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RESEARCH ARTICLE

Trauma Surveillance and Epidemiology in Haiti: A Pilot Study

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ABSTRACT

Introduction: Trauma remains a leading cause of mortality worldwide, with eighty-nine percent of deaths occurring in low-to-middle-income countries (LMIC). In Haiti, the mortality rate due to injuries is estimated to be twice the rate of the United States. Currently, no standardization of reporting trauma statistics exists in Haiti. The purpose of this project was to pilot a trauma surveillance logbook at four hospitals in four different regions of the country.

Methods: A 17-item registry logbook was developed. Training for emergency department (ED) staff was performed on an iPad for 8-10 minutes. Data collection took place prospectively over four weeks. After this period, the logbook was compared to ED registries, and data was collected retrospectively for unrecorded, qualifying patients.

Results: Eleven to sixty-nine patients were included in data analysis. The average age of patients was 27.3 years (range 0.25–87) and 68.1% were male. The majority of injuries were seen in patients ages 15–29. The highest number of patients presented on Fridays, and the highest volume of patients per hour occurred in the afternoon nursing shift (1 to 7 pm or 2 to 8 pm). The majority of patients arrived alert (94.7%), within four hours of their injury (77.9%), and by motorcycle (35%). The three most common mechanisms of injury were traffic accident (37.7%), fall (17.0%) or knife/cut wound (12.6%). The upper extremity (33.6%), lower extremity (30.8%) and the head/neck (26.7%) were the most commonly injured body regions. Treatments received in the ED are presented for 90.1% patients with the majority receiving minor and medical treatment (46.9%), and discharge status was recorded for 1009 (86.3%) patients, with 54.9% simply being treated and discharged.

Discussion: Trauma and injury surveillance has become a national priority in Haiti. This study represents an initial attempt to qualify the burden of trauma-related disease in the country to make data-informed decisions regarding resource allocation and injury prevention programs.

Keywords: Haiti, Pilot, Registry, Surveillance, Trauma

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INTRODUCTION

In 2010, the Global Burden of Disease study estimated the total number of deaths related to injuries worldwide to be 5.1 million, up 24% from 4.1 million in 1990.[1] The burden of disease is unevenly distributed among high-income countries (HIC) and low-and-middle income countries (LMIC) with 89% of deaths from injury occurring in LMIC.[2,3] In the region of the Americas, injury moved from the 4th leading cause of death in 2000 to the 3rd leading cause of death in 2011.[2] Haiti, the poorest country in the western hemisphere is no exception. Indeed, the age-standardized mortality rate for injuries in Haiti is estimated to be 89/100,000, approximately 1.5 times the rate of its neighbor, the Dominican Republic (66/100,000), and the twice the rate of the United States (44/100,000).[4]

Most mortality estimates in Haiti come from model-based analyses. Currently, no standardized surveillance system exists in Haiti for tracking occurrence and outcomes of injury-related disease burden although limited historic data is available. In 2003, Schultz et al compared the development of a provider-based registry versus a coordinator-based registry at a single health care center in Haiti.[5] They demonstrated improved outcomes and greater feasibility of a provider-based registry that could be filled out by nurses and physicians directly involved in patient care. They recommended wider implementation of a provider-based registry throughout the country; however, limited funding and support for the registry system prevented its global utilization. More recently, Dewberry and colleagues conducted a trauma capacity assessment at seven hospitals in Haiti, identifying limitations in facilities, staffing, and equipment.[6] During the

course of their evaluation, they observed that there was no uniformity across the nation for recording patient and injury characteristics. Each hospital varied as to what information was logged and reported. Their study highlighted the need for more thorough trauma education, improved access to resources, and a uniform national trauma registry.

Registry implementation has been proven to reduce morbidity and mortality and contribute to standardization, organization, and improved quality of care.[7-10] A number of other LMICs have had success piloting and implementing trauma surveillance systems.[7, 11-18]

The purpose of the current research project was twofold: to develop and pilot a standardized injury surveillance tool at four hospitals in Haiti; and to summarize the trauma burden and epidemiology in Haiti from the data collected.

METHODS OF RESEARCH

Settings

This pilot project took place within the EDs of four hospitals in Haiti. The first is Hopital Immaculee Conception (HIC) in Les Cayes in the Sud department. HIC is a tertiary care facility that serves a population of 763,176 people (with 100 beds and two operating rooms). The second hospital was Hopital Universitaire Justinien (HUJ) in the Nord Department. Located in Cap Haitien, this tertiary care hospital serves a population of 1,050,922 people throughout the department (with 300 beds and three operating rooms). Third, L'hopital Providence in Gonaives (HPG) serves the Artibonite Department with a population of 1,701,220 people (with 200 beds and a block of operating rooms). Lastly, Hopital de l'Universite d'Etat d'Haiti (HUEH) is located in Port-au-Prince in the Ouest Department. It is a tertiary care facility that serves 3,968,343 people in the metro area (with 500 beds and 12 operating rooms). Statistics come from the 2014 trauma capacity evaluation.

