Epidemiology of trauma victims admitted to a level 2 trauma center of North India

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ABSTRACT

Background: Good quality information on characteristics of victims, types, and frequency of injuries, causes of accidents, vehicles involved in injury and outcome is essential for understanding and planning required for managing the trauma epidemic. The objective of this study was to describe the characteristics of trauma victims admitted to King George’s Medical University trauma center.

Methods: This observational study enrolled trauma victims over a 1-year period. Characteristics recorded were age, sex, systolic blood pressure at admission, respiratory rate at admission, Glasgow Coma Scale (GCS) score at the time of admission, time since injury to admission, referral, specific injury, Injury Severity Score (ISS), chronic medical condition, mechanism of injury, and the regions involved. Outcome at the end of hospital stay was recorded.

Results: A total of 3280 injuries were recorded in 2288 patients. Mean age 40.81 ± 16.3 years, predominantly male (83.57%), mean ISS 12.56 ± 7.3, mean GCS 12.20 ± 4.1. Mean time to admission (hospitalization) to trauma center was 54.22 ± 185.2 h. Head was the most commonly involved region (32.44%). Patients referred from peripheral hospitals had significantly lower GCS, higher time to admission to trauma center, and longer duration of hospital stay. Road traffic accidents were responsible for 1514 (66.40%) injuries. Five hundred and ten (22.37%) patients sustained injury due to a fall. Three hundred and ninety (68.59%) patients were discharged, 67 (11.69%) left the hospital against medical advice, 8 absconded from the trauma center, and 104 expired within the hospital.

Conclusion: Traumatic brain injuries and orthopedic injuries constitute a majority of injured admitted to the trauma center. Motorcycle collision with other vehicles and pedestrian hits by other vehicles are the most common causes of traumatic brain injuries. In contrast to west, the most common cause of spinal cord injury was falls. Pedestrians, bicyclists, and motorcyclists are the vulnerable road users. Long time to admission is an alarming finding.

Key Words: Characteristics, collision, epidemiology, injury, motorcycle, trauma

INTRODUCTION

Injury-related information is collected, compiled, analyzed, and disseminated by the National Crime Records Bureau under the ministry of home affairs, Government of India. It uses police records as its source of data. A vast number of injuries do not report
to the police as reporting nonmedicolegal injuries is not required by law. Another loop hole is that a lot of accident victims do not report the injury to the police if the matter is solved amicably between the victim and the perpetrator of the accident. Another problem with police records is that it is collected by individuals not trained to collect trauma-related data for the purpose of research. Other sources of information on injuries are hospital records which again are collected by people not trained to do research in trauma. Good quality information on characteristics of victims, types, and frequency of injuries, causes of accidents, vehicles involved in injury and outcome is essential for understanding and planning required to manage the trauma epidemic. Information on each of these is available in fragments from multiple agencies that deal with them. Research in trauma requires surveillance; creation of trauma registries and a dedicated pool of professionals trained to collect, analyze, and report data.

The objective of this study was to describe the characteristics of trauma victims admitted to the trauma center and thereby create baseline data for future use.

**METHODS**

This observational study was conducted at the King George’s Medical University (KGMU) trauma center after obtaining permission from the Institutional ethics board of KGMU. Keeping in mind, the possibility of patients admitted on different days of the week being different, all patients admitted on one randomly selected day of the week (including Sunday) were enrolled in the study. Since seasons may affect the nature of patients, it was decided to collect data for 1 year. A questionnaire was prepared, in which item analysis for inter- and intra-observer error done. The same was used for data collection.

Characteristics recorded were age, sex, systolic blood pressure (BP) at admission, respiratory rate at admission, Glasgow Coma Scale (GCS) score at the time of admission, coagulopathy at admission, time since injury to admission (hospitalization) to trauma center, referral from other center, specific injury (abbreviated injury scale), injury severity (Injury Severity Score [ISS]), and mechanism of injury. Information about common preexisting chronic conditions (ischemic heart disease, hypertension, diabetes mellitus, liver disease, malignancy, renal disease) was also collected. Injured region was also recorded. Since many trauma patients suffer from more than injury, regions involved were recorded as head injury associated with other injuries (neuropoly) and orthopedic injuries with other injuries (orthopoly). All other multiple injury patients not fitting in neuropoly and orthopoly were grouped together as polytrauma. These groups were created keeping in mind that about 80% of injuries reporting to trauma center are either orthopedic or neurological injuries. Outcome at the end of hospital stay was recorded as discharged, expired, left against medical advice, and absconded. Since a number of patients leave hospital against medical advice (LAMA) or abscond, it was decided to follow them up for 1 year to report the outcome regarding mortality.

