Original Article

A Retrospective Cross-Sectional Study of Profile Severity and Outcome of Pedestrian Road Traffic Trauma Patients Presenting to the Emergency Department in South India during 2018–2019

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Abstract

Background and Objectives: Pedestrian injuries are a common mode of trauma presenting to the emergency department (ED). This study analyzes the profile, severity, and hospital outcome of these victims. **Methods:** We conducted a retrospective cross-sectional analysis of pedestrian trauma victims who presented to our ED from January 2017 to December 2018. **Results:** During the 2-year study period, our ED received 463 patients with pedestrian trauma. The mean age was 39 (standard deviation: 22.72) years, with a male (309/463: 66.6%) predominance. Based on their hemodynamic stability, majority were triaged as Priority 2 (279/463: 60.2%). Injuries included fractures (49.5%; $n = 229$), lacerations (46.4%; $n = 215$), abrasions: (38.9%; $n = 179$) and brain contusions (23.1%; $n = 107$). Extremities were the most injured (66.6%), followed by the scalp/head (39.9%) and face/neck injuries (20.3%) patients. A New Injury Severity Score of more than or equal to 14 was noted in 64 (13.9%) patients. Most of the victims required surgical (major/minor) intervention as part of their treatment which accounted for 63.9% ($n = 296$) patients. The ED mortality rate was 0.4% ($n = 2$), whereas the in-hospital mortality rate was 2.2% ($n = 8$). **Conclusions:** Middle-aged males were the leading demographic affected by most events taking place in the evening. Extremities were the most injured body part with fractures being the principal type of injury. A significant number of victims had injuries that were grievous and required hospital admission.

Keywords: Collision, emergency department, pedestrian injuries, road traffic accidents, two-wheeler-related injuries

Introduction

Pedestrian accidents are a major safety concern in developing countries and worldwide. With the boom in the usage of motorized vehicles on our country's roads, this is a concern that will only demand increasing attention as time passes. In developing and underdeveloped countries, walking is a common and obvious mode of transport and pedestrian accidents have been increasing in number in these countries.[1]

About one in every ten road traffic accidents in India is a pedestrian crash-related injury.[1,2] As per the National Crime Records Bureau, 10,125 victims suffered from a pedestrian-related injury in India. As per the available literature, death toll for pedestrians in India has increased from 12,330 in 2013 to an alarming 20,457 in 2017.[3] Latest data from the National Highway Traffic Safety Administration (NHTSA) estimates that in 2019, 6205 pedestrians died in traffic crashes occurring on public roads. This same report states that pedestrian

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traffic deaths occurred more in the urban settings (82%), on the open road (73%) versus intersections (26%), and during dark lighting conditions (80%) which are road-related risk factors. World data suggest that in 2016 pedestrian-related deaths were ranked as the sixth cause of premature death and as the eighth cause of death of all ages with 1.35 million annual deaths worldwide.[4,5] World road traffic injury statistics showed that the global economic burden of motor vehicle collisions and pedestrian injuries totals approximately $500 billion a year including medical costs, loss of daily wages, and legal and court loss are also included in these costs[2] Disabilities of neurological functions, vision, speech, hearing, locomotor activities, and psychological functioning are the direct outcomes of injury. The WHO report on disability-adjusted life-years (DALYs) states that five of the top ten causes of death globally are due to injuries. Among the total DALY, 13% were due to injuries. As per the Indian census, the disability rate in India is 2.1% in 2001 for any injuries.[6]