Instrument

The surveillance logbook was developed in collaboration with Le Ministère de la Santé Publique et de la Population (MSPP). Existing registries from Uganda, Jamaica, and other low-income countries, including a provider-based registry previously piloted in Haiti in 2003, provided templates.[5,11-17] The tool was developed in English and then translated into French. It included demographic and injury information in 17 categories. Data collected by free response included date and hour of arrival, name, age, date of birth, address, and vital signs. Data collected by check-list format included gender, neurologic status, time to ED presentation, mode of transportation to the hospital, injury mechanism, injury location, body zone injured, injury type, other medical conditions, injury severity, procedures or treatment received in the ED, and discharge status from the ED (Fig. 1). The format of the data collection page was trialed at Hopital Bernard Mevs in Port-au-Prince in February 2015 for one week. Each page had space to collect information on two patients, and the logbook had the capacity to capture data on 400 patients.

Study Design and Procedures

This prospective study was reviewed and deemed exempt from Emory University Institutional Review Board approval because of its quality improvement nature and because it was designed to simply collect injury surveillance data. It was similarly reviewed by the National Bioethics Committee of Haiti. The study took place from July 6, 2015 to August 24, 2015, and began with the research team being present at each hospital for one week. Over the course of the week, investigators (EL and MCI) provided an 8 to 10 minute training for hospital administrators, medical directors, nurses, physicians, and healthcare workers during the morning, afternoon, and night shifts. The purpose of the training was to introduce the larger trauma system goals of the Ministry of Health and the aims of our current project, as well as to instruct the staff on the logistics of completing the survey for trauma patients. Training sessions were provided multiple times over the course of 3-4 days with a Haitian Creole translator available to ensure the inclusion and understanding of all nurses and physicians who would be working in the EDs during the study time frame.

Once training was complete, data was collected on all patients presenting with trauma or injuries at each hospital for a four-week pilot period. The new logbook did not replace charting or recording of patient data within the pre-existing ED registries. A weekly phone call was implemented to the ED director and the charge nurse at each hospital in order to ensure ongoing utilization of the logbook and to troubleshoot any issues that had arisen. Ultimately, data was collected for four weeks at each hospital. When the study team returned to the hospital, the trauma surveillance logbook was compared to the existing ED registries. For patients not captured in the logbook, who had a medical record number and an available medical chart, the research team conducted a retrospective chart review to record data on missed patients and, thus, more accurately reflect the trauma population presenting to each hospital. After the surveillance logbook was deemed complete, data was de-identified, photographed, and kept on a password-protected iPad. The information was then coded and transferred to a

Date/heure d'arrivée	**Nom de famille, prénom**	Date de naissance, âge	Sexe	Quartier / Adresse	Signes vitaux	État neurologique	Temps depuis la blessure	Mode de transport à l'hôpital
__/__ /___ ___:___		__/__ /___ _____ yrs	M / F		TA:___/___ P: ____ R:____ Temp: ____ O2Sat: ___	__ Alerte __ Stim verbale __ Stim douloureux __ Ne répond pas	__< 4 heures __4-24 heures __>24 heures	__à pied __ hôpital ambulance __voiture privée __ CAN ambulance __moto __ hélicoptère __taxi

Origine/Cause de la blessure	Le lieu du blessure	Zones du corps blesses	Type de blessure	D'autres blessures médicales	Procédure / traitement	Décharge
__Véhicule (__Passager ou __Conducteur) __Moto __ Coup de feu __Piéton heurté __ Brûlere __Chute __ Couteau __Autre:_____ Nombre de blessures graves: __0 __1 __>1	___Maison ___Travail/industrie ___Route/rue ___école ___Ferme ___Sport/récréation ___Bâtiment public ___Autre:_____	___Tête/cou ___Visage ___Poitrine ___moelle épinière ___Abdomen ___Bassin /périnée ___Extrém. supér. ___Extrém. infér. ___Dos ___Autre:_____	__Lacération __Contusion __Fractures [__ouverte vs ___ fermée] __Pénétrant __émoussé __Dislocation __Aucun visible	__ crise cardiaque __ AVC __ état septique __ insuffisance rénale __ BPCO/emphysème __ acidocétose diabétique __Autre : _____	__Attelle/plâtre __Traction __Rayon X __Ultrason __Fluides IV __ Antibiotiques __Transfusion sanguine __Lacération réparation __Analgésie __Collier cervical __Pansement __Traitement médical __Drain thoracique /Thoracotomie	__Traité / Accueil envoyé __Admis ___ service général ___ ICU ___ obstétrique ___ chirurgie __Transféré __ Gauche avant la sortie __ Mort à l'arrivée __ Morts dans le département

Date/heure d'arrivée	**Nom de famille, prénom**	Date de naissance, âge	Sexe	Quartier / Adresse	Signes vitaux	État neurologique	Temps depuis la blessure	Mode de transport à l'hôpital
__/__ /___ ___:___		__/__ /___ _____ yrs	M / F		TA:___/___ P: ____ R:____ Temp: ____ O2Sat: _____	__ Alerte __ Stim verbale __ Stim douloureux __ Ne répond pas	__< 4 heures __4-24 heures __>24 heures	__à pied __hôpital ambulance __voiture privée __ CAN ambulance __moto __ hélicoptère __taxi