**Statistical analysis**

Data were collected using Microsoft Excel. Analysis was done using Stata.

**RESULTS**

Number of patients included was 2288. Of these, 1308 (57.16%) were referred from other hospitals and 980 (42.84%) were direct admissions to the trauma center. GCS score could not be recorded in 140 (6.11%) patients due to the presence of paralysis, quadriplegia (104 patients), or injury to maxillofacial region (36 patients) while data on ISS could not be recorded in 8 (0.35%) patients. Mean age 40.81 ± 16.3 years (median 38), predominantly male (83.57%), mean ISS 12.56 ± 7.3 (median 9), mean GCS 12.20 ± 4.1 (median 15). Of the 2148 patients whose GCS could be recorded, 528 (23.07%) had a score in the range 3–8; 204 (8.9%) had a score in the range 9–12; and 1416 (61.88%) had a score range 13–15. Mean time to admission (hospitalization) to the trauma center was 54.22 ± 185.2 h. About 26% (25.69%) patients required blood transfusion. Average number of transfusion required was 2.34 ± 1.6 for these five hundred and eighty-eight patients (25.69%). Five hundred and sixty-nine died (24.96%; 9 due to unrelated causes) during 1-year follow-up [Table 1].

A total of 3280 injuries were recorded in 2288 patients. Orthopedic and neurological injuries constituted a vast majority of these injuries [Table 2], Head was the most commonly involved region (1064/3280 i.e., 32.44%). Common injuries to head region included cerebral contusions, intracranial hematoma, vault fractures, and cerebral edema. Lower extremity injuries were the 2nd most frequent (n = 972/3280 i.e. 29.63%). Upper extremity injuries (n = 380) constituted 11.59% of all injuries. Common fractures of the upper extremity were fracture of the distal radius, fracture both bone forearm, and fracture shaft humerus. Spinal injuries were 6.46% (n = 212), chest injuries were 3.17% (n = 104), and abdominal injuries were 1.71% (n = 56). Most common injury reported was contusion of the brain (n = 448; 13.66% of injuries). Common fractures of lower extremity were both bone leg (n = 272; 8.29%), fracture shaft of femur (n = 120; 3.66%), intertrochanteric fracture (n = 96; 2.93%), and fracture neck of femur (n = 56; 1.71%). Common dislocations of lower extremity were central fracture dislocation of hip and posterior dislocation...
of hip. Of the 844 fractures in lower extremity, 248 were compound fractures (248/844 i.e. 29.38%). Of the ninety-six pelvic injuries, 76 (79.1%) were stable and 20 (19.1%) were unstable. There were 60 facial fractures. Cervical spine was the most commonly involved region of the spine.

Patients referred from peripheral hospitals had significantly lower GCS (mean 11.87 ± 4.2 vs. 12.66 ± 3.9; \( P = 0.0296 \)), higher time to admission to trauma center (mean 78.02 ± 235.0 h vs. 22.44 ± 68.8/5 h; \( P < 0.0001 \)), and longer duration of hospital stay (mean 10.89 ± 12.3 9.25 ± 13.3/6; \( P = 0.013 \)). Mean time to admission to referral center after sustaining injury was 12.65 ± 36.5 h. ISS was not significantly different in two groups (mean 13.08 ± 7.4 vs. 11.87 ± 7.2; \( P = 0.06 \)). Patients referred from peripheral hospitals had a higher proportion of hypotensive (systolic BP < 100 mmHg) patients (16.82% in referred group and 11.43% in directly admitted group) at admission, a greater proportion of head injuries (45.26% in referred group and 39.60% in directly admitted group), and higher proportion of female patients (18.96% in the referred group and 13.6% in the directly admitted group), but the differences were not statistically significant. One-year mortality since the time of injury was 27% in the referred group and 22% in the directly admitted group, the difference being statistically insignificant.