There are many natural, human, and road-related risk factors for a pedestrian injury. According to the NHTSA, the following are found to be the most common: Failure to yield right of way, crossing a roadway or intersection improperly or standing, lying, playing, or working in a roadway. The other human-related risk factors include driving too fast or too fast to be able to safely stop; distracted driving; driving while intoxicated; disobeying traffic signs/signals; reckless driving; and careless driving.[4,5] However, unlike occupants in cars and other heavy vehicles, these road users are directly exposed to traffic environments and are thus unprotected. They come in direct contact with the impacting vehicle in the event of a crash.[3] The energy transfer is high in both high and low velocity crashes resulting in serious injuries and even deaths.[3] National data indicate that most of these incidents occur after sundown. Low vision and alcohol consumption by either the driver or the pedestrian or both, are two of many possible explanations for this finding.[4] Another intrinsic cause is a lack of understanding regarding road etiquette in our country, where it is not an uncommon sight to find people crossing busy roads illegally and putting themselves and other drivers on the road at risk. Despite the diversity on Indian highways – cars, heavy vehicles, two-wheelers, cyclists and pedestrians competing for space– pavements, motorcycle paths, footpaths, over bridges, pedestrian crossings, traffic signals, road signals, highway patrols, and para-medical teams are also in the short supply.[3,5] Local shops/hawker's stalls facing the roads in Indian cities have now made it even more difficult for pedestrians to walk on the roads safely.[6,7]

Pedestrians, motorized two-wheeler riders, and bicyclists form the major bulk on Indian road users. There is a lacuna of information in the pattern and severity of these victims presenting to the emergency department (ED), especially from India where compliance to traffic rules is minimal. The main objective of this study was to profile these injuries based on the physiological and anatomical severity scoring system determining the magnitude, impact and ED, and hospital outcome. With this study, we hoped to have a better understanding of the patient load on each department involved in a trauma care center and to identify the areas of need.

Methods

Study design

This was a retrospective cross-sectional study on pedestrian-related trauma patients.

Setting

This study was conducted in the ED of Christian Medical College Hospital, Vellore, which is a tertiary health care center. The ED is a 49-bed department and tends to about 75,000 patients per year, including trauma and nontrauma patients.

Participants

All patients with pedestrian injuries over the study period from January 2017 to December 2018 were included in the study. Patients who were brought dead to the ED following trauma and those that had charts with missing data were excluded.

Variables

The charts were reviewed, and the relevant details of history, clinical findings, laboratory investigations including blood alcohol concentration (BAC) and triage priority levels were documented in the study form. Triaging of trauma victims was done by the standard Canadian triage system depending on the hemodynamic status of the patient. Triage Priority I included victims with airway, breathing or circulation compromise or head injury with Glasgow Coma Scale (GCS) ≤8. Triage Priority II included patients with stable airway, breathing and circulation with long bone injuries, dislocations, stable abdomino-thoracic injuries, head injury with GCS 9 or more. Hemodynamically stable patients with minor trauma were triaged as priority 3.

Data source and management

Data were extracted from our hospital's electronic database and documented in a standard abstract datasheet.

Bias

This is a retrospective study, and therefore, we could not control the exposure or outcome assessment and instead relied on others for accurate record keeping.

Details of management

Whether surgical (minor/major) or conservative was noted as were the outcomes of patients from the ED-whether they required admission, were discharged safely, were discharged against medical advice, or succumbed to their injuries.

Outcome variable

Severity of injuries according to the new injury severity score (NISS) and the injury severity score (ISS) was noted. The NISS and ISS are anatomical scoring systems of the severity of trauma. NISS is calculated by the sum of the squares of the Abbreviated Injury Scale (AIS) scores of three

of the patient's most severe injuries irrespective of the body region in which they occur whereas, ISS by the sum of the squares of the highest AIS code in each of the three most severely injured ISS body regions in which they occur.[8] ED and hospital outcomes in the terms of admission, discharged in a stable condition, left against medical advice and mortality were documented separately.