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__ Véhicule (__Passager ou __Conducteur) __Moto __ Coup de feu __Piéton heurté __ Brûlere __Chute __ Couteau __Autre:_____ Nombre de blessures graves: __0 __1 __>1	___Maison ___Travail/industrie ___Route/rue ___école ___Ferme ___Sport/récréation ___Bâtiment public ___Autre:_____	___Tête/cou ___Visage ___Poitrine ___moelle épinière ___Abdomen ___Bassin /périnée ___Extrém. supér. ___Extrém. infér. ___Dos Autre:_____	__Lacération __Contusion __Fractures [__ouverte vs ___ fermée] __Pénétrant __émoussé __Dislocation __Aucun visible	__ crise cardiaque __ AVC __ état septique __ insuffisance rénale __ BPCO/emphysème __ acidocétose diabétique __ Autre : _____	__Attelle/plâtre __Traction __Rayon X __Ultrason __Fluides IV __ Antibiotiques __Transfusion sanguine __Lacération réparation __Analgésie __Collier cervical __Pansement __Traitement médical __Drain thoracique /Thoracotomie	__Traité / Accueil envoyé __Admis ___ service général ___ ICU ___ obstétrique ___ chirurgie __Transféré __ Gauche avant la sortie __ Mort à l'arrivée __ Morts dans le département

Fig. 1 : Patient Logbook page: The logbook (translated into French) collected demographic, vital sign, neurologic status, injury characteristics, interventions and outcomes data on each trauma/injury patient. It was mostly a fill-in-the-blank or checklist format with 17-items per patient. Each book had the capacity to collect data on 400 patients.

Microsoft Excel spreadsheet on a password-protected computer in order to be analyzed.

Data Analysis

Injury data collected from the trauma surveillance survey was quantitative and is generally presented as means, ranges or percentages. Comparisons between gender were made using chi-square analysis. Statistical analysis was performed with IBM SPSS v 22 (IBM Corporation, Armonk, NY).

RESULTS

Data on patients presenting with injuries were collected and recorded at all four hospitals for four weeks each in 2015. HIC from July 6 to August 2, HUJ from July 17 to August 13, HPG from July 21 to August 17, and HUEH from July 27 to August 23.

Patient Inclusion

During the one-month pilot period, approximately 6,060 ED patient encounters occurred across the four hospitals. In total, 1369 patients presented with trauma or injury, representing 22.6% of patients presenting overall to the ED. Of those patients, 556 (40.6%) were recorded in the surveillance logbook by ED intake staff. An additional 813 patients were identified by research staff in the ED registry logbooks qualifying for the study. A total of 200 patients were excluded because they lacked an MRN or chart, leaving 613 patients to be recorded by associate investigators through retrospective chart review. In total, 1169 cases met the study criteria and were analyzed (Fig. 2).

Demographics

The average age of the patients was 27.3 years (range 0.25–87). The largest group of patients was ages 15–29 (40.2%), followed by 30–44 (23.7%) years. Male patients totaled 779 (68.1%) and female patients represented 365 (31.9%) of the cohort. Demographics and vital signs are presented in Table 1.

Injury Presentation

Information on the mode of transport from the location of injury to the ED was available for 621 (53.1%) of the patients. The most frequent mode of transport was motorcycle (216/621, 34.8%), followed by on foot (128/621, 20.6%), and private car (108/621, 17.4%). The least frequently utilized services were the CAN ambulance system (4.3%), hospital ambulance (3.9%), and Ayiti Air Ambulance helicopter (0%). Upon presentation, 94.7% of patients were alert; whereas, 2.4% were unconscious. Neurologic status was recorded for 61.8% of patients. A complete set of vital signs, including oxygen saturation, was recorded for 276/1169 (23.6%) of patients.

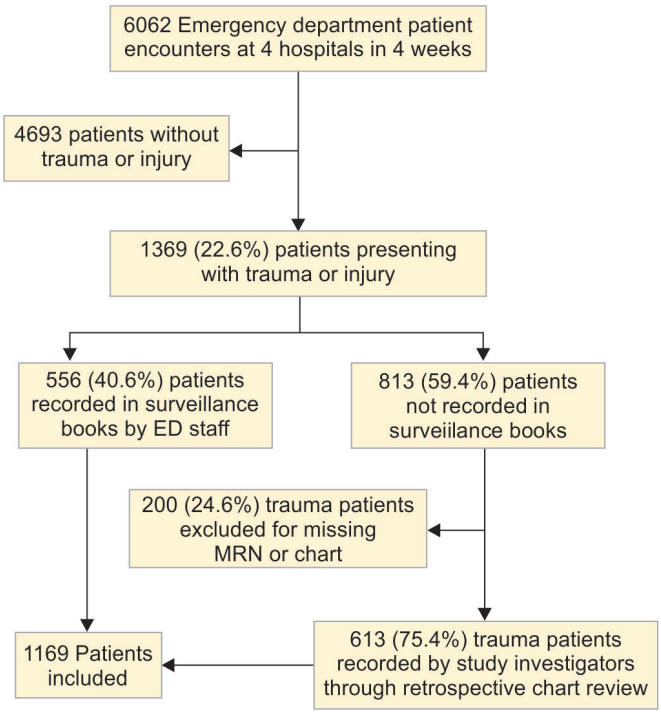

Fig. 2: Patient Inclusion: More than 6000 patient encounters were observed over the 1-month study at all four hospitals, with 1369 (22.6%) of these encounters relating to trauma. Of all injuries seen, 1169 patients were included in the trauma analysis (556 recorded prospectively by ED staff and 613 recorded retrospectively by research staff). 200 injury encounters were excluded due to limitations on availability of information for these patients.