One thousand five hundred and fourteen (66.40) sustained injuries due to a road traffic accident (RTA). Five hundred and ten (22.37%) patients sustained injury due to a fall, of which 277 (54.31%) were fall from less than body height, 209 (40.98%) were fall from more than body height, and 24 (4.71%) were fall from a moving train. Three hundred and ninety-three injured (17.24% of 2280) sustained an injury on being hit by a speeding vehicle, of which 309 (78.63%) were pedestrians and 84 were cyclists (21.37%). Two hundred and sixty-five injured (11.62%) sustained an injury due to skid of the two-wheeler, of which 233 (87.92%) were due to a motorcycle skid and 32 (12.08%) due to a bicycle skid. Seventy-six were injured when they slipped from the motorcycle while sitting with legs on same side. All of these were females. Six hundred and forty-eight (28.42%) injured sustained injury due to a collision, of which 504 (77.78%) were due to motorcycle colliding with some other vehicle. Table 3

Table 4 summarizes the most common causes for resulting trauma pattern. The common causes of head injury in decreasing order of frequency were motorcycle collision, pedestrian hit, motorcycle skid, pillion slipping from the motorcycle, and assault. The common causes of orthopedic injury in decreasing order of frequency were fall less than body height, motorcycle collision, motorcycle skid, pedestrian hits, and fall more than body height. The most common cause of spine injuries was fall from more than body height. Common causes of “orthopoly trauma” in decreasing order of frequency were motorcycle collision, pedestrian hits, motorcycle skid, fall more than body height, and heavy motor vehicle (HMV)-HMV collision [Table 4].

One thousand five hundred and sixty-three (68.54%) patients were discharged, 269 (11.78%) left the hospital against medical advice, 32 (1.41%) absconded from the trauma center, and 416 (18.28%) expired with in the hospital [Table 5]. Forty patients died after being discharged from the hospital, 96 of the 269 (35.82%) LAMA patients also expired, and two of the absconded patients died later.

**DISCUSSION**

Our study confirms the finding of other studies that traumatic brain injuries and orthopedic injuries constitute a majority of injured admitted to trauma centers.[3,4]
Table 2: Injuries (n = 3280) recorded in 2288 patients