Laboratory test

All patients had relevant radiological tests and routine blood investigations based on the initial primary and secondary surveys. BAC levels were sent as a routine protocol for all these victims. Whole blood was collected into 2-ml BD Vacutainer ® tubes with grey rubber stoppers containing 3-mg sodium fluoride and 6-mg sodium Ethylene-diamine-tetra-acetic acid as additives as per the Clinical and Laboratory Standards Institute standards. The analysis was performed using a Roche Cobas 8000 analyzer (Roche Diagnostics, Mannheim, Germany), based on the alcohol dehydrogenase principle. The inter-assay coefficient of variation was <5% during the study period. The method is highly specific with cross-reactivity of 0.8% for N-propanol and 2.8% for N-butanol at a concentration of 2000 mg/L.

Statistical analysis

All categorical variables were expressed as frequencies and percentages. The data were analysed using Statistical Package for Social Sciences for Windows (SPSS Inc. Released 2007, version 23.0. Armonk, New York, USA). Data were summarized using mean along with standard deviation (SD) for the continuous variables and frequencies along with percentages for dichotomous variables. The Chi-square test was used for the categorical variables and an independent student *t*-test was used for the continuous variables. A bivariate analysis was done to identify the relationship between these variables and the potential determinants.

Ethical considerations

This study was approved by the Institutional Review Board. Before the commencement of the study, approval from the Institutional review board ethical committee was obtained (IRB Min no: 12390 dated 20 November 2019). Patient confidentiality was maintained using unique identifiers and password-protected data entry software with restricted users.

Results

Participants

The ED attended to a total of 143,621 patients during the 2-year study period. The prevalence of trauma was 9.47% (n = 13,604) with pedestrian-related trauma comprising 3.4% (n = 463) [Figure 1].

Descriptive data

The mean age of this cohort was 39 (SD: 22.72) years, with a male predominance of 66.6% patients (n = 309) [Table 1]. According to the physiological status at arrival, patients were categorized into priority I, II, and III. The majority were categorized at ED triage as Priority II, i.e., 279 patients (60.2%), whereas 86 (18.6%) were triaged as Priority I. Most (67.4%: n = 312) patients had not received first aid before reaching our hospital. As expected, most of the incidents happened during the evening hours (5 p. m–12 a. m.). The baseline characteristics are given in Table 1.

Outcome data: Modes of pedestrian injuries

The profile of the injuries included a collision with motor vehicles ranging from motorized 2-wheelers to lorries. Most of the patients (59.6%: n = 276) had collisions with motorized 2-wheelers, followed by 4-wheelers collisions in (18.4%: n = 85) and motorized public 3-wheelers (auto-rickshaw) in (7.1%: n = 33). Details of modes of injury could not be determined in 5 (1.0%) victims [Table 2]. Head injuries were noted in 104 patients: GCS ≤8 in 21.9% (n = 23), GCS 9–13 in 21.0% (n = 21) and GCS 14–15 in 60 (n = 57.1%) patients. NISS of more than or equal to 14 was noted in 64 (13.9%) patients, while ISS of more than or equal to 14 were noted in 35 (7.6%) patients [Table 2]. The anatomical locations of these injuries are depicted in Figure 2.

Outcome data-hospital course and outcome

The ED team was involved in the primary evaluation and management of all the patients, whereas the remaining required interventions (major/minor) were done by various trauma surgical teams. The trauma surgical teams involved in patient care in the ED were orthopedics in 164 cases (35.3%), neurotrauma in 138 (29.7%), pediatric orthopedics in 50 (10.8%), plastic surgery in 44 (9.5%), trauma surgery in 44 (9.5%), hand reconstructive surgery in 25 (5.4%), ENT surgery in 18 (3.9%), dental surgery in 17 (3.7%), pediatric surgery in 18 (3.9%), vascular surgery in 13 (2.8%), as given in Figure 3.

ED disposition was as follows: 58.1% (n = 269) patients were discharged stable from the ED, while 33.7% (n = 156) were admitted with 21.2% (n = 98) requiring major surgical intervention. Details of ED disposition and interventions required are detailed in Table 1. The ED mortality rate was 0.4% (n = 2), while the in-hospital mortality rate was 2.2% (n = 10).