Individually, pulse was most frequently recorded (61.1%) and oxygen saturation was logged least commonly (41.2%). Average systolic pressure was 122 mm Hg (SD 19.8, range 40-220); diastolic pressure averaged at 77 mm Hg (SD 14.5, range 20-180); pulse averaged 91.4 beats/minute (SD 16.65, range 0-160); respiration rate was 23.7 breaths per minute on average (SD 4.37, range 0-48); the mean temperature was 36.7°C (SD 0.67, range 32.7-39.4) and oxygen saturation averaged 97.3% (SD 4.91, range 0-100).

Injury Characteristics

An overview of patients with injuries as they were distributed by gender is presented in Table 2. Injury mechanism was recorded in 1019 (87.2%) patients. The most common mechanisms in the cohort were traffic crashes (including vehicle, motorcycle, and unspecified mode of transportation), occurring in 384 (33.6%) patients. Falls and knife wounds/lacerations were the next most common mechanisms affecting 175 (15.3%) and 129 (11.3%) patients, respectively. The distribution across gender remained similar for the top three mechanisms. More details presented in Table 1. Conversely, odds of being injured by an animal (OR 4.71; 95% CI = 2.02, 11.01; $x^2 = 15.33$, $p < 0.0005$), burn (OR 2.47; 95% CI = 0.89, 6.87; $x^2 = 3.21$, $p = 0.07$), or as a pedestrian (OR 2.04; 95% CI = 1.00, 4.18; $x^2 = 3.98$, $p < 0.05$) was significantly greater in females than males. On the other hand, gunshot wounds occurred more frequently in the male population with an odds ratio of 2.88 (95% CI = 1.11, 7.49; $x^2 = 5.16$, $p < 0.05$). Variation in mechanism existed by age group as well. Falls were the top mechanism of injury for children under 5 and ages 5 to 14, followed by traffic or unknown injury mechanism. In the 15 to 29, 30 to 44, 45 to 59 and 60+ age groups, traffic was the number one mechanism; yet the second most common mechanism was different for each group. In the 15 to 29 age group, knife or cut wounds were second; in the 30 to 44 age group, general assault or aggression was second; falls were the next most common injury after traffic for the 45 to 59; and unknown injury mechanism was second for 60+.

Table 1: Patient Demographics and Vital Signs

Characteristic	*Value*
Average age (N = 1109)	27.3 years
Range	0.25–87 years
Standard Deviation	15.7 years
Gender (N = 1144)	
Male	779 (68.1%)
Female	365 (31.9%)
Average Systolic Blood Pressure (N = 621)	122 mmHg
Range	40–220 mmHg
Standard Deviation	+/– 19.8
Average Diastolic Blood Pressure (N = 621)	77 mmHg
Range	20-180 mmHg
Standard Deviation	+/– 14.5
Average Pulse (N = 714)	91.4 bpm
Range	0-160 bpm
Standard Deviation	+/– 16.65
Average Respirations (N = 599)	23.7 breaths/minute
Range	0-48
Standard Deviation	+/– 4.37
Average Temperature (N = 678)	36.7 °C
Range	32.7-39.4 °C
Standard Deviation	+/– 0.67
Average Oxygen Saturation (N = 482)	97.3%
Range	0-100%
Standard Deviation	+/– 4.91

Place of injury was recorded in 732 patients (62.6%). It was noted that 61.6% (451/732) of injuries occurred on the road (regardless of mechanism), followed by 27.0% (198/732) occurring in the home, and 5.3% (39/732) in the workplace. While the rank order of place of injury remains the same across gender, it should be noted that the odds ratio for a female experiencing an injury in the home is 1.66 times that of a male (95% CI = 1.21, 2.27; $x^2 = 9.96$, $p < 0.005$). On the contrary, odds of a male being injured on the farm was 4.25 times a female injury on the farm (95% CI = 0.54, 33.71; $x^2 = 15.1$, $p < 0.0005$) and 3.32 times greater in a sports setting (95% CI = 0.75, 14.69; $x^2 = 2.81$, $p = 0.09$). Odds of a male being injured at work were 2.65 times greater than a female (95% CI = 1.10, 6.37; $x^2 = 5.07$, $p < 0.05$). Time to ED presentation after