| Region                  | Type of injury                  | n (%)          | Comment                                                                 |
|-------------------------|---------------------------------|----------------|-------------------------------------------------------------------------|
| Head injury             | Contusion                       | 448 (13.66)    | 93 were single and 19 multiple                                          |
| (n = 246)               | Vault fractures                 | 192 (5.85)     | 26 were simple and 22 compound                                          |
|                         | Cerebral edema                  | 148 (4.51)     |                                                                          |
|                         | Extradural hemorrhage           | 124 (3.78)     | 30 were single and 1 multiple                                           |
|                         | Subdural hemorrhage             | 76 (2.32)      |                                                                          |
|                         | Subarachnoid hemorrhage         | 32 (0.98)      |                                                                          |
|                         | Intraventricular bleed          | 16 (0.49)      |                                                                          |
|                         | Diffuse axonal injury           | 12 (0.37)      |                                                                          |
|                         | Intracerebral/intracerebellar   | 12 (0.37)      | 2 were intracerebral and 1 intracerebellar                             |
|                         | Fractures of the base of the skull | 4 (0.12)    |                                                                          |
| Lower extremity injuries| Fractures of lower extremity (n = 211; 85.08%) | 272 (8.29) | 34 were simple and 34 compound                                          |
|                         | Fracture both bone leg          | 120 (3.66)     | 24 were simple and 6 compound                                            |
|                         | Intertrochanteric fracture femur | 96 (2.93)     |                                                                          |
|                         | Fracture neck of femur          | 56 (1.71)      |                                                                          |
|                         | Fracture supracondylar femur    | 52 (1.59)      | 8 were simple and 5 compound                                             |
|                         | Fracture shaft tibia            | 52 (1.59)      | 9 were simple and 4 compound                                             |
|                         | Fracture upper end tibia        | 44 (1.34)      | 10 intercondylar and 1 lateral condyle, 6 were simple and 5 compound    |
|                         | Fracture patella                | 40 (1.22)      | 8 were simple and 2 compound                                             |
|                         | Pott’s fracture                 | 36 (1.10)      | 7 were simple and 2 compound                                             |
|                         | Metatarsal fracture             | 28 (0.85)      | 6 were simple and 1 compound                                             |
|                         | Subtrochanteric fracture femur  | 16 (0.49)      |                                                                          |
|                         | Fracture shaft/head fibula      | 16 (0.49)      | Shaft (3), head (1)                                                     |
|                         | Fracture greater trochanter     | 8 (0.24)       |                                                                          |
|                         | Fracture lower end tibia        | 4 (0.12)       |                                                                          |
|                         | Fracture calcaneum              | 4 (0.12)       |                                                                          |
|                         | Dislocations (n = 11; 4.4%)     | 44 (1.34)      | Hip (4), CFD (5), knee (1), interphalangeal (1)                          |
|                         | Crush injury (n = 11; 4.4%)     | 44 (1.34)      | Leg (4), foot (5), knee (1), ankle (1)                                  |
|                         | Amputations (n = 7; 2.84%)      | 28 (0.85)      | Below knee (5), above knee (1), midtarsal (1)                           |
|                         | Degloving injuries (n = 2; 0.8%)| 8 (0.24)       | Thigh (1), leg (1)                                                      |
|                         | Nerve injury (n = 1; 0.40%)     | 4 (0.12)       | Common peroneal nerve (1)                                               |
| Upper extremity injuries| Fractures of upper extremity (n = 82) | 24 (0.73) | Neck (3), body (3)                                                      |
|                         | Fracture scapula                | 80 (2.44)      | 19 were simple and 1 compound                                            |
|                         | Fracture lower end radius       | 64 (1.95)      | 12 were simple and 4 compound                                            |
|                         | Fracture both bone forearm      | 64 (1.95)      | 13 were simple and 3 compound                                            |
|                         | Fracture shaft humerus          | 44 (1.34)      |                                                                          |
|                         | Fracture clavicle               | 12 (0.37)      |                                                                          |
|                         | Fracture radial head or neck/capitulum | 12 (0.37) | Radial head (1), radial neck (1), capitulum (1)                          |
|                         | Montaggia fracture dislocation  | 12 (0.37)      | 2 were simple and 1 compound                                             |
|                         | Fracture styloid process radius/ulna | 8 (0.24) | Radius (1), ulna (1)                                                    |
|                         | Number of medial condyle humerus| 4 (0.12)       |                                                                          |
|                         | Number of inter condylar humerus| 4 (0.12)       |                                                                          |
|                         | Neurovascular involvement       | 24 (0.73)      | Brachial plexus (4), PIN (1), radial artery (1)                          |
|                         | Crush injuries                  | 20 (0.61)      | Hand (3), wrist (1), forearm (1)                                        |
|                         | Amputations                     | 8 (0.24)       | Below elbow (1), metacarpophalangeal dislocation (1)                    |
|                         | Pelvic injuries (n = 24; 2.98%)  | 96 (2.93)      | 19 were stable and 5 unstable                                            |
|                         | Facial fractures (n = 15; 1.86%) | 60 (1.83)     | Maxillary (7), zygoma (4), mandible (3), nasal (1)                      |
|                         | Chest injuries (n = 26; 3.09%)  | 36 (1.10)      |                                                                          |
|                         | Hemothorax with fracture of ribs| 28 (0.85)      |                                                                          |
|                         | Multiple rib fractures          | 16 (0.49)      |                                                                          |
|                         | Lung contusion                  | 8 (0.24)       |                                                                          |
|                         | Flail chest                     | 12 (0.37)      |                                                                          |
|                         | Pneumothorax                    | 4 (0.12)       |                                                                          |
|                         | Spinal injuries (n = 53; 6.1%)  | 128 (3.90)     | 26 were with neurological deficit and 6 without                         |
|                         | Dorsal spine                    | 40 (1.22)      | 9 were with neurological deficit and 1 without                          |
|                         | Lumbar spine                    | 44 (1.34)      | 9 were with neurological deficit and 2 without                          |
|                         | Abdominal injuries (n = 14; 1.8%) | 36 (6.46) | Stomach (2), jejunum (5), urinary bladder (1), rectal (1)              |
|                         | Perforation                     | 12 (1.10)      | Liver (1), spleen (1), kidney (1)                                       |
|                         | Mesenteric tear                 | 4 (0.12)       |                                                                          |
|                         | Urethral injury                 | 4 (0.12)       |                                                                          |
|                         | External injuries               | 336 (10.24)    |                                                                          |

