World J Surg
DOI 10.1007/s00268-014-2604-1

World Journal of Surgery

Analysis of Prospective Trauma Registry Data in Francophone Africa: A Pilot Study from Cameroon

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Abstract

Introduction Injury rates in sub-Saharan Africa are among the highest in the world, but prospective, registry-based reports from Cameroon are limited. We aimed to create a prospective trauma registry to expand the data elements collected on injury at a busy tertiary center in Yaoundé Cameroon.

Methods Details of the injury context, presentation, care, cost, and disposition from the emergency department (ED) were gathered over a 6-month period, by trained research assistants using a structured questionnaire. Bivariate and multivariate models were built to explore variable relationships and outcomes.

Results There were 2,855 injured patients in 6 months, comprising almost half of all ED visits. Mean age was 30 years; 73 % were male. Injury mechanism was road traffic injury in 59 %, fall in 7 %, penetrating trauma in 6 %, and animal bites in 4 %. Of these, 1,974 (69 %) were discharged home, 517 (18 %) taken to the operating room, and 14 (1 %) to the intensive care unit. The body areas most severely injured were pelvis and extremity in 43 %, head in 30 %, chest in 4 %, and abdomen in 3 %. The estimated injury severity score (eISS) was <9 in 60 %, 9–24 in 35 %, and >25 in 2 %. Mortality was 0.7 %. In the multivariate analysis, independent predictors of mortality were eISS ≥9 and Glasgow Coma Score ≤12. Road traffic injury was an independent predictor for the need to have surgery. Trauma registry results were presented to the Ministry of Health in Cameroon, prompting the formation of a National Injury Committee.

Conclusions Injuries comprise a significant proportion of ED visits and utilization of surgical services in Yaoundé. A prospective approach allows for more extensive information. Thorough data from a prospective trauma registry can be used successfully to advocate for policy towards prevention and treatment of injuries.

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Introduction

More than 90 % of mortality due to unintentional injuries occurs in low- or middle-income countries (LMIC) [1]. Although poorer countries are disproportionally affected by trauma, information on patterns of injury is scarce in these settings. Injury rates in sub-Saharan Africa are among the highest in the world [2]. While the experience in South Africa has generated a significant amount of hospital-based literature, the economic and political context in this country is unique and inferences made based on these

Published online: 04 May 2014

reports may not be generalizable to the rest of the continent [3, 4]. Unfortunately, information on injury epidemiology and trauma care in other parts of sub-Saharan Africa, while increasing, is still relatively limited [5].

According to the World Health Organization (WHO), Cameroon has a death rate of 101.8 per 1,000 population and 4,430 Disability Adjusted Life Years (DALYs) per 100,000 population attributable to trauma; this burden of disease in Cameroon is comparable to that of malaria [6, 7]. In addition to several small, hospital-based injury-specific series available from Cameroon [8–11], a retrospective review of administrative data from a single institution in Cameroon's capital city, Yaoundé, has been reported [12].

Hospital administrative and medical records have been used in developing country settings to understand patterns and mechanisms of injury; although helpful, this method has been found incomplete in several settings [13–16]. Often retrospective, administrative data do not provide information on potential risk factors, treatment costs and modalities, or patient outcomes. In Cameroon, an analysis of administrative data in a level III trauma center revealed that fundamental information on patient demographics and clinical condition were frequently absent: 21 % were missing information on age, sex, and injury mechanism; pulse and respiratory rate were documented only 13 and 2 % of the time, respectively [16]. In the same study, descriptions of anatomic lesions allowed estimation of injury severity score (ISS) in 8 % of patients, whereas the revised trauma score (RTS) could be calculated in only 2 %. Reliance on administrative records as a source of injury surveillance in this setting would likely result in gross underreporting of injuries and provide inadequate information for injury prevention policy or trauma care quality improvement efforts.