Discussion

Our study showed the prevalence, profile, severity, and outcome of pedestrian-related trauma. India is a developing country with 1.2 billion people, a large proportion of whom travel to work, from work or for work on the roads.[3-10] With the massive rise in dependence on motorized vehicular transport due to urbanization, it is a small wonder that the number of accidents related to them is rising exponentially as well.[11] This is clearly depicted in several recent studies done in our country.[12,13] We did this study to highlight specifically those accidents involving pedestrians, the most vulnerable population on the roads. They made up 3.4% of all the trauma victims who presented to our ED, and it is imperative to note

Table 1: Baseline characteristics, vital signs at presentation, type of injury, anatomical location, emergency department, and hospital outcome

Variables	Frequency				*P*
	Total (*n*=463), *n* (%)	Priority 1 (*n*=86), *n* (%)	Priority 2 (*n*=279), *n* (%)	Priority 3 (*n*=98), *n* (%)	
Gender					
Male	309 (66.6)	60 (12.9)	178 (38.4)	71 (15.3)	0.218
Female	154 (33.4)	26 (5.6)	101 (22.0)	27 (5.8)	-
Time of incidence					
8 am-5 pm	211 (45.6)	38 (8.2)	133 (28.7)	40 (8.6)	0.006
5 pm-12 am	223 (48.2)	43 (9.3)	136 (29.4)	44 (9.5)	-
12 am-8 am	29 (6.3)	5 (1.1)	10 (2.2)	14 (3.0)	-
Time of presentation					
8 am-5 pm	151 (32.6)	28 (6)	91 (19.7)	32 (6.9)	0.015
5 pm-12 am	195 (42.1)	43 (9.3)	116 (25.1)	36 (7.8)	-
12 am-8 am	14 (3)	3 (0.6)	4 (0.9)	7 (1.5)	-
after 24 h	74 (16)	10 (2.2)	52 (11.2)	12 (2.6)	-
after 48 h	29 (6.3)	2 (0.4)	16 (3.5)	11 (2.4)	-
First aid received in other medical center					
Yes	133 (28.7)	32 (6.9)	86 (18.6)	15 (3.2)	<0.001
No	312 (67.4)	43 (9.3)	189 (40.8)	80 (17.3)	-
Not known	18 (3.9)	11 (2.4)	4 (0.9)	3 (0.6)	-
BAC					
≤0.03 (mg/dl)	338 (73.0)	61 (13.2)	246 (53.1)	31 (6.7)	0.032
>0.03 (mg/dl)	24 (5.2)	9 (1.9)	15 (3.2)	0	-
BAC not done	101 (21.8)	16 (3.5)	10 (2.2)	67 (14.5)	-
Vital signs at ED presentation					
SBP <90 mmHg	55 (11.9)	41 (8.8)	14 (3)	0	<0.001
SpO2 <94%	58 (12.5)	46 (9.9)	12 (2.6)	0	<0.001
Tachycardia	157 (33.8)	42 (9.1)	97 (20.9)	18 (3.9)	<0.001
Type of injury					
Laceration	215 (46.4)	52 (11.2)	135 (29.2)	28 (6)	<0.001
Abrasion	179 (38.7)	38 (8.2)	113 (24.4)	29 (6.0)	0.057
Fracture	229 (49.5)	54 (11.7)	148 (32.0)	27 (5.8)	<0.001
Contusion – (head injury)	104 (23.1)	33 (7.3)	58 (12.7)	13 (3)	<0.001
Crush injuries	24 (5.2)	12 (2.6)	12 (2.6)	0	<0.001
Sprain/dislocation	3 (0.7)	1 (0.2)	2 (0.4)	0	0.603
Anatomical location of the injury					
Face and neck	94 (20.3)	17 (3.7)	67 (14.4)	10 (2.2)	0.014
Head and scalp	185 (39.9)	55 (11.9)	118 (25.4)	12 (2.6)	<0.001
Thorax	31 (6.7)	17 (3.7)	13 (2.8)	1 (0.2)	<0.001
Abdomen	21 (4.5)	10 (2.2)	9 (1.9)	2 (0.4)	0.002
Back and spine	27 (5.8)	5 (1.1)	16 (3.4)	6 (1.3)	0.989
Extremities (UL/LL/both)	307 (66.6)	48 (10.4)	183 (39.7)	75 (16.5)	0.007
Intervention required					
Major surgical intervention	98 (21.2)	38 (8.2)	59 (12.7)	1 (0.2)	<0.001
Minor surgical intervention	198 (42.8)	25 (5.4)	129 (27.9)	44 (9.5)	-
Conservative management	167 (36.1)	23 (5)	91 (19.7)	53 (11.4)	-
Emergency department outcome					
Admitted	156 (33.7)	58 (12.5)	96 (20.7)	2 (0.4)	<0.001
Discharged stable from ED	269 (58.1)	16 (3.5)	171 (36.9)	82 (17.7)	-
Died in ED	2 (0.4)	2 (0.4)	0	0	-
LAMA	36 (6)	10 (2.2)	10 (2.2)	16 (3.5)	-
Hospital outcome					
Discharged stable (*n*=156)	146 (93.6)	49 (84.5)	95 (98.9)	2 (100)	<0.001
Died in hospital or LAMA	10 (6.4)	9 (15.2)	1 (1.1)	0	-