CFS: Congenital femoral deficiency; PIN: Posterior interosseous neuropathy

Traumatic brain injury is known to have poor long-term outcome in terms of mortality as well as morbidity. A majority of patients that died after leaving the hospital in our study were traumatic brain injury patients and this could be because of the long-term effects of traumatic brain injury. However, we are unable to confirm this on
the basis of the results of our study. Another study that investigates this long-term mortality after patients leave the hospital will be able to throw better light on the causes and methods to prevent this long-term mortality.

We confirm the findings of other studies that motorcycle collision with other vehicles and pedestrian hits by other vehicles are the most common causes of traumatic brain injuries.[5] An interesting mechanism of injury for traumatic brain reported by us is pillow slipping from the motorcycle. All of these were women. In India, women pillow riders on motorcycles sit with both the legs on the same side. This habit combined with bad roads explains the mechanism of injury as well as predilection of women for this particular mechanism of injury.

In our study, the most common cause of spinal cord injury was falls, while RTA involving pedestrians being hit by speeding vehicles was the second most common cause of spinal injury. This is in contrast to results reported in studies from developed countries where RTA has been incriminated as the most common cause of spinal cord injury.[7] Different behavior patterns in different populations can affect the spinal cord injury etiology.[8] In India, lack of parapet on roads combined with darkness due to lack of electricity supply in many rural areas makes people sleeping on roof liable to falls during night. Improvement in designs of houses making parapets compulsory can prevent falls.

An alarming finding in our study is a very long time to admission to trauma center or the referral hospital. Mortality in trauma patients is known to follow a trimodal distribution with the 1st week with in seconds to minutes, second phase within hours, and the third phase within days to months.[9] Mortality during different phases of mortality is known to be decreased by phase-specific interventions. For the first phase, the interventions are primary prevention; during the 2nd phase, the interventions include better transport facilities and care during transport; during the 3rd phase, the interventions include better care in the hospital.[9] Long time to admission to trauma center as well as referral centers raises the possibility that our existing emergency medical response system is not responding to the second phase of mortality. Only 49 patients were brought to the trauma center using ambulances, and therefore, the reason for this delay could be unavailability of ambulances. However, we are unable to comment on factors that determined his choice of vehicle for transport as many other factors may be responsible for the choice other than availability.

A vast majority of road users in India are pedestrians, bicyclists, and motorcyclists. Unlike users of light

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Table 3: The mechanism of injury

| Mechanism of injury | Total, n (%) | Expiry, n (%) |
|---------------------|-------------|--------------|
| Hit by a speeding vehicle (n = 465; 20.39%) |
| *Pedestrian hit by a speeding motor cycle | 161 (7.06); 36 (22.38%) |
| Pedestrian hit by some other vehicle | 148 (6.49); 76 (51.35%) |
| *Cycle hit by a speeding motor cycle | 84 (3.68); 20 (23.81%) |
| Cycle hit by some other speeding vehicle | 72 (3.16); 44 (61.11%) |
| Two wheeler skid (n = 266; 11.62%) |
| Bicycle skid | 32 (1.40); 4 (12.50%) |
| *Motorcycle skid | 233 (10.22); 40 (17.17%) |
| *Pillion slipped from a moving motorcycle | 76 (3.33); 36 (47.37%) |
| Collision (n = 648; 28.42%) |
| *Motorcycle involved in collision with a moving vehicle | 504 (22.11); 108 (21.43%) |
| LMV-HMV | 56 (2.46); 4 (7.14%) |
| LMV-LMV | 48 (2.11); 0 |
| HMV-HMV | 40 (1.75); 0 |
| LMV overturned (n = 60) | 60 (2.63); 16 (26.67%) |
| Falls (n = 510; 22.37%) |
| Fall < body height | 277 (12.15); 24 (8.66%) |
| Fall > body height | 209 (9.17); 92 (44.02%) |
| Fall from train | 24 (1.05); 4 (16.67%) |
| Assault | 92 (4.04); 16 (17.39%) |
| Gunshot | 56 (2.46); 20 (35.71%) |
| Stuck by falling object | 56 (2.46); 12 (21.43%) |
| Machine injuries | 52 (2.28); 8 (15.38%) |