In view of the limitations of previously published retrospective data, we aimed to create and test a prospective trauma registry to expand the data collected on injury and trauma care at a busy tertiary center in the capital city of Cameroon. Our aims were: (1) to pilot a data collection system designed to describe patterns of injury and emergency clinical trauma care using a prospective data collection system; and (2) assess the pilot trauma registry's performance respective to prior experience using administrative retrospective data from the same setting. The results of this experience would be used to inform planning for a sustainable trauma registry in this setting.

Methods

Study setting

Information on patients presenting to the emergency department (ED) of the busiest trauma center in Cameroon's capital city of Yaoundé were collected prospectively over a 6-month period from April to October, 2009. The Central Hospital of Yaoundé (CHY) is a 500-bed hospital that is one of five tertiary centers in Cameroon's administrative capital, serving an estimated population of more than 1.5 million inhabitants. This large hospital is estimated by the Ministry of Public Health to capture approximately 75 % of trauma patients in the city of Yaoundé and constitutes multiple buildings covering a relatively large area near the urban center of the city. Medical record keeping is minimal and patient flow often involves transfers from one building to another, which may require that the patient be transported in an ambulance. Once patients leave care in one ward to receive care in another ward, any minimal medical record keeping is interrupted and further information on patient care is very difficult to determine.

Data gathering

Injury was defined according to the International Classification of Diseases (ICD) codes listed in Chapters XIX and XX of the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)*, according to the WHO *Guidelines for Injury Surveillance* [17]. Information gathering was based in the ED, as patient flow and medical record keeping challenges in this busy center made the tracking of injured patients and subsequent information gathering extremely difficult and likely to result in a high proportion of uncaptured patients. Given the paucity of information on injury surveillance in this LMIC setting, any patient presenting to the ED with an injury was included, regardless of hospital admission status or injury severity in order to maximize capture of injuries in this context.

Patients were interviewed using a structured questionnaire, based previous work done in lower income settings [18–21]. Data on demographic information, details of the injury context, clinical presentation, care, and disposition from the ED were gathered. Clinical information, including vital signs, anatomic location of injury, treatments administered, and injury severity also were gathered. Injury severity was calculated using the Kampala Trauma Score (KTS), the Revised Trauma Score (RTS), and an "estimated Injury Severity Score" (eISS). The term eISS was used in this context, as the information necessary for calculating a traditional Injury Severity Score, including radiologic and operative findings, often is unavailable in LMIC [22]. As is often the case in LMIC settings, abbreviated injury scale (AIS) was generated based on the clinical assessment in the ED, then eISS was calculated based on the AIS for each patient. Although eISS and ISS are often used interchangeably in LMIC settings due to

resource constraints, eISS methodology has been previously described and validated in a high-income country; therefore, the term eISS is used in this report [23]. Disposition outcomes from the ED were death in the ED, discharged home, admitted to ward, transferred to the intensive care unit (ICU), transferred to the operating room, or transfer to another facility. Additionally, patients were asked about socioeconomic indicators using questions derived from the 2004 Demographic and Health Survey in Cameroon and were asked to report the cost of treatment received in the ED prior to disposition (not including the cost further care beyond the ED, such as ICU care, ward care, or operative costs) [24].

Research assistants underwent training and were required to complete Collaborative Institutional Training Initiative (CITI) certification [25]. Medical record keeping is limited to ward admission logbooks and a small notebook carried by the patient documenting physician prescriptions, which would not be adequate for injury surveillance or trauma registry data collection; therefore, data collection was done 24 hours per day and seven days per week prospectively in the ED by nine research assistants for this pilot study period. Because medical record keeping in this facility is extremely skeletal and patient information cannot simply be culled from existing records, data gathering for this pilot study were limited to each injured patient's emergency department course.