ED: Emergency department, BAC: Blood alcohol concentration, SBP: Systolic blood pressure, LAMA: Left against medical advice, UL: Upper, LL: Lower

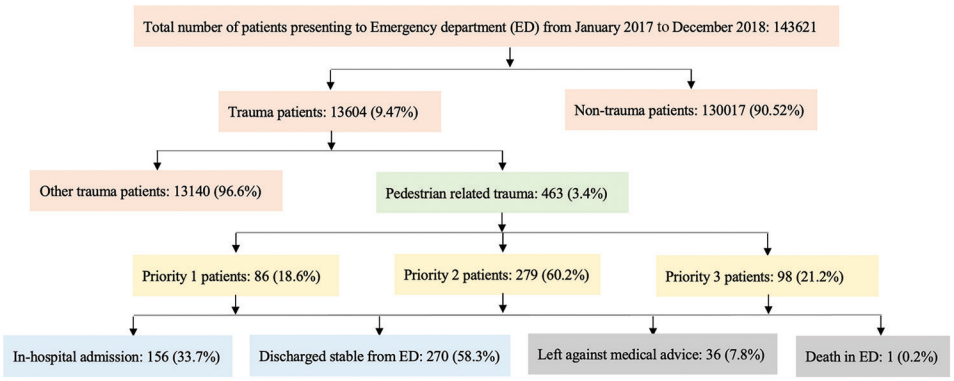

Figure 1: STROBE diagram

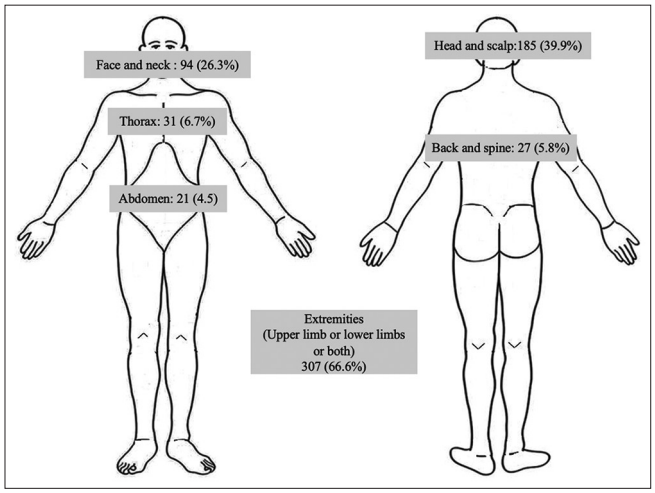

Figure 2: Regions of the body involved

that they are usually the section who present with major grievous injuries. Demographics and age were the crucial factors to consider and unsurprisingly for our social setting, the middle-aged male population were the most affected.