*Indicates involvement of a motorcycle in the accident in some capacity.

LMV: Light motor vehicle, HMV: Heavy motor vehicle

Table 4: Mechanism of injury for common trauma patterns

| Region       | Top five mechanism of injury                                                                 |
|--------------|---------------------------------------------------------------------------------------------|
| Spine        | Fall more than body height (n = 66; 40.35%)                                                  |
|              | Pedestrian hit by speeding vehicle (n = 29; 17.54%)                                           |
|              | Fall less than body height (n = 17; 10.53%)                                                   |
| Neuropoly    | Motorcycle collision with some other vehicle (n = 100; 40.32%)                                |
|              | Pedestrian hit by speeding vehicle (n = 40; 16.13%)                                           |
| Neuro        | Motorcycle collision with some other vehicle (n = 185; 25.27%)                               |
|              | Pedestrian hit by speeding vehicle (n = 105; 14.29%)                                          |
| Ortho        | Fall less than body height (n = 184; 26.09%)                                                  |
|              | Motorcycle collision with some other vehicle (n = 97; 13.71%)                                 |
| Orthopoly    | Motorcycle collision with some other vehicle (n = 48; 27.91%)                                 |
|              | Pedestrian hit by speeding vehicle (n = 38; 20.93%)                                           |
| Other        | Motorcycle collision with some other vehicle (n = 41; 25.64%)                                 |

LMV-HMV: Light motor vehicle-heavy motor vehicle
motor vehicles and HMVs, these are exposed to traffic environment and are thus unprotected in the event of a crash. In the event of a crash, they come in direct contact with the impacting vehicle and the energy transfer is high resulting in serious injuries and death.\[10\] Results of our study confirm the findings of other studies that have reported a high proportion of deaths in these groups of injured.\[11,12\] These groups constituted a majority among those admitted to the trauma center of KGMU. Thus, measures taken to protect these groups will result in decreasing the number of admissions and consequent mortality due to trauma.

Previous studies done at the trauma center have also reported a lack of difference in mortality in the directly admitted and referred groups.\[13\] However, Sampalis et al.\[14\] have reported that direct transport to a tertiary care center lowers mortality among major trauma victims, but this could be done after introducing a system of effective prehospital care, an organized system of triage, referral, and transport. We have reported a lack of significant difference in the referred and directly admitted groups. This can be explained on the basis of low number of patient groups for which direct transport to tertiary care center lowers mortality, i.e., patients with time critical injuries (such as intracranial hematoma) and major trauma victims. Another reason for this lack of difference as reported by us could be due to lack of a system of effective prehospital care, an organized system of triage, referral, and transport.

## CONCLUSION

Traumatic brain injuries and orthopaedic injuries constitute a majority of injured admitted to the trauma center. Long term effects of traumatic brain injury could be the cause of post discharge mortality in cases of traumatic brain injury. Motorcycle collision with other vehicles and pedestrian hits by other vehicles are the most commonest causes of traumatic brain injuries. In contrast to west, the most common cause of spinal cord injury was falls. Pedestrians, bicyclists, and motorcyclists are the vulnerable road users. Long time to admission to trauma center as well as referral center as reported by us raises the possibility that our existing emergency medical response system does not cater to the second phase of mortality. Lack of significant difference in mortality of the referred and directly admitted groups as reported by us could be due to low number of patients for which direct transport to tertiary care center lowers mortality or it could be due to lack of a system of effective prehospital care, an organized system of triage, referral, and transport.

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### Conflicts of interest
There are no conflicts of interest.

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