Each injured patient was approached by a research assistant, who obtained oral consent through an institutional review board-approved oral consent script. Consent for minors was obtained through their guardian and oral assent was obtained from minors older than 7 years of age. Information was only gathered on patients who gave their consent to participate. Research assistants gathered clinical information through direct observation and assistance from the clinical providers; socioeconomic, mechanism, and context information was obtained through direct questioning of the patient by the research assistant. Data were written on a paper data collection instrument, which were then dropped in a securely locked box located in the emergency department office. These forms were periodically collected by the study supervisor who then stored them in a secure, locked location.

Data analysis

Once data collection was complete, data were entered into EpiInfo, converted to Excel, and imported into Stata version 11.0 for statistical analysis [26]. Univariate and bivariate analyses were performed on demographic characteristics, mechanisms, injury severity, and outcomes. Bivariate analyses were done using the chi-square test for dichotomous variables and the *t* test with unequal variance for continuous variables. Multivariate models were built for all outcomes controlling for age as a dichotomous variable (<18 years vs. ≥18 years), Injury severity score (ISS) as a dichotomous variable (ISS ≥9 vs. ISS <9), gender, and RTI-related mechanism versus non-RTI-related mechanism.

The study was conducted in collaboration with the Ministry of Public Health in Cameroon and the Central Hospital of Yaoundé, Cameroon. The protocol was reviewed and approved by the Cameroonian Ministry of Public Health, the Central Hospital of Yaoundé, the National Ethics Review Committee in Cameroon, and the Institutional Review Board of the Bloomberg School of Public Health at Johns Hopkins University.

Table 1 Demographics ($n = 2{,}855$)

Age (year) (mean, SD)	30.2	14.1
Gender (*n*, %)		
Male	2071	73.2
Female	760	26.9
Residence (*n*, %)		
Yaoundé	2650	88.6
Outlying villages	340	11.4
Occupation (*n*, %)		
Student	437	15.31
Private sector	273	9.6
Driver	253	8.9
Small business owner	236	8.3
Civil servant	195	6.8
Self-employed[a]	318	11.4
Housewife	235	8.2
Other	698	24.5

Reported as mean (SD) for continuous variables and frequency (%) for categorical variables; percent based on nonmissing values only; missing values range from 0.8 to 1.4 % of total n, except for "Occupation," where missing comprised 7.4 %

[a] Farmers, casual laborers, street vendors, walking vendors

Results

During the 6-month study period, 91 % of patients presenting to the ED consented to participate, comprising a total of 2,855 injured patients and nearly 50 % of all ED visits (Table 1). The mean age of injured persons was 30.2 years (SD 14.1); 72 % were males. Nearly 90 % of those presenting to the hospital with injuries were from the city of Yaoundé, with only a small proportion coming from the outlying villages (11.4 %). Students comprised 15.4 % of injured patients, followed by self-employed at 11.4 %, and those working in the private sector or as drivers (9.6 and 8.9 %, respectively). Most patients reported that they arrived at the hospital by public taxi (62 %), whereas 22 % arrived by private car; ambulance services provided

Table 2 Mechanism, activity, and location at time of injury ($n = 2,855$)

Characteristic	Frequency	Proportion (%)
Mechanism		
Road traffic injury	1,686	59.05
Fall	211	7.4
Penetrating trauma	180	6.3
Blunt trauma[a]	102	3.6
Animal bite	97	3.4
Burn	77	2.7
Other	465	16.3
Missing	37	1.3
Activity		
Traveling	692	24.2
Sports/leisure/recreation	594	20.8
Work (other than home)	566	19.8
Unspecified (hanging around)	189	6.6
Work (home)	84	2.9
Usual daily activities	77	2.7
Housework	25	0.9
Education	20	0.7
Other	498	17.4
Missing	110	3.9
Location		
Road/highway/paved road	1,612	56.5
Home	573	20.1
Small/dirt road	160	5.6
Market/shopping center	130	4.6
Industrial/construction area	80	2.8
Sport/recreation field or facility	66	2.3
Farm/field	76	2.7
School/education area	15	0.5
Other	94	3.3
Missing	49	1.7

[a] Excluding RTI

transportation to the hospital less than 3 % of cases. Treatment at another health care provider was sought by 18 % of patients before arriving at CHY, most frequently at a health clinic, health post, or district hospital.