In our country, this population tends to be the one that spends the most time outside of the house and on the roads. This finding was echoed in other similar trauma studies done in this geographical area in the past.[12] Pedestrians were more prone to collide with two wheelers in our study rather than 3 or 4 wheelers, and the justification for this can be put forth in a twofold manner. The first and perhaps the more obvious is that there simply might be a larger number of two wheelers on most Indian roads than any other mode of transport.[5] The second is based on the intuitive assumption that two wheelers are more likely to drive on the edges of roads where pedestrians walk and are therefore more likely to collide with them. The severity of injury based on an anatomical scoring system (ISS and NISS) more than 14 was seen in priority 1 patients as expected. This was mainly because most of the priority 1 patients presented with multiple grievous injuries and required emergent lifesaving resuscitation and or surgery. A study done in China by Hui li *et al*. reported ISS and NISS for prognosticating ICU admission and mortality rate for severe blunt trauma.[14] A study by Smith *et al*. in hospitalized trauma patients showed that NISS could outperform ISS as a predictor of both mortality and complications in civilian penetrating trauma patients.[15] However, ours' is ED-based where trauma victims were evaluated and prognosticated at arrival to the hospital by using these two anatomical scoring systems which have proven accuracy.

As seen in our study, alcohol consumption was a major determinant in pedestrian trauma. However, alcohol levels were not obtained in all patients, either due to their refusal or because a large proportion of them presented to us more than 24 h following trauma. People tend to consume alcohol after dusk. There does seem to be a strong relation regarding a higher number of traumas that occurred in the evening which lends credit to the theory that alcohol may be a cause for this. This association is also seen in previous studies done by us.[4,16]

Despite the Indian health-care system leaving a lot to be desired, most of our patients had received first aid before the presentation. We must be cautiously optimistic of our prehospital care system since a large proportion of them are not well equipped to handle difficult trauma situations and in not doing so, can compromise the precious so-called "golden hour of trauma" where effective interventions could potentially be life-saving. It is important to note that most patients did require admission and further surgical interventions in our hospital. This serves also as a reminder of the necessity of a multi-disciplinary team in managing a trauma patient including emergency physicians and nurses, surgeons, pediatric surgeons, hand surgeons, orthopedic surgeons, neurosurgeons, etc.

Finally, we would be remiss without a mention of the Indian road and traffic system. Lack of infrastructure for pedestrians is undoubtedly one of the biggest reasons for accidents in this group. Proper roads, footpaths, more zebra crossings, and the clever use of signals and streetlights would go a long way toward preventing these incidents. More stringent rules against hawking alongside the side of roads, intelligent road planning, keeping up with the latest technology such as electronic road crossing systems are just a few of the steps in the right direction.[3,12]

Table 2: Triage priority level/mode of injury with object of collision and severity of injury