Table 2: Overview of Injuries

Characteristic	*Male N (%)*	*Female N (%)*	*Total*
Age (N = 1088)			
< 5	46 (6.1%)	21 (6.2%)	67 (6.2%)
5–14	94 (12.5%)	54 (16.0%)	148 (13.6%)
15–29	320 (42.6%)	139 (41.2%)	459 (42.2%)
30–44	207 (27.6%)	67 (19.9%)	274 (25.2%)
45–59	55 (7.3%)	34 (10.1%)	89 (8.2%)
+60	29 (3.9%)	22 (6.5%)	51 (4.7%)
Total	751 (100%)	337 (100%)	1088 (100%)
Mechanism (N = 1019)			
Traffic*	274 (35.2%)	110 (30.1%)	384 (33.6%)
Fall	122 (15.7%)	53 (14.5%)	175 (15.3%)
Knife/Cut	84 (10.8%)	45 (12.3%)	129 (11.3%)
Other-Assault	80 (10.3%)	31 (8.5%)	111 (9.7%)
Other-Unspecified	44 (5.6%)	16 (4.4%)	60 (5.2%)
Other-Glass/Metal	34 (4.4%)	20 (5.5%)	54 (4.7%)
Gunshot Wound	30 (3.9%)	5 (1.4%)	35 (3.1%)
Pedestrian	16 (2.1%)	15 (4.1%)	31 (2.7%)
Other-Animal	8 (1.0%)	17 (4.7%)	25 (2.2%)
Burn	7 (0.9%)	8 (2.2%)	15 (1.3%)
Total	699 (100%)	320 (100%)	1019 (100%)
Location (N = 732)			
Road	330 (64.0%)	121 (56.0%)	451 (61.6%)
Home	116 (22.5%)	82 (38.0%)	198 (27.0%)
Work	33 (6.4%)	6 (2.8%)	39 (5.3%)
Sport	14 (2.7%)	2 (0.9%)	16 (2.2%)
Other	10 (1.9%)	2 (0.9%)	12 (1.6%)
Farm	9 (1.7%)	1 (0.5%)	10 (1.4%)
Public Space	3 (0.6%)	1 (0.5%)	4 (0.5%)
School	1 (.2%)	1 (0.5%)	2 (0.3%)
Total	516 (100%)	216 (100%)	732 (100%)
Discharge (N = 965)			
Discharged w/o	359 (54.6%)	181 (58.8%)	540 (56.0%)
referral	37 (5.6%)	13 (4.2%)	50 (5.2%)
Discharged w/ referral	66 (10.0%)	23 (7.5%)	89 (9.2%)
Admission	68 (10.4%)	29 (9.4%)	97 (10.1%)
Observation	9 (1.4%)	3 (1.0%)	12 (1.2%)
Death	35 (5.3%)	17 (5.5%)	52 (5.4%)
Left AMA	83 (12.6%)	42 (13.6%)	125 (13.0%)
In Hospital Referral	657 (100%)	380 (100%)	965 (100%)
Total			

*Traffic includes vehicle driver or passenger, motorcycle, taxi, and unspecified modes of transportation.

injury was logged for 845 (72.3%) patients and the majority (658/845, 77.9%) were brought into the department within four hours. A minority, 6.4%, presented over 24 hours after the injury occurred.

The tool collected information on the body area affected by the trauma, and 1128 (96.5%) had data recorded. The majority of patients, 867/1128 (76.9%), only had one body region injured whereas almost a quarter of patients (261/1128, 23.1%) had two or more body areas affected. The body regions most commonly injured overall, irrespective of individual versus multiple injuries, were the upper extremity (379/1128, 33.6%), the lower extremity (347/1128, 30.8%) and the head/neck (301/1128, 26.7%). In analyzing types of injuries, data was recorded on 1071 patients. For those patients with information available, the majority of patients had single injury types (84.9%) yet 15.1% had two or more injury types. The most common individual injury types were laceration (45.6%), fracture (14.2%), and contusion (8.5%). Two injury types occurred in 13.2% of patients, and 1.9% of patients had three or more injuries.

Treatment and intervention in the ED was logged for presenting injury patients, and 1047 (89.6%) patients had the information listed in the logbook. Treatments were coded into four categories: diagnostic intervention (X-ray and ultrasound), minor treatment (IV fluids, laceration repair, bandages, cervical collar), major treatment (cast/plaster, traction, blood transfusion, thoracic drain), and medical treatment (analgesia, antibiotics, other medication). The majority of patients received a minor treatment and a medication (491/1047, 46.9%), a minor procedure only (165/1047, 15.8%), or medication only (109/1047, 10.4%). Major interventions were only performed on 6.5% of patients either solo or in conjunction with diagnostic and medical treatment (76/1047, 6.5%).

Data on discharge from the ED was available for 965 patients (82.5%) in the study. The majority (540/965, 56.0%) were treated and discharged (without a referral or recommendation for follow-up). A smaller portion were solely referred to another service (125/965, 13.0%), or admitted for the severity of their injuries (89/965, 9.2%). Referral specialties include general surgery, orthopedics, ORL (ear, nose, and throat), ophthalmology, internal medicine, neurosurgery, etc. Thirteen patient deaths were recorded, including those that were dead on arrival or that died in the ED as a result of their trauma.

Temporal Factors Related to Trauma

Most of the patients presenting with injury arrived on a Friday (228, 19.6%). Tuesday and Wednesday were the next two days of the week with the highest volume of patients (167, 14.3% and 163, 14.0%). Hourly data was captured for 826 patients, and a temporal distribution was identified (Fig. 3). A linear rise in trauma volume occurs from 4 a.m. to 12 noon and then plateaus through the afternoon until 11 p.m. when numbers start to decrease. Shift data was collected on 1035 patients. At all four hospitals, the morning and afternoon shifts are 6 hours (either 7 am to 1 pm. and 1 to 7 pm or 8 am to 2 pm and 2 pm to 8 pm) and the overnight shift is 12 hours (7 pm. to 7 am or 8 pm to 8 am). When analyzed as patients per week per hour, the afternoon shift was discovered to be the highest volume period of trauma with 14.5 patients/hour seen on average