RTI was the most frequent mechanism of injury recorded, involving nearly 60 % of those arriving (Table 2). Falls comprised 7.4 % of those injured, followed by penetrating trauma (6.3 %). Nearly 25 % of people stated that they were injured while traveling, whereas 20.8 % had their injuries occur while participating in recreational activities, and 19.8 % occurred while people were working away from home. Injuries occurred most frequently on highways or paved roads (56.5 %), followed by those occurring at home (20.1 %). Age analysis revealed that those 15–45 years of age comprised 74 % of all injured patients and 52 % of those injured by falls (Table 3). Those less than 15 years of age comprised only 11.2 % of injured patients but contributed 24.8 % of fall-related injuries.

When males and females were compared using a bivariate analysis, there was no statistically significant difference in the age of injured subjects (Table 4). Males comprised 73.2 % of injured individuals and females only 26.8 %. Males were more likely than females to be injured by all mechanisms, a difference most emphasized in penetrating mechanism (82.1 vs. 17.9 %, $p = 0.005$); however, women were disproportionately affected by burns and animal bites at 45.5 and 43.2 %, respectively ($p < 0.001$).

The body area most severely injured were pelvis and extremity in 43 % and head in 30 %; pelvis and extremity injuries were overrepresented in falls and penetrating trauma, where they comprised 56 and 57 % of injuries (Table 5). The estimated injury severity score (eISS) was <9 in 60 %, 9–24 in 35 % and >25 in 2 %. A total of 1,974 patients (69 %) were discharged home, 517 (18%) were taken to the operating room, and 14 (0.5 %) were taken to the ICU. A total of 29 patients died in the ED, resulting in an ED mortality of 1.02 % (Table 6).

More than 40 % of individuals who were injured required either minor operative treatment (25.4 %) or immediate transfer to the operating room for major surgery (18.11 %; Tables 6 and 7). Those with injuries of the bony pelvis and extremities were overrepresented in their need for immediate major surgery (25 %). Patients subjected to penetrating trauma were more likely to undergo surgical treatment, either in terms of minor procedures or major operative intervention, at 51. 7%. Immediate operations were needed by 31 % of people with abdominal injuries and 22 % of those with chest injuries. Emergency radiology was used in 26.4 % of cases, but 52 % of patients whose injury was a result of a fall underwent a radiologic study as a part of their ED assessment. While the bony pelvis and extremities comprised 43 % of injuries, this area was overrepresented in falls and penetrating trauma, where it comprised 56 and 57 % of injuries, respectively.

A multivariable regression analysis was performed including age, gender, ISS, and whether the injury was RTI-related or not. Individual models were constructed for each of the possible outcomes of patients: admission, transfer to the operating room, transfer to the ICU, discharge home, or death. ISS ≥9 was found to be predictive of death (odds ratio [OR] 3.47, $p = 0.001$), transfer to an ICU (OR 6.67, $p = 0.004$), and transfer to the operating room (OR 12.39, $p < 0.001$; Table 8). Discharge home from the ED was found to be predicted by ISS <9 (0.11, $p < 0.001$). RTI was associated with increased odds of needing an operative intervention (OR 1.31, $p = 0.017$) and decreased likelihood of being sent home (OR 0.8, $p = 0.028$).