Variables	Frequency Total (n=463), n (%)	Priority 1 (n=86), n (%)	Priority 2 (n=279), n (%)	Priority 3 (n=98), n (%)	P
Motorized two-wheelers	277 (59.6)	23	164	90	<0.001
Motorized – four-wheelers	85 (18.4)	24	54	7	0.01
Auto rickshaws (motorized – three-wheelers)	33 (7.1)	1	31	1	<0.001
Heavy vehicles – (buses/lorry/van/tractors)	52	30	22	0	<0.001
Others (tripped and fall on level ground/bullock cart)	14	8	6	0	0.600
Unknown	3	0	3	0	0.371
Severity of head injuries: (n=104)					
Glasgow Coma Scale ≤8	23 (21.9)	23 (100)	0	0	<0.001
Glasgow Coma Scale 9-13	21 (21.0)	11 (52.4)	10 (47.6)	0	
Glasgow Coma Scale 14-15	60 (57.1)	10 (16.7)	47 (78.3)	3 (5.0)	
NISS (n=463)					
Mean NISS (SD)	6.72 (6.74)	11.67 (8.73)	6.83 (5.90)	2.05 (2.36)	<0.001
NISS <14	399 (86.1)	56 (14.1)	245 (61.4)	98 (24.6)	<0.001
NISS ≥14	64 (13.9)	30 (46.9)	34 (53.1)	0	
ISS (n=463)					
Mean ISS (SD)	5.28 (5.55)	9.58 (8.04)	5.18 (4.94)	1.80 (1.95)	<0.001
ISS <14	428 (92.4)	66 (15.4)	264 (61.7)	98 (22.9)	<0.001
ISS ≥14	35 (7.6)	20 (57.2)	15 (42.8)	0	

NISS: New injury severity score, ISS: Injury severity score, SD: Standard deviation

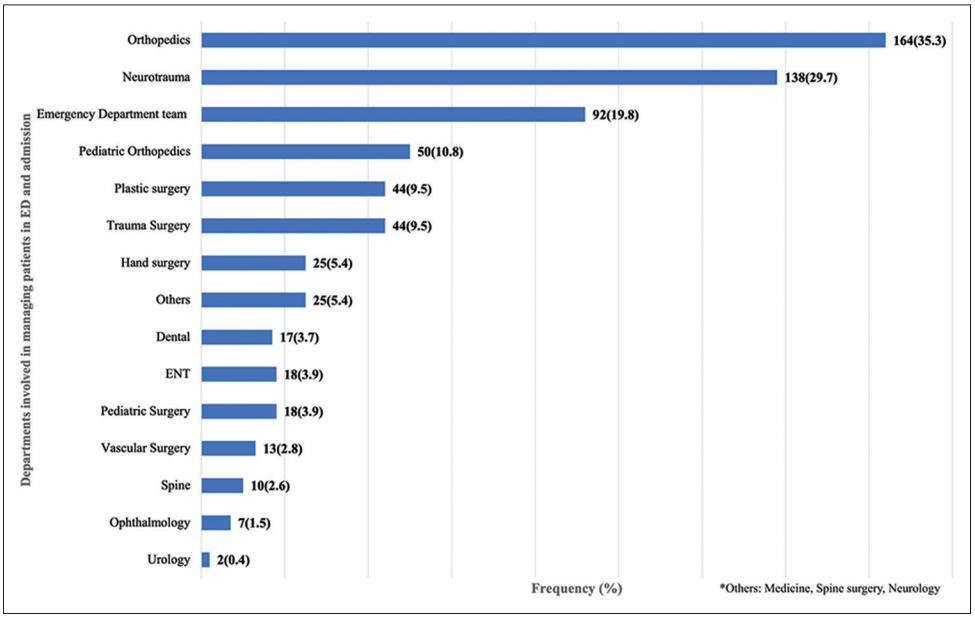

Figure 3: Departments involved in managing patients in emergency department and admission

Conclusion

The geographic location of the incident from a designated health-care center with trained ED physicians, staff and multi-specialty trauma team are crucial in successfully managing these victims. Future research and implementation of strategic education and technological programs can reduce the risk exposure to those at risk. Our study showed that middle-aged males were the leading demographic affected by most events taking place in the evening. One-tenth of the incidents happened under the influence of alcohol. Extremities were the most injured body part with a significant number of victims having grievous injuries requiring hospital admission.

Research quality and ethics statement

The authors of this manuscript declare that this scientific work complies with reporting quality, formatting and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was determined to require Institutional Review Board/Ethics Committee review, and the corresponding protocol/approval number is (IRB Min no: IRB Min no: 12390 dated 20 November 2019). We

also certify that we have not plagiarized the contents in this submission and have done a Plagiarism Check.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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