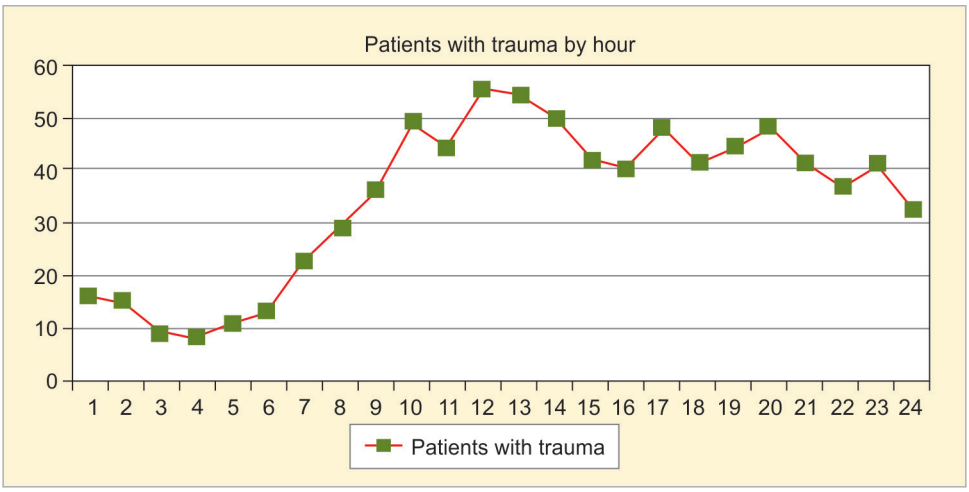

Fig. 3: The number of patients presenting to the emergency departments across the study by hour of the day. There is a linear rise over the morning with a peak at 1200. Volume plateaus until approximately 2300 when it begins to decrease in the late night and early morning.

across the four hospitals. The morning burden was 12.5 patients/hour and overnight volume was 8.1 patients/hour.

DISCUSSION

Trauma registries are an integral part of a functional trauma system. They allow health officials and policy makers to track characteristics and circumstances surrounding patient injuries in a standardized fashion. Data collected can be utilized to produce epidemiological statistics and to inform prevention and management strategies. It has been recommended that a successful surveillance system should be simple, acceptable, practical, affordable, and non-burdensome, particularly when implemented in a low-resource country.[19] In this pilot study, we were able to demonstrate that a standardized a registry can be implemented within four EDs in Haiti, and epidemiologic statistics and future prevention strategies could be produced.

The surveillance logbook tracked patient demographics and injury mechanism. Demographically, the trauma population in Haiti is young (27.3 years) and predominantly male (68.1%), similar to the trauma population in the United States. This summary is also concordant with the international trauma literature.[13-15] The top injury mechanisms across the Haitian nation were traffic crashes, falls, and knife wounds/lacerations, occurring most frequently on the street or in the home. Our findings are consistent with surveillance studies in Rwanda, Cape Town, and Trinidad, where falls, sharp objects, and traffic are top mechanisms of injury[13-15] with the road and household being the most common place of injury.[14,17] It has been suggested that the rate of traffic crashes is higher in LMIC because of poorer transportation infrastructure, more frequent utilization of open vehicles like motorcycles, and a general lack of laws and regulations and their enforcement.[14,20]

With demographic and mechanism knowledge, Haiti can focus education and prevention strategies to target a younger, male population, while emphasizing the high yield mechanisms. For example, proper utilization of safety equipment such as seat belts and helmets necessary to reduce road traffic injuries and techniques for the safe handling of knives and machetes could be introduced in primary school. This early provision of information is especially critical as the majority of the population in Haiti only attends primary school. Other culturally sensitive approaches could be utilized as well. Public service announcements could be integrated into the church sermons and radio broadcasting in order to reach a more widespread audience throughout the country.

The pilot registry also allows health officials to track patient outcomes. The majority of patients in this study received minor procedures plus medical treatment or only a minor or medical treatment. A major procedure, either by itself or in combination with other interventions, was only performed in 6.5% of the study population. Unfortunately, it is difficult to differentiate between ability to provide versus the need for major medical treatments in this data set. This is an area for further research. Similarly, it is important to note that 122 patients (10.4% of the study population) had no treatment or intervention recorded and 52 (5.4% of discharges recorded) left against medical advice or before being seen by a physician. An integral part of a successful trauma system is having the capacity to provide the needed care when patients present.[15] Long wait times, lack of supplies, and inability of patients to pay for equipment can create barriers to care. While the pre-hospital ambulance system is, unfortunately, under-funded in the country and mostly

relegated to Port-au-Prince, certain organizations have tried to address patient differences in socioeconomic status. For instance, the Haiti Air Ambulance, a helicopter and ground-based transport company, assigns fees based on patients' means, equating to free service for those in the lowest income bracket.[21] It would also be important to collect data on the financial burden of care; though, this was not within the purview of the current study. More work and legislation are needed overall to reduce cost as a barrier to care.

Another important aspect of this data set is that it provides information related to the limited use of existing pre-hospital resources. The majority of patients arrived to the ED on motorcycle, by foot, or in a private car. The CAN and hospital ambulances were used for less than 10% of patients. In Haiti, a centralized emergency contact system, such as dialing 9-1-1, does not exist. This potentially contributes to the paucity of emergency services used. The helicopter, or Ayiti Air Ambilans, which had been available in the country for approximately 15 months at the time of the study, was not used at all. Future community education could include the best means of contacting emergency transport services for more severe injuries.

The registry also demonstrated that the highest burden of trauma occurs during the afternoon shift (1 to 7 pm. or 2 to 8 p.m depending on the region) and the weekdays, with the highest volume on Fridays and Tuesdays. This differs slightly from the international literature, when the night and the weekend days tend to be the time periods with the highest number of trauma patient presentations. While there are a number of factors that could be contributing to this finding in our study, one in particular stands out. Haiti as a country is not very active at night based on availability of electricity and power. Very few restaurants, markets, or bars stay open late, and many street lights do not remain on overnight.