Table 3 Mechanism by age ($n = 2,814$; age missing for 1.4 % of sample)

Age group (year)	RTI	Fall	Penetrating trauma	Blunt trauma	Animal bite	Burn	Other	Missing	Total
<15	159	52	17	12	24	28	20	3	315
	9.6 %	24.8 %	9.6 %	11.9 %	25.3 %	36.8 %	4.4 %	8.6 %	11.2 %
15–45	1,272	110	143	77	56	43	367	26	2,094
	76.6 %	52.4 %	80.3 %	76.2 %	58.9 %	56.6 %	80.1 %	74.3 %	74.4 %
46–59	169	31	16	10	12	2	54	5	299
	10.2 %	14.8 %	9.0 %	9.9 %	12.6 %	2.6 %	11.8 %	14.3 %	10.6 %
>60	61	17	2	2	3	3	17	1	106
	3.7 %	8.1 %	1.1 %	2.0 %	3.2 %	3.9 %	3.7 %	2.9 %	3.8 %
Total	1,661	210	178	101	95	76	458	35	2,814

Table 4 Age, injury mechanism by gender ($n = 2,831$)

	Males ($n = 2,071$)	Females ($n = 760$)	p value[a]
Age (mean, SD)	30.2 (13.5)	30.3 (15.7)	0.9
Injury mechanism (n, %)			
Road traffic injury	1,232 (73.7)	440 (26.3)	0.44
Fall	143 (68.4)	66 (31.6)	0.11
Penetrating trauma	147 (82.1)	32 (17.9)	0.005
Blunt trauma	80 (79.2)	21 (20.8)	0.16
Animal bite	54 (56.8)	41 (43.2)	<0.001
Burn	42 (54.5)	35 (45.5)	<0.001
Other	351 (75.8)	112 (24.2)	0.16
Missing	22 (62.9)	13 (37.1)	0.17
Total	2,071 (73.2)	760 (26.8)	<0.001

[a] t test for unequal variance for age (missing for 1.4 % of sample). One-sample binomial test for overall male/female representation. Chi-square test for each mechanism, nonmissing values only

In 2009, the per capita Gross National Income was $1,210 USD, making the average monthly income per capita approximately $100 USD [27]. Cost data were collected on 2,531 (88.7 %) patients. Average cost of treatment was 8,613 Central African CFA franc (standard deviation [SD] 6574), equivalent to $18.25 (SD 14.58) (2008 USD) [28]. Mechanism of pay data was available for 88.8 % of patients interviewed; the vast majority (97.9 %) of those reported paying out of pocket. Insurance, NGO assistance, or government assistance were each used less than 1 % of the time to pay for health care.

The prospective trauma registry had basic demographic variables available for 97 % of records. Additionally, the prospective registry system had available information for patient vital signs, neurologic status, and injury severity scoring systems over 95 % of the time for all elements. Transport time was available 92 % of the time for the prospective registry.

Discussion

The prospective method allows for collection of other information on critical aspects of patient care and outcomes not available through retrospective administrative data, including: more specific demographic information (occupation and residence of the subject); more detailed injury mechanism information (activity at the time of injury, location of injury, and transport time); information on treatments delivered in the ED (including analgesic, radiologic, and procedural interventions); information on outcomes and surgical interventions; and injury scoring. Additionally, basic demographic and clinical information, such as vital signs and neurologic status, was much more frequently available than when using administrative records alone (Table 9) [12, 16].

As seen elsewhere in sub-Saharan Africa and in retrospective data available from Yaoundé, males (73 %) represented a greater proportion of those injured than females in our study. In reports from other sub-Saharan contexts, the proportion of RTI as a mechanism of injury is consistently high, ranging from just >40 % reported in Malawi to >90 % in data from Nigeria [13, 29]. In this report, RTI served as the mechanism of injury for 59 % of patients, which is nearly identical to the proportion reported in the retrospective study from the same institution [12]. Also, females were again overrepresented among patients injured by bites and burns, highlighting the need for further investigation of potential risk factors specific to this population. Findings, such as these provide evidence for targeting prevention efforts in a data-driven fashion, underscoring the need for injury prevention efforts focused towards these specific problems in particular at-risk populations.

