, our findings may underestimate mortality and underrepresent the association between outcomes and care-seeking behavior or transport method. The patterns observed at this single referral hospital may differ from hospitals in the region, especially in more remote areas, where tertiary-level care is unavailable. Additionally, the data for this study were collected in 2009. While it is possible that these data may not reflect the precise situation in Yaoundé at present, no major changes in the organization of prehospital care have been implemented since these data were collected, suggesting that the findings of this study remain relevant and congruent with present day trends". This study's strengths include its large sample size and inclusion of information that is often difficult to access in LMIC settings, such as injury severity estimates using several scoring systems.

Conclusions

This study demonstrates that a trauma registry can be leveraged to characterize prehospital trends and specific quality improvement opportunities in prehospital care. Our findings reflect a gross deficiency of formal prehospital care, transport, and communication in Cameroon. A sustainable approach towards strengthening prehospital trauma care would require multi-disciplinary stakeholder buy-in and partnerships involving private, governmental and non-governmental agencies in health, transport, communication, and finance. Based on our findings, logical next steps in strengthening prehospital care system may include:

(1) Conducting a feasibility study to evaluate the possibility of training and using commercial vehicle workers as prehospital care providers;
(2) Evaluating the existing and desired resources for training and deploying formal EMS providers;
(3) Identifying and implementing a context-appropriate formal communication protocol to facilitate field triage, referral, and transfer of injured patients to designated care facilities;
(4) Understanding the rationale behind the referral site choice(s) of or for injured patients; and
(5) Assessing and building political will for prehospital care development through continued research and stakeholder engagement.

Our findings can inform decision-making regarding prehospital care systems and policy design in Cameroon. Although tertiary-level facilities often have the greatest capacity to definitively treat trauma, nearly 20% of trauma patients arriving to the ED at CHY sought care elsewhere first. The organization of field triage or referral may expedite access to timely, appropriate care. There is a potential opportunity to leverage commercial drivers both as prehospital care providers and transporters and a need to prioritize populations that are farther away from major hospitals when planning for prehospital trauma care systems.

Acknowledgements We would like to thank the leadership and staff of the Central Hospital of Yaoundé and the Ministry of Public Health of Cameroon for their continued support of this research through their contributions to the implementation of the pilot trauma registry upon which this work is based.

Funding Second Assist, a 501c3 organization.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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