Having the capacity to track hourly and weekday data related to the occurrence of traumatic injuries can be utilized to reallocate and redistribute human resources. Collecting hourly data is beneficial for providers as well; data from an urban center in the United States demonstrated that tracking the peak hours of trauma arrivals allows residents and supervisors to shift work schedules, thus allowing for maximal training while on shift.[22] In our observation, the morning shifts tended to be the most well-covered with staff; it's possible that patient care and education exposure could be improved by increasing the number of nurses and physicians working in the EDs in the afternoon.

Finally, an important factor that contributes to the success of a trauma registry within a nationwide system is the feasibility of utilization.[19] High quality patient care should always be the main focus and role of the staff in the ED, and completing the registry should not detract from caregiving. While the time to complete the checklist format of the registry is usually 1–2 minutes per patient, it's possible that each hospital could benefit by hiring a nurse or a scribe whose main role would be to complete the registry as patients present during shifts. In addition, enacting a 24 to 48 hour review policy in order to compare the surveillance registry to the normal ED registry and overall ensuring accuracy of reporting from the hospital to the Ministry of Health would be beneficial.

This is a pilot study, and thus the intent was simply to prove feasibility. Certain limitations should be noted. While we included four tertiary care facilities, the burden of trauma may be distributed more widely throughout the country. Therefore, the four hospitals included in the study might not have representatively captured the national volume. It is possible that the injury mechanism and outcome profile would be different if more hospitals within the same region or across the nation were included. Additionally, injuries that occur in the workplace may not present to the hospitals included in this study as Office d'Assurance Accidents du Travail, Maladie et Maternité (OFATMA) facilities generally care for patients injured in industrial settings. Similarly, patients with severe trauma who die prior to hospital presentation or with very minor trauma (who may seek care at a small clinic setting) would not be included in this study, leading to an underrepresentation of trauma occurrences in the country. However, this is an important population to capture in trauma research. As our partnership with the Haitian Ministry of Health continues, we hope to add another arm of investigation to capture and analyze patients who do not make it successfully to the hospital in order to determine if pre-hospital mortality can be minimized. Unfortunately, this was not within the scope of this particular study. Moreover, within the four hospitals included, researchers relied on the record-keeping of staff within the logbook for the prospective portion of the study and within medical records for the retrospective portion of the study. Subjectively, it was observed that this paper-based, fee for service system, with limited staff and resources, could be overwhelmed by the high patient volume and need. Paper charting was reduced at times when patients could not afford to pay for a chart or when the patient to nurse ratio climbed too high. Another limitation exists with biases in reporting. Sometimes mechanisms, like falls or burns, were surprising to Haitian providers to be considered a trauma. Training during the first pilot week addressed the variety of mechanisms possible, but not every provider who utilized the logbook was trained by the research staff.

Future directions for this project include opportunities to strengthen the quality of data collection and the trauma system overall. As mentioned earlier, in order to improve the accuracy of patient data logging, it is possible that the hospitals could invest in hiring a nurse or a scribe with the specific role to maintain the registry book. His/her purpose could be to log all patients during the shift while other nurses are collecting history and physical exam on patients. A 24-48 hour check system could be implemented to compare the current ED registry to the trauma surveillance logbook and guarantee complete patient data capture. At the end of the pilot study, the Ministry of Health requested that data continue to be collected for 6 months. Analysis of data over a longer period of time will allow for seasonal variations in trauma to be collected and would hopefully more accurately reflect the overall trauma burden in the country. Recommendations could also be made to expand the regions of data capture to include all ten Departments through data collection at 15-20 hospitals throughout Haiti. Finally, the system could be strengthened by expanding trauma education and services available for patients. Requiring trauma evaluation and management (TEAM), advanced trauma life support (ATLS), or another trauma-specific training course during medical school, nursing school, or first year of residency training could improve ED staff evaluation, triage, and management of incoming trauma patients. Also, by addressing the burden of extremity and head injuries that are occurring throughout the country, hospital care could be strengthened by the greater availability of orthopedic and neurologic surgery services.

In summary, this pilot study demonstrated that a simple, check-list formatted logbook can be successfully implemented in the ED setting in four hospitals in Haiti. Providers found the book acceptable in format and function and supported its further implementation throughout the country. Continuing to collect data at these hospitals and others throughout Haiti will allow the Ministry and hospitals to produce local and national statistics, address the current burden of trauma, and develop appropriate prevention strategies.