Somewhat surprisingly, nearly one-fifth of injured patients presenting to the ED required transfer to the operating room for surgical treatment of their injuries, and another 25 % required surgical procedures in the ED. Although strengthening surgical services is not routinely

Table 5 Body area injured by mechanism ($n = 2,749$)

Mechanism	Body area injured						
	None	Head, neck, face	Chest	Spinal cord	Abdomen, pelvic contents	Bony pelvis and extremities	Total
Road traffic injury	303 (18.4)	499 (30.2)	66 (4.0)	8 (0.5)	54 (3.3)	720 (43.6)	1,650 (100)
Fall	32 (15.4)	34 (16.4)	7 (3.4)	4 (1.9)	14 (6.7)	117 (56.3)	208 (100)
Penetrating trauma	38 (21.5)	28 (15.8)	6 (3.4)	–	4 (2.3)	101 (57.1)	177 (100)
Blunt trauma	30 (30.0)	40 (40.0)	3 (3.0)	–	4 (4.0)	23 (23.0)	100 (100)
Animal bite	20 (21.3)	4 (4.3)	–	1 (1.1)	5 (5.3)	64 (68.1)	94 (100)
Burn	12 (16.7)	15 (20.8)	6 (8.3)	–	4 (5.6)	35 (48.6)	72 (100)
Other	54 (12.1)	226 (50.5)	16 (3.6)	1 (0.2)	38 (8.5)	113 (25.2)	448 (100)
Total	489 (17.8)	846 (30.8)	104 (3.8)	14 (0.5)	123 (4.5)	1,173 (42.7)	2,749 (100)

Table 6 Patient disposition from emergency department ($n = 2,855$)

Disposition	Frequency	Proportion (%)
Discharge	1,974	69.14
Transfer (operating room)	517	18.11
Admit	84	2.94
Transfer (another facility)	62	2.17
Death	29	1.02
Transfer (intensive care unit)	14	0.49
Missing	175	6.13
Total	2,855	100

emphasized from a public health perspective, the proportion of patients utilizing surgical services in this study population underscores the need for surgical services in this setting. This finding in Cameroon adds to the growing evidence that surgical services are a neglected priority in improving health systems in low- and middle-income countries [30–32].

Information on the cost incurred by patients to obtain treatment can be difficult to obtain and is often useful in the evaluation of the impact of injury on vulnerable populations. Additionally, direct treatment costs may inform future interventions at a policy level to improve access to care by addressing potential financial barriers and cost-effectiveness of interventions at a population level. In 2009, the average monthly income per capita in Cameroon was approximately $100 USD [27]. The average cost of ED care for injured patients was approximately $18.25 2008 USD, roughly equivalent to just under one week's salary for the average Cameroonian, which was paid out of pocket by nearly every patient. This cost represents only the average cost of the ED course per patient and does not include the costs incurred by further hospital treatment likely to be received by the more seriously injured patients, such as ward care, ICU care, or surgery. Although this sum may seem relatively inexpensive, one week's salary can constitute a significant burden for the many patients who subsist at or near poverty levels and could represent a potential barrier to care. Additionally, these data do not include potential patients who may have chosen not to seek care at a large tertiary care center, specifically due to cost constraints, found to be a deterrent to seeking formal care in other sub-Saharan African settings [33, 34]. Conversely, when viewed from a national population perspective, the aggregate cost of ED treatment for injured patients in this sample suggests cost-effectiveness in terms of potential lives saved [35].

Table 7 Proportion of patients injured by each mechanism who receive a given treatment in the emergency department ($n = 2,818$)

Mechanism	Analgesic/anesthetic medication (%)	Emergency radiology (%)	Procedural or operative treatment (%)	Medical resuscitation (%)
Road traffic injury	52	28.9	23.2	18.3
Fall	54.5	52.1	16.6	22.8
Penetrating trauma	57.8	16.1	51.7	7.2
Blunt trauma	64.7	24.5	23.5	10.8
Animal bite	58.8	8.3	14.4	17.5
Burn	50.7	13	18.2	27.3
Other	39.6	16.6	30.8	21.5
Total (frequency, %)[a]	1456 (51)	753 (26.4)	718 (25.11)	526 (18.4)

[a] Total patients who received each treatment (frequency, proportion)

Table 8 Results of multivariate logistic regression models exploring predictors for disposition outcomes (OR, *p* value)

Outcome (*n*, %)	Male vs. Female	<18 years vs. ≥18 years	ISS ≥9 vs. ISS <9	RTI vs. non-RTI
Death in ED (29, 1.02)	1.08 (0.86)	0.97 (0.96)	3.47 (0.001)	1.48 (0.31)
Went home (1974, 69. 14)	1.08 (0.48)	0.80 (0.12)	0.11 (<0.001)	0.8 (0.028)
Admitted to ward (84, 2.9)	0.76 (0.31)	1.11 (0.73)	0.97 (0.9)	0.76 (0.21)
Transfer (ICU) (14, 0.5)	0.77 (0.68)	1.81 (0.37)	6.67 (0.004)	1.48 (0.48)
Transfer (OR) (517, 18.1)	0.98 (0.9)	1.09 (0.61)	12.39 (<0.001)	1.31 (0.017)
Transfer (other facility) (62, 2.2)	0.91 (0.77)	1.92 (0.037)	3.1 (<0.001)	1.15 (0.61)

Table 9 Data available for injured patients using administrative versus trauma registry sources

Variable	Limbe (administrative)[a]	Yaoundé (administrative)	Yaoundé (registry)
Time period	12 months	12 months	6 months
Number	1713	6324	
Basic demographic variables			
Age, sex, and injury Mechanism	79 %	90 %[b]	97 %
Location	83 %	98 %[c]	96 %[d]
Patient occupation	79 %	0	93 %
Clinical data			
Blood pressure	13 %	0	98 %
Heart rate	7 %	0	99 %
Respiratory rate	2 %	0	99 %
Glasgow coma score	7 %	0	96 %
Injury severity score	8 %	0	97 %
Revised trauma score	2 %	0	96 %
Kampala trauma score	N/A	0 %	97 %
Transport time	4 %	0	92 %
Patient disposition from ED	45 %	99 %	94 %

Administrative data are from previously published reports [13, 17]

[a] Limited to patients 15 years or older

[b] Intentional injury was associated with missing information on specific mechanism in 38.5 % of cases

[c] Although location of injury was present in 98 % of cases, the specificity of this information was limited to "Inside Yaounde" and "Outside Yaounde"

[d] In this case, location of injury was precise, including quartier of the city or name of the village, if outside of Yaounde

This pilot study demonstrates the increased quality and quantity of data available through a prospective surveillance system compared with reliance on medical records. Additionally, the resulting data are less subject to the biases often associated with record data [36]. While there are clear benefits to prospective data collection, the instruments and methods used should be scrutinized for sustainability, given the resource constraints in most developing country settings [36, 37]. The instrument used in this pilot study was useful in collecting data that are typically difficult to obtain, but this was achieved at the cost of human resources and training, likely unsustainable for long term data collection in this setting. A modified, simpler version would be easily sustainable and deliver a number of core variables necessary for a basic trauma registry [17]. Such a trauma registry could deliver information on the cause of the injury, nature of the injury, severity, interventions delivered, and outcome [20, 36]. An appropriate next step is identification of such "core" variables to include in a trauma registry applied in Cameroon [13, 20, 38–41].

Limitations of this study include the selection bias inherent in data collection that is hospital based [42]. Although CHY is an urban center and therefore is more likely to be utilized by its catchment population, it is very likely that the number of injured patients captured by this pilot study underestimates the true injured population in Yaoundé due to lower utilization of formal care in this context. Additionally, ED mortality was only 1% in this study, which is also likely to be grossly underestimated. Injuries resulting in on-scene mortality are often not captured in hospital-based data collection, because these individuals are often taken directly to the morgue. Patients who are in critical condition, and therefore quickly transferred to the operating room, ICU, or admitted to the hospital, also may have injuries that result in mortality later in their hospitalization but are not represented by ED mortality.

Another limitation is the information available in this context to score injury severity. Injury severity is reported here using several methods, including the "estimated Injury Severity Score." Injury severity score (ISS) is often reported in LMIC reports, with the implied understanding that the information sources (radiologic and operative findings) often used to accurately score anatomic injury are frequently unavailable for many patients in these settings due to resource limitations [22, 43]. Due to the patient flow and hospital record-keeping difficulties previously described, the

estimation of injury severity in this report is limited to the ED context, excluding operative or radiologic information that may have been available in the patient's hospital course beyond the ED. To reflect these subtleties of anatomic scoring in this LMIC setting, the term "eISS" was used, which was described in a high-income setting as a scoring system consisting of estimated AIS based on only the information available in the trauma resuscitation and found to have a high correlation with traditional ISS [23]; however, the resultant likely underestimation of injury severity using this method must be appreciated.

Finally, while the prospective nature of this method allows for an overall improvement in the detail and variety of injury data collection, each patient was approached for consent and entered in the study on a voluntary basis, resulting in an estimated capture of 91 %. This rate may reflect a combination of limitations: injured patients who are in pain are understandably unlikely to want to participate; additionally, several multicasualty events occurred that overwhelmed the system both in terms of clinical care and the research assistants' ability to capture all the patients. Review of the retrospective, administrative data does not allow for an estimation of how many records were captured, so a comparison cannot be made to this method. Missing data are a problem even in the most advanced data collection systems available. The National Trauma Data Bank, widely used for both research and quality improvement in the United States, routinely lacks information for common variables, resulting in incomplete records 13 to 25 % of the time [44, 45]. Despite this limitation, it is still viewed as a rich and valuable source of trauma data both domestically and internationally. Similarly, the limitations of prospective data collection in Cameroon must be weighed against the advantages, and resulting data must be interpreted with both in mind.

This pilot study used 24-hour research assistants to provide thorough data collection, given the challenges in this environment. While this provided a thorough foundation for future work and prioritization in Cameroon, 24-hour surveillance is not sustainable on a longer-term basis. This pilot study will help to inform which variables should be used minimum data set for future prospective trauma registry work in Cameroon. Additionally, this pilot study provided the experience necessary to suggest how information gathering can be streamlined into the process of clinical care, by potentially creating a short form that could be used as a medical record and trauma registry intake form in one instrument. With adequate intake information, labor costs could be reduced to several 0.5 full-time equivalent (FTE) research nurses and one 0.5 FTE data coding and entry research assistant, estimated to be adequate support at a feasible cost in another sub-Saharan African setting [43].

These findings reiterate the importance of trauma as a contributor to the burden of disease seen in the hospital system in Cameroon, identify vulnerable populations for focused injury prevention efforts, and underscore the importance of surgical intervention in the treatment of trauma patients. Prospective data collection systems provide an opportunity for more thorough and complete information with which to inform prevention and treatment efforts [36, 46]. This pilot study was the first prospective trauma registry performed in Cameroon and created a unique opportunity for hospital staff at the Central Hospital of Yaoundé to quantify the frequency and pattern of injury cared for at their hospital. At the conclusion of data collection, results were presented at a meeting hosted by Cameroon's Ministry of Public Health that included multiple stakeholders, including representatives from national health care, police, and research leadership. The findings of this prospective data collection system generated interest in the Ministry of Public Health in trauma in Cameroon, ultimately enabling stakeholders to successfully advocate for creation of a national injury committee in Cameroon.

The creation of a prospective trauma registry in Cameroon is both feasible and practical. This pilot study illustrates the advantages of the prospective approach, as well as illustrates areas for optimization in the future. Prospective collection of hospital-based trauma data provides valuable information on trauma epidemiology and can be used as data-driven advocacy for furthering policy on injury prevention and treatment.

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