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REFERENCES

1. Lozano R, Naghavi M, Foreman K, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380(9859):2095-2128.
2. World Health Organization. Global Health Estimates [Health statistics and information systems webpage]. c2018. Updated 2018. Available from http://www.who.int/healthinfo/global_burden_disease/en/
3. Norton R, Kobusingye O. Global Health Injuries: Review article. N Engl J Med 2013;368(18):1723-30.
4. World Health Organization. Disease burden and mortality estimates [Health Statistics and Information Systems webpage]. c2018. Updated 2018. Available from http://www.who.int/healthinfo/global_burden_disease/estimates/en
5. Schultz CR, Ford HR, Cassidy LD, et al. Development of a hospital-based trauma registry in Haiti: an approach for improving injury surveillance in developing and resource-poor settings. J Trauma Injury Infect Crit Care 2007;63(5):1143-54.
6. Dewberry L, McCullough C, Goss J, Hugar LA, Dente CJ, Sharma J. Trauma capacity in the central plateau department of Haiti. J Surg Res 2014;192(1):34-40.
7. O'Reilly GM, Joshipura M, Cameron PA, Gruen R. Trauma registries in developing countries: a review of the published experience. Injury 2013;44(6):713-721.
8. Cameron PA, Gabbe B, Cooper DJ. A statewide system of trauma care in Victoria: effect on patient survival. Med J Aust 2008;189(10):546-50.
9. Mock CN, Adzotor KE, Conklin E, Denno DM, Jurkovich GJ. Trauma outcomes in the rural developing world: comparison with an urban level I trauma center. J Trauma 1993;35(4):518-23.
10. Gabbe BJ, Simpson PM, Sutherland AM, et al. Improved functional outcomes for major trauma patients in a regionalized, inclusive trauma system. Ann Surg 2012;255(6):1009-15.
11. Mehmood A, Razzak JA, Kabir S, Mackenzie EJ, Hyder AA. Development and pilot implementation of a locally developed trauma registry: lessons learnt in a low-income country. BMC Emerg Med 2013;13:4.
12. Ward E, Arscott-Mills S, Gordon G, Ashley D, McCartney T. The establishment of a Jamaican all-injury surveillance system. Inj Control Saf Promot 2002 Dec;9(4):219-25.
13. Schuurman N, Cinnamon J, Walker BB, et al. Intentional injury and violence in Cape Town, South Africa: an epidemiological analysis of trauma admissions data. Glob Health Action 2015; 8:27016.
14. Nsereko E, Brysiewicz P. Injury surveillance in a central hospital in Kigali, Rwanda. J Emerg Nurs 2010; 36(3):212-6.
15. Ramroop S, Turner MC, Bynoe R, et al. Injury surveillance in Trinidad: an accident and emergency based injury surveillance system at the San Fernando General Hospital. West Indian Med J. 2009; 58(2):118-23.
16. Liu X, Li L, Cui H, Liu X, Jackson VW. Evaluation of an emergency department-based injury surveillance project in China using WHO guidelines. Inj Prev 2009;15(2):105-10.
17. John IA, Mohammed AZ, Lawoko S, et al. Implementing a hospital based injury surveillance system: a case study in Nigeria. Med Confl Surviv 2008; 24(4):273-9.

18. Hutchinson AM, Johnston L. Bridging the divide: a survey of nurses' opinions regarding barriers to, and facilitators of, research utilization in the practice setting. J Clin Nurs 2004; 13(3):304-15.
19. Holder Y, Peden M, Krug E, et al, editors. Injury surveillance guidelines. Geneva, World Health Organization, 2001.
20. World Health Organization. The world report on road traffic injury prevention. c2004. Updated 2004. Accessed February 6, 2007. Available from: http://www.paho.org/English/DD/PUB/Summary_World_ report_Road_safety.pdf.
21. DeGennaro V Jr, Owen, J, Chandler, J, McDaniel, R. Operational Implementation and Lessons Learned from Haiti's First Helicopter Emergency Medical Service. Injury 2016;47(5):1001-6.
22. Watkins CJ, Feingold PL, Hashimoto B, Johnson LS, Dente CJ. Nocturnal violence: implications for resident trauma operative experiences. Am Surg 2012; 78(6): 657-62.

INVITED COMMENTARY

Injury Surveillance, Systems and Capacity Building: Critical Areas for PTS Countries

Ludi et al present an excellent example of a methodical feasibility study of implementing a context-appropriate trauma registry across many facilities in Haiti and using it to examine the burden of injury in detail. Injury is a major problem worldwide with the majority of the burden distributed among low and middle income countries.[1,2] This paper is great example of a multi-institutional collaborative effort with thoughtful engagement of the Ministry of Health in studying an important problem.

While recognition of the injury burden is a key issue, development, implementation and sustainability of injury surveillance programs can be major challenges in resource-limited settings that bear the brunt of the injury burden. PTS has taken the leadership in advocating for trauma systems in Latin America and has supported a freely available trauma registry through VCU's International Trauma Systems Development Program that may be of interest to readers. It can be found here and may be of use to institutions who would like to implement injury surveillance without having the resources to develop a registry or training program.

Lastly, while the buy-in from the Director General of the Haitian Ministry of Health is a critical part of this project. We encourage authors and readers to more actively involve local physicians, administrators, nurses and students in developing and conducting such research and involve them in manuscript writing and publication. Surely there werecollaborators at each facility who recognized the value of implementing this project and whose academic careers could be enriched by being credited with co-authorship on this paper. An essential part of global partnerships is global diplomacy, research capacity building and demonstration of equitable relationships as a model for other partners. Such inclusiveness is also likely to have an impact on overall project sustainability by developing local champions who can lead into the future.

We encourage PTS member countries to review this collaboration's experience and use the many resources available through PTS to study and address the burden of injury in the Americas. As we all know, if you don't measure it, you can't fix it.

REFERENCES

1. World Health Organization. Global Health Estimates Summary Table. http://www.who.int/healthinfo/global_burden_disease/en/
2. Norton R and Kobusingye O. Global Health Injuries: Review article. N Engl J Med 2013;368:1723-